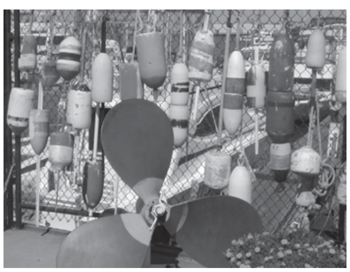



2004 Massachusetts Bays Symposium




Proceedings

A regional symposium hosted by
The Massachusetts Bays Program

Boston, Massachusetts
May 6 and 7, 2004

Commonwealth of Massachusetts
Mitt Romney, Governor
Kerry Healey, Lieutenant Governor

Executive Office of Environmental Affairs
Ellen Roy Herzfelder, Secretary

Massachusetts Office of Coastal Zone Management
Susan Snow-Cotter, Director

The Massachusetts Bays Program

251 Causeway Street, Suite 800
Boston, MA 02114
(617) 626-1230
www.massbays.org

Jan Smith, Executive Director

The Massachusetts Bays Program is a cooperative venture of the Massachusetts Executive Office of Environmental Affairs/Coastal Zone Management and the U.S. Environmental Protection Agency.

This project is funded by the Massachusetts Environmental Trust.

Printed on Recycled Paper

This information is available in alternate formats upon request.

About the Massachusetts Bays Program

The Massachusetts Bays Program is a partnership of citizens, communities, and government that strives to protect and enhance the coastal health and heritage of Massachusetts and Cape Cod Bays.

The Massachusetts Bays Program (MBP) was launched in 1988 to address the mounting threats to the health of Massachusetts and Cape Cod Bays. In 1990, the U.S. Environmental Protection Agency (EPA) accepted the MBP into the National Estuary Program, which was established to identify nationally significant estuaries threatened by pollution, development, or overuse, and to promote the preparation of comprehensive management plans to ensure their health. The MBP developed a Comprehensive Conservation and Management Plan (CCMP) for the Bays region with the help of nearly 300 individuals representing a wide array of private, government, and community interests. This large network of partners, called the Management Conference, directs and implements the MBP. The final CCMP, published in 1996 and revised in 2003, is a blueprint for coordinated management and protection of the Bays' resources. It features 17 action plans containing 87 specific actions for preventing pollution, preserving habitat, and restoring the Bays' degraded resources.

To ensure that each of the MBP's 50 communities receives its share of attention, the Program partners with watershed associations and Regional Planning Agencies to provide regional coordinators in five subregions: Upper North Shore, Salem Sound, Metro Boston, South Shore and Cape Cod. This unique structure enables MBP staff to identify and solve environmental problems that require a local focus. Thanks to this effective and efficient partnership, the MBP leverages significant funding to conduct a wide variety of local and regional projects benefiting the Bays, from coordinating volunteers to help monitor the success of wetland restoration projects to helping local officials reduce land use impacts on their community's coastal resources.

ACKNOWLEDGEMENTS

The Massachusetts Bays Program would like to thank the following organizations, agencies, and people:

The Massachusetts Environmental Trust for its generous support in funding the printing of this proceedings document as well as the accompanying *State of the Bays Report 2004*.

The Massachusetts Office of Coastal Zone Management, U.S. Environmental Protection Agency, Battelle, and Salem Sound Coastwatch for their generous financial and staff support.

All of the speakers who presented their important work at the conference.

The Federal Reserve Bank of Boston for the use of its wonderful facility.

Final report compilation by Peter Hanlon, Christian Krahforst, and Jan Smith (Massachusetts Bays Program)

Cover photos:

Top Row (from left to right): Shannon Weigle; Peter Hanlon; Ben Fertig; NOAA Photo Library

Bottom Row (from left to right): Ben Fertig; Ben Fertig; MBP Archives; Ben Fertig

Massachusetts Bays Symposium logo designed by Arden Miller

CONTENTS

Massachusetts Bays Symposium 2004

Day One

May 6, 2004

CONTENTS

Massachusetts Bays Symposium 2004

Day Two

May 7, 2004

On May 6 and 7, 2004, the Massachusetts Bays National Estuary Program convened the first Massachusetts Bays Symposium since 1994. The symposium brought together experts from throughout the region to describe the current condition of the Massachusetts and Cape Cod Bays, to review progress made in protecting and restoring the Bays over the past ten years, and to strengthen scientific partnerships. Scientists, resource managers, and policy experts from numerous universities and government and nonprofit organizations participated in the two-day event along with over 100 attendees.

Day One

May 6, 2004

Introduction

Jan Smith, Executive Director
Massachusetts Bays Program

Ellen Roy Herzfelder, Secretary,
Massachusetts Executive Office of Environmental Affairs

Ira Leighton, Deputy Administrator,
U.S. Environmental Protection Agency, Region I

The workshop began with a welcome and introduction by Mr. Jan Smith, Executive Director of the Massachusetts Bays Program (MBP). Mr. Smith provided a brief statement about the National Estuary Program (NEP) and Massachusetts Bays in the role of the NEP. The Massachusetts Bays joined the NEP in 1990 and developed a Comprehensive Conservation and Management Plan (CCMP) in 1996. The CCMP serves as a blueprint for the protection and restoration of Massachusetts and Cape Cod Bays. Nearly a decade has passed since the last symposium was held and MBP is looking forward to the valuable outcome that will further help protect the health and resources of Massachusetts Bays.

Mr. Smith stated that the goals of the current workshop included 1) Providing a summary of the current state of the Massachusetts Bays; 2) Determining the next steps needed to support the future of the Massachusetts Bays; and 3) Beginning to develop a plan to coordinate and integrate efforts. He also introduced the new Massachusetts Bays Estuary Association; a non-profit organization that is supporting the Massachusetts Bays Program. Opening statements were given by Secretary Ellen Roy Herzfelder, Massachusetts Executive Office of Environmental Affairs (EOEA) and Ira Leighton, Deputy Administrator of the EPA New England Region.

Secretary Herzfelder stated that Massachusetts is 45th in size in the nation and that 50 percent of the population of Massachusetts lives within the coastal zone. With such a large population living within the coastal zone, human activities are directly affecting the coast and ocean. Secretary Herzfelder reported that Massachusetts Governor, Mitt Romney is looking at the leadership role that Massachusetts could play in environmental and economic growth and has a crucial role in the stewardship of coastlines and bays. There are many programs that are working towards the goal of Massachusetts sustaining environmental and economic growth. One such program is the Boston Harbor Cleanup Project. Due to a huge effort of this project, the Charles River is now fishable and swimmable and she emphasized that it is important to build on this success. Several groups have been formed to help continue this success, such as the Ocean Management Task Force, the Bays Initiative, and the Water Quality Initiative. The Bays Initiative has put the spot light on Bay issues and created new legislation for business that want to create new developments. In addition to the Bays Initiative, the Water Quality Initiative has also brought focus on Bay issues by concentrating on the quantity and quality of water and stormwater related issues.

Mr. Leighton noted that the challenge and theme of managing the Massachusetts and Cape Cod Bays is dealing with the competing use of resources. For example, the development of gas pipelines and the creation of reefs. The Massachusetts Bays are widely used for human activity while also supporting the local economy; it brings in $1.5 billion in travel and tourism and supports 81,000 jobs. Mr. Leighton acknowledged that there are many efforts that are working towards managing the Massachusetts Bays' resources. One example of this successful management is the Boston Harbor cleanup, which is a tremendous effort that is incorporating several issues into the project, such as: stormwater and combined sewer overflows (CSO) management issues, cleaner marine engines, a regional clean marina initiative, clean beach initiatives, advancing the pace of the National Pollution Discharge Elimination System (NPDES) permits, and wastewater plant upgrades. He also discussed the National Coastal Condition and PEW Report which assessed the national coastal condition and reported that 31 percent of the coast and 41 percent of aquatic life are impaired by human use, and shellfish contamination and closings must be reduced. There has been $4 million invested into the Massachusetts Bays so far, and a half million dollars is going to be invested this year alone. Another topic Mr. Leighton discussed was that there has been $1.1 million spent on monitoring for the Beach Initiative in New England. One benefit of the Beach Initiative is that results of the beach monitoring are to be reported to the public in a timely manner. This information will help to educate the public with knowledge of their local beaches. However, there are still too many beach closures and it is important to demonstrate the successful beaches. One type of effort would be to showcase flagship beaches to help support the Beach Initiative.

After these opening statements, the Massachusetts Bays Program introduced the 2004 State of the Bays report. The report discusses 14 questions related to changes in the past ten years plus major efforts highlighted in focus studies. The questions and focus studies that are discussed in the 2004 State of the Bays report are the main topics for sessions presented at the Symposium. The presentation sessions on Day One were Offshore and Land Use followed by a Management Panel and Discussion on linking the management of offshore water with land use. On Day Two the presentation sessions were focused on Estuaries followed by a Management Panel and Discussion on emerging issues.

Physical Oceanography of Massachusetts Bay

Christian Krahforst
Massachusetts Bays Program
251 Causeway Street, Suite 800
Boston, MA 02114
(617) 626-1216
christian.krahforst@state.ma.us

Mr. Krahforst opened his presentation stating that a meaningful assessment of the "condition" or "state" of the Massachusetts and Cape Cod Bays requires a good understanding of the processes that affect circulation and mixing in the Bays. This understanding is also paramount for sound management and directing appropriate monitoring. Because Massachusetts Bay is part of the larger Gulf of Maine, much of the conditions that prevail in the Gulf proper are significant to setting the conditions for Massachusetts Bay. The Massachusetts Bays Program initiated the first system-wide description of the mechanisms controlling circulation and mixing in the bays in the early 1990's (Geyer et. al., 1992). Much of the physical oceanographic work that followed augments the key findings of this work, some of which are:

- Strong seasonal stratification in the bays;
- Weak, persistent counter-clockwise flow within the Bays;
- Flushing or water residence time is largely the result of mean through flow of northern water from the Gulf of Maine.

Efforts to better understand the functionality of the Bays were mostly the result of needs associated with the then-proposed transfer of waste effluent from the confines of Boston Harbor to the new outfall site in western Massachusetts Bay. More recent efforts that link to the broader regional perspective along with a broad overview of the general physical oceanography of Massachusetts Bay were presented.

Offshore

Modelling the Massachusetts Bay System

Dr. Mingshun Jiang
Department of Environmental, Earth and Ocean Sciences,
University of Massachusetts Boston
100 Morrissey Blvd.
Boston, MA 02125
(617) 287-7416
mingshun.jiang@umb.edu

As a semi-enclosed coastal embayment, Massachusetts Bays system is strongly influenced by the atmospheric forcing, anthropogenic inputs and open boundary forcing from the Gulf of Maine. Dr. Jiang presented a brief overview of the previous and on-going efforts in modeling the hydrodynamic processes, ecosystem and water quality in the Massachusetts Bay system. Findings from these works related to the environmental issues are:

- The summer upwelling/downwelling have strong influences on the transport direction of biota boundary fluxes and bottom water renewal in Massachusetts Bay;
- The ecosystem in Massachusetts Bay is strongly influenced by the GOM water intrusion;
- A high nutrient pool found in central Cape Cod Bay during late summer may be the result of predominantly southward transport of organic matter coupled with relatively long residence times in Cape Cod Bay.

As of 2004, the Massachusetts Bays water quality model is a three-dimensional model containing 26 prognostic variables that include 3 phytoplankton groups, nutrients (N, P, Si, and C), particulate and dissolved organic matter, dissolved oxygen, and has a two-layer sediment sub-model. Summaries from the coupled ecosystem-water quality model are:

- The onset of the spring bloom is earlier in Cape Cod Bay than the rest of the Massachusetts Bays system;
- Nitrogen appears limiting to phytoplankton growth in the late spring and summer;
- Meso-scale processes may have significant influences on biological-chemical processes such as primary production;
- Numerical experiments indicate that the relocation of Boston's municipal wastewater discharge to western Massachusetts Bay may not have significant impacts on phytoplankton productivity;
- The mechanisms responsible for strong fall blooms remain unclear

Dr. Jiang also discussed future research that is needed to continue to understand the complex system of Massachusetts Bays. Future research should include: more process-oriented studies for understanding better the short-term processes of coupled physical-biological-chemical events, improved characterization of inter-annual ecosystem variability, better representation of zooplankton in the biological model for Massachusetts Bay, data assimilation and development of near real-time forecast system. The Massachusetts Bay model has monitoring needs as well: enhanced temporal and spatial coverage, particularly, for the open boundary area.

Modeling the Massachusetts Bay System: An Overview

M.S. Jiang, M. Zhou, G. T. Wallace, Y. Zhu and G. B. Gardner
Department of Environmental, Coastal and Ocean Sciences
University of Massachusetts Boston

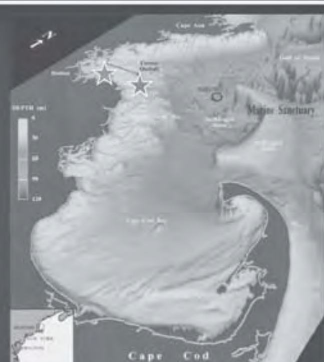
The project is supported by University of Massachusetts & Massachusetts Water Resources Authority

Acknowledgements: M. Michaelson, W. Leo, S.-Y. Liang, R. Isleib, J. Fitzgerald, S. Libby, C. Hunt, B. Butman, D. Payne and D. Townsend

Outline

- Introduction
- Previous works
  - Hydrodynamic model
  - Ecosystem and water quality model
- Current Mass Bay model
  - Model descriptions
  - Some new results
- Future work

Introduction



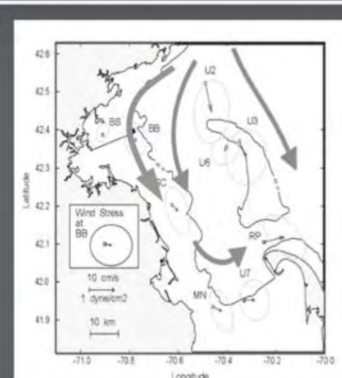
New outfall online on Sept. 6, 2000

Figure courtesy of USGS

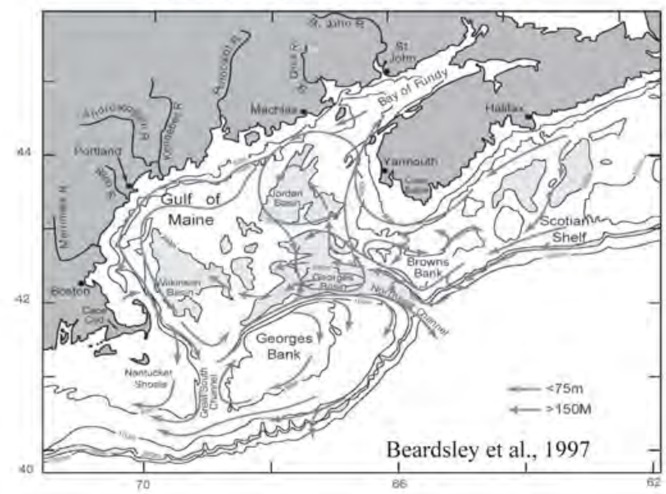
General Circulation Pattern in Mass Bay

Conventional view (Geyer et al., 1992):

- Cyclonic pattern
- GOM intrusion into Massachusetts Bay, which may penetrate into Cape Cod Bay
- Strong variability in association with wind



General Circulation During Stratified Season



Beardsley et al., 1997

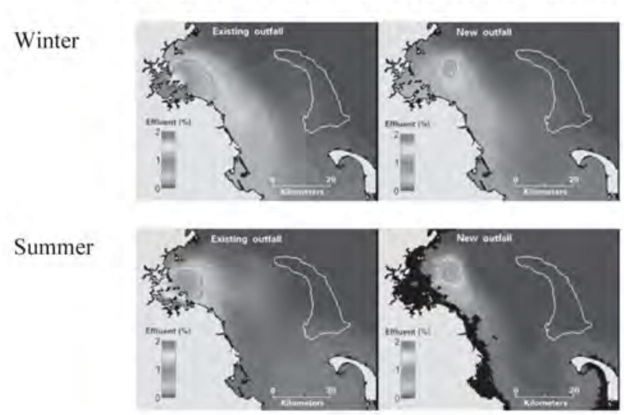
Previous Works: Hydrodynamic Model

- Process-oriented studies
  - Blumberg et al. (1996): Modeling plume behavior
  - Zhang and Adams et al.(1999): Modeling plume behavior
  - Signell et al. (1999): Impacts of outfall relocation
  - Lermusiaux (2001): Meso-scale process study
- Two-dimensional model
  - Walton et al. (1990)
  - Signell and Butman (1992): Boston Harbor
- Three-dimensional model
  - Signell and HydroQual (2000): Simulation for 1998-1999
  - Jiang and Zhou (2004): Simulation for 2000-2001

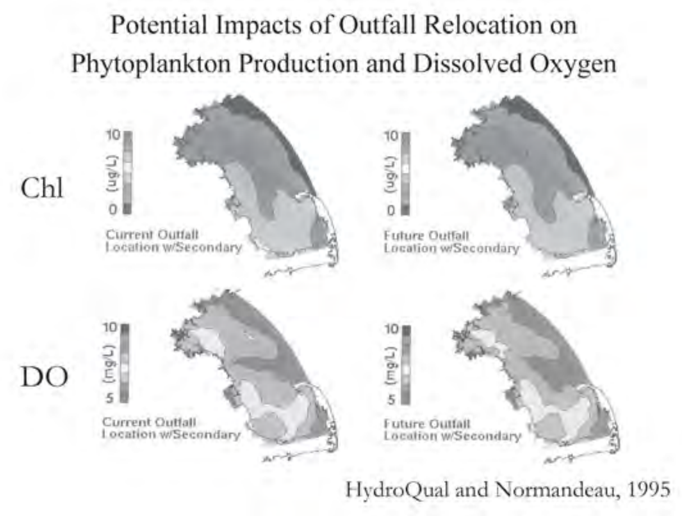
Previous Works: Ecosystem and Water Quality Model

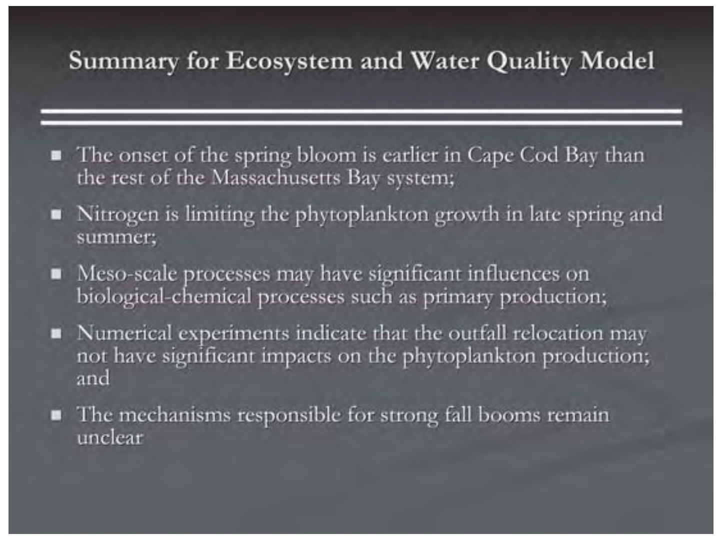
- Box-model
  - Kelly (1998): Nitrogen budget for Boston Harbor
- Process-oriented studies
  - Townsend et al. (1994): Timing of spring blooms
- Three-dimensional model
  - Besiktepe et al. (2003): NPZ model
  - HydroQual(2000): Water quality model, 1992-1994
  - HydroQual(2003): Water quality model, 1998-1999
  - Zhou and Jiang (2004): Water quality model, 2000-2001

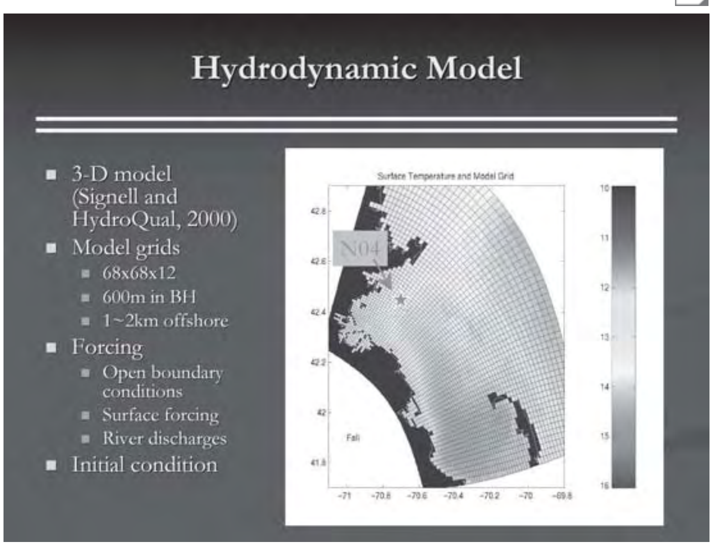
Distributions of Effluents in Winter and Summer

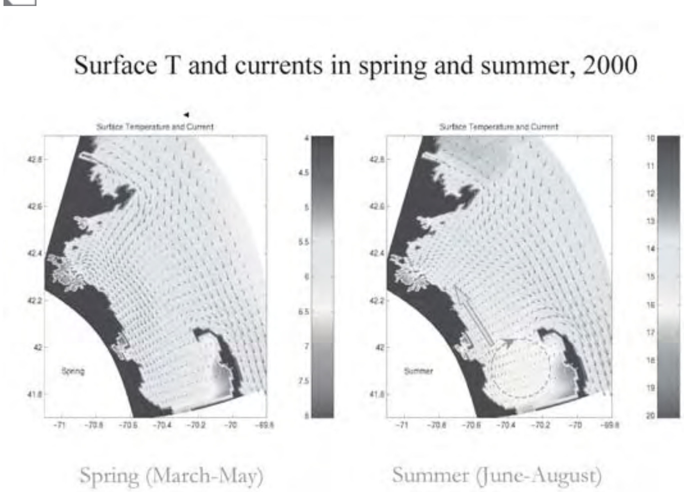


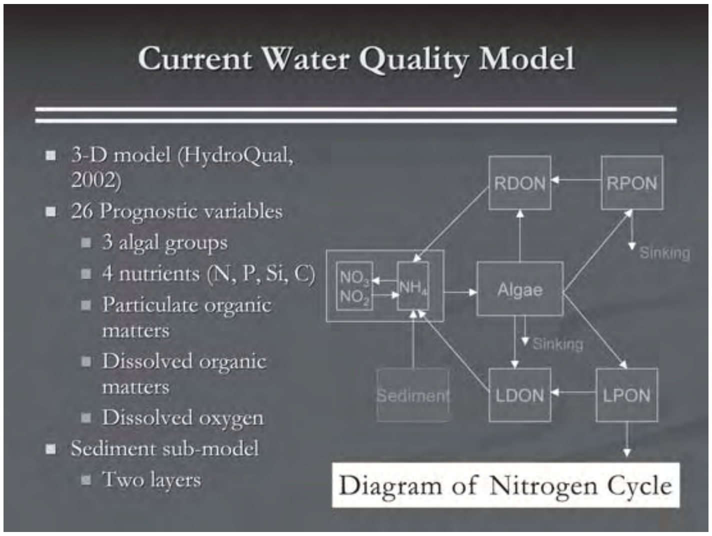
Signell et al., 1999

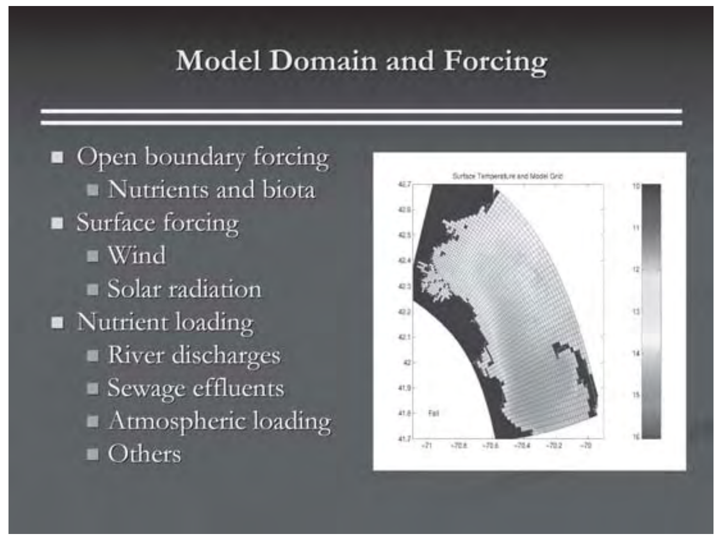

Potential Impacts of Outfall Relocation on
Phytoplankton Production and Dissolved Oxygen
Chl
DO
10
0
(ug/L)
(mg/L)
5
Current Outfall Location w/Secondary
Future Outfall Location w/Secondary
HydroQual and Normandeau, 1995

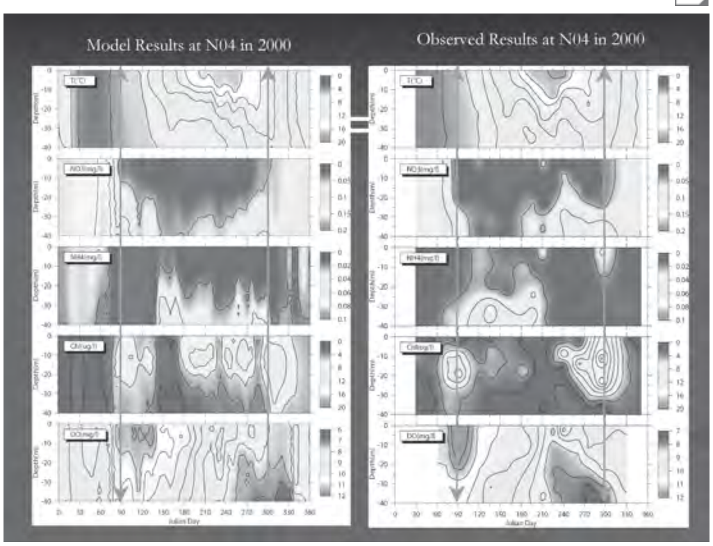

Summary for Ecosystem and Water Quality Model
The onset of the spring bloom is earlier in Cape Cod Bay than the rest of the Massachusetts Bay system;
Nitrogen is limiting the phytoplankton growth in late spring and summer;
Meso-scale processes may have significant influences on biological-chemical processes such as primary production;
Numerical experiments indicate that the outfall relocation may not have significant impacts on the phytoplankton production; and
The mechanisms responsible for strong fall booms remain unclear

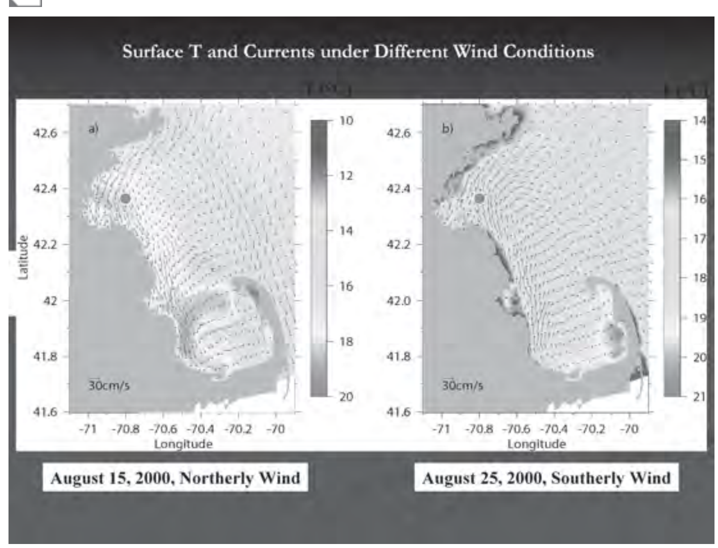

Hydrodynamic Model
3-D model (Signell and HydroQual, 2000)
Model grids
68x68x12
600m in BH
1~2km offshore
Forcing
Open boundary conditions
Surface forcing
River discharges
Initial condition
Surface Temperature and Model Grid
N04
Fall

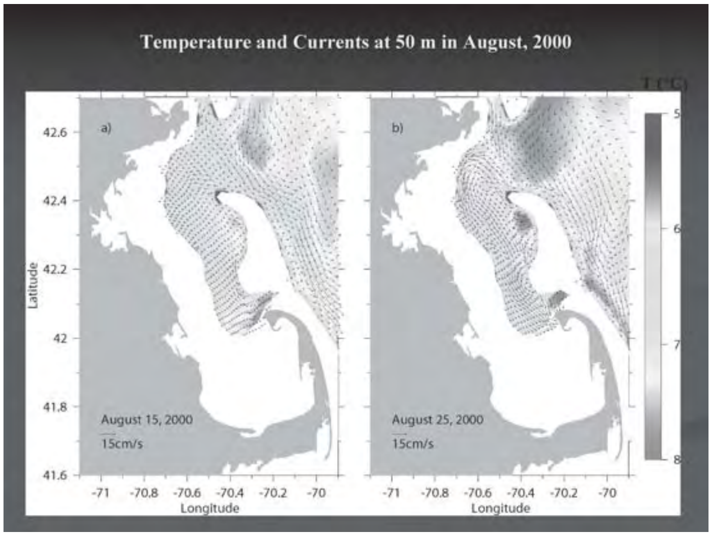

Surface T and currents in spring and summer, 2000
Surface Temperature and Current
Spring
Summer
Spring (March-May)
Summer (June-August)

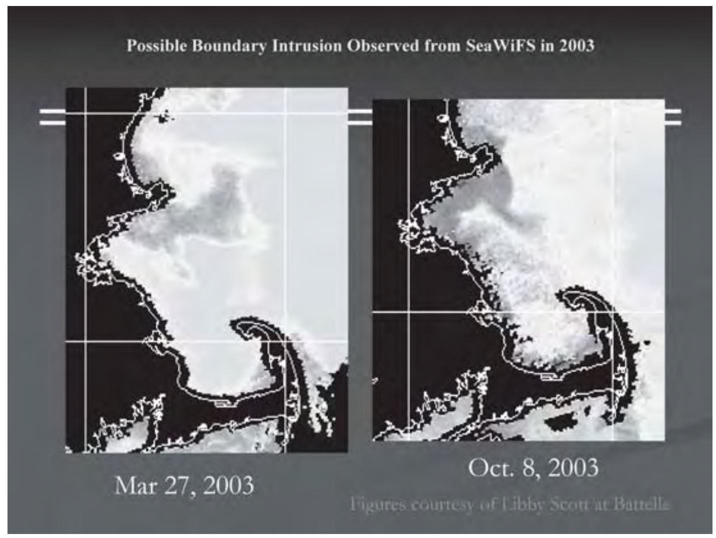

Current Water Quality Model
3-D model (HydroQual, 2002)
26 Prognostic variables
3 algal groups
4 nutrients (N, P, Si, C)
Particulate organic matters
Dissolved organic matters
Dissolved oxygen
Sediment sub-model
Two layers
RDON
RPON
Sinking
NO3
NO2
NH4
Algae
Sinking
Sediment
LDON
LPON
Diagram of Nitrogen Cycle

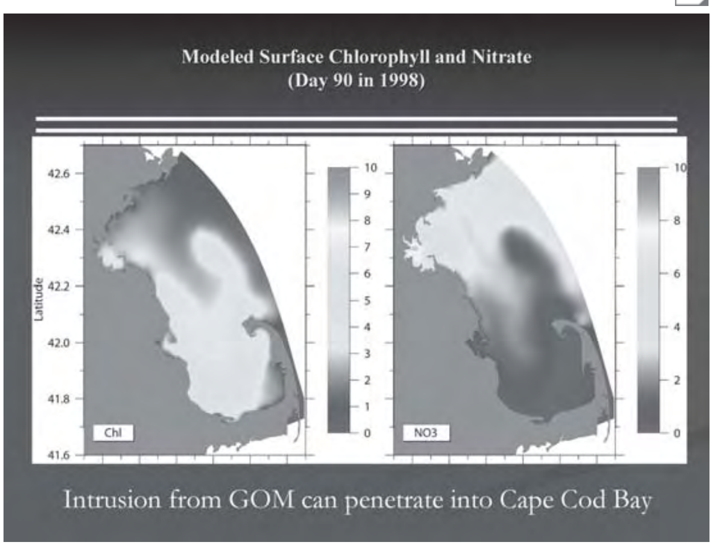

Model Domain and Forcing
Open boundary forcing
Nutrients and biota
Surface forcing
Wind
Solar radiation
Nutrient loading
River discharges
Sewage effluents
Atmospheric loading
Others

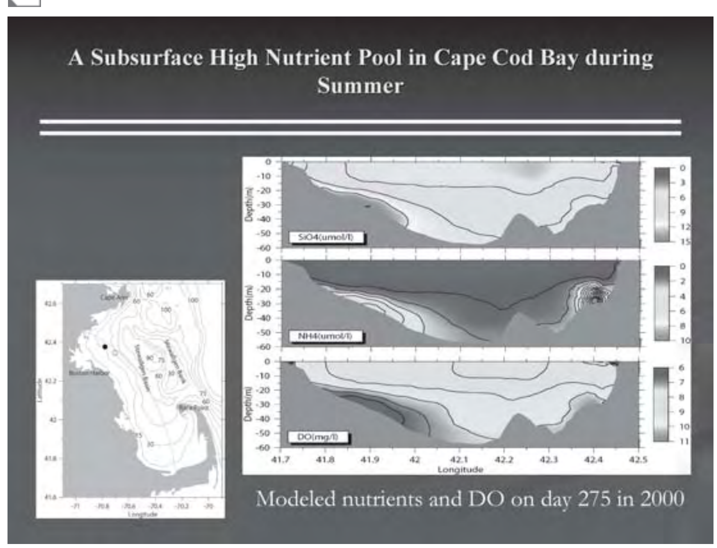

Model Results at N04 in 2000
Observed Results at N04 in 2000

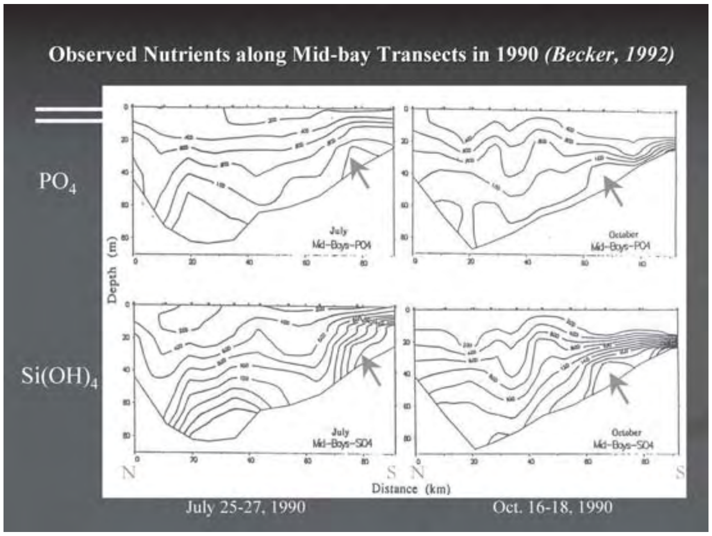

Surface T and Currents under Different Wind Conditions
a)
b)
30cm/s
30cm/s
Latitude
Longitude
Longitude
August 15, 2000, Northerly Wind
August 25, 2000, Southerly Wind

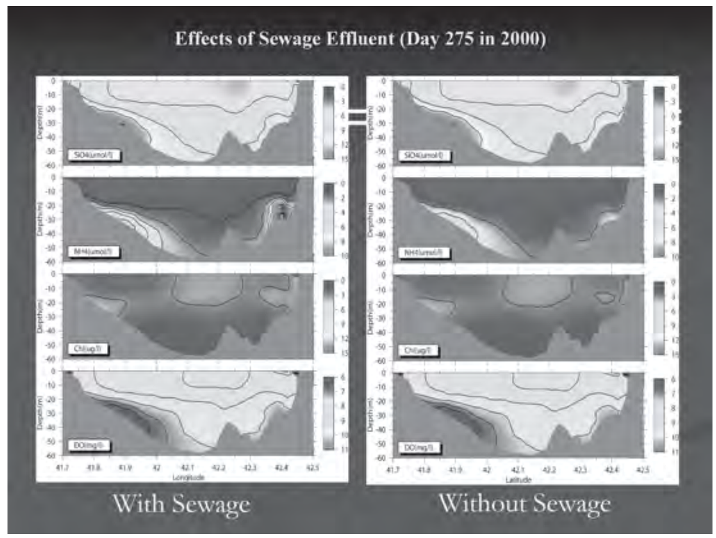

Temperature and Currents at 50 m in August, 2000
a)
b)
August 15, 2000
15cm/s
August 25, 2000
15cm/s
Latitude
Longitude


Possible Boundary Intrusion Observed from SeaWiFS in 2003
Mar 27, 2003
Oct. 8, 2003
Figures courtesy of Libby Scott at Battelle


Modeled Surface Chlorophyll and Nitrate
(Day 90 in 1998)
Chl
NO3
Latitude
Intrusion from GOM can penetrate into Cape Cod Bay


A Subsurface High Nutrient Pool in Cape Cod Bay during Summer
SiO4(umol/l)
NH4(umol/l)
DO(mg/l)
Depth(m)
Longitude
Modeled nutrients and DO on day 275 in 2000





Summary

- The summer upwelling/downwelling have strong influences on the transport direction of biota, boundary fluxes and bottom water renewal in Massachusetts Bay;
- The ecosystem in Massachusetts Bay is strongly influenced by the GOM water intrusion; and
- A high nutrient pool found in central Cape Cod Bay during late summer may be produced by the southward transport of organic matters and long residence time in CCB.

Future Work

- More process studies for understanding the coupled physical-biological-chemical processes, short-term events, and inter-annual ecosystem variability;
- Better representation of zooplankton in the biological model;
- Data assimilation and development of near real-time forecast system; and
- Observation needs: Enhanced temporal and spatial coverage, particularly, for the open boundary.

Offshore

Twelve Years of Water Quality Monitoring in Massachusetts and Cape Cod Bays

Dr. Michael Mickelson, Massachusetts Water Resource Authority,
Dr. Scott Libby and Dr. Carlton Hunt (Battelle)
Charlestown Navy Yard
100 First Ave
Boston, MA 02129
(617) 788-1170
http://www.mwra.state.ma.us

The Massachusetts Water Resource Authority (MWRA) has collected water quality data in Massachusetts and Cape Cod Bays for the Harbor and Outfall Monitoring (HOM) Program since 1992. Dr. Mickelson presented results from monitoring efforts that were designed to support the HOM Program's mission to assess the environmental effects of the relocation of effluent discharge from Boston Harbor to western Massachusetts Bay. A monitoring plan was developed and included parameters that are ecologically important, respond early to perturbation, indicate longer-term response, and provide explanatory information. The data from 1992 through September 5, 2000 were collected to establish baseline water quality conditions and to provide the means to detect significant departures from the baseline after the Bay outfall became operational. This data was then compared to the data collected after the Bay outfall went online on September 6, 2000. In general, typical trends emerged when the baseline data were compared to the 2001 to 2003 data. There was an increase in nutrients in the nearfield region of the Bay outfall. However, there was a measurable decrease in nutrients inshore. Phytoplankton and zooplankton observed in the nearfield outfall region showed no post discharge change in community structure or abundance. Studies have shown that dissolved oxygen (DO) trends are driven by meso-scale processes and no DO change is evident. Changes from the outfall are primarily expressed as an increase in nearfield nutrient concentrations with offshore changes being small and localized.

Over the course of the HOM program, a general sequence of water quality events has become evident even though the timing and year-to-year manifestations of these events are variable. Dr. Mickelson noted that there has been little change in the timing or magnitude of these events in comparison to baseline data since the Bay outfall became operational. Further, knowledge gained through monitoring, modeling, and research has substantially increased the understanding of the variability of the Massachusetts Bays System, the factors that drive variability, and relationships among stressors (causes) and responses (effects). Future MWRA efforts include: answering long-term questions about the outfall effects, improving efficiency of monitoring efforts, consideration of technical options, and sharing the cost of ecosystem monitoring with other organizations.

Massachusetts Water Resources Authority — Battelle, The Business of Innovation

Offshore water quality: Monitoring the MWRA outfall

Scott Libby, Battelle
Mike Mickelson, MWRA
Carlton Hunt, Battelle

Mass Bays Symposium
May 6, 2004

Presentation Outline

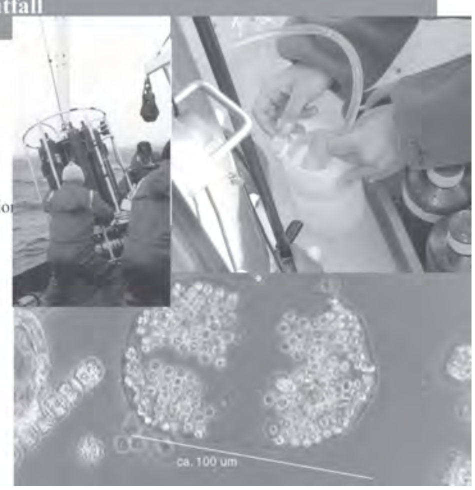
- Where we have been?
  - Improving sewage treatment and disposal
  - Monitoring the outfall
  - Model predictions
- What have we learned and where are we today?
  - Nutrient Loading
  - Nutrient Changes
  - Biomass – Chlorophyll and POC
  - Production
  - Plankton
  - Dissolved Oxygen
- Where are we going in the future?
  - New technologies
  - Collaborative monitoring efforts

Improving sewage treatment and disposal

Date	Major Upgrade
December 1991	Sludge discharges ended
January 1995	New primary plant on-line
December 1995	Disinfection facilities completed
August, 1997 to March, 2001	Secondary treatment phased in
July 9, 1998	Nut Island discharges ceased – south system flows transferred to Deer Island
September 6, 2000	New bay outfall diffuser system on-line

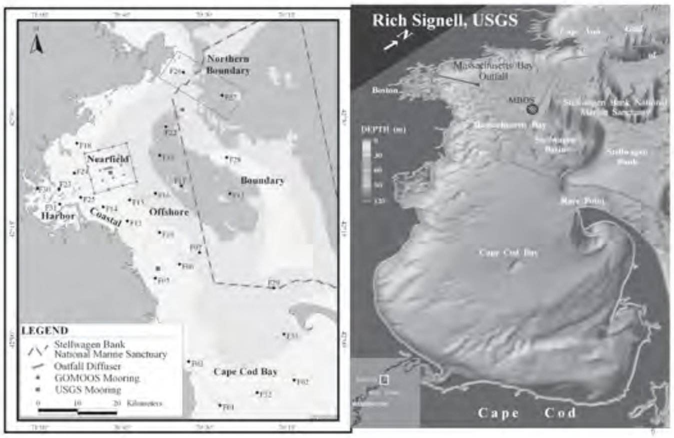
Monitoring the outfall

- Effluent
  - TSS, cBOD
  - nutrients
- water column
  - nutrients
  - photosynthesis, respiratio
  - chlorophyll
  - dissolved oxygen
  - water clarity
  - plankton counts
  - nuisance and noxious algae
  - marine mammal observations
- benthos, fish



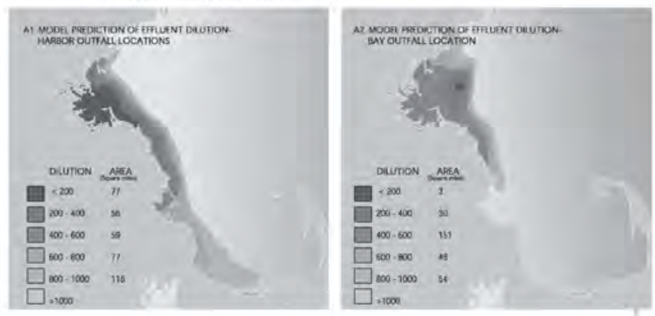
17 Nearfield surveys per year, 6 Farfield surveys per year.

Additional data from USGS mooring, GoMOOS moorings, and satellite imagery.



Model predictions

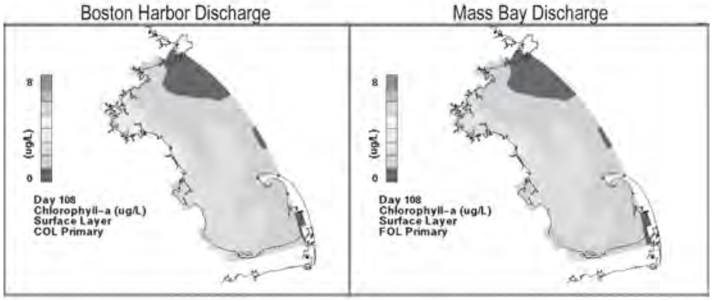
- Transfer of nutrient load to deep waters of Mass Bay
  - Reduction in nutrient concentrations in Harbor, coastal, and 'downstream'
  - Increase in nutrients in nearfield, but isolated from the photic zone during stratified conditions



Expected Response to relocation

- Localized water quality changes near the outfall
  - Chlorophyll – small increase? (decrease in Harbor and coastal waters)
  - DO – NC
  - Primary Production – unkown
  - Phytoplankton and Zooplankton Communities - NC

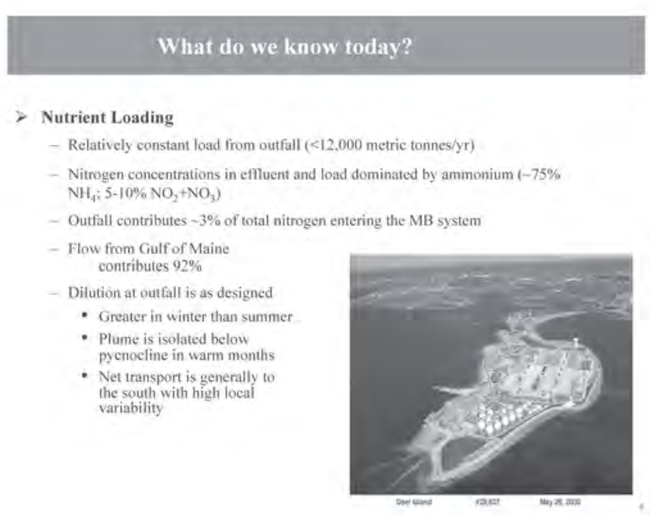
Boston Harbor Discharge | Mass Bay Discharge

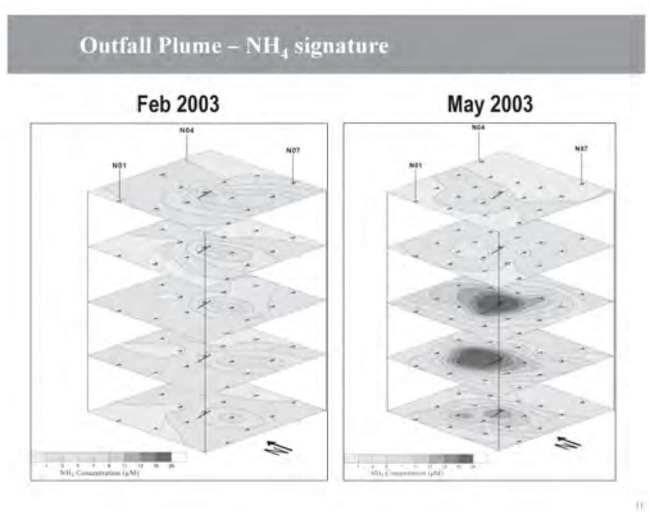


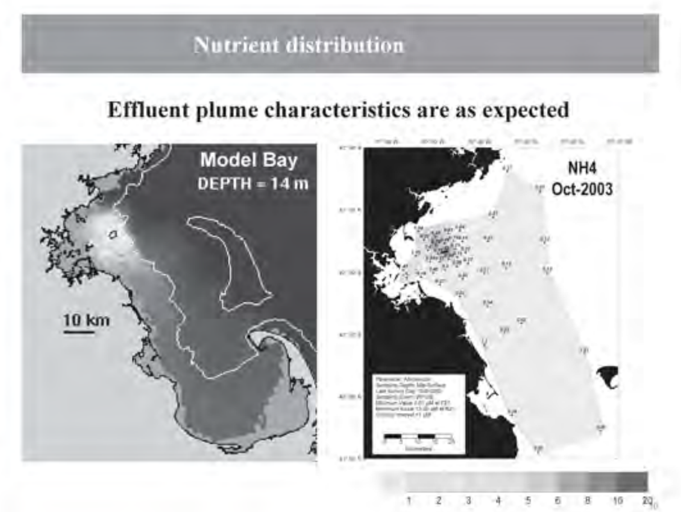
What do we know today?

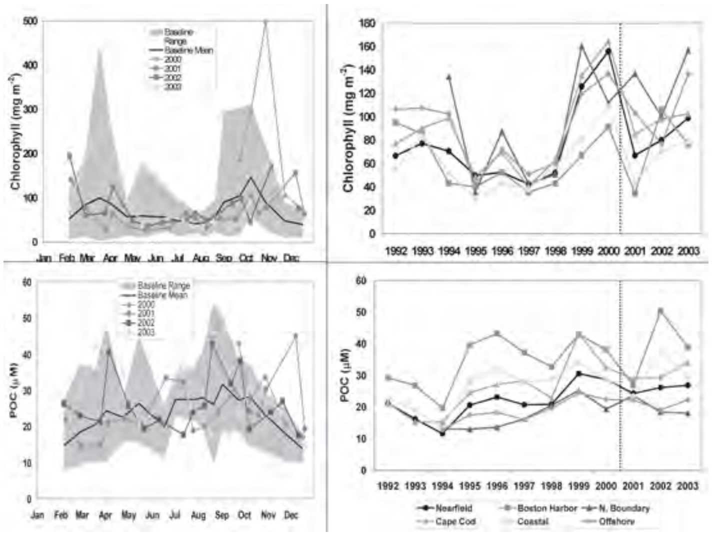
- Physical processes
  - Mass Bay and Gulf of Maine are coupled
  - Mass Bay circulation is influenced by seasonal and local winds plus runoff
  - Nearfield area does not have a consist mean flow
  - Interannual and regional factors contribute to spatial and temporal variability in key monitoring parameters (e.g., DO)
  - Large scale processes affect the local system. (e.g. NAO => zooplankton)

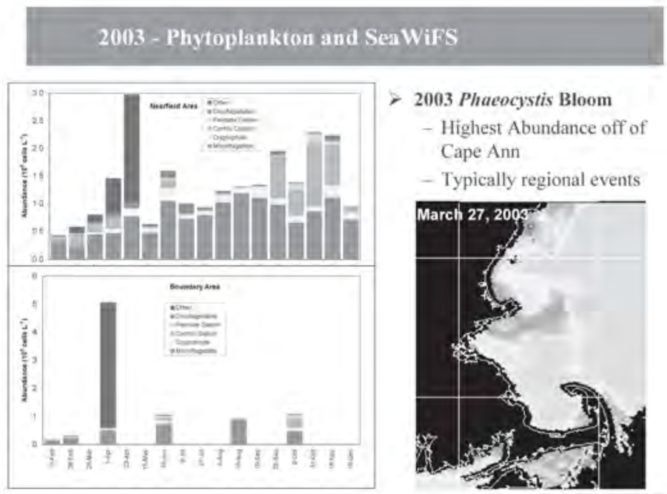
Map by Pierre Lermusiaux, Harvard Univ.

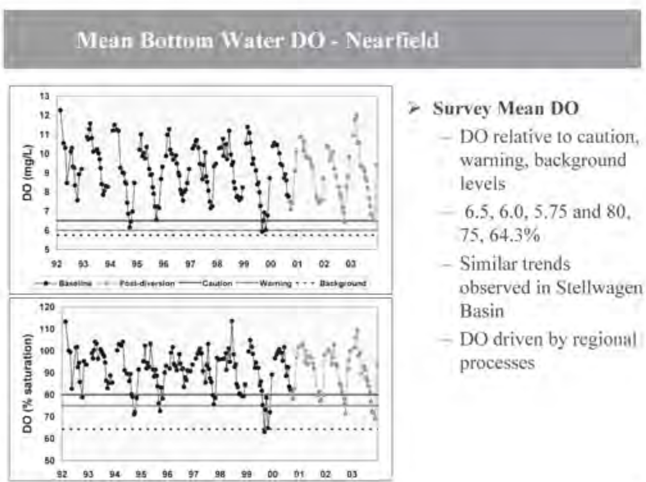

What do we know today?
Nutrient Loading
– Relatively constant load from outfall (<12,000 metric tonnes/yr)
– Nitrogen concentrations in effluent and load dominated by ammonium (~75% NH4; 5-10% NO2+NO3)
– Outfall contributes ~3% of total nitrogen entering the MB system
– Flow from Gulf of Maine contributes 92%
– Dilution at outfall is as designed
• Greater in winter than summer
• Plume is isolated below pycnocline in warm months
• Net transport is generally to the south with high local variability

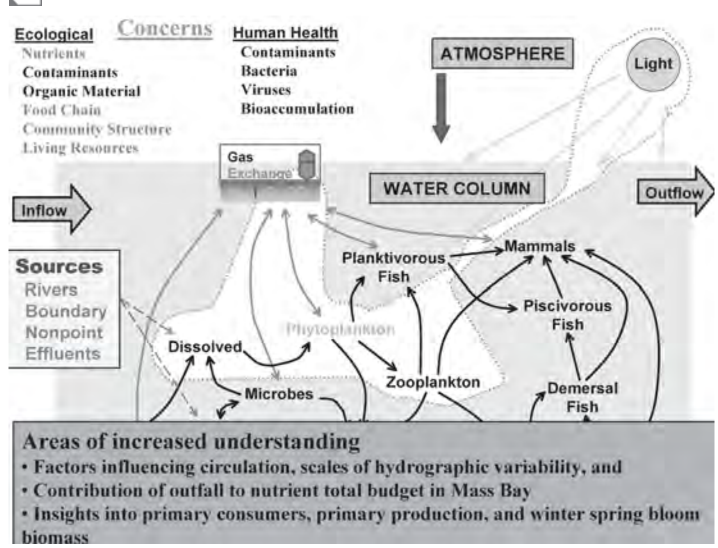

Outfall Plume – NH4 signature
Feb 2003
May 2003


Nutrient distribution
Effluent plume characteristics are as expected
Model Bay
DEPTH = 14 m
10 km
NH4
Oct-2003


Chlorophyll (mg m^{-2})
Baseline Range
Baseline Mean
2000
2001
2002
2003
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
POC (µM)
Nearfield
Boston Harbor
N. Boundary
Cape Cod
Coastal
Offshore


2003 - Phytoplankton and SeaWiFS
Nearfield Area
Boundary Area
➢ 2003 *Phaeocystis* Bloom
– Highest Abundance off of Cape Ann
– Typically regional events
March 27, 2003


Mean Bottom Water DO - Nearfield
DO (mg/L)
DO (% saturation)
92 93 94 95 96 97 98 99 00 01 02 03
Baseline
Post-diversion
Caution
Warning
Background
➢ Survey Mean DO
– DO relative to caution, warning, background levels
– 6.5, 6.0, 5.75 and 80, 75, 64.3%
– Similar trends observed in Stellwagen Basin
– DO driven by regional processes


Ecological
Concerns
Human Health
Nutrients
Contaminants
Organic Material
Food Chain
Community Structure
Living Resources
Contaminants
Bacteria
Viruses
Bioaccumulation
ATMOSPHERE
Light
Gas Exchange
WATER COLUMN
Inflow
Outflow
Sources
Rivers
Boundary
Nonpoint
Effluents
Planktivorous Fish
Mammals
Piscivorous Fish
Dissolved
Phytoplankton
Zooplankton
Microbes
Demersal Fish
Areas of increased understanding
• Factors influencing circulation, scales of hydrographic variability, and
• Contribution of outfall to nutrient total budget in Mass Bay
• Insights into primary consumers, primary production, and winter spring bloom biomass

Baseline Comparison Summary

- **"Typical" trends observed in 2001 – 2003 compared to baseline**
- **Nutrients**
  - Increase in nutrients in nearfield (primarily NH_4)
  - Decrease in nutreints inshore.
  - Ammonium NH_4 is a good tracer of the effluent plume
  - Elevated NH_4 concentrations limited to within ~10-20 km of outfall
- **Biomass and productivity**
  - Major spring and fall blooms appear to be regional phenomena
  - Magnitude and trends roughly comparable to baseline
  - Large increases noted unrelated to outfall – i.e. 1998-2000 trend of increasing chlorophyll throughout the Bays
  - Inshore: decreased productivity and seasonality becoming similar to offshore.
  - Often a disconnect between fall bloom chlorophyll and carbon

Baseline Comparison Summary

- **Phytoplankton and Zooplankton**
  - Very complex community structure
  - No post discharge change in community or abundances observed
- **Dissolved Oxygen**
  - No change evident in DO
  - DO %saturation often below 75% baseline and post-transfer
  - DO trends driven by regional processes
- **Overall the expectations from diversion were correct**
  - Primarily expressed as an increase in nearfield nutrient concentrations
  - Offshore changes are small and near the outfall.

Future MWRA Efforts

- Answer longer-term questions about outfall effects
- Improve efficiency of monitoring
- Consider technical options
- Share the cost
  - Ocean Observing System
  - regional partners
  - encourage collaborative studies in Mass Bay

21

Offshore Benthic Habitat

Kenneth Keay
Massachusetts Water Resources Authority
Charlestown Navy Yard
100 First Ave
Boston, MA 02129
(617) 788-1170
Kenneth.Keay@mwra.state.ma.us

Benthic (seafloor) habitats in the Massachusetts Bays system vary from a complex patchwork of rock, gravel, sand and mud bottoms in Boston Harbor and western Massachusetts Bay to broad expanses of sand and mud in Cape Cod Bay and Stellwagen Basin. Offshore soft-sediment infaunal studies by the Massachusetts Water Resources Authority (MWRA) over the past 12 years document species-rich communities similar to those observed in early studies in the late 1960s and early 1970s. The benthic infauna of the Massachusetts Bays includes communities that are a mixture of nearshore and offshore components. Polychaetes are the most abundant in terms of numbers of individuals and species in the Bays. Around 450 species of benthic invertebrates have been identified from the Bays through 2003 and the fauna is typical of both mud and sand substrates. Mr. Keay also pointed out that there are dozens of species not previously described.

Since monitoring began in 1992, fluctuations in the biodiversity of the Bays infauna suggest that the communities may be responding to decade-scale variability in the regional oceanography, though the causative factors remain unknown and are currently under investigation. Mr. Keay noted if environmental conditions deteriorate, benthic organisms have no choice but to adapt to the changing environment. Since the outfall has gone online there are have been several changes observed in benthos of Massachusetts Bays. Near the discharge, there has been an increase in Clostridium perfringens, the total abundance in the infaunal community has increased, and PAHs levels are elevated due to the presence of coal-tar by products. However, Mr. Keay remarked that there have been no changes in the sediment in the nearfield or farfield regions (relative to the outfall site) since the outfall came online. The benthic biodiversity model questioned whether the outfall has an effect and the data states that the change has not been large.
Many benthic monitoring findings have been established about the effects of the outfall on Massachusetts Bays, the findings include:

- No increases in sediment contaminants in nearfield region of the Bay outfall;
- Small localized increases in the MWRA effluent tracer bacterium;
- No change in sediment metabolism or depth of oxygen penetration into sediments;
- Small increase in sediment drape in some rocky subtidal sites;
- No changes in benthic communities that can be related to outfall discharge;
- Substantial long-term fluctuations in density and species richness that may be related to large-scale oceanographic factors.

Mr. Keay also discussed important findings observed by the U. S. Geological Survey (USGS) in relation to sediments in Massachusetts Bays. Major repositories of fine sediments are in depositional sites in Boston Harbor, Stellwagen Basin, and Cape Cod Bay. Trace metal concentrations in Harbor sediments have decreased since the late 1970s. Major storms are the primary factor in the transport of fine sediments and associated contaminants within the system. Lastly, analysis of sediment traps in the vicinity of the new outfall allows detection of a subtle MWRA effluent signature not detectable in the seafloor.

Offshore Benthic Habitats in the Massachusetts Bays System

Kenneth Keay

Massachusetts Water Resources Authority

Boston MA 02129

Acknowledgements

Studies of seafloor communities and processes in the Massachusetts Bays system have been a cooperative effort involving dozens of scientists from MWRA, USGS, and a number of academic institutions and private sector firms.

Key researchers include (but are not limited to):

- Mike Bothner and Brad Butman, US Geological Survey; Sediment and contaminant transport, geology, seafloor mapping.
- Carlton Hunt and Deirdre Dahlen, Battelle; Gordon Wallace, U/Mass; Damian Shea, NCSU: Sediment Contaminants

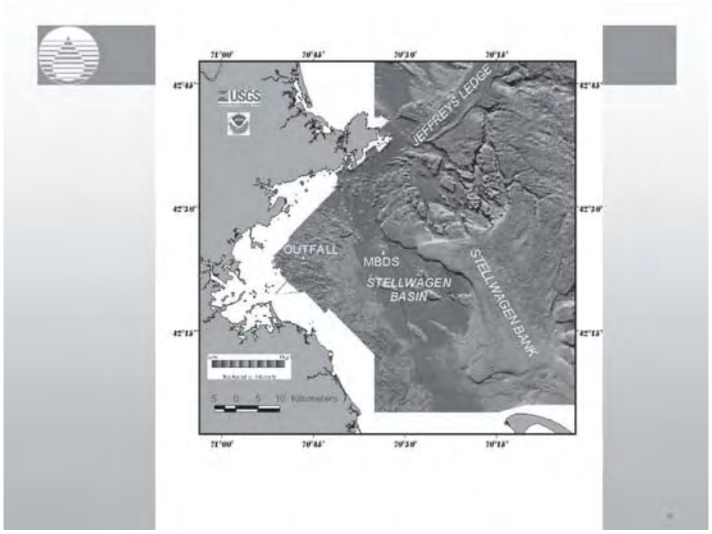
Acknowledgements (cont.)

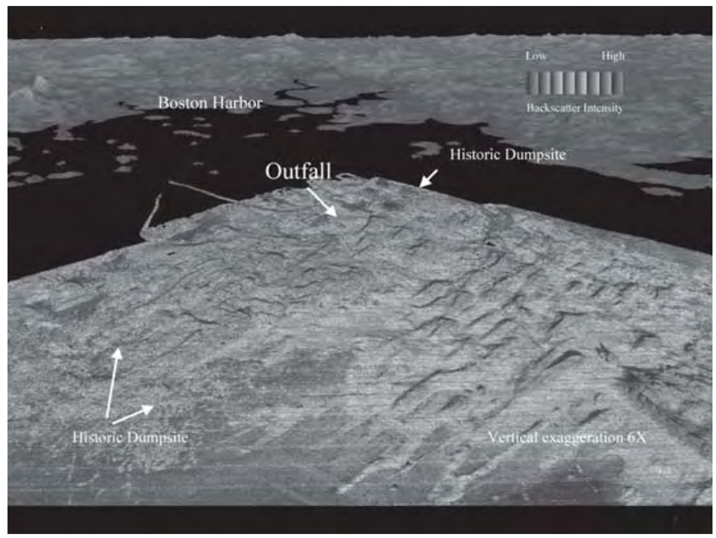
- Anne Giblin, MBL; Brian Howes, U/Mass: Sediment metabolism.
- Barbara Hecker, Hecker Environmental; Doug Coats, MRS: Rocky seafloor monitoring[1]:
- Roy Kropp, Battelle; James Blake and Nancy Maciolek, ENSR; Robert Diaz, VIMS; Eugene Gallagher, U/Mass: Soft-sediment infaunal monitoring:

1. Multi-decade studies of subtidal rocky-seafloor species and communities in Massachusetts Bay by Kenneth Sebens (U/Mass) and his colleagues represent some of the most groundbreaking environmental research extant.

Because it's there, and a couple of other reasons

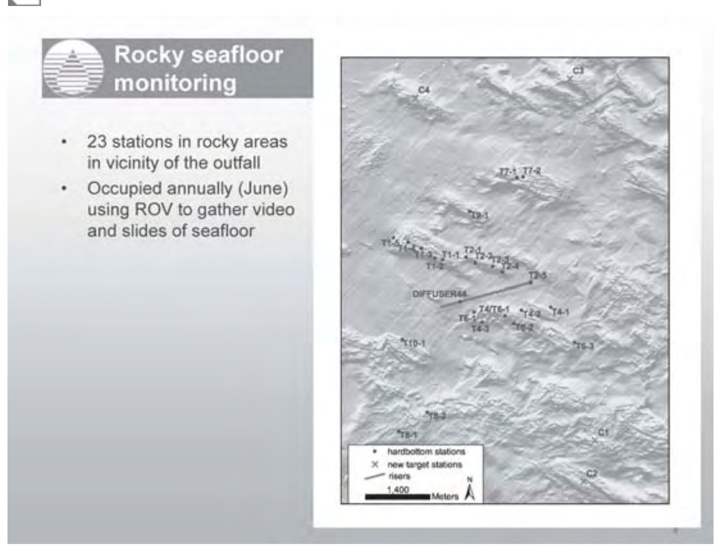
- Seafloor organisms and microbial metabolism in sediments play important roles in water column oxygen dynamics and nutrient regeneration.
- Benthic organisms include many commercially important species and are important links in ocean food webs.
- Eutrophication can result in excess organic matter depositing on the sea-floor. Metabolism of this matter can decrease dissolved oxygen within sediments and in the overlying water.
- Contaminants tend to adsorb onto fine particulates in the water column and settle to the sea-floor.
- Animals living attached to (epifauna) or within the seafloor (infauna) tend to be sessile. They can't relocate if conditions deteriorate.

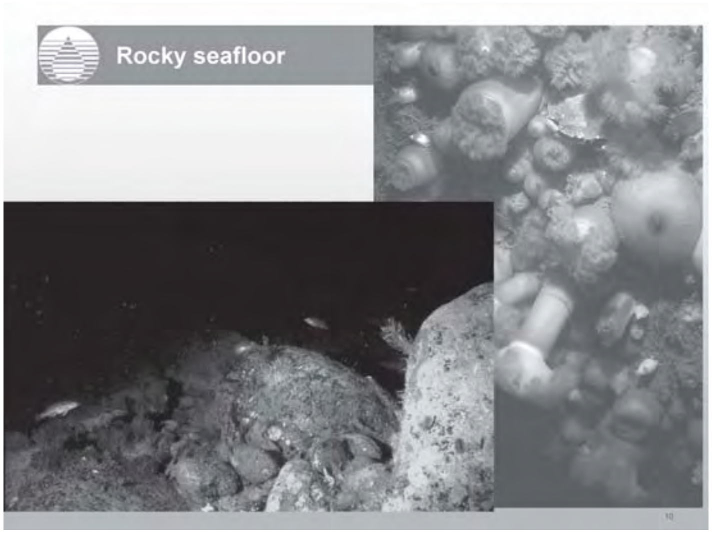


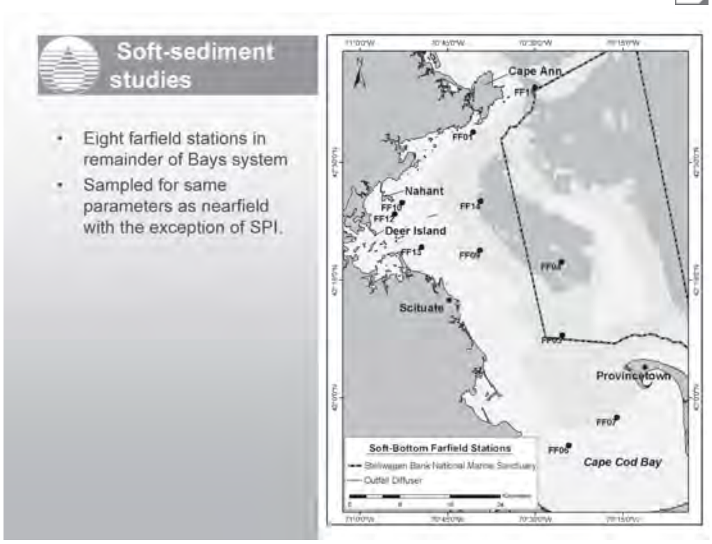


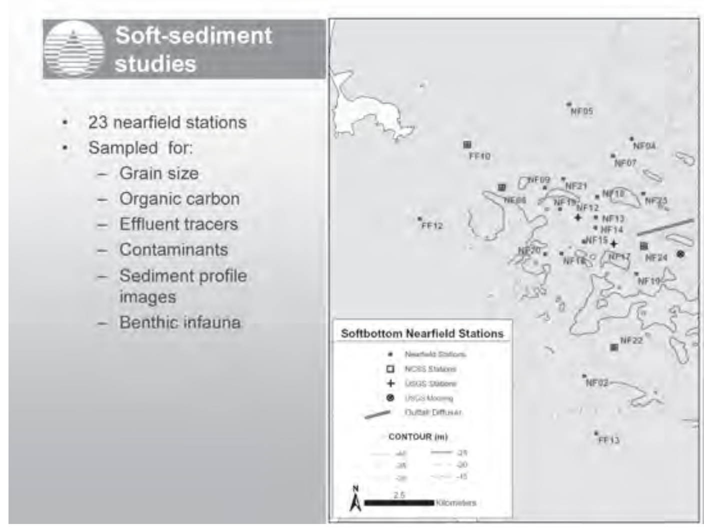
Other findings of USGS studies

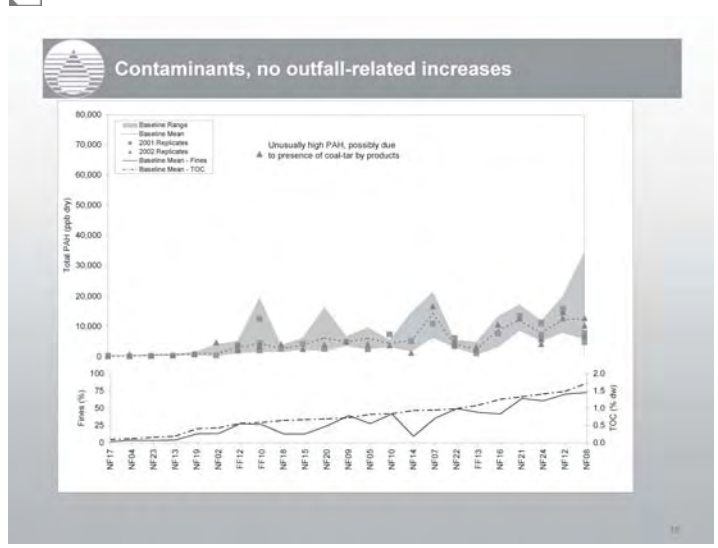
- Major repositories of fine sediments are in depositional sites in Boston Harbor, Stellwagen Basin, and Cape Cod Bay
- Trace metal concentrations in Harbor sediments have decreased since the late 1970s.
- Major storms are the primary factor in the transport of fine sediments and associated contaminants within the system.
- Analysis of sediment traps in the vicinity of the new outfall allows detection of a subtle effluent signature not detectable in the seafloor.

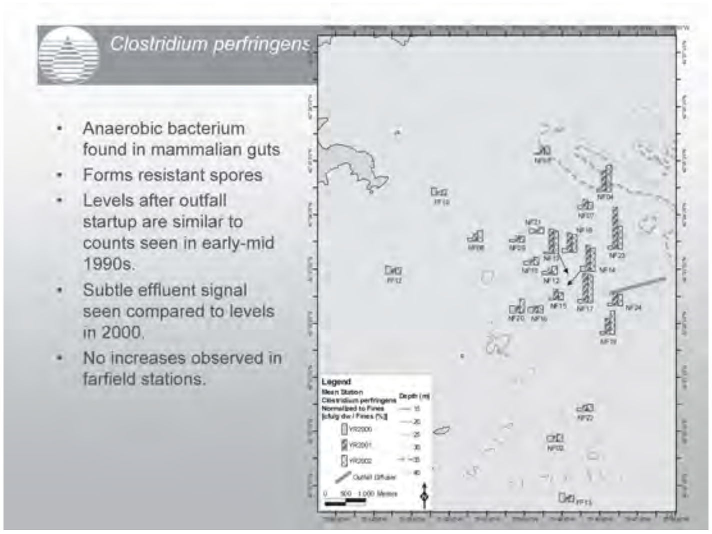


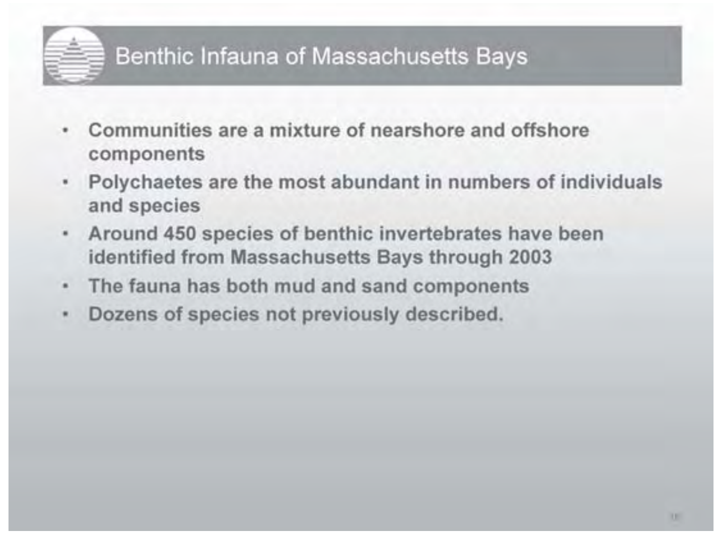

Rocky seafloor

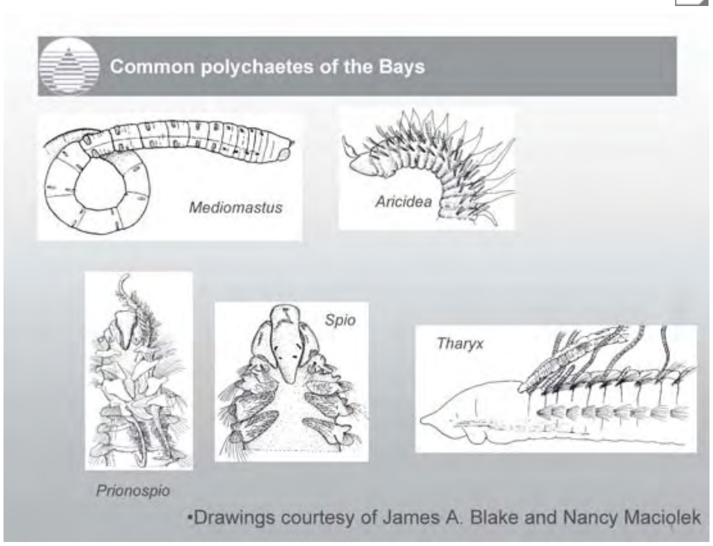

Soft-sediment studies
• Eight farfield stations in remainder of Bays system
• Sampled for same parameters as nearfield with the exception of SPI.
Cape Ann
Nahant
Deer Island
Scituate
Provincetown
Cape Cod Bay
Soft-Bottom Farfield Stations
Stellwagen Bank National Marine Sanctuary
Outfall Diffuser

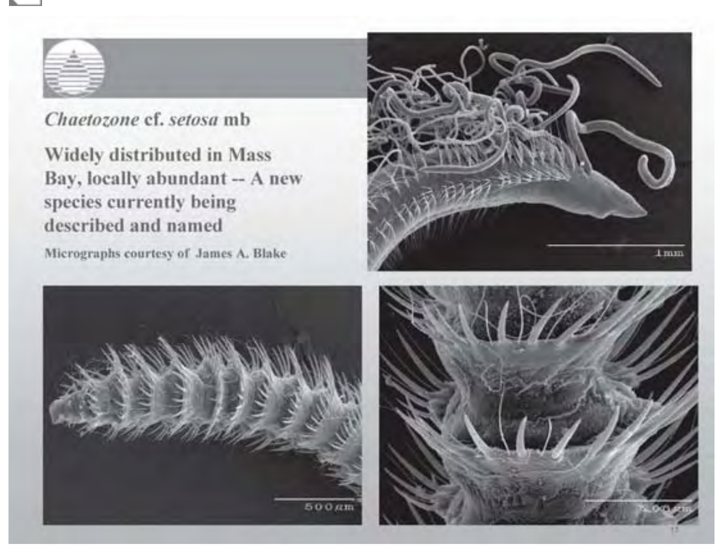

Soft-sediment studies
• 23 nearfield stations
• Sampled for:
– Grain size
– Organic carbon
– Effluent tracers
– Contaminants
– Sediment profile images
– Benthic infauna
Softbottom Nearfield Stations
CONTOUR (m)
Kilometers

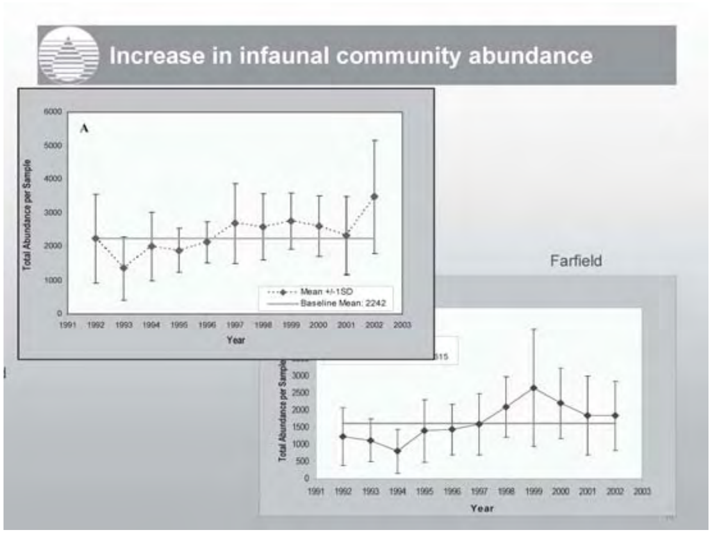

Contaminants, no outfall-related increases
Unusually high PAH, possibly due to presence of coal-tar by products
Total PAH (ppb dry)
Fines (%)
TOC (% dw)

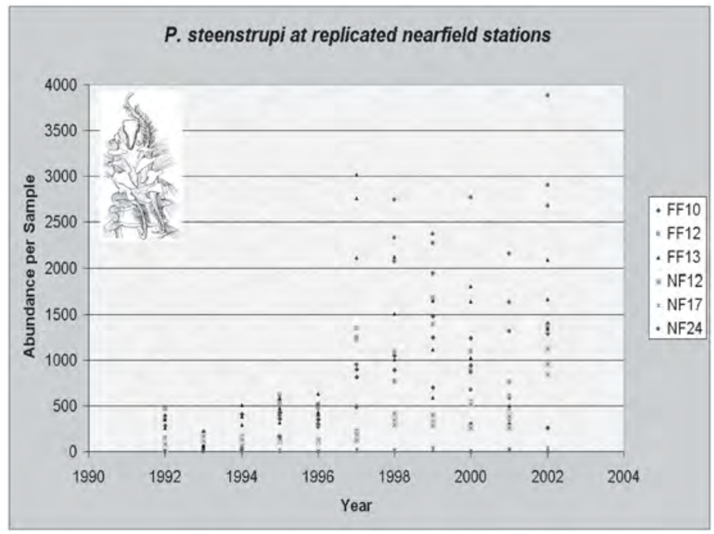

Clostridium perfringens
• Anaerobic bacterium found in mammalian guts
• Forms resistant spores
• Levels after outfall startup are similar to counts seen in early-mid 1990s.
• Subtle effluent signal seen compared to levels in 2000.
• No increases observed in farfield stations.
Legend

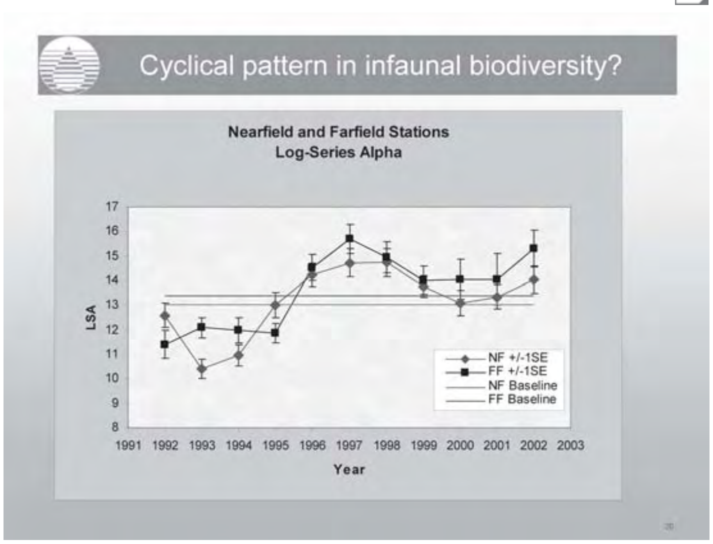

Benthic Infauna of Massachusetts Bays
• Communities are a mixture of nearshore and offshore components
• Polychaetes are the most abundant in numbers of individuals and species
• Around 450 species of benthic invertebrates have been identified from Massachusetts Bays through 2003
• The fauna has both mud and sand components
• Dozens of species not previously described.

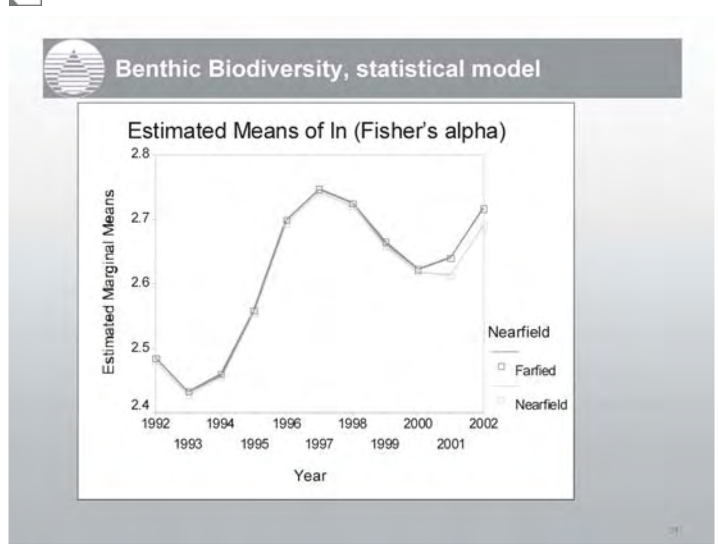

Common polychaetes of the Bays
Mediomastus
Aricidea
Spio
Tharyx
Prionospio
•Drawings courtesy of James A. Blake and Nancy Maciolek


Chaetozone cf. setosa mb
Widely distributed in Mass Bay, locally abundant -- A new species currently being described and named
Micrographs courtesy of James A. Blake
1 mm
500 µm


Increase in infaunal community abundance
A
Total Abundance per Sample
Year
Mean +/-1SD
Baseline Mean: 2242
Farfield
Total Abundance per Sample
Year


P. steenstrupi at replicated nearfield stations
Abundance per Sample
Year
FF10
FF12
FF13
NF12
NF17
NF24


Cyclical pattern in infaunal biodiversity?
Nearfield and Farfield Stations
Log-Series Alpha
LSA
Year
NF +/-1SE
FF +/-1SE
NF Baseline
FF Baseline


Benthic Biodiversity, statistical model
Estimated Means of ln (Fisher's alpha)
Estimated Marginal Means
Year
Nearfield
Farfied
Nearfield

Nearfield communities

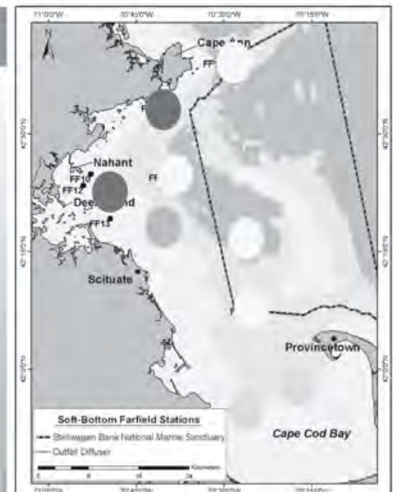
- Sediment grain size a major determinant of nearfield communities.
  - Sand stations (e.g. NF17, NF13) support a distinctly different community than do muddy sites (e.g. NF12, NF24)
- Evaluation of community composition indicates no changes attributable to outfall discharge

Benthic monitoring findings

- No increases in sediment contaminants in nearfield
- Small localized increases in effluent tracer bacterium
- No change in sediment metabolism or depth of oxygen penetration into sediments.
- Small increase in sediment drape in some rocky subtidal sites
- No changes in benthic communities that can be related to outfall discharge
- Substantial long-term fluctuations in density and species richness that may be related to large-scale oceanographic factors.

Soft-sediment studies

- Communities show some regional distinction.
- Communities similar to those sampled in early studies in the 1960s and 1970s.



Sources for more information

- USGS Project Website, "Boston Sewage Outfall: The Fate Of Sediments And Contaminants In Massachusetts Bay" http://woodshole.er.usgs.gov/project-pages/bostonharbor/index.html
- The Boston Harbor and Massachusetts Bays pages at MWRA's website http://www.mwra.com/ contains
  - Links to general information
  - Links to monitoring results
  - Online copies of interpretive reports "technical report list" including
    - An annual summary of the monitoring (e.g. report # 2003-12)
    - Detailed annual interpretive reports on study areas (e.g. #2003-13 for benthic community monitoring, 2003-8 for sediment metabolism studies)

Offshore

Endangered Right Whales

Dr. Charles Mayo
Center for Coastal Studies
P.O. Box 1036
Provincetown, MA 02657
(508) 487-3622
stormym33@pobox.com

In the 1700s, the North Atlantic right whale (*Eubalaena glacialis*) population was hunted to near extinction. Today, there are about 350 right whales in the world. There are three factors to the success of right whales: status, threats, and food and feeding habits. Whales are in the Massachusetts Bays for socialization, nursing of calves, and feeding. Cape Cod Bay is of particular interest for the right whales, noted Dr. Mayo, because it is a significant feeding ground in winter. Many threats to right whales have been identified. For example, they can become entangled in discarded fishing nets or injured or killed when struck by ships. The rate of reduction is decreasing but threats are increasing with human population growth.

To help conserve whales, it is important to understand their behavior and their feeding habits. While feeding in the region, most right whales work in the area of eastern Cape Cod Bay and can feed up to 24 hours a day. The importance of zooplankton to the success of right whales was proven in recent studies. Feeding is triggered by up to 11 taxa of zooplankton, and the food source is variable from year to year. When searching for food, the whales use area-restricted searching based on zooplankton abundance, therefore the feeding pattern is a path through the area of searching. To understand the system, zooplankton sampling should be done within a few meters of that path, but for background it is important to sample far from the path as well. Cape Cod Bay has had problems because it was found to have zooplankton biomass levels that may not be conducive to feeding. 2002 saw the fewest whales sighted, shortest residency, least feeding, and earliest departure in nineteen years of study. Dr. Mayo stated that the collapse of bay sightings of right whales has caused significant concern that whales are leaving the bays. There has been a close association between food quality on the winter feeding ground of Cape Cod Bay and calving success of the population two years later. The low quality of the food resource through the 1990's associated with low rates of calving may also be related to low survival rates.

Conclusions:

- Cape Cod Bay appears to be supplying a portion of the energy needs of as many as 100 right whales that visit the embayment each year.
- There is a relationship between measures of food availability in Cape Cod Bay and calving of the right whales.
- The distribution of right whales within the bays of Massachusetts reflects the distribution of the planktonic foods.
- Though we can demonstrate how the addition of sewage effluent (from the MWRA outfall) to the bays system might affect right whales, there are no indications that sewage discharge has had detrimental impacts.

Massachusetts Marine Fisheries' Inshore Bottom Trawl Survey

Steven Correia
Massachusetts Division of Marine Fisheries
251 Causeway Street, Suite 400
Boston, MA 02114
(617) 626-1520
steven.correia@state.ma.us

Massachusetts has conducted inshore bottom trawl surveys during May and September from 1978 to the present. Mr. Correia presented the survey design and methodology along with biomass indices for five of the most prominent species in Cape Cod and Massachusetts Bays.

Two surveys are conducted annually. The spring survey occurs in May when many species are spawning in Massachusetts waters. This survey tracks the adult biomass indices of many species. The fall survey occurs in September when many species utilize state waters as a nursery ground, thus the fall survey catch is dominated by younger fish (ages 0 and 1). The fall survey is more useful for providing indices of year class strength for many species than the spring survey. The primary objectives of the surveys are relative abundance, size/age/maturity composition, geographic distribution of finfish species, and taking hydrographic observations. Secondary objectives for the surveys include taking pathology observations and contaminant and water quality monitoring. The survey design is stratified random with sampling strata defined by depth and geographic region. On average, 93 stations are sampled per survey. Spring surveys average 69 species with a total catch of 15, 000 kg and 69,000 individuals per survey. Fall surveys average 88 species with a total catch of 28,000 kg and 23,000 individuals per survey.

Mr. Correia discussed trends of numerous species in the survey (see following slides), and other applications for survey data, such as providing data for defining essential fish habitat. Data from the surveys are used to develop trends in biomass and abundance (stock assessments), evaluate potential area closures, help management decide on mesh size/ minimum size restrictions, and provide geographic distributions used to define essential fish habitat.

Massachusetts Division of Marine Fisheries

Resource Assessment Project

Inshore Bottom-Trawl Survey Program

Background

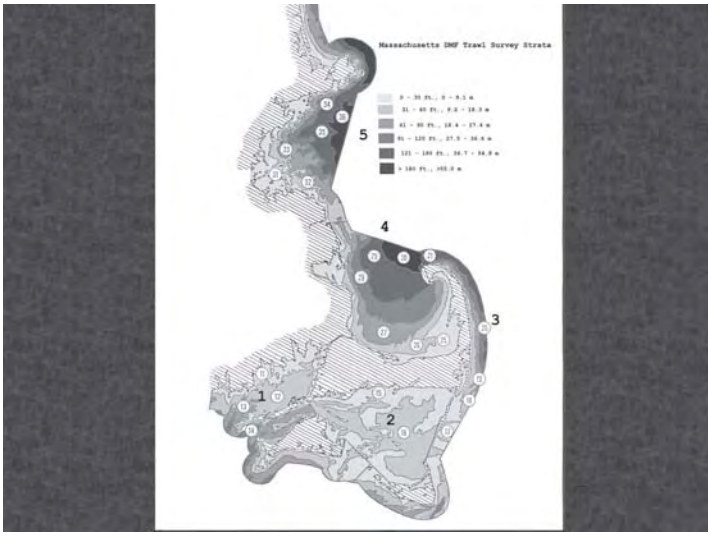
- 26 year time-series - survey began in 1978
- Accomplished twice per year - May and September
- Coast to 3 mile-limit and all of Cape Cod Bay and Nantucket Sound

Survey Objectives

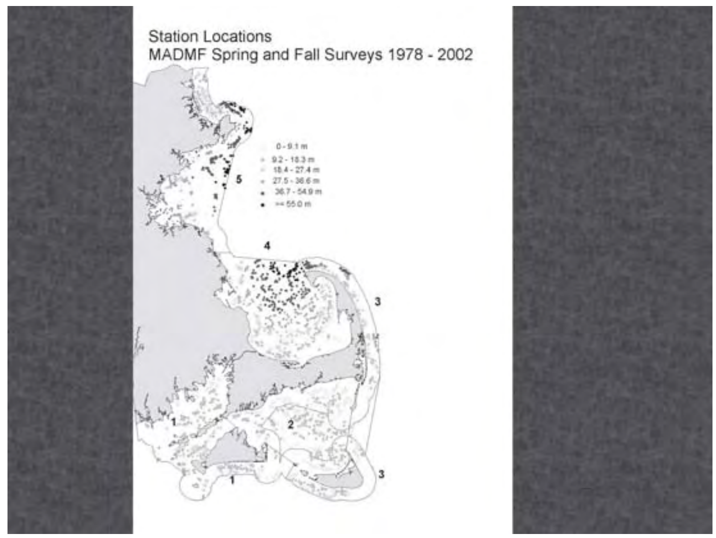
- Primary
  - describe relative abundance (weight / number per tow)
  - size / age composition
  - geographic distribution
  - hydrographic observations
- Secondary
  - maturity observations
  - pathology observations
  - contaminant monitoring
  - water quality monitoring

Survey Design

- Random Stratified Sampling Design
  - Depth / Geographic Division
  - Sampling frequency proportional to stratum area
  - Sampling Stations chosen randomly
  - Average of 93 stations accomplished per survey



Survey stratified by depth and region



Station locations

Sampling Gear

- 3/4 size North Atlantic-type two-seam otter trawl
- Tow speed of 2.5 knots
- Tow duration of 20 minutes


RV Gloria Michelle

Net being set out

Emptying cod-end on deck

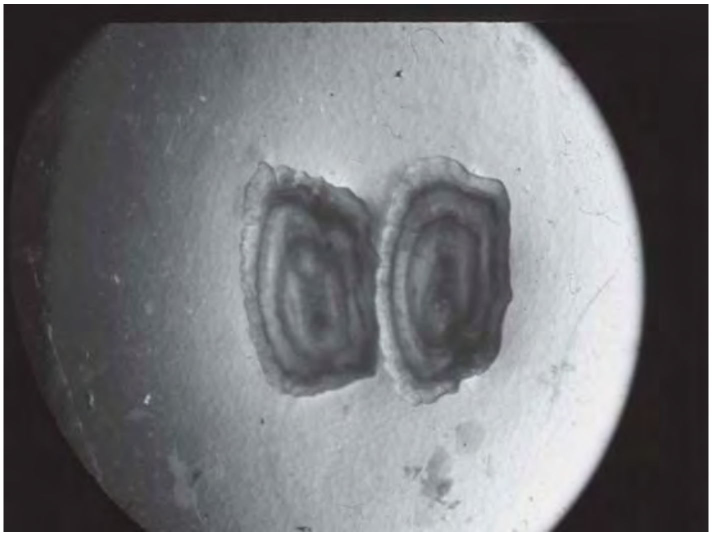
Unsorted catch in the checker

Sorting the catch by species

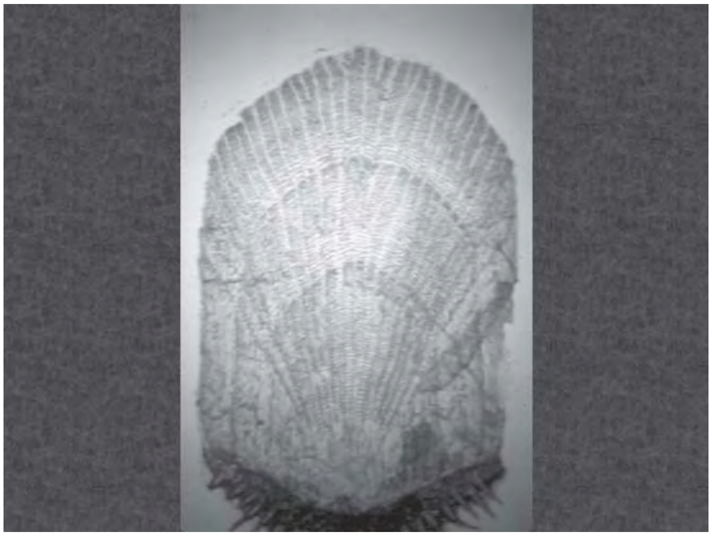
Weighing the catch by species

Measuring the length by species

Taking the otolith from a cod for ageing

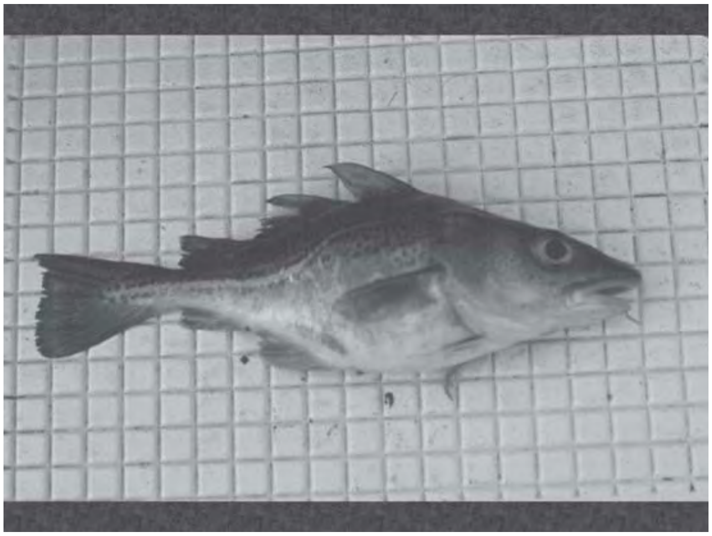


Winter flounder otolith showing annuli (annual rings) used to determine age



Winter flounder scale (annuli)

Winter flounder external pathology (ambi-coloration)



Dwarf cod

Summary Statistics

- Spring Surveys
  - average 69 species per survey
  - 15,000 kg total weight
  - 69,000 individuals
- Autumn Surveys
  - average 88 species per survey
  - 28,000 kg total weight
  - 233,000 individuals

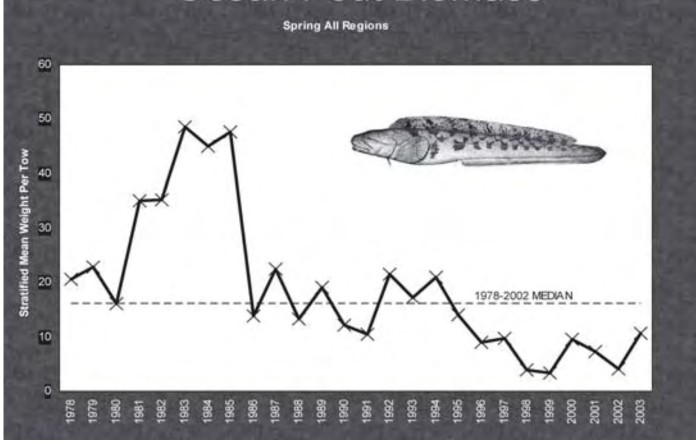
Data Management

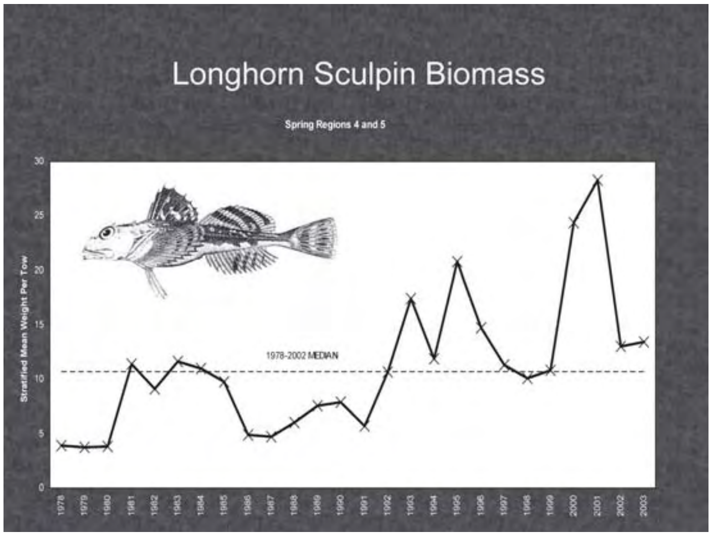
- Data managed by RAP staff with support of NMFS Woods Hole Lab
- Data is housed on NMFS SUN™ in Oracle
- Preliminary and annual reports issued periodically
- Frequent data summaries produced by request

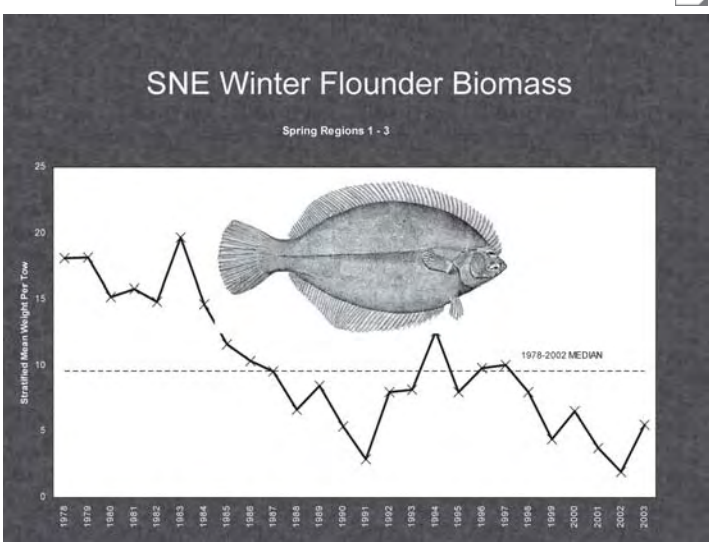
Data Utility

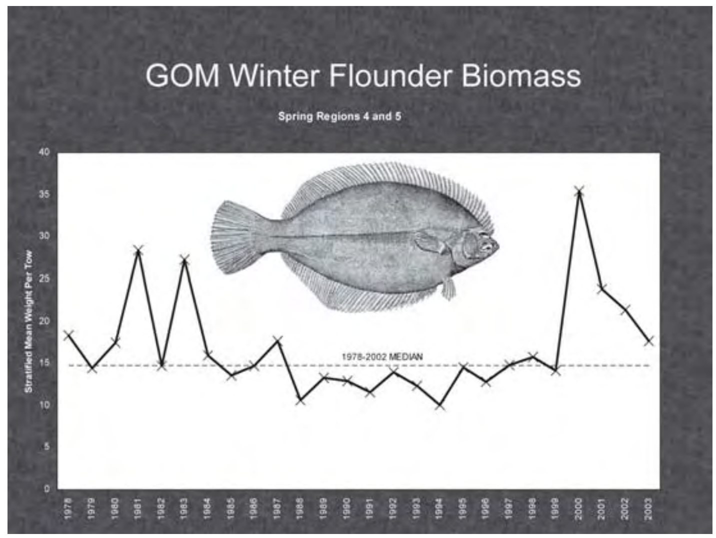
- Trends in biomass and abundance - Stock Assessments
- Developing and evaluating area closures
- Minimum size/mesh size restrictions
- Defining Essential Fish Habitat

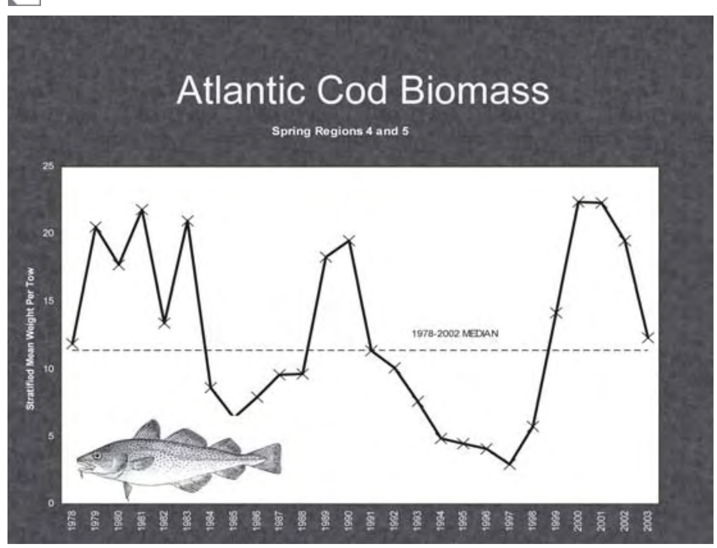
Ocean Pout Biomass

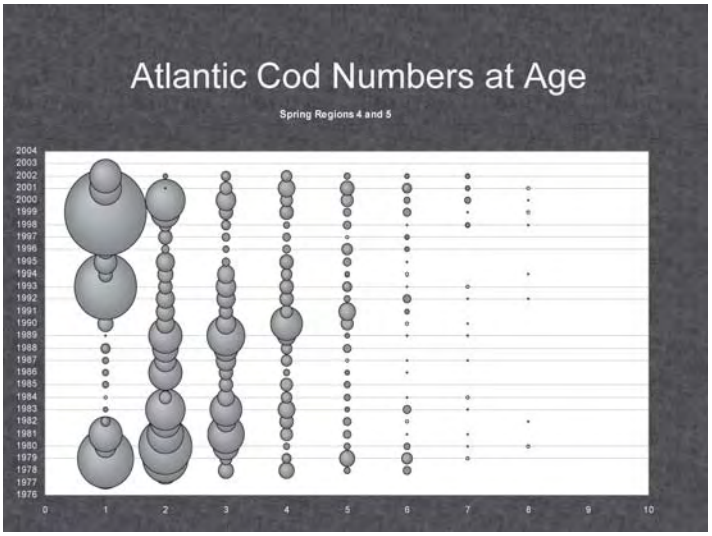



Longhorn Sculpin Biomass
Spring Regions 4 and 5
Stratified Mean Weight Per Tow
1978-2002 MEDIAN

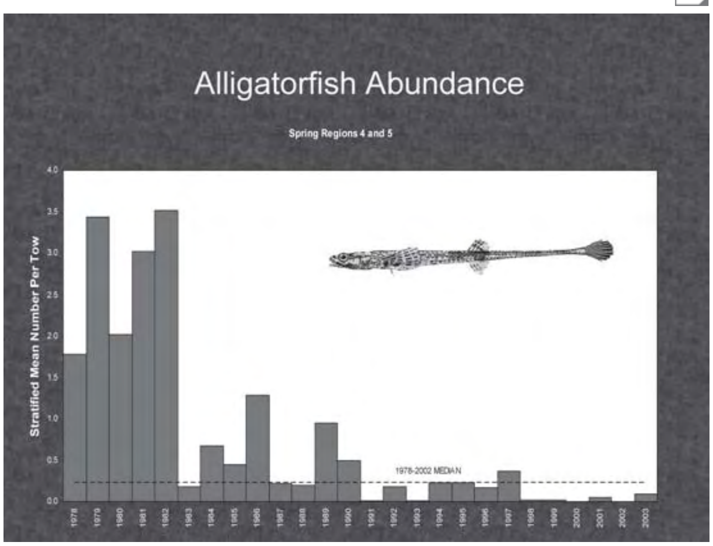

SNE Winter Flounder Biomass
Spring Regions 1 - 3
Stratified Mean Weight Per Tow
1978-2002 MEDIAN

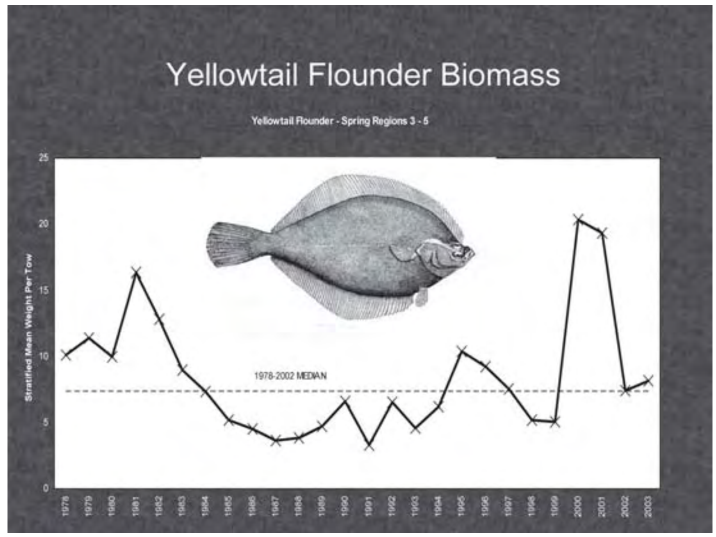

GOM Winter Flounder Biomass
Spring Regions 4 and 5
Stratified Mean Weight Per Tow
1978-2002 MEDIAN

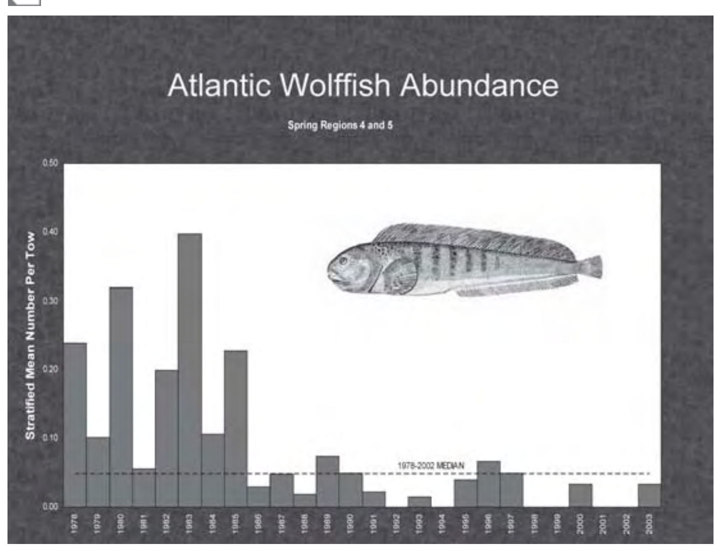

Atlantic Cod Biomass
Spring Regions 4 and 5
Stratified Mean Weight Per Tow
1978-2002 MEDIAN



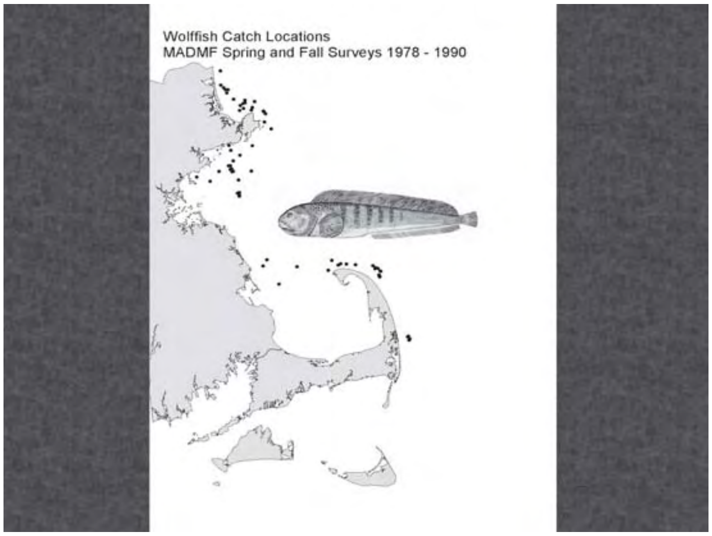
Bubble plot—size of bubble proportional to number at age



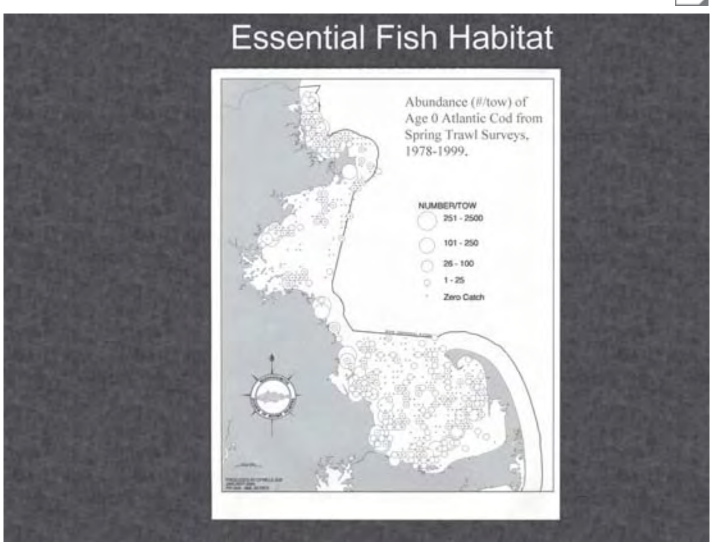




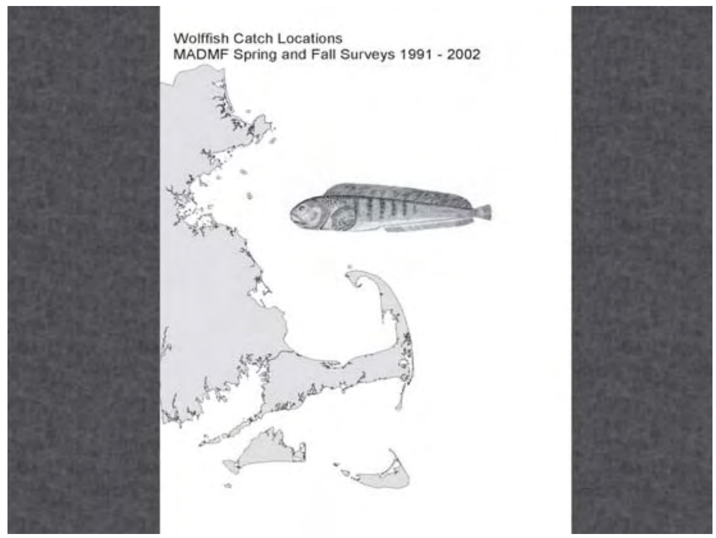
Wolffish abundance—note decline in abundance over time



Distribution of wolfish catches when abundance was relatively high



Geographic distribution of cod helps to define essential fish habitat



Truncated distribution of wolfish when abundance was low

What is the Massachusetts Bays Region?

Peter J. Hanlon
Massachusetts Bays Program
251 Causeway Street, Suite 800
Boston, MA 02114
(617) 626-1230
peter.j.hanlon@state.ma.us

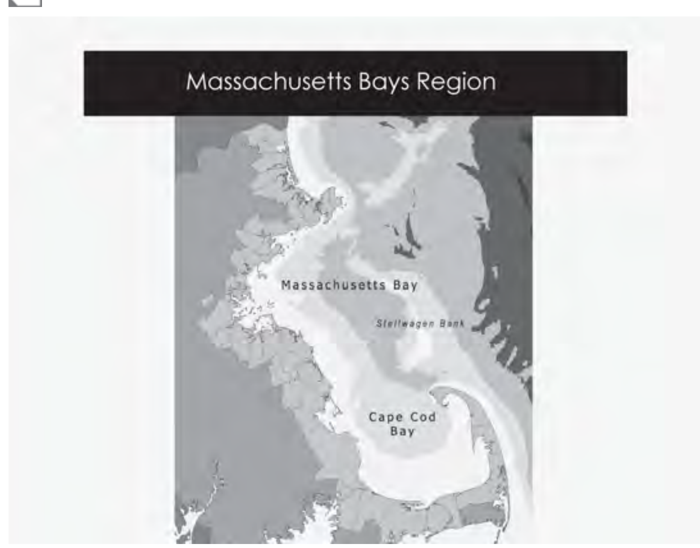
The Massachusetts Bays are located at the southern end of the Gulf of Maine Watershed. Mr. Hanlon explained that based on the region's large size, the Massachusetts Bays Program focuses on the fifty Massachusetts communities adjacent to the Bays, an area with a population of 1.7 million residents. For management purposes, the region is broken down into five subgroups: the Upper North Shore, Salem Sound, Boston Metro, South Shore, and Cape Cod. All five regions have seen population and development increases over the time period from 1990 to 2000, with Cape Cod having the greatest population increase of 28.5 percent. Within the Massachusetts Bays region over 50,000 acres have been developed for residential use, and 58,000 acres of forestland has been lost, mostly to residential development. Nearly 25 percent of the region's land has been permanently protected from future development.

Studies have shown that watersheds with greater than ten percent of their land area covered by impervious surface may suffer from degraded water quality, and greater than 20 percent imperviousness may cause significant deterioration. An estimated 20 percent of the Massachusetts Bays region is covered by impervious surfaces. Furthermore, it was noted that within the region, every community exceeded ten percent impervious surface coverage. The 2002 Pew Oceans Commission Coastal Sprawl report highlighted suburban development patterns, growth in auto use, and land consumption as the main drivers of coastal pollution and habitat degradation. Connections between land use and ecosystem performance need to be examined further.


What is the Massachusetts Bays Region?


Bay of Fundy
Nova Scotia
ME
NH
MA
Gulf of Maine
Massachusetts Bay
Cape Cod Bay
Georges Bank


Massachusetts Bays Watershed
Maine
New Hampshire
Massachusetts


Massachusetts Bays Region
Massachusetts Bay
Stellwagen Bank
Cape Cod Bay

Upper North Shore
(Eight Towns and the Bay/MVPC)

1990-2000
Population Change:
+8.4%
New Housing Units:
+7.4%

Salem Sound
(Salem Sound Coastwatch)

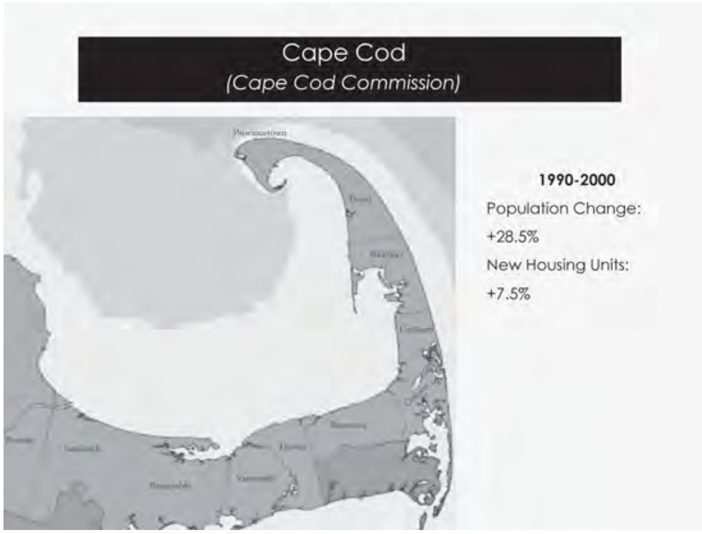
1990-2000
Population Change:
+3.7%
New Housing Units:
+4.4%

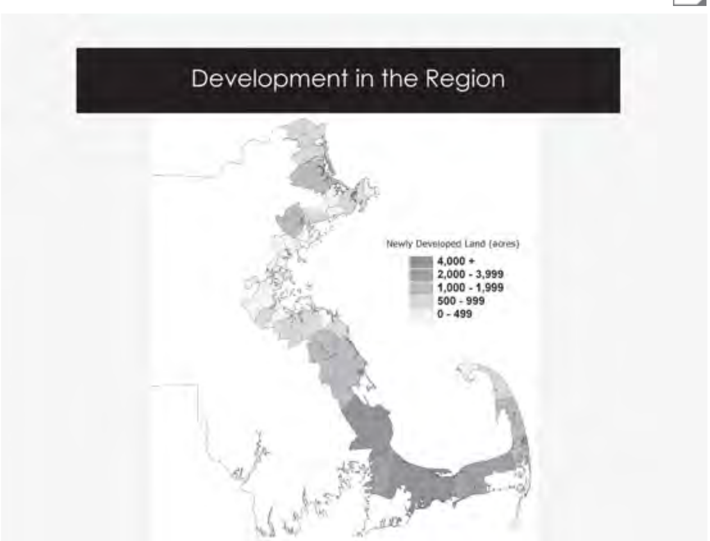
Boston Metro

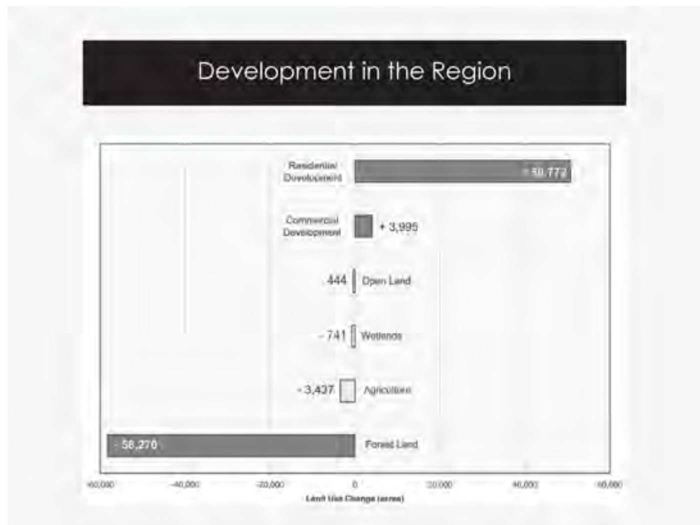
1990-2000
Population Change:
+3.9%
New Housing Units:
+2.0%

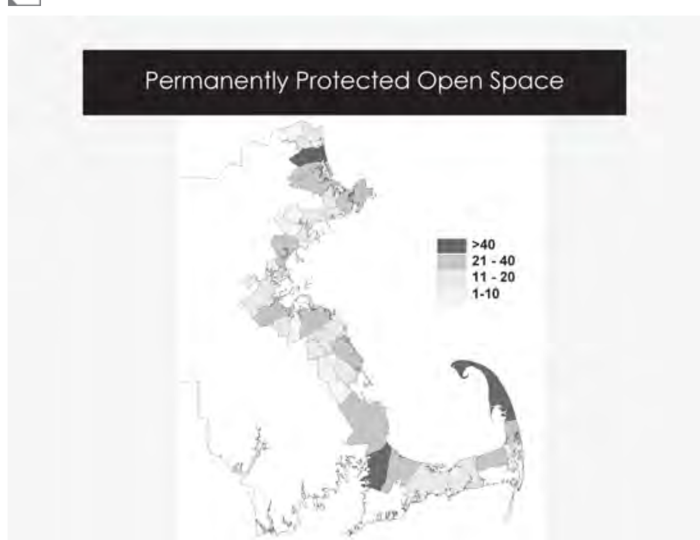
South Shore
(North and South Rivers Watershed Association)

1990-2000
Population Change:
+11.6%
New Housing Units:
+11.2%


Cape Cod
(Cape Cod Commission)
1990-2000
Population Change:
+28.5%
New Housing Units:
+7.5%


Development in the Region
Newly Developed Land (acres)
4,000 +
2,000 - 3,999
1,000 - 1,999
500 - 999
0 - 499


Development in the Region
+ 3,995
444
Open Land
- 741
- 3,437
- 58,270
Forest Land
0


Permanently Protected Open Space
>40
21 - 40
11 - 20
1-10


Impervious Surface
38 - 48
34 - 37
28 - 33
20 - 27
18 - 19
14 - 17
10 - 13


Connections
Coastal Sprawl
Pew *Coastal Sprawl* Report
Major drivers of coastal pollution and habitat degradation:
· Suburban development patterns
· Growth in auto use
· Land consumption
Connection between land use changes and coastal ecosystem performance are not well understood. Cross-disciplinary work that links regional planning to ecosystem health has been rare.


MASSACHUSETTS BAYS PROGRAM

Losing Ground: At What Cost?

Jack Clarke
Massachusetts Audubon Society
208 South Great Road
Lincoln, MA 01773
(781) 259-9500
jclarke@massaudubon.org

The relationship of land development with the coast is illustrated by recent growth within coastal Massachusetts communities. According to a new Mass Audubon report, *Losing Ground: At What Cost?* (the latest edition in its *Losing Ground* series), low density, large lot residential development continues to consume forest and agricultural land in ecologically sensitive areas. The report is based on research into changes in land use and their impact on habitat, biodiversity, and ecosystem services in Massachusetts.

Mr. Clarke stated that while the state has seen little or no growth in single-family housing starts, residential development represents a growing proportion of land consumption. Forty acres of habitat are lost per day in Massachusetts, 88 percent of which is for housing. The average living area for new homes increased 44 percent between 1970 and 2002, while average lot sizes increased 47 percent in the same period. Average lot sizes more than doubled in Plymouth, Bristol, Essex, Franklin, and Hampshire counties. Particularly inefficient land consumption involving a large number of acres per new housing unit or new permanent resident could be seen in a "sprawl frontier" running through Worcester County and north of the Cape Cod Canal. This new type of development is unsustainable.

There are five million acres of land in Massachusetts; one million acres are protected and one million acres are developed. This leaves three million acres open for development and Mass Audubon is calling to protect at least half of the three million acres. The growth due to the expansion of the commuter railway system is creating a mounting need to create a plan for housing development growth. Mr. Clarke emphasized that this is a warning to the government that help with growth issues is desperately needed. The last administration in the White House budgeted $70 million dollars to deal with the growth issue, that budget has been reduced to just $18 million under the current administration. Mr. Clarke emphasized that it is important to focus on sustainable development, smart growth, zoning reform, and creating an infrastructure for planning for development.

Losing Ground: At What Cost?

3rd edition of Losing Ground Series

Findings & Recommendations

Mass Audubon

November 3, 2003

Losing Ground: At What Cost?

- Changes in Statewide Land Use
- Housing and Sprawl
- State of Land Protection
- Land Use Threats to Biodiversity
- Value of Ecosystem Services
- Conclusions and Recommendations

Losing Ground: Partnerships

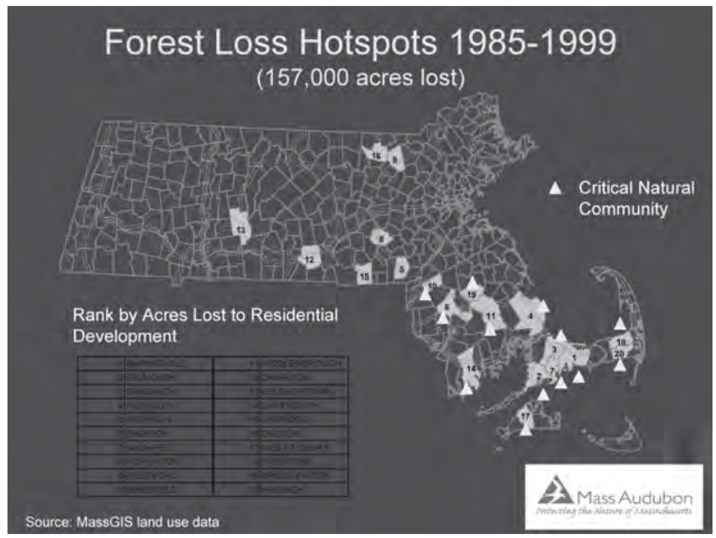
- GIS data and technical assistance: MassGIS (EOEA)
- Assessor database: The Warren Group
- Ecosystem Services analysis and GIS: Dr. Matthew Wilson and Dr. Austin Troy, Gund Institute, University of Vermont
- Support, input and feedback provided by EOEA, MAPC, MLTC, TTOR, TNC, TPL, AMC, ECGA, CCCLT

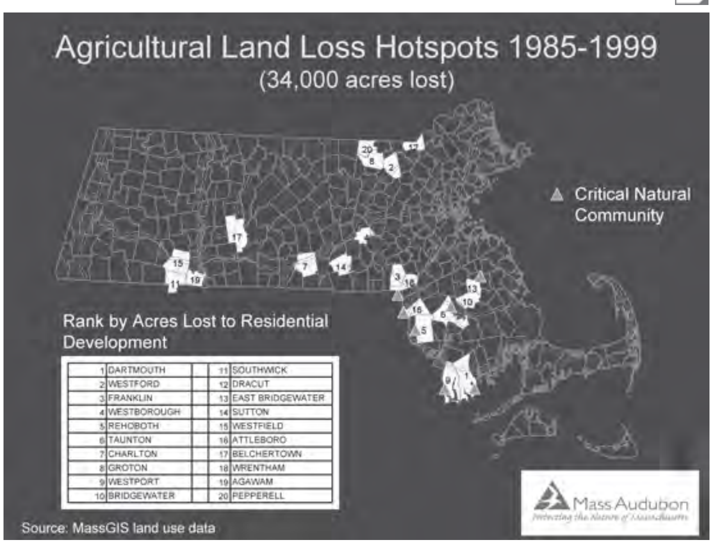
Changes in Land Use

"Visible" Changes in Land Use - Findings

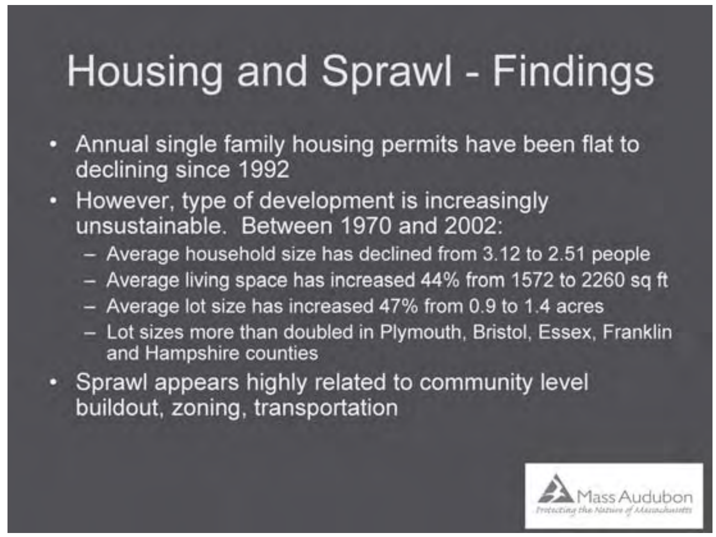
- 202,000 acres, or 40 acres per day, lost to development between 1985 and 1999
  - Includes 31 acres of forest, 7 acres of agricultural land and 2 acres of open space converted each day
- 88% of land converted to development was used for housing
  - 65% of housing land used for low density development
- 24% of the state land area was developed as of 1999, vs. 19% in 1985 and 17% in 1971

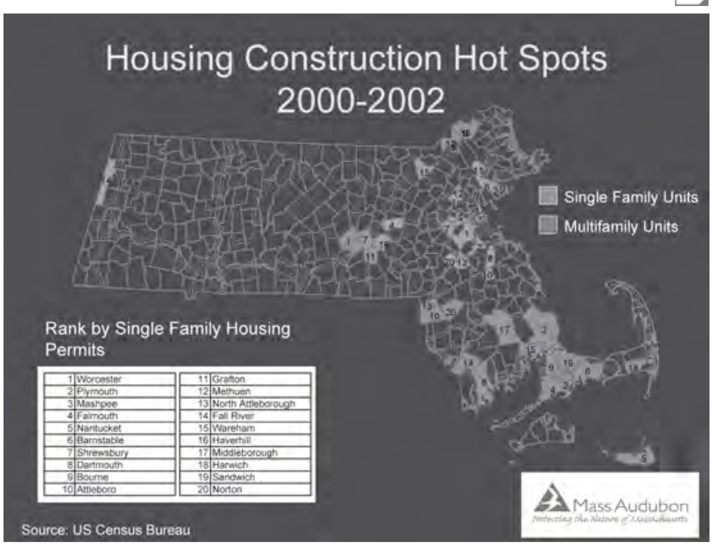
Mass Audubon



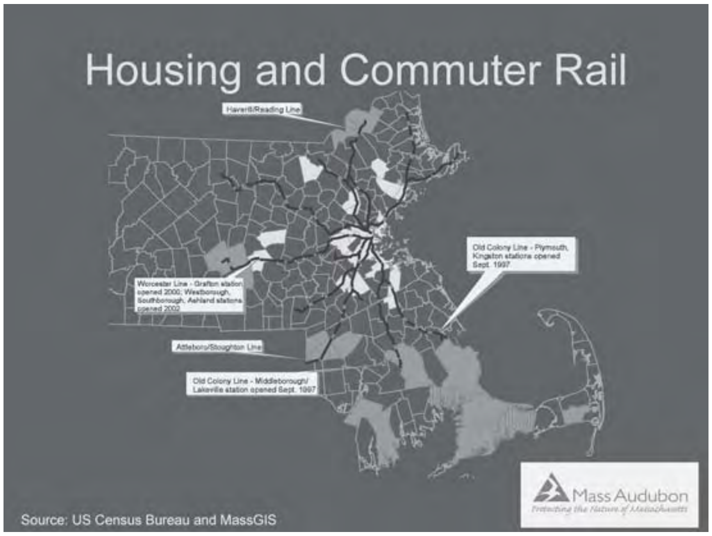



Housing and Sprawl
Mass Audubon
Protecting the Nature of Massachusetts

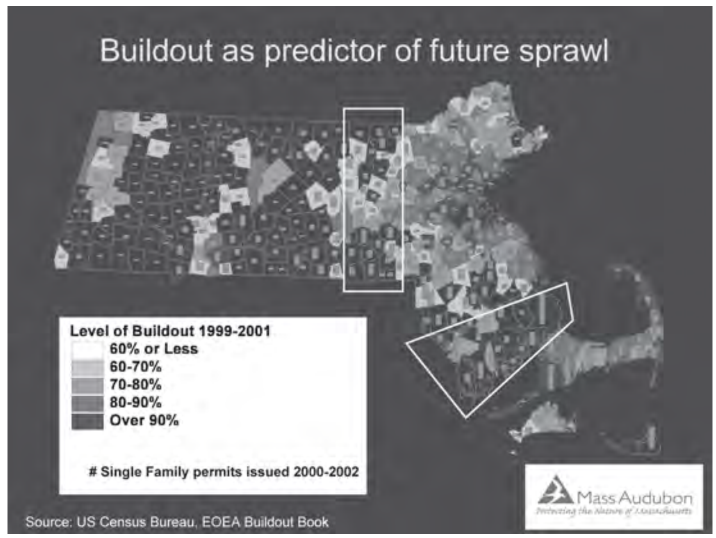

Housing and Sprawl - Findings
• Annual single family housing permits have been flat to declining since 1992
• However, type of development is increasingly unsustainable. Between 1970 and 2002:
– Average household size has declined from 3.12 to 2.51 people
– Average living space has increased 44% from 1572 to 2260 sq ft
– Average lot size has increased 47% from 0.9 to 1.4 acres
– Lot sizes more than doubled in Plymouth, Bristol, Essex, Franklin and Hampshire counties
• Sprawl appears highly related to community level buildout, zoning, transportation
Mass Audubon
Protecting the Nature of Massachusetts


Housing Construction Hot Spots 2000-2002
Single Family Units
Multifamily Units
Rank by Single Family Housing Permits
1 Worcester
2 Plymouth
3 Mashpee
4 Falmouth
5 Nantucket
6 Barnstable
7 Shrewsbury
8 Dartmouth
9 Bourne
10 Attleboro
11 Grafton
12 Methuen
13 North Attleborough
14 Fall River
15 Wareham
16 Haverhill
17 Middleborough
18 Harwich
19 Sandwich
20 Norton
Source: US Census Bureau
Mass Audubon
Protecting the Nature of Massachusetts

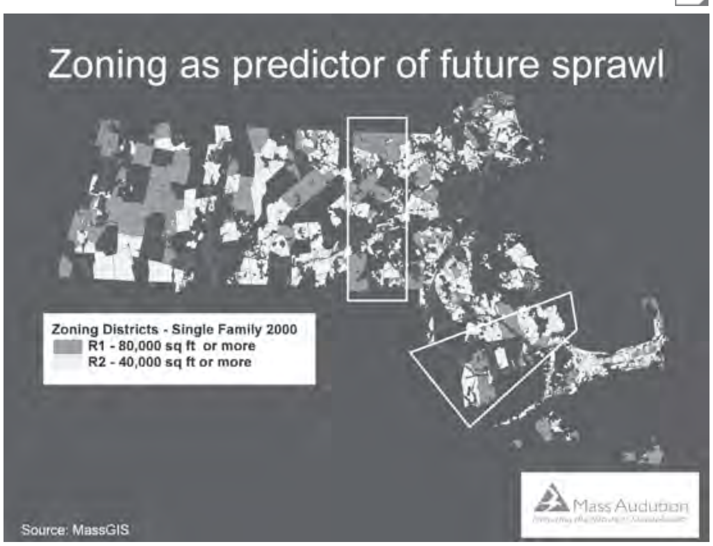

Changing Housing Characteristics
Average Lot Size - Single Family Residential Houses 1970 & 2002
Dukes*
Worcester
Suffolk*
Plymouth
Norfolk
Nantucket+
Middlesex
Hampshire
Hampden*
Franklin
Essex
Bristol
Berkshire
Barnstable
2002
1970
Average Lot Size (acres)
Mass Audubon
Protecting the Nature of Massachusetts



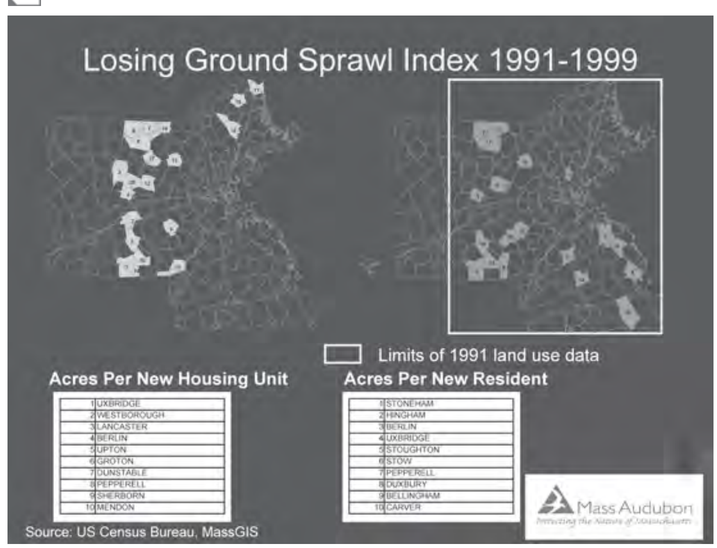
Housing and Commuter Rail
Haverill/Reading Line
Old Colony Line - Plymouth, Kingston stations opened Sept. 1997
Worcester Line - Grafton station opened 2000; Westborough, Southborough, Ashland stations opened 2002
Attleboro/Stoughton Line
Old Colony Line - Middleborough/ Lakeville station opened Sept. 1997
Mass Audubon
Source: US Census Bureau and MassGIS



Buildout as predictor of future sprawl
Level of Buildout 1999-2001
60% or Less
60-70%
70-80%
80-90%
Over 90%
Single Family permits issued 2000-2002
Mass Audubon
Source: US Census Bureau, EOEA Buildout Book



Zoning as predictor of future sprawl
Zoning Districts - Single Family 2000
R1 - 80,000 sq ft or more
R2 - 40,000 sq ft or more
Mass Audubon
Source: MassGIS



Losing Ground Sprawl Index 1991-1999
Limits of 1991 land use data
Acres Per New Housing Unit
1 UXBRIDGE
2 WESTBOROUGH
3 LANCASTER
4 BERLIN
5 UPTON
6 GROTON
7 DUNSTABLE
8 PEPPERELL
9 SHERBORN
10 MENDON
Acres Per New Resident
1 STONEHAM
2 HINGHAM
3 BERLIN
4 UXBRIDGE
5 STOUGHTON
6 STOW
7 PEPPERELL
8 DUXBURY
9 BELLINGHAM
10 CARVER
Mass Audubon
Source: US Census Bureau, MassGIS

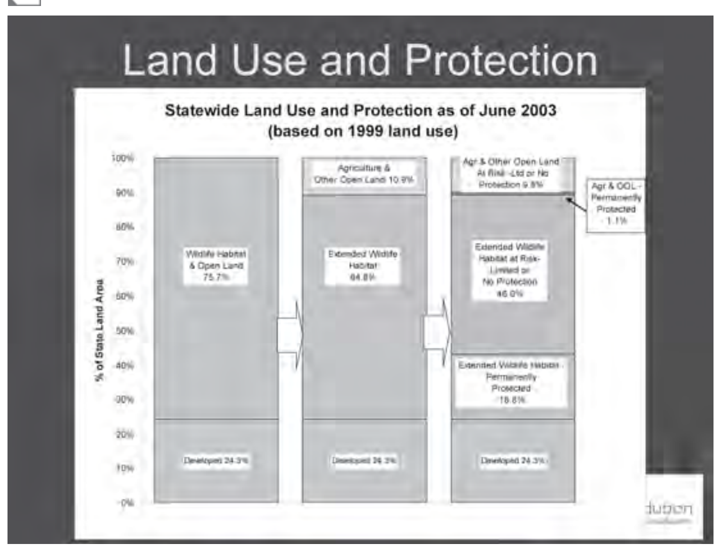
State of Land Protection

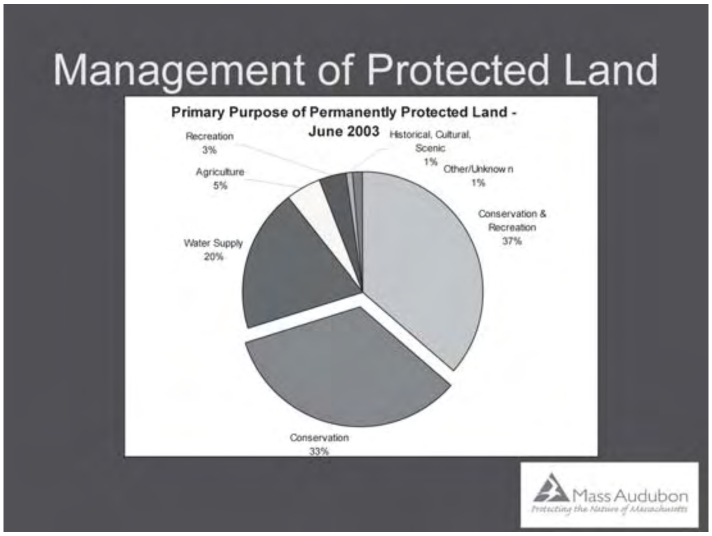
Mass Audubon
Protecting the Nature of Massachusetts

State of Land Protection - Findings

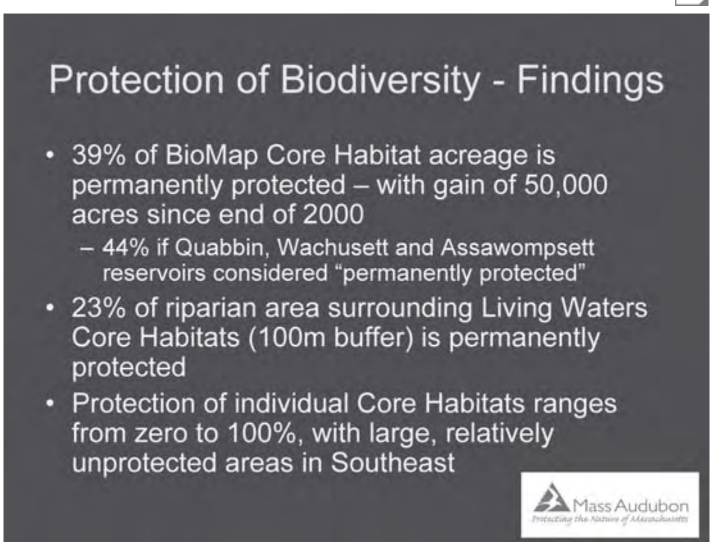
- 29% of extended wildlife habitat is permanently protected; 71% is unprotected
  - Forest, wetlands, open space designated for conservation, conservation/recreation, water supply
  - Inland water bodies are considered habitat but are generally *excluded* from protected open space data
- 24% of state land area is developed, 19% is permanently protected wildlife habitat, 46% is unprotected wildlife habitat
- 90% of permanently protected land has habitat value; 33% protected primarily for conservation
  - Potential of conflicting use in water supply, dual use conservation/recreation land

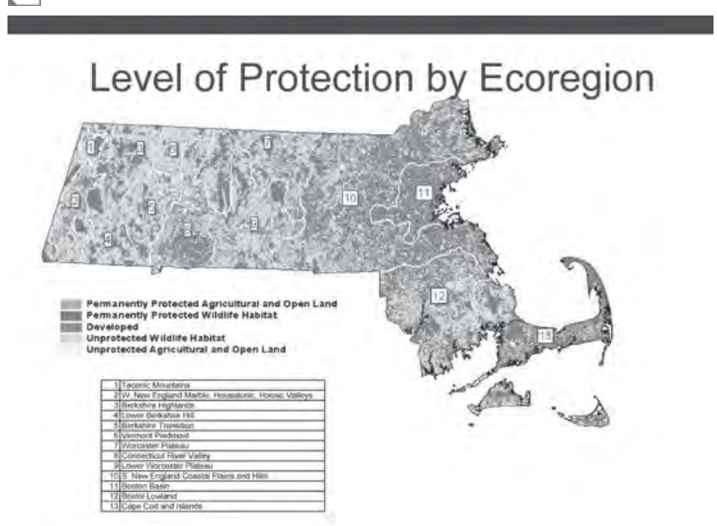
Mass Audubon
Protecting the Nature of Massachusetts

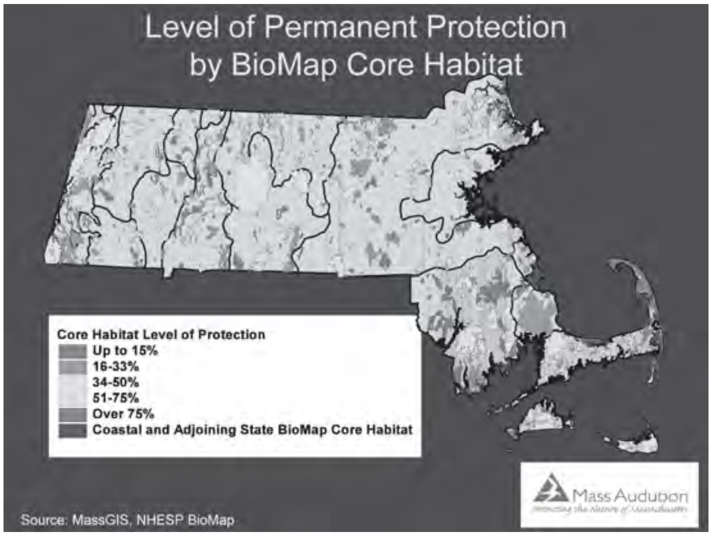


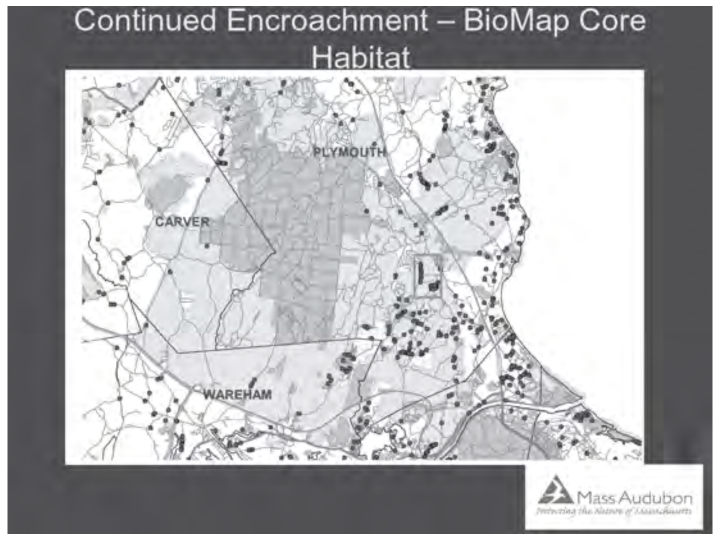

Management of Protected Land
Primary Purpose of Permanently Protected Land - June 2003
Recreation 3%
Historical, Cultural, Scenic 1%
Other/Unknown 1%
Agriculture 5%
Conservation & Recreation 37%
Water Supply 20%
Conservation 33%
Mass Audubon
Protecting the Nature of Massachusetts

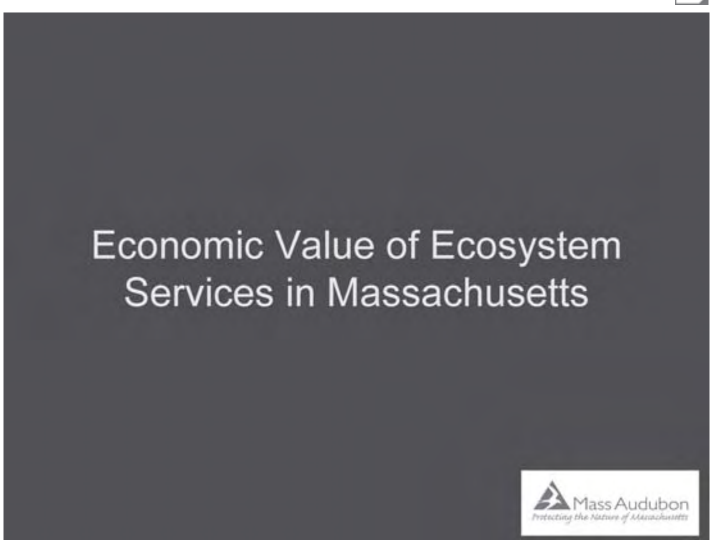

Protection of Biodiversity in Massachusetts
Mass Audubon
Protecting the Nature of Massachusetts


Protection of Biodiversity - Findings
• 39% of BioMap Core Habitat acreage is permanently protected – with gain of 50,000 acres since end of 2000
– 44% if Quabbin, Wachusett and Assawompsett reservoirs considered "permanently protected"
• 23% of riparian area surrounding Living Waters Core Habitats (100m buffer) is permanently protected
• Protection of individual Core Habitats ranges from zero to 100%, with large, relatively unprotected areas in Southeast
Mass Audubon
Protecting the Nature of Massachusetts


Level of Protection by Ecoregion
Permanently Protected Agricultural and Open Land
Permanently Protected Wildlife Habitat
Developed
Unprotected Wildlife Habitat
Unprotected Agricultural and Open Land
1 Taconic Mountains
2 W. New England Marble, Housatonic, Hoosic Valleys
3 Berkshire Highlands
4 Lower Berkshire Hill
5 Berkshire Transition
6 Vermont Piedmont
7 Worcester Plateau
8 Connecticut River Valley
9 Lower Worcester Plateau
10 S. New England Coastal Plains and Hills
11 Boston Basin
12 Bristol Lowland
13 Cape Cod and Islands







ECOSYSTEM SERVICE	EXAMPLE	SCALE
Climate and Atmospheric Gas Regulation	Maintenance of a favorable climate for human habitation	Global
Freshwater Regulation and Supply	Provision of water for drinking, irrigation	Regional
Waste Assimilation	Pollution control/detoxification and filtering of water and air	Regional
Nutrient Regulation	Nitrogen fixation in healthy soils and phosphorous fixation in wetland ecosystems	Regional
Habitat Refugium	Provision of suitable living space for wild plants and animals	Regional
Soil Retention and Formation	Maintenance of arable land and prevention of damage from erosion/siltation; maintenance of natural productive soils	Local
Pollination	Services provided by natural pollinators such as insects and birds	Local
Recreation and Aesthetic Benefits	Tourism, outdoor sports, and enjoyment of scenery	Local
Disturbance Prevention	Storm protection and flood prevention	Local

Ecosystem Services - Findings

- Undeveloped, agricultural and recreational lands provide $6.3 billion annually in *non-market* ecosystem services based on 1999 land use
  - 85% of this value from land left in its natural state
- $200 million in annual non-market ecosystem services were lost to due development between 1985 and 1999
- Freshwater wetlands have highest per acre value; Forest cover has highest aggregate value
- Highest per acre service values can be found on Cape and Southeast, North Shore, Miller/Chicopee watersheds, Housatonic Watershed

Mass Audubon
Protecting the Nature of Massachusetts

Likely Services vs. Available Research

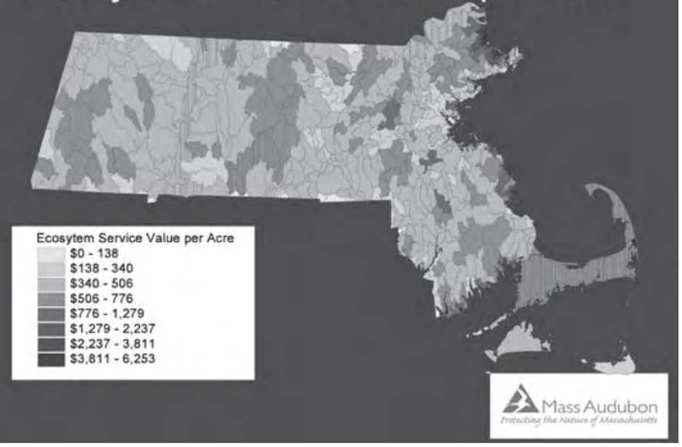
Simplified Land Use Category	Climate Regulation	Freshwater Regulation & Supply	Waste Assimilation & Water Quality	Nutrient Regulation	Habitat Refugium	Soil Formation & Retention	Disturbance Prevention	Pollination	Recreation & Aesthetics
Cropland	⦿			⦿	⦿	●	⦿	●	●
Pasture	⦿			⦿	⦿	⦿	⦿	●	●
Forest	●	⦿	⦿	⦿	●	⦿	●	⦿	●
Wetland-Fresh	⦿	●	●	⦿	●	●	●	⦿	●
Wetland-Salt	⦿	⦿	⦿	●	●	⦿	●	⦿	●
Open Land	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿
Urban green space*	⦿		●	⦿	⦿	⦿		⦿	●
Woody perennial	⦿			⦿	⦿	⦿		●	⦿
Water & Coastal Embayments		●	⦿	⦿	●				●
Water-based Recreation					⦿				⦿
Highly impacted+									

Values by Land Cover

Land Use Type	Ecosystem Services Used in Valuation	# Data Sources	Mean Total $acre/yr (2001 dollars)	Min value	Max value
Freshwater Wetland	Disturbance Prevention; Freshwater Regulation & Supply, Waste Assimilation, Aesthetic/Amenity, Soil Retention	13	**$ 15,452.30**	$ 7,683.96	$ 31,771.74
Salt Wetland	Disturbance Prevention, Nutrient Regulation, Habitat, Recreation	10	**$ 12,579.51**	$ 9,991.02	$ 24,457.18
Freshwater or Coastal Embayment	Freshwater Regulation and Supply, Habitat, Recreation, Aesthetic/Amenity	25	**$ 982.73**	$ 64.37	$ 2,985.37
Forest	Climate and Atmosphere, Disturbance Prevention, Habitat Refugium, Recreation	8	**$ 983.56**	$ 406.78	$ 1,997.53
Cropland	Aesthetic/Amenity, Soil Retention, Pollination	3	**$ 1,387.06**	$ 1,387.06	$ 1,387.06
Pasture	Aesthetic/Amenity, Pollination	2	**$ 1,381.16**	$ 1,381.16	$ 1,381.16
Woody Perennial	Pollination	1	**$ 49.42**	$ 49.42	$ 49.42
Urban Green Space	Waste Assimilation, Recreation	3	**$ 3,429.55**	$ 2,691.90	$ 4,167.20

Mass Audubon
Protecting the Nature of Massachusetts

Ecosystem Service Value per Acre



Mass Audubon
Protecting the Nature of Massachusetts


Recommendations
Mass Audubon
Protecting the Nature of Massachusetts


Call to Action
• State
– Restore past land acquisition funding of $70M annually in support of Statewide Land Conservation Plan
– Enact meaningful zoning reform to close loopholes
– Tie infrastructure investment to local progress on density, brownfield development
– Permanent matching funds for NHESP
• Local
– Adoption of Community Preservation Act
– Adoption for local cluster and conservation zoning, using Open Space Residential Design as model
Mass Audubon
Protecting the Nature of Massachusetts


For copies of report
www.massaudubon.org/losingground
advocacy@massaudubon.org
Mass Audubon
Protecting the Nature of Massachusetts

Integrating Land Use and Water Quality Data to Assess Status and Trends in Nonpoint Source Pollution in the Parker Watershed

Jay Baker
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114
(617) 626-1200
jason.baker@state.ma.us

Mr. Baker discussed how land use affects water quality and how tracking long-term changes in water quality can help in the management of nonpoint source (NPS) pollution. As part of the Massachusetts Coastal Nonpoint Pollution Control Program (1995), CZM and partner agencies have identified a suite of management measures to control nonpoint source pollution. Control measures range from the proper maintenance of septic systems, to the protection of riparian buffers, and include both enforceable and voluntary pollution mitigation practices. A major component of this program is the NPS Monitoring Strategy, which seeks to track the implementation of these management measures and resulting changes in water quality. The difficulty in making the links between best management practices, land use patterns, and water quality trends has led CZM to undertake a pilot monitoring project in the Parker Watershed, which is being used to develop a methodology to conduct comprehensive NPS assessments at the watershed scale. Mr. Baker's presentation provided a preliminary overview of project results, including land use trends in the Parker Watershed, progress in implementing key management measures, and an overview of water quality conditions in the Parker. Project results have revealed a need for standardized, digital reporting of monitoring data, as well as a shared approach to monitoring water quality changes in coastal watersheds. Two important land use characteristics were incorporated into the analysis, impervious cover and riparian buffers. Impervious cover limits the amount of stormwater and runoff that can percolate through the soil resulting in decreased adsorption of nutrients, microbes, and other pollutants, increased water temperatures of local water bodies, decreased groundwater recharge, and higher intensity flooding. Riparian buffers are critical for wildlife habitat, flood prevention, nutrient cycling, and filtration of pollutants. Additional NPS indicators were also identified, including the type, age and location of septic systems, stormwater outfalls, and agricultural operations.

Based on the analysis, the study was able to show general relationships between poor water quality (elevated levels of fecal coliform and lowered dissolved oxygen), increasing impervious surface and development, and loss of riparian buffers: The study was also able to identify water quality "hot spots" and their relationship to changes in land use over time.

The results of the project relate to the Massachusetts Bays in many instances. The study suggests that even the most pristine watersheds, such as the Parker, are seeing water quality impairments as a result of development practices. Also, over the past 20 years, there has been a disproportionate level of development within riparian buffers. Further, it is very difficult to gain a complete understanding of pollution mitigation efforts and overall water quality as a result of the disparate methods used for collecting and storing water quality and management measure information, suggesting that an effort should be made to develop more standardized methods and digital tools for conducting watershed and subwatershed scale assessments.

Status and Trends in Nonpoint Source Pollution in the Parker Watershed

A Watershed Scale Land Use and Water Quality Assessment

Jay Baker
Bruce Carlisle
Marc Carullo

CZM
Massachusetts Office of Coastal Zone Management

Who Has the Recipe for Watershed Scale NPS Assessment?

Our Goal: Evaluate Massachusetts Success in reducing impacts from nonpoint source pollution to coastal waters

- Track the implementation of NPS management measures
- Track resulting changes in water quality

How do we do it for all of coastal Massachusetts?

We're not completely sure

Background: The Coastal NPS Control Program (§6217)

Nonpoint Source Pollution (NPS) (rainfall and snowmelt driven) poses a significant threat to water quality in Massachusetts Bay

Under the CZMA (§6217), coastal states are required to develop comprehensive NPS control plans

The Massachusetts plan (July, 1995) seeks to balance land use activities with the protection of coastal aquatic resources

A key component of the plan is the coastal monitoring strategy

Relate the implementation of the NPS Control Plan with Improvements in Water Quality

Pollution Sources and Management Measures

Septic systems	Upgrades and Maintenance
Road drainage (stormwater outfalls)	Stormwater BMPs
Impervious surfaces	Pervious materials
Residential development	Wastewater management
Agriculture	Agricultural BMPs
Construction activities	Sediment and erosion control
Hydromodification Wetland / Riparian area loss Timber cutting / deforestation	Don't do it / Mitigate

Approach: Comprehensive Land Use and Water Quality Assessment

Develop a framework for evaluating water quality conditions in the context of land use and NPS management measures

Project focus areas:

1) Land use status and trends (development and impervious surfaces)
2) Loss of pollution mitigating resources (wetland and riparian buffers)
3) Implementation of NPS control measures
4) Water quality status and trends

A Range of Questions and Considerations

The ideal: Find significant links between management measures and water quality conditions

A Range of Questions and Considerations

The reality:

Identify waters at high risk from degradation by NPS Pollution

Identify existing NPS pollution "hot spots"

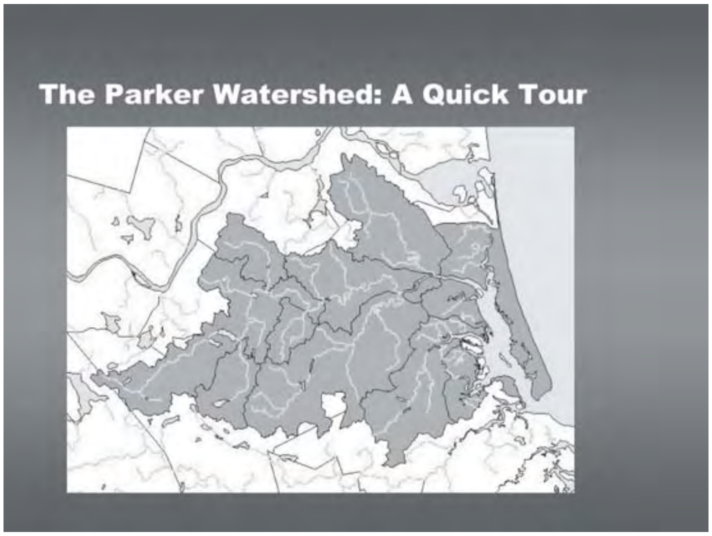
Evaluate success in implementing key NPS management measures

Evaluate the distribution of current NPS monitoring efforts in the watershed

Make follow-up recommendations

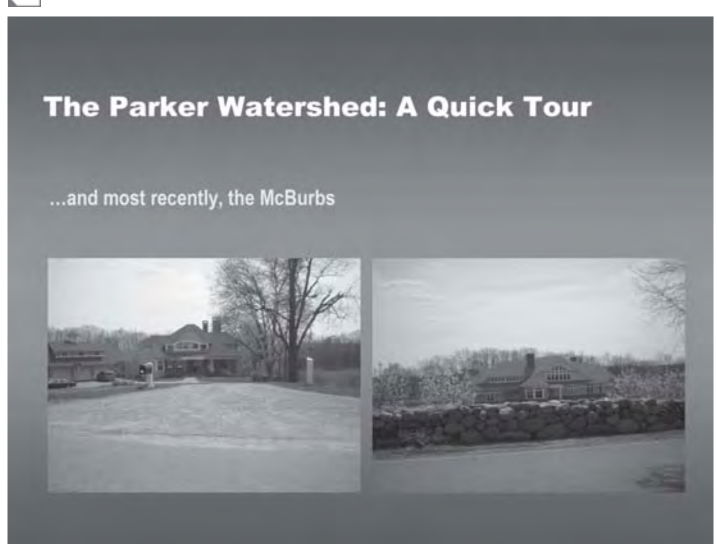
The Parker Watershed: A Quick Tour

- Covers 214 square kilometers in Northeastern Massachusetts
- Made up of nine towns
- Contains the Great Marsh ACEC
- Parker River National Wildlife Refuge
- Only a few permitted wastewater discharges in the watershed
- Lots of water quality data
- Great place for "field work"


The Parker Watershed: A Quick Tour


The Parker Watershed: A Quick Tour
The watershed maintains a rural character


The Parker Watershed: A Quick Tour
...with a few highly developed urban centers


The Parker Watershed: A Quick Tour
...and most recently, the McBurbs

Land Use: The Data Foundation

MacConnell land use layers for 1971, 1985, 1991, and 1999 maintained by MassGIS

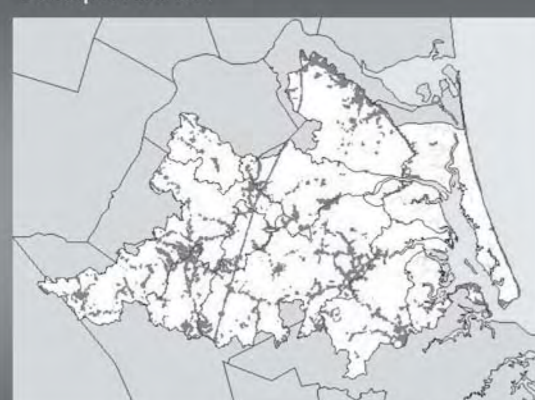
Land Use Type: MacConnell Land Use Categories

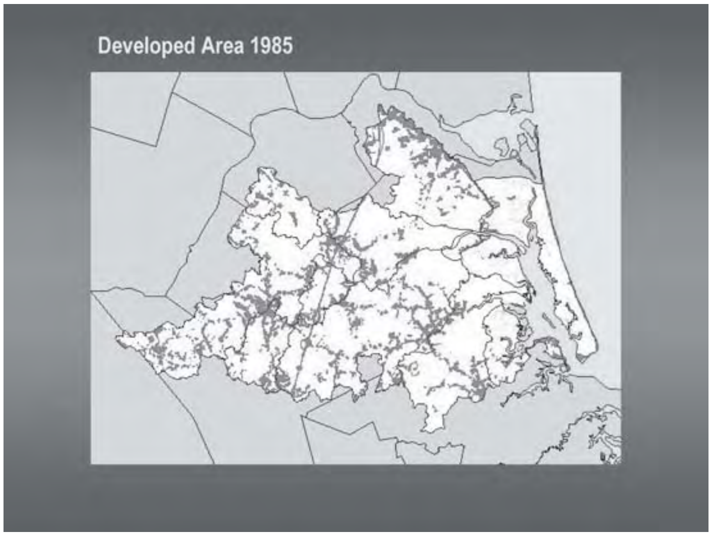
Land Use Code	Land Use Category
1	Cropland
2	Pasture
3	Forest
4	Wetland
5	Mining
6	Open Land
7	Participation Recreation
8	Spectator Recreation
9	Water-based Recreation
10	Multi-family Residential
11	High-density (<1/4 ac) Residential
12	Medium-density (1/4-1/2 ac) Residential
13	Low-density (>1/2 ac) Residential
14	Salt Wetland
15	Commercial
16	Industrial
17	Urban Open
18	Transportation
19	Waste Disposal
20	Water-based Recreation
21	Woody Perennial

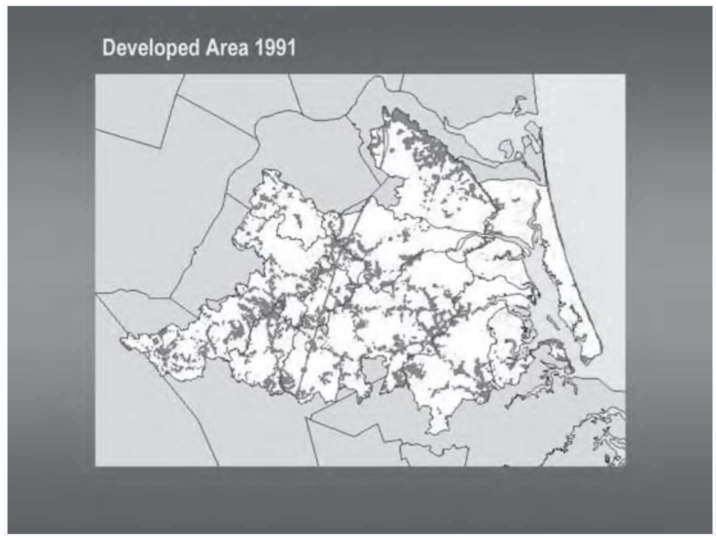
Land Use Type: MacConnell Land Use Categories

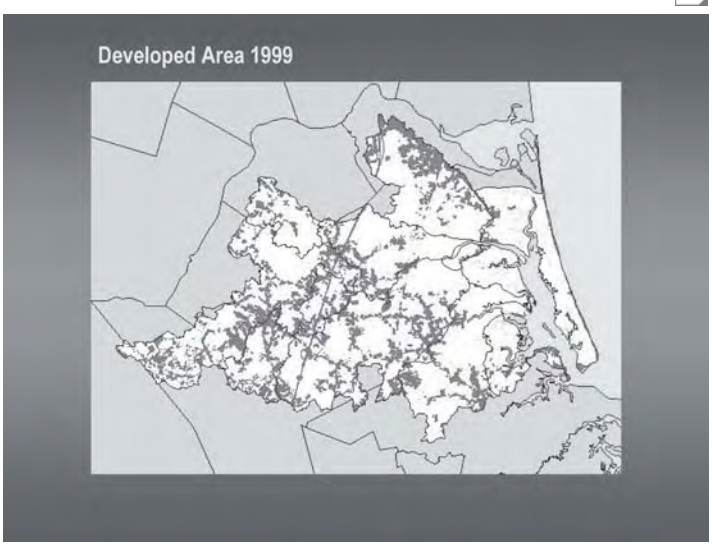
Land Use Code	Land Use Category
1	Cropland
2	Pasture
3	Forest
4	Wetland
5	Mining
6	Open Land
7	Participation Recreation
8	Spectator Recreation
9	Water-based Recreation
10	Multi-family Residential
11	High-density (<1/4 ac) Residential
12	Medium-density (1/4-1/2 ac) Residential
13	Low-density (>1/2 ac) Residential
14	Salt Wetland
15	Commercial
16	Industrial
17	Urban Open
18	Transportation
19	Waste Disposal
20	Water-based Recreation
21	Woody Perennial

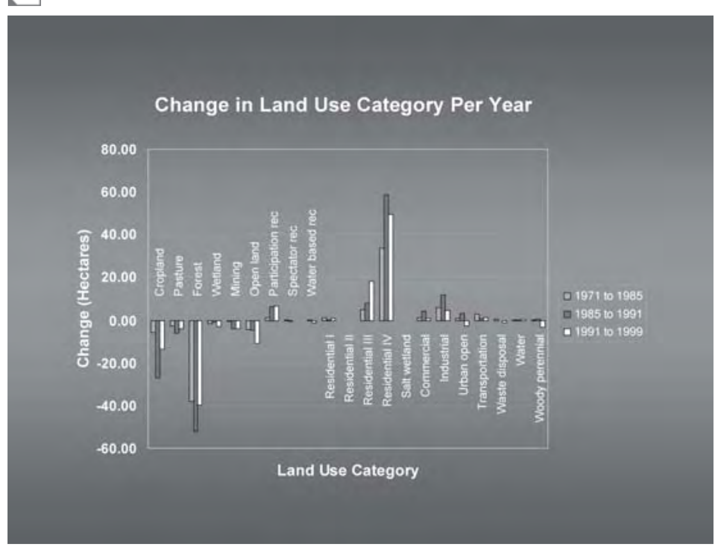
Developed Area 1971




Developed Area 1985


Developed Area 1991


Developed Area 1999

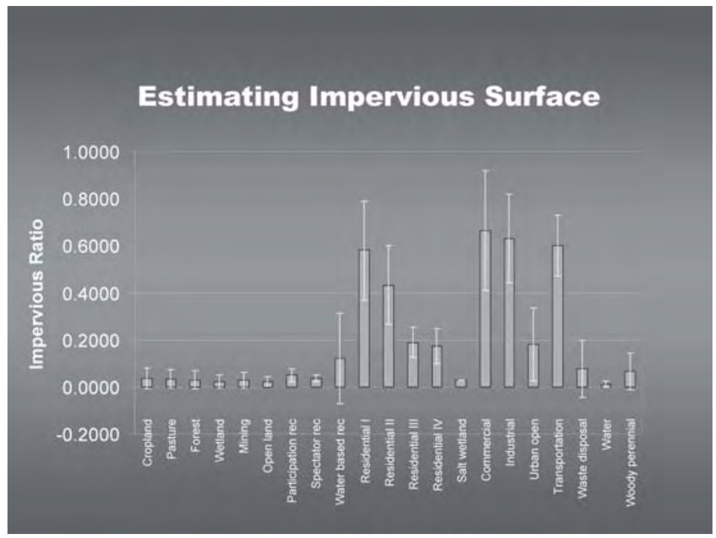

Change in Land Use Category Per Year
Change (Hectares)
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
Cropland
Pasture
Forest
Wetland
Mining
Open land
Participation rec
Spectator rec
Water based rec
Residential I
Residential II
Residential III
Residential IV
Salt wetland
Commercial
Industrial
Urban open
Transportation
Waste disposal
Water
Woody perennial
1971 to 1985
1985 to 1991
1991 to 1999
Land Use Category

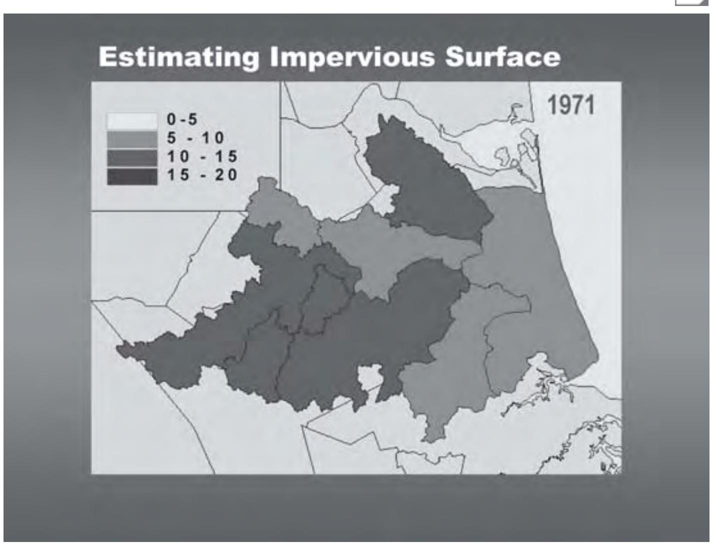
Impervious Cover: A Notorious Indicator

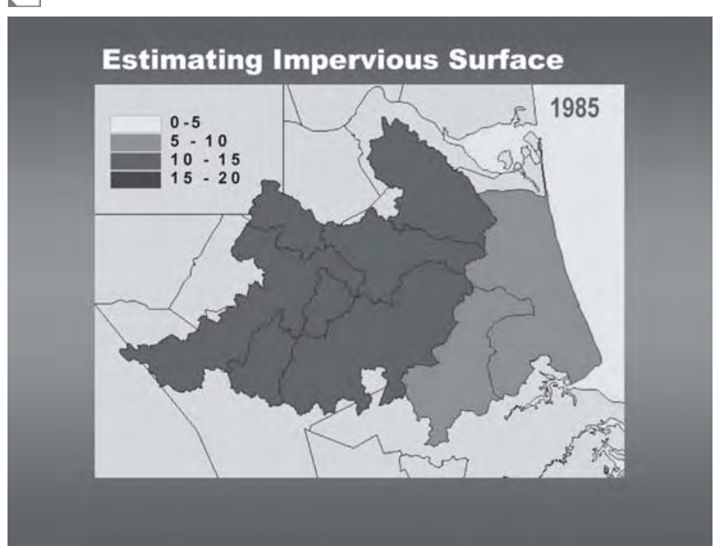
Limits amount of stormwater and runoff that can percolate through the soil resulting in:

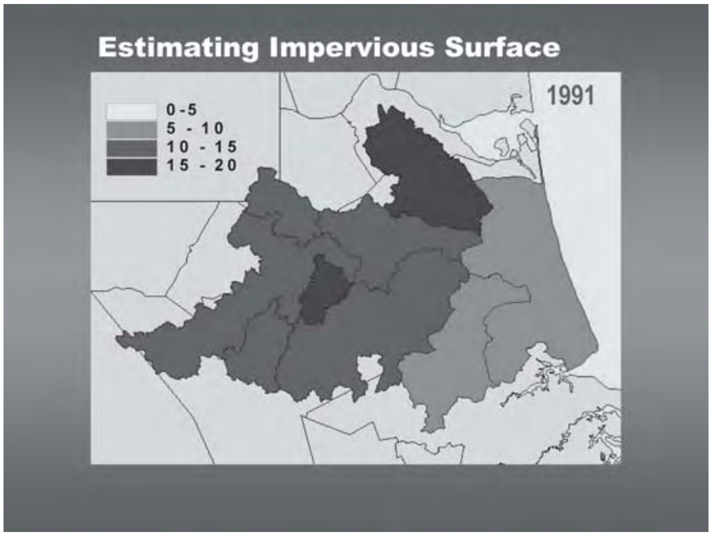
- Decreased adsorption of nutrients, microbes, and other pollutants
- Increased water temperatures
- Decreased groundwater recharge
- Higher intensity flooding

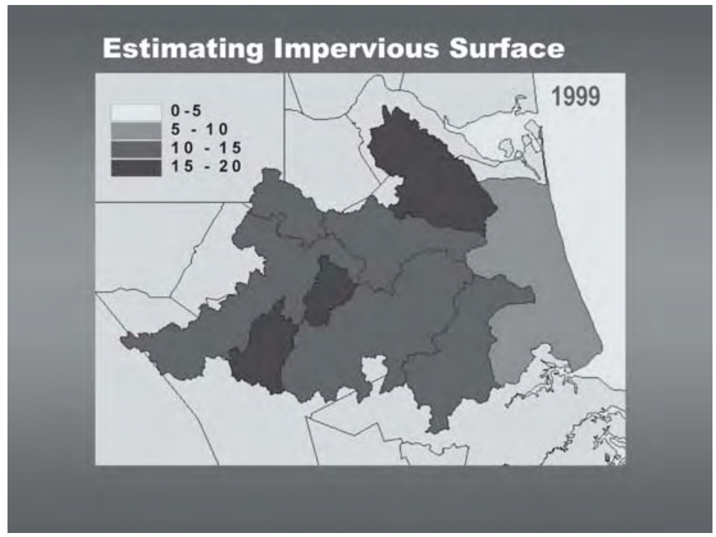
Center For Watershed Protection estimates that > 10% leads to impact; > 25% leads to impairment





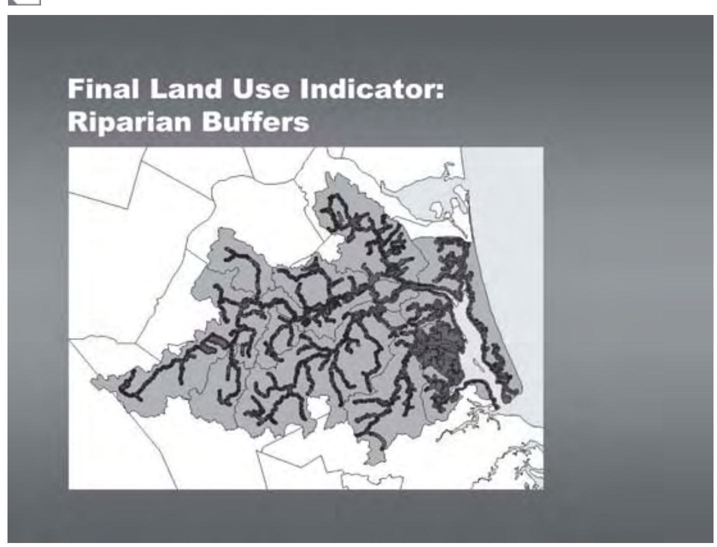


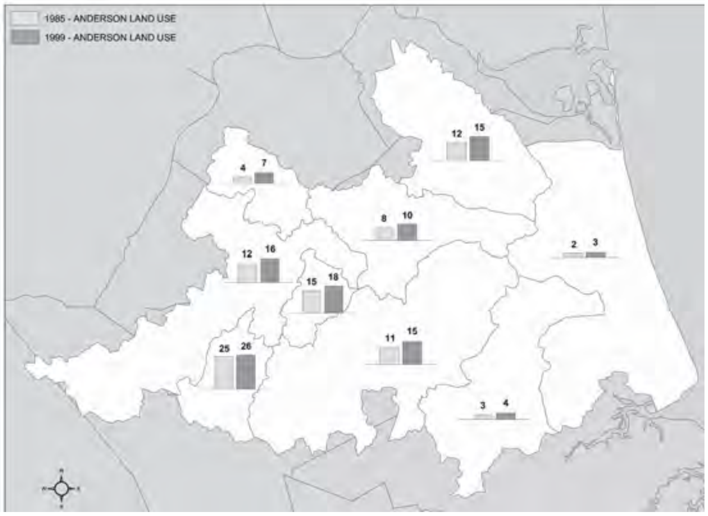


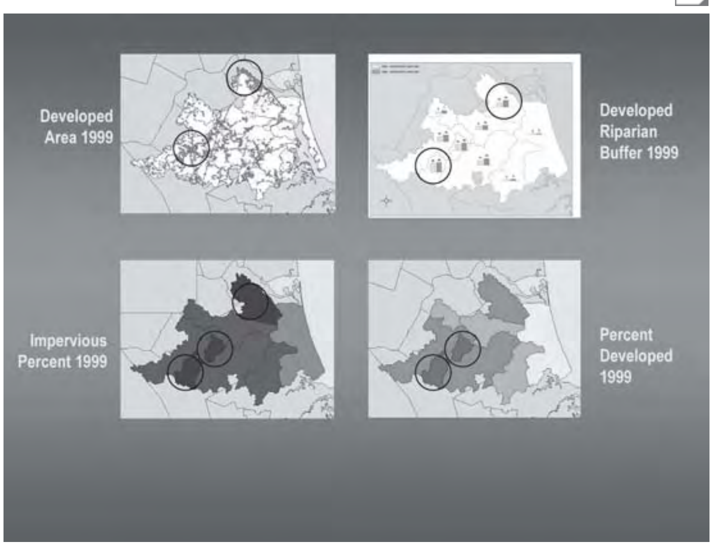


Final Land Use Indicator: Riparian Buffers

- Critical for wildlife habitat, flood prevention, nutrient cycling, and filtration of pollutants
- Contract with USFWS to develop detailed Riparian buffer land use classification (100m) for 1985 and 1999
- Quarter acre resolution
- 100m buffer around wetlands and perennial streams

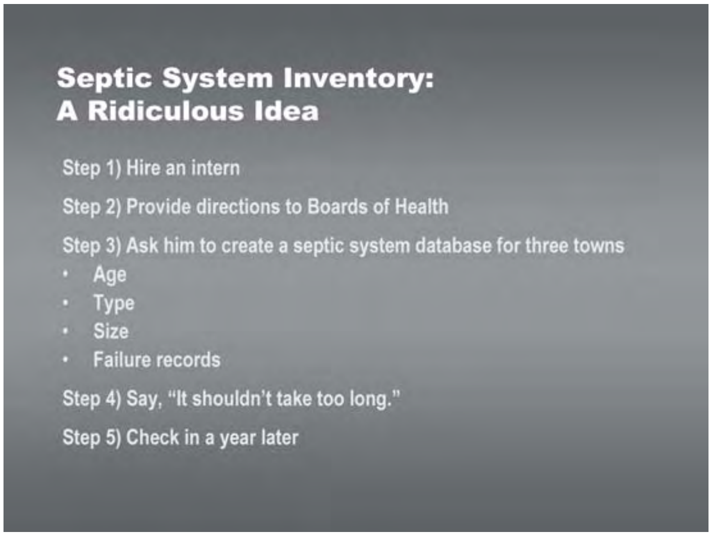


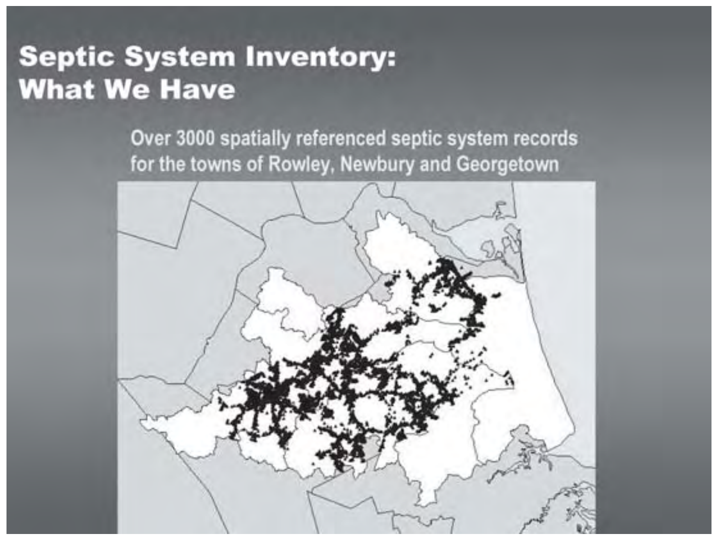

1985 - ANDERSON LAND USE
1999 - ANDERSON LAND USE


Developed
Area 1999
Developed
Riparian
Buffer 1999
Impervious
Percent 1999
Percent
Developed
1999

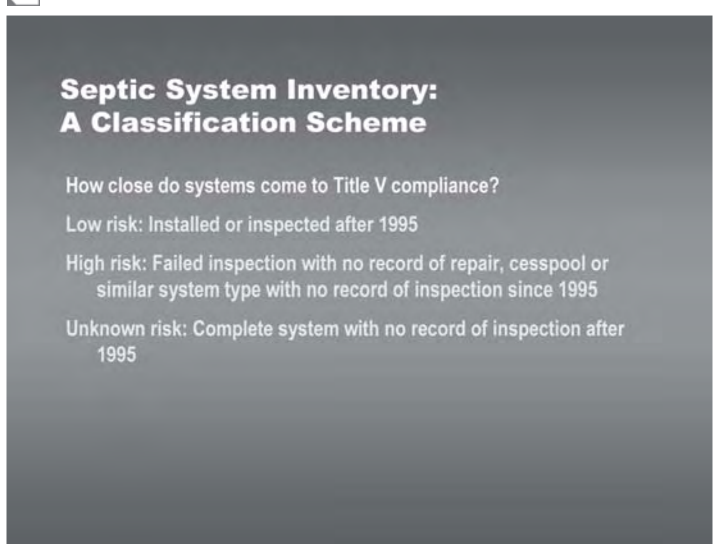

Developed
Area 1999
Developed
Riparian
Buffer 1999
Impervious
Percent 1999
Percent
Developed
1999


Inventory of Local Impacts and Management Measures
A Review:
• Percent developed
• Impervious surface
• Riparian buffer condition
Additional NPS Indicators:
• Septic systems
• Stormwater outfalls
• Agriculture


Septic System Inventory:
A Ridiculous Idea
Step 1) Hire an intern
Step 2) Provide directions to Boards of Health
Step 3) Ask him to create a septic system database for three towns
• Age
• Type
• Size
• Failure records
Step 4) Say, "It shouldn't take too long."
Step 5) Check in a year later


Septic System Inventory:
What We Have
Over 3000 spatially referenced septic system records
for the towns of Rowley, Newbury and Georgetown


Septic System Inventory:
What We Have


Septic System Inventory:
A Classification Scheme
How close do systems come to Title V compliance?
Low risk: Installed or inspected after 1995
High risk: Failed inspection with no record of repair, cesspool or similar system type with no record of inspection since 1995
Unknown risk: Complete system with no record of inspection after 1995

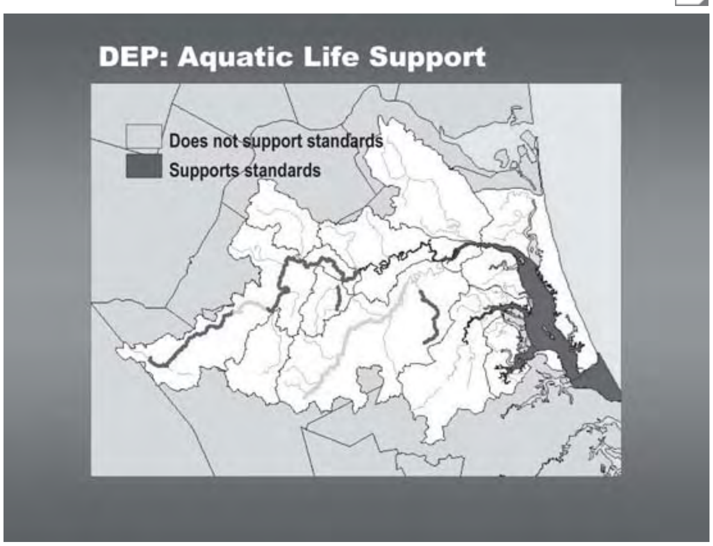
Water Quality: Capitalize on Past Assessments

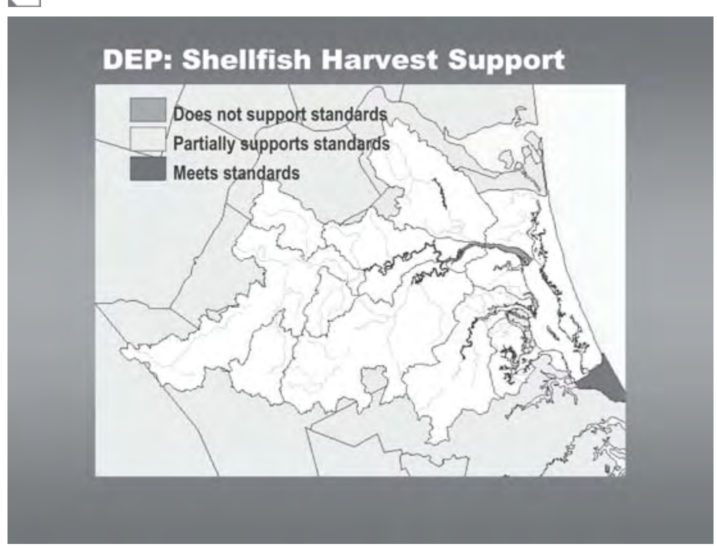
Over 20 data sets compiled for the Parker Watershed:

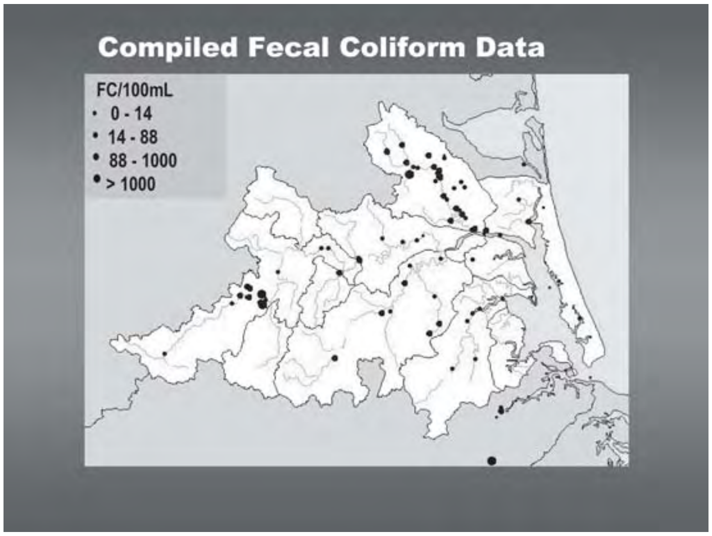
- DEP / Watershed Initiative Water Quality Assessment Reports
- Plum Island Sound LTER
- Mass Audubon / Massachusetts Bays Minibays Study
- Merrimack Valley Planning Commission Little River Study

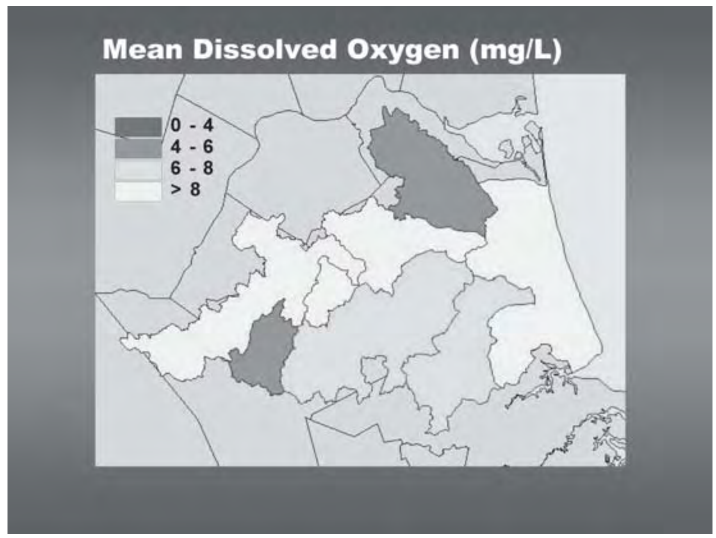
The trick: Compile these data sets, develop a master database, and convert to common fields and units (Exa Data and Mapping)

Red Flags: No substitute for study reports

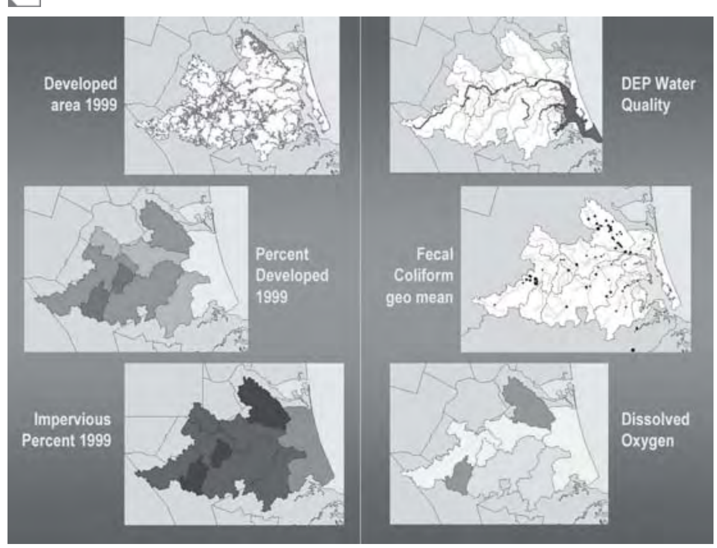


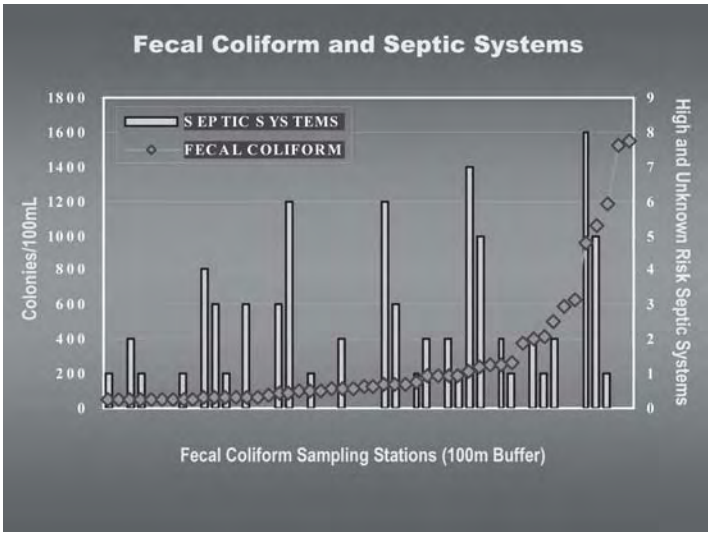


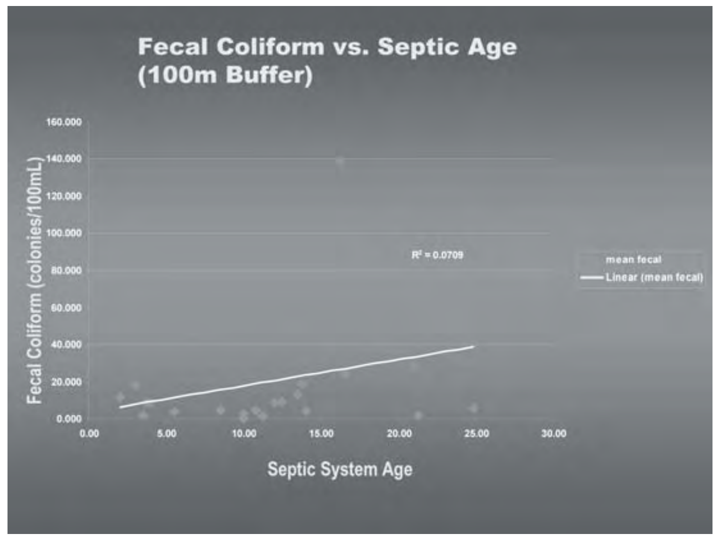

Compiled Fecal Coliform Data
FC/100mL
0 - 14
14 - 88
88 - 1000
> 1000


Mean Dissolved Oxygen (mg/L)
0 - 4
4 - 6
6 - 8
> 8

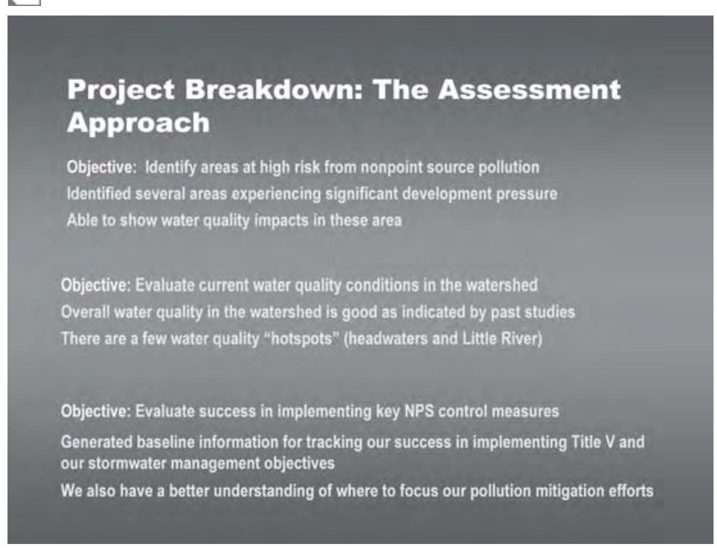

Putting the Pieces Together: Land Use, Management Measures and Water Quality
We still have the charge of relating land use condition to and management measures to changes in water quality
Can We Do It?


Developed area 1999
DEP Water Quality
Percent Developed 1999
Fecal Coliform geo mean
Impervious Percent 1999
Dissolved Oxygen


Fecal Coliform and Septic Systems
SEPTIC SYSTEMS
FECAL COLIFORM
Colonies/100mL
High and Unknown Risk Septic Systems
1800
1600
1400
1200
1000
800
600
400
200
0
Fecal Coliform Sampling Stations (100m Buffer)


Fecal Coliform vs. Septic Age
(100m Buffer)
Fecal Coliform (colonies/100mL)
Septic System Age
R² = 0.0709
mean fecal
Linear (mean fecal)


SAMPLING STATIONS
SEPTIC SYSTEMS
STREAMS
100M BUFFER
CROPLAND
PASTURE


Project Breakdown: The Assessment Approach
Objective: Identify areas at high risk from nonpoint source pollution
Identified several areas experiencing significant development pressure
Able to show water quality impacts in these area
Objective: Evaluate current water quality conditions in the watershed
Overall water quality in the watershed is good as indicated by past studies
There are a few water quality "hotspots" (headwaters and Little River)
Objective: Evaluate success in implementing key NPS control measures
Generated baseline information for tracking our success in implementing Title V and our stormwater management objectives
We also have a better understanding of where to focus our pollution mitigation efforts

What Does it Mean for Massachusetts Bay?

Even the most pristine watersheds are seeing water quality impairments

Over the past 20 years, there has been a disproportionate level of development within riparian buffers

It is very difficult to gain a complete understanding of pollution mitigation efforts and overall water quality

Our monitoring efforts are insufficient to generate cause and effect links

Needs: The Future of NPS Assessments for CZM

Needs

Standardized digital data

- Water quality
- Management measures
- Land use

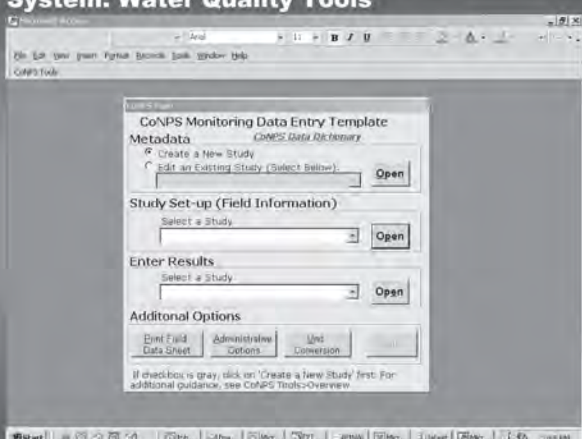
Smaller scale NPS assessments

Integration of monitoring efforts

Solutions

Building a digital water quality and management measure infrastructure

Massachusetts Ocean Resource Information System: Water Quality Tools



Beyond Buildout: One Coastal Community's Call to Action

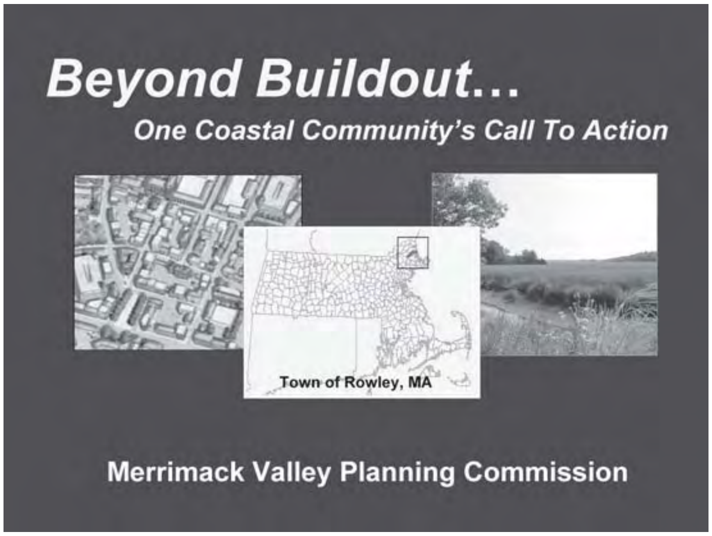
Alan Macintosh and Jerrard Whitten
Merrimack Valley Planning Commission
160 Main Street
Haverhill, MA 01830
(978) 374-0519
amacintosh@mvpc.org *and* jjwhitten@mvpc.org

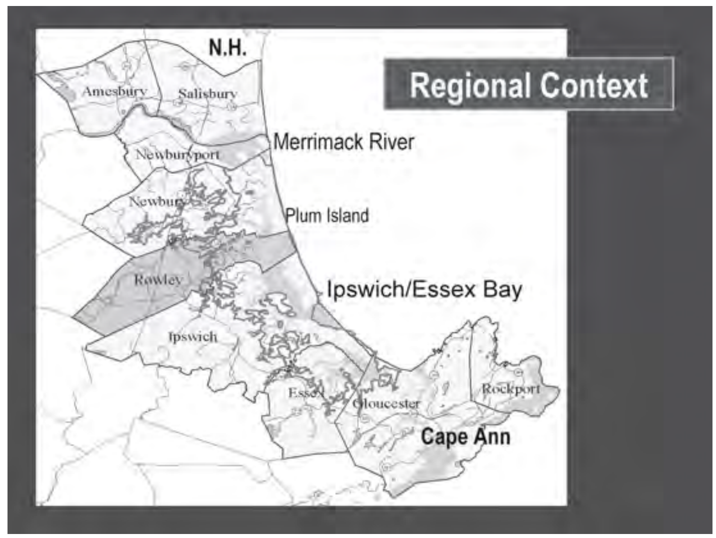
The Massachusetts Executive Office of Environmental Affairs (EOEA) and the Merrimack Valley Planning Commission (MVPC) recently estimated the future land use and environmental impacts of current zoning and other local control measures of the town of Rowley, MA, through a buildout analysis process. In response to the buildout forecast, Rowley officials and residents have taken a number of positive actions, including but not limited to: preparation of a town-wide master plan; adoption of a *Green Neighborhoods*-style open space residential development bylaw (with built-in developer incentives); adoption of the Community Preservation Act; adoption of a local wetlands protection bylaw; acquisition and preservation of several key watershed parcels; development and implementation of a septic data management system (in progress); and identification and mapping of stormwater pollution "hotspots."

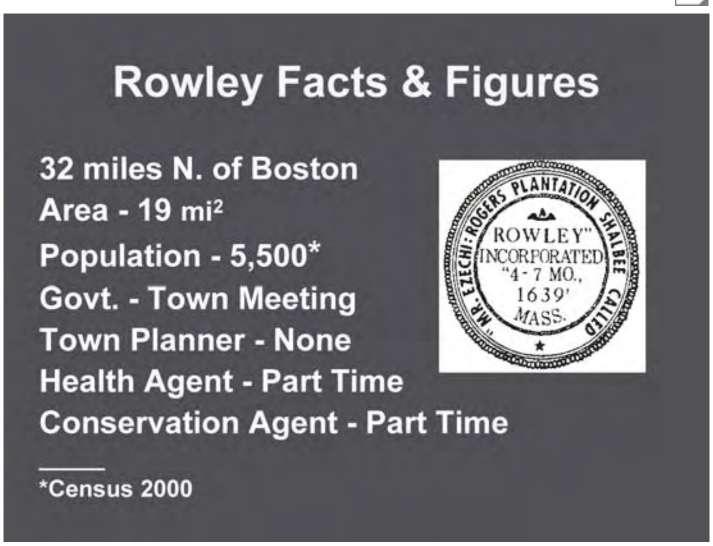
The Rowley Master Plan examined key community issues/challenges and developed action strategies aimed at better managing land use and urban sprawl, diversifying the local economy, preserving community character, and protecting the environment. The plan embraced principles of smart growth and sustainable development, and integrated these principles into the action recommendations. The Open Space Residential Development Bylaw established a creative land development option as an alternative to conventional subdivision design. Key bylaw provisions include an interactive process between town boards and prospective developers, preserving at least 50 percent of a site as open space, protecting unique or fragile habitats, lowering site development costs, decreasing infrastructure maintenance costs, enhancing community character and sense of "neighborhood", and providing opportunities for trails and other public amenities. One tangible measure of success from these initiatives has been the preservation of 400 acres of prime open space, including mixed forest, meadows, pasture, and wetlands.

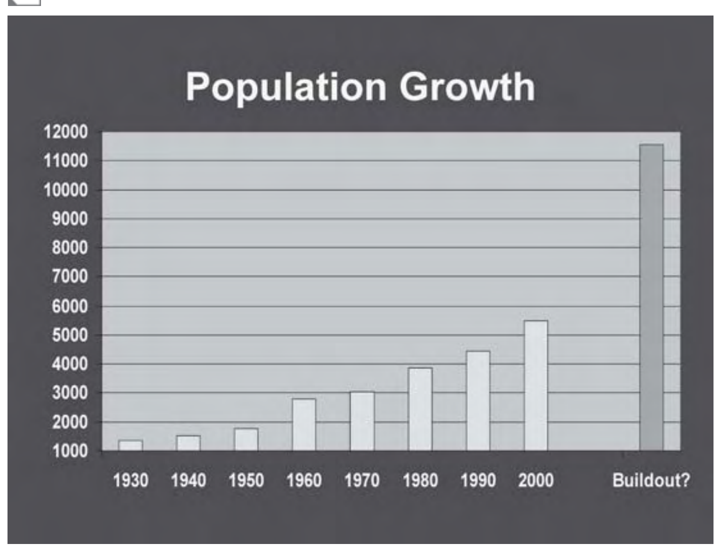
The Local Wetlands Bylaw and accompanying regulations afford greater protection to Rowley's expansive coastal and inland wetlands. Key bylaw provisions include stricter performance standards within buffer zones, heightened protection for vernal pools, and a higher fee structure to support Conservation Commission enforcement activities. A user-friendly, *Access*-based Septic Data Management System, developed by MVPC and CZM for the Rowley Board of Health, will enhance the town's capacity to record, retrieve, query, analyze, and update key Title 5 septic system information.

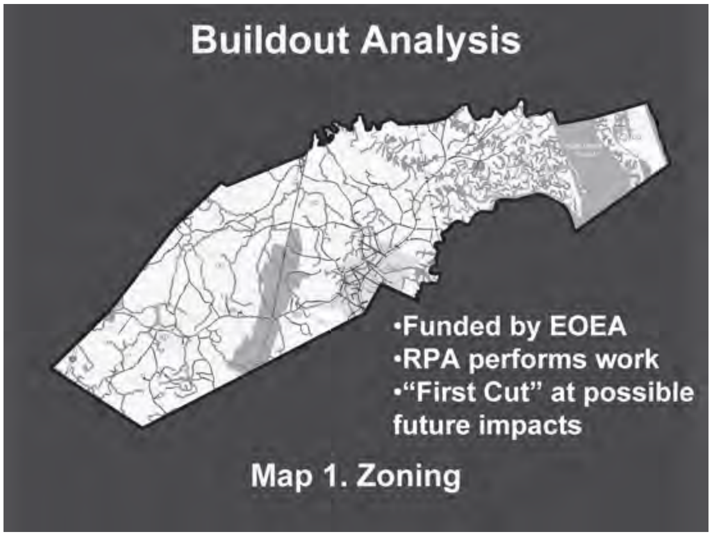
In the face of mounting development pressure along the coast (and the adverse impacts that typically ensue), Mr. Macintosh explained that communities are not powerless. Through timely, focused action, communities can anticipate and avert unwanted impacts and help to shape a future that is in keeping with the residents' shared community vision. Rowley, a small but rapidly growing coastal community with limited personnel and financial resources, is an example of what can be accomplished when a few dedicated people decide to make a difference. Their experience can serve to inspire and galvanize other communities into positive action.

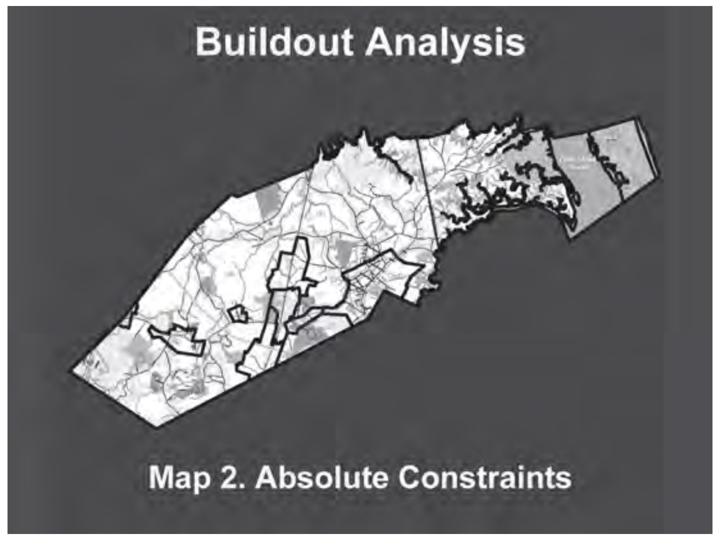

Beyond Buildout…
One Coastal Community's Call To Action
Town of Rowley, MA
Merrimack Valley Planning Commission

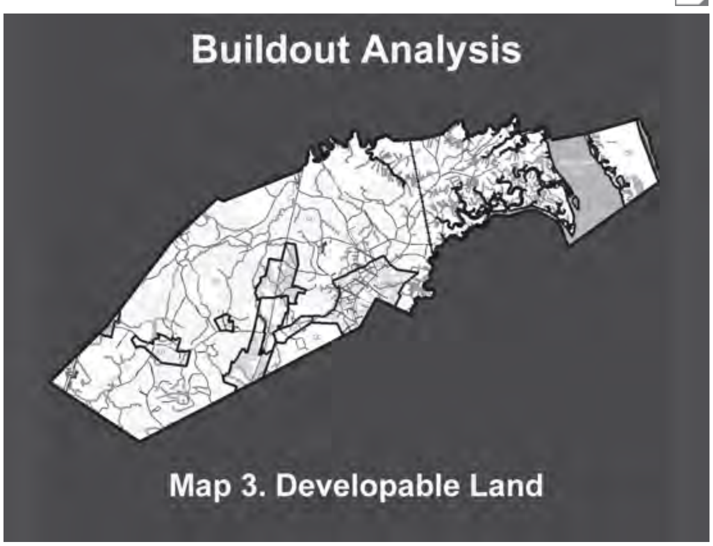

N.H.
Regional Context
Amesbury
Salisbury
Merrimack River
Newburyport
Newbury
Plum Island
Rowley
Ipswich/Essex Bay
Ipswich
Essex
Gloucester
Rockport
Cape Ann

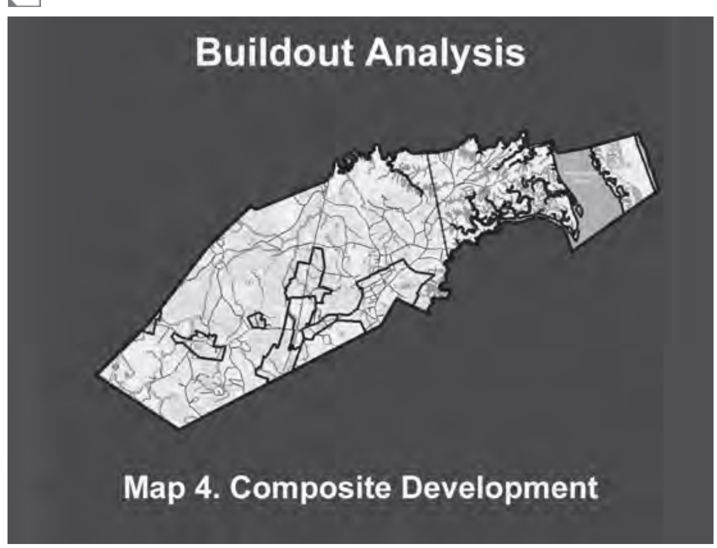

Rowley Facts & Figures
32 miles N. of Boston
Area - 19 mi²
Population - 5,500*
Govt. - Town Meeting
Town Planner - None
Health Agent - Part Time
Conservation Agent - Part Time
*Census 2000
MR. EZECHI: ROGERS PLANTATION SHALBEE CALLED
"ROWLEY" INCORPORATED "4 - 7 MO., 1639' MASS.


Population Growth
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
1930
1940
1950
1960
1970
1980
1990
2000
Buildout?


Buildout Analysis
•Funded by EOEA
•RPA performs work
•"First Cut" at possible future impacts
Map 1. Zoning


Buildout Analysis
Map 2. Absolute Constraints

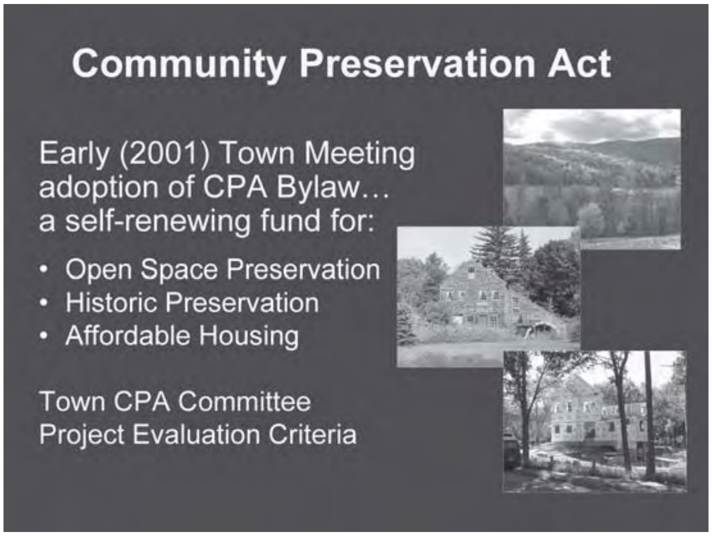

Buildout Analysis
Map 3. Developable Land

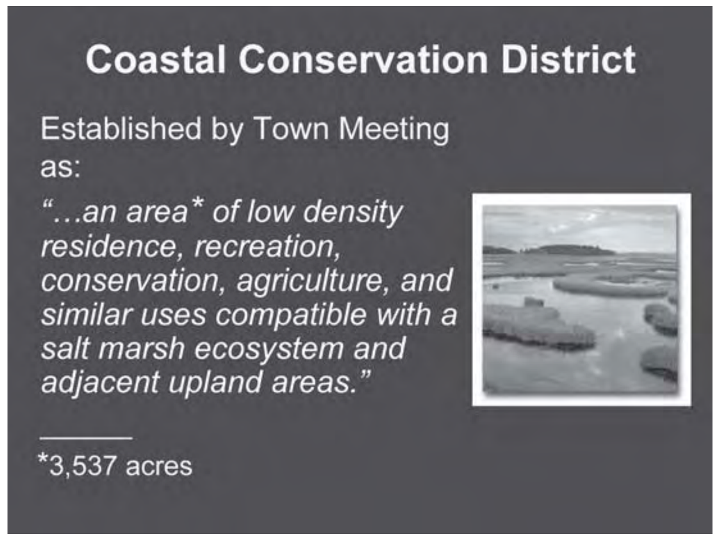

Buildout Analysis
Map 4. Composite Development

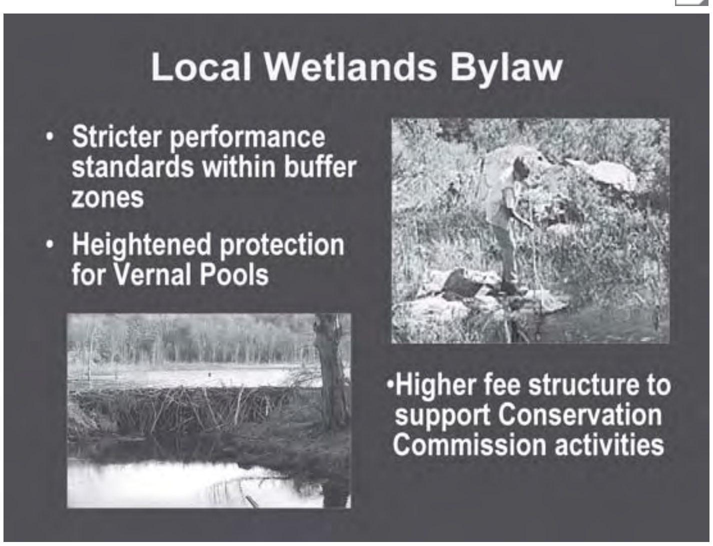
SUMMARY BUILDOUT STATISTICS
(New Development and Associated Impacts)

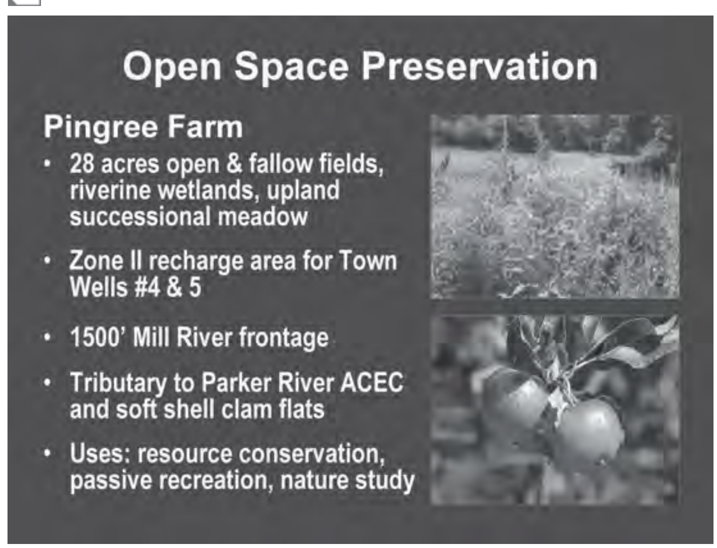
Developable Land (sq.ft.)	167,052,600.0
Developable Land (acres)	3,835.0
Total Residential Lots	1,990.0
Comm./Ind. Buildable Floor Area (sq. ft.)	5,207,159.0
Residential Water Use (gallons per day)	453,906.0
Comm./Ind. Water Use (gallons per day)	390,537.0
Municipal Solid Waste (tons)	3,649.4
Non-Recycled Solid Waste (tons)	2,118.2
New Residents	6,052.0
New Students	1,108.0
New Residential Subdivision Roads (miles)	33.9

Notes:
1. "Residential Water Use" is based on 75 gallons per day per person.
2. "Comm./Ind. Water Use" is based on 75 gallons per 1,000 square feet of floor space.
3. "Municipal Solid Waste" is based on 1,206 lbs per person per year. All waste estimates are for residential uses only.
4. "Non-Recycled Solid Waste" is a subset of Municipal Solid Waste and is based on 730 lbs per person per year ending up in a landfill or incinerator.
5. The number of "Residents" at buildout is based on the persons per household figure derived from the 1990 US Census.
6. The number of "Students" at buildout is based on a student per household ratio taken from 1990 US Census data.
7. "New Residential Subdivision Roads" are based on the assumption that 60% of the new residential lots will have required frontage on new subdivision roads.

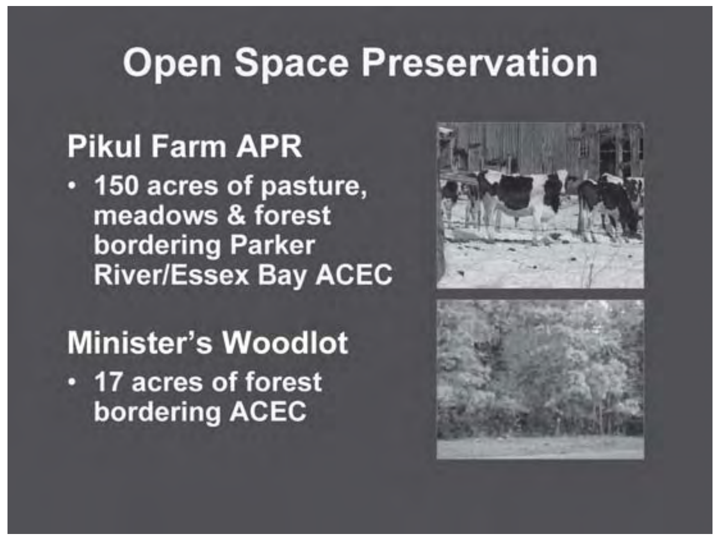

Community Preservation Act
Early (2001) Town Meeting adoption of CPA Bylaw… a self-renewing fund for:
• Open Space Preservation
• Historic Preservation
• Affordable Housing
Town CPA Committee Project Evaluation Criteria

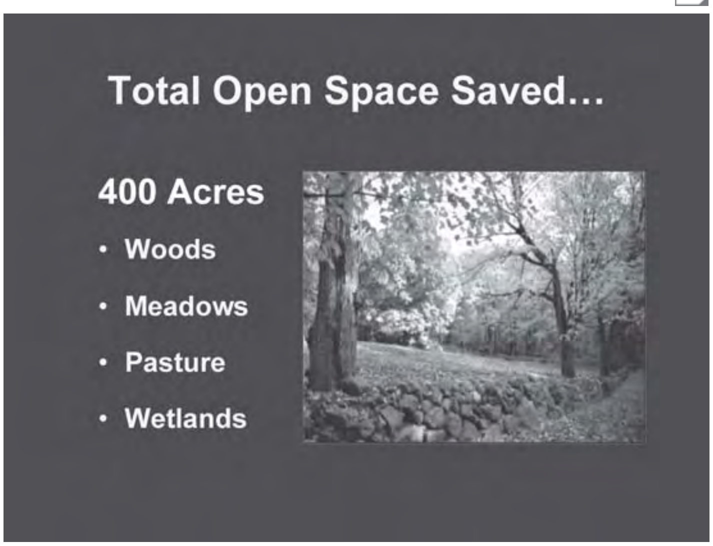

Coastal Conservation District
Established by Town Meeting as:
"…an area* of low density residence, recreation, conservation, agriculture, and similar uses compatible with a salt marsh ecosystem and adjacent upland areas."
*3,537 acres


Local Wetlands Bylaw
• Stricter performance standards within buffer zones
• Heightened protection for Vernal Pools
•Higher fee structure to support Conservation Commission activities


Open Space Preservation
Pingree Farm
• 28 acres open & fallow fields, riverine wetlands, upland successional meadow
• Zone II recharge area for Town Wells #4 & 5
• 1500' Mill River frontage
• Tributary to Parker River ACEC and soft shell clam flats
• Uses: resource conservation, passive recreation, nature study


Open Space Preservation
Hunsley Hills
• 104 acres of steeply-sloped mixed hardwood forest
• Sweeping vistas of Rowley Town Center & countryside, Great Marsh, Plum Island Sound, Atlantic Ocean
• Drains to Mill Brook, Parker River ACEC, and Plum Island Sound clam flats
• Conservation, hiking & equestrian trails


Open Space Preservation
Pikul Farm APR
• 150 acres of pasture, meadows & forest bordering Parker River/Essex Bay ACEC
Minister's Woodlot
• 17 acres of forest bordering ACEC


Total Open Space Saved…
400 Acres
• Woods
• Meadows
• Pasture
• Wetlands


Multiple Partners…Helping Hands
Massachusetts Audubon
Essex County Greenbelt Association
DCS Self-Help Program
DF&A APR Program
Private Foundations

Septic Data Management

- Outgrowth of CZM Parker Watershed Study
- 3-Town pilot project, funded by CPR Plus & MVPC
- Create user-friendly *Access* database of key Title 5 on-site systems data
- Link to local Assessors' records & GIS to facilitate data querying and analysis

Tracking Stormwater "Hotspots"

- 8T&B project funded by ECCF and MVPC
- In collaboration with local highway dept., inspect drainage swales & outfall pipes for runoff pollution evidence
- Document, prioritize & map suspected problem sites
- Pursue funds for follow-up assessment & BMPs

"Rowley is a lot like Blanche DuBois … we both rely on the kindness of strangers."*

- **John "Jack" Ewell**
  Former Rowley Conservation Commissioner

*A Street Car Named Desire, Tennessee Williams

Acknowledgements

Special Kudos to Key Rowley Residents:
Andrea Cooper, MCZM
Sue Moses, Planning Consultant
Cliff Pierce, Rowley Planning Board

Key Partner Organizations:

MassAudubon/N. Shore	Mass Bays Program
Eight Towns & The Bay	Coastal Zone Mgmt.
Essex County Greenbelt	ACEC Program
Trustees of Reservations	MVPC

Green Neighborhood Alliance

Land Use

Linking Management of Our Offshore Waters with Land Use

Dr. Carlton Hunt, Battelle *(moderator)*
Dr. Joe Costa, The Buzzards Bays Project
Dr. Dennis Ducsik, Massachusetts Office of Coastal Zone Management
Vivien Li, The Boston Harbor Association
Jack Wiggin, Urban Harbors Institute

Following the first day of sessions, the first panel discussion of the workshop was held. This panel was aimed at responding to the questions "Can we link the discussion of managing offshore waters and land use? Have we tried to make the link, and how successful have we been?" The format of the panel involved brief responses to the question by the members and then group discussions.

Mr. Jack Wiggin.
Mr. Wiggin stated that the linkage has been made between managing offshore waters and land use. Over the last decade, the linkage has manifested and there is a strong basis for stating that what takes place on the land does affect the water. These linkages have helped to create the Water Shore Initiative. One issue that was identified was that municipalities have been limited in focus to land use changes.

Dr. Joe Costa.
Dr. Costa stated that many other groups are also doing similar work and are trying to make the same linkage. He stated that the Buzzards Bay Project has an ecosystem where it is easier to make the case than the Massachusetts Bays Program. That is, Buzzards Bay has warmer water and shallower depths, and land-based nitrogen inputs have been clearly linked to coastal water degradation, such as loss of eelgrass. Stormwater closures are also the principal cause of shellfish bed closures. The science is getting better and is helping to identify management strategies. The management of stormwater has led to less shellfish closures due to high fecal coliform counts. More effort is needed, especially to manage impervious surfaces, and to implement state and local control to manage nitrogen. In the next 10 years, there will be lots of challenges, and the EPA is becoming tougher on requiring action. To receive grants, it is increasingly important to have a Watershed Management Plan in place. In the past, the NEP Comprehensive Conservation and Management Plans would qualify but this will no longer be the case. Each town will now need to develop new bay specific Watershed Management Plans to justify funding. Certainly there are linkages between offshore waters and land use, but the real challenge is developing and implementing management plans to achieve environmental benefits.

Dr. Dennis Ducsik.
Dr. Ducsik indicted that considerable reduction of stormwater flows to waterways could be achieved through "retrofit" measures at the household level, and drew a parallel with advances made in reducing home energy consumption. He emphasized that the focus of stormwater mitigation is usually on new development projects with little attention to existing individual structures. In this regard, fairly simple measures could be implemented to attain 20 to 30 percent reduction in most cases, and as much as a 50 to 70 percent reduction in many others. Dr. Ducsik acknowledged that generally people know that they should conserve water but progress needs to be made in raising a parallel awareness of the need for stormwater conservation.

There is already strong evidence and data to support stormwater conservation but a grassroots education campaign is still lacking. A key question is: how can we create incentives for this type of conservation, since at present stormwater "disposal" is essentially free to the individual property owner.

Ms. Vivien Li.
Ms. Li began with a discussion on the recent Boston Conservation Commission Meeting about the proposed new runway at Logan Airport. She stated that there are no environmental laws or practices that are in place for the airport. However, each individual airline has the responsibility to have practices in place. The larger development of a new runway needs to be reviewed and should mirror other development growth in towns.

Management Panel I - Discussion.

Following the responses to the above question the Management Panel addressed questions and comments from the group.

How do you manage the system as a holistic approach?
The panel responded with many answers including that in 1992 Mass Port applied for NPDES permits and the permits have still not been updated. The process of applying and receiving permits takes too long. Whether the development is large or small, permits should be in place to manage water quality. There are new rules by the EPA for NPDES permits, Phase One and Phase Two. Anyone who develops five acres of land must have a stormwater plan. This year, however, even if one acre of land is going to be developed a stormwater plan must be in place. The compliance rate for these construction permits is probably only one percent and compliance for "industrial" sites, including marinas may only be 15 to 20 percent. There are requirements to manage stormwater on the books for the marinas and other sites, but there is little effort to enforce compliance with the program. Some developers submit the required paperwork but there is little review of the stormwater management plans. Individual towns are doing better on their municipal stormwater plans, and the state works more closely with municipalities. At this time, EPA manages stormwater from the top down, with increasing burden placed on the local governments. Stormwater management costs towns money to enforce but they lack the necessary staff or funding to effectively implement these programs.

Discussion continued further on the issue of permitting. Municipal Conservation Commissions have the authority to issue state wetland permits. They can also adopt more stringent local wetlands bylaw, and even include provisions for a fee to have engineers review permit applications. However, in many cases municipal officials need to more carefully read and implement their local regulationsif they wish to make projects more environmentally sound. Local officials and the public must recognize that regulations are not created as obstacles to kill projects but rather to make them more environmentally acceptable and to incorporate environmentally sustainable measures into practice.

Where does a local person go to find out about regulations?
The response from the panel was that at the municipal planning staff may not have the time or capacity to conduct a detailed review or update of their regulations. Regional planning agencies can help municipal boards with such efforts, but are underutilized.

What is the land interface to regional monitoring?
The panels' response was that there are various groups undertaking regional monitoring, not just the municipalities. These programs may be collecting large amounts of data to answer more regional questions. These efforts should be expanded to address broader ocean impacts to evaluate stressors from the land. The Ocean Commission Report highlighted the need for NEPs to promote watershed management beyond municipal boundaries.

The real challenge for monitoring programs is managing the information and translating it into implementation actions to address the many issues involved. The emerging smart growth agenda should be embraced as the focus for the future. For example, municipal Department of Public Works (DPWs) can be a part of the problem and the solution. In Worcester, the DPW runs the water utilities and is a proactive agency. This can be effective because DPWs are closer to the homeowner and can help focus the public on stormwater runoff issues and water conservation issues, as well as disseminate this information to the public.

Automobile traffic volume has increased four percent with the rate of population growth, is the increase of traffic increasing water quality affects?
The panel response stated that waterfront development should include green space as part of its required open space area. However, even where such regulations are adopted, loopholes may exist where for example, paved surfaces might be considered open space. It is desirable for new development to keep 50 percent (or more) of the land as open space but parking lots certainly need to be differentiated from green spaces. It was also added that sprawl development is tied to traffic increase and that better transportation alternatives need to be incorporated into society. One suggestion offered was a gasoline tax to make transport expensive, but others do not see this as an effective solution. Currently most stormwater runoff often enters marine water directly without treatment. Part of the solution is to store more stormwater runoff so that it can be cleaned by stormwater treatment system. In Rockport, MA, areas of salt marsh were being smothered by sediments from stormwater discharge, but controls were put in place treating the runoff reducing sediment discharges to the marshes.

If it is important to link the grassroots level to the system, how do you deal with watershed, stormwater, and sewer systems?
The answer from the panel was that smart growth has to be from the bottom up, not from the state down. A solution might be to change regulations so that hurdles to environmentally-responsible development are not there and at the same time encourage smart growth principles such as smaller streets and no curbs which could both save developers money and be good for the environment. If the state changes its thinking on its stormwater regulations and policies, the local governments will follow. At the local level, thinking needs to be more creative. To be successful we must understand local regulations and recognize that the hardest part of implementation is often the political process. Cities and towns will need to be more proactive, rather than reactive to achieve environmental improvements in the long-term.

Day Two

May 7, 2004

The Massachusetts Ocean Management Task Force

Susan Snow-Cotter, Acting Director
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114
(617) 626-1200
susan.snow-cotter@state.ma.us

Ms. Snow-Cotter discussed the driving forces behind the Ocean Management Task Force's creation and its mandate to take a comprehensive look at the management of ocean resources. Recently, major projects such as Cape Wind and the Boston Harbor Pipeline have brought this need to the forefront. The Task Force was announced in June of 2003 as the first phase of a broader Ocean Management Initiative. Membership is made up of 23 public and private sector individuals. Representatives from relevant federal agencies and state and federal elected officials from Massachusetts and neighboring states were also asked to participate as *ex-officio* members.

Ms. Snow-Cotter affirmed that up until recently ocean management policy had been handled on an issue by issue and sector by sector basis. Municipalities play a large role in the management of shorelines and shoreline uses, encompassing good regulations but no comprehensive planning. With coastlines full of densely populated areas, and busy ocean waters that are shallow and accessible, Massachusetts needed to use this occasion to take an environmental leadership role in management of these complex waters.

The Task Force and its working group met between June 2003 and March 2004. Six working groups were established to explore issues in greater depth. The Task Force developed recommendations for guidance of ocean management principles. Sixteen recommendations were made within the areas of governance, management tools, and improvement of scientific understanding, data management, and outreach.

Specific recommendations cited in the Task Force's conclusions were to:

- Create a Comprehensive Ocean Resources Management Act (CORMA).
- Coordinate Ocean Management to promote interagency cooperation.
- Address climate change and impacts of sea level rise.
- Clarify the Marine Sanctuaries Act, especially the aesthetic criteria.
- Reconsider fee structure for ocean-based projects.
- Convene a working group to look into Marine Protected Areas (MPAs).
- Coordinate mitigation.
- Address enforcement.
- Standardize visual, cultural, aesthetic impacts.
- Characterize uses of marine waters.
- Appoint a Marine and Ocean Resource Trends Advisory Group to advise Secretary Herzfelder on trends in marine and fisheries issues.
- Develop a plan for ocean monitoring and research.
- Acquire maps of the sea floor.
- Standardize data collection and reporting protocols and make publicly available.
- Promote ocean literacy and stewardship.
- Disseminate ocean resource data to the public.

Massachusetts Ocean Management Task Force

May, 2004

Overall Goals of the Massachusetts Ocean Management Task Force

- Define guiding principles for the use of state waters and ocean resources
- Examine Massachusetts coastal policies and the adequacy of the current legal/regulatory framework
- Determine future information requirements for managing state waters
- Recommend framework and tools for governance and management of state waters to ensure that statewide interests are met

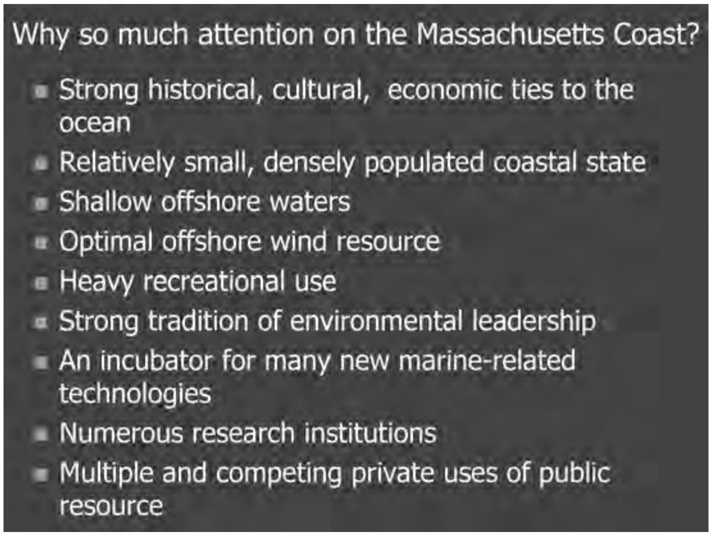
Ocean Management Background

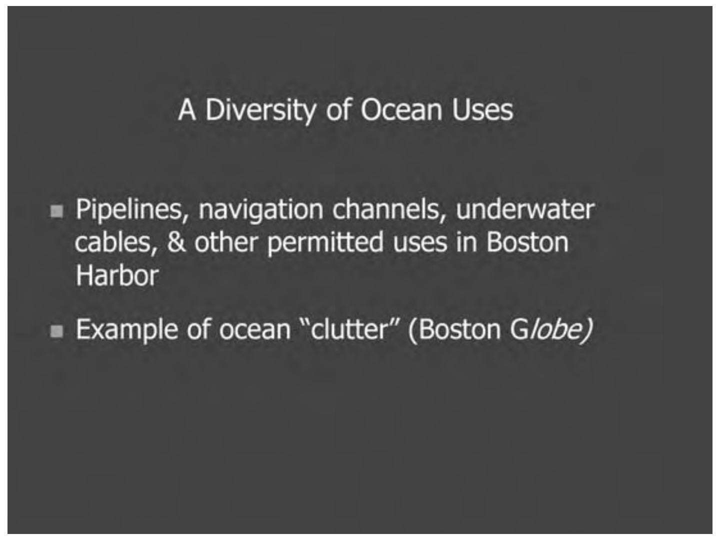
- Ocean management historically focused on a single resource or activity (*e.g.*, fishing regulations or shipping lanes) rather than a comprehensive approach
- In Massachusetts, municipalities and state agencies regulate many near-shore uses (e.g., mooring fields, Chapter 91 public trust licenses)
- No overarching planning or coordination of ocean uses/activities

Massachusetts Coastal and Ocean Jurisdictions

- Generally, state waters extend 3 miles offshore, (except for Mass. Bay and Cape Cod Bay)
- Court ruling: the center of Nantucket Sound is federal waters
- "Home Rule" traditions give municipalities regulatory authority in town waters
- Stellwagen Bank NMS adjacent to state waters

169 Waterman Street, Providence, RI 02906
(401) 456-0761

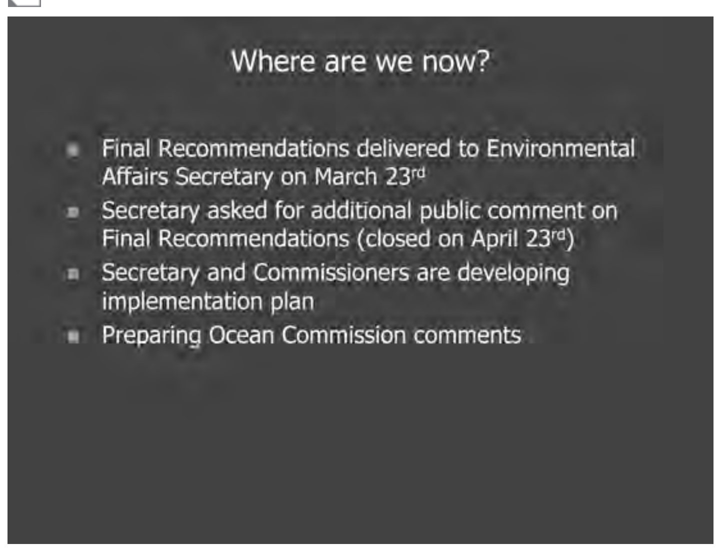


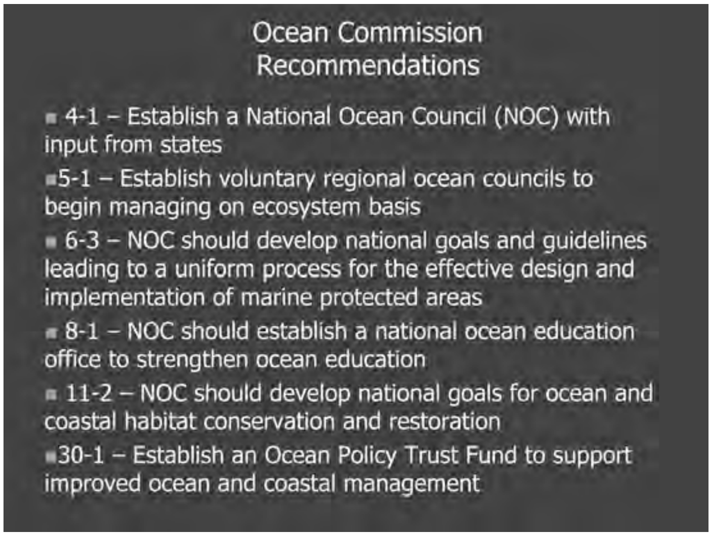



Recommendations
Comprehensive Ocean Resource Management Act (CORMA)
Codify ocean management principles
Articulate statewide interests
Provide legal authority to develop ocean management plans, streamline governance of ocean resources, and establish an oceans coordinating council
Establish standards for allowable use and impact control
Dedicated license fee structure for flowed tidelands


Recommendations (continued)
Ocean management coordination (federal/state and regional)
Climate Change
Ocean Sanctuaries Act revisions
Fees for structures and non-fishing activities in ocean waters
Study group to look at structure for designating Marine Protected Areas
Coordination of mitigation
Enforcement


Recommendations (continued)
Visual, cultural, and aesthetic impacts
Use characterization
Marine and Ocean Resource Trends Advisory Group
Ocean monitoring and research
Seafloor mapping
Standardize protocols for data collection
Ocean literacy and stewardship
Dissemination of ocean resource data


Where are we now?
Final Recommendations delivered to Environmental Affairs Secretary on March 23rd
Secretary asked for additional public comment on Final Recommendations (closed on April 23rd)
Secretary and Commissioners are developing implementation plan
Preparing Ocean Commission comments


Ocean Commission Recommendations
4-1 – Establish a National Ocean Council (NOC) with input from states
5-1 – Establish voluntary regional ocean councils to begin managing on ecosystem basis
6-3 – NOC should develop national goals and guidelines leading to a uniform process for the effective design and implementation of marine protected areas
8-1 – NOC should establish a national ocean education office to strengthen ocean education
11-2 – NOC should develop national goals for ocean and coastal habitat conservation and restoration
30-1 – Establish an Ocean Policy Trust Fund to support improved ocean and coastal management


Thank You!
Recommendations, Public Comment Letters, Meeting Summaries, Background Information, and PowerPoint Presentations are available at:
mass.gov/czm
Susan.Snow-Cotter@state.ma.us

I n t r o d u c t i o n

Boston Harbor: What a Change a Decade Makes

Dr. Andrea Rex and Mr. David Taylor
Massachusetts Water Resources Authority
Charlestown Navy Yard
100 First Ave
Boston, MA 02129
(617) 788-1170
andrea.rex@mwra.state.ma.us *and* david.taylor@mwra.state.ma.us

1992 marked the first year that discharges to Boston Harbor significantly decreased; MWRA's Boston Harbor Project ended discharges of solid waste sludge from greater Boston's sewage to Boston Harbor. Instead, the sludge was processed into fertilizer. By 1998, when the failing Nut Island Treatment Plant in Quincy was closed down, MWRA was treating most of the wastewater to secondary standards. In September 2000, treatment plant discharges to the harbor ended with the start-up of the ocean outfall diffuser in western Massachusetts Bay. Simultaneously with the construction of new sewage treatment facilities, MWRA has been planning and constructing projects to control combined sewer overflows (CSOs). Of 25 CSO projects, costing $645 million, fourteen have been completed, and six more are under construction. By the completion of these projects in 2011, 95 percent of the CSO discharge will be treated.

MWRA bacteria monitoring (161 stations and more than 40,000 samples collected since 1987) shows how the waters of the harbor have responded to these changes. Average (geometric mean) Enterococus counts decreased markedly from 1987 to 2003. One highly visible change in Boston Harbor is that most areas, even those formerly chronically polluted, are now considered safe for swimming. Dr. Taylor noted that a statistically significant (about 30 percent) reduction in the amount of nitrogen has been observed in the harbor. Summer chlorophyll decreased by approximately 35 percent and summer bottom dissolved oxygen increased nearly 10 percent after September 2000, when harbor discharges ended.

What a Change a Decade Makes!

How Water Quality Changed During and After the Boston Harbor Cleanup

Andrea Rex
David Taylor

Massachusetts Water Resources Authority

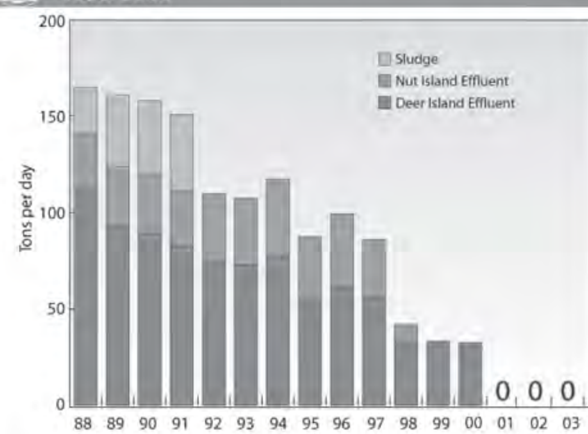
A Decade of Change in Boston Harbor

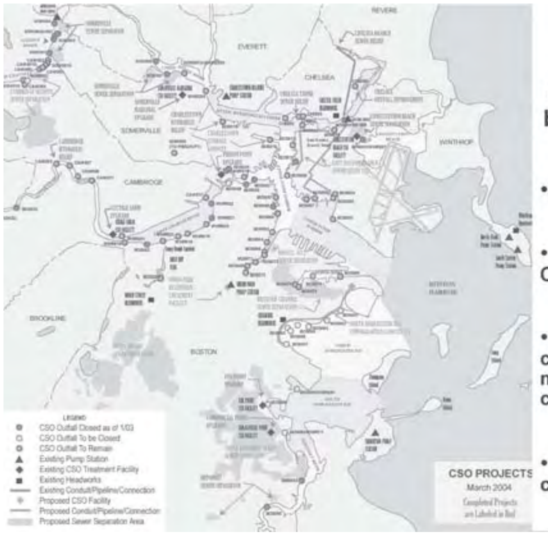
The $4-billion massive Boston Harbor Project produced environmental change as each milestone was completed

Timeline
Milestones of Boston Harbor Project

- 1991 End of sludge discharges
- 1995 First components of improved primary treatment
- 1998 South system flows to DITP, all flow receives some secondary treatment
- 2000 New ocean outfall, end of discharges to harbor
- 2001 Third battery of secondary on-line

MWRA Solids Discharges to Boston Harbor 1988-2003

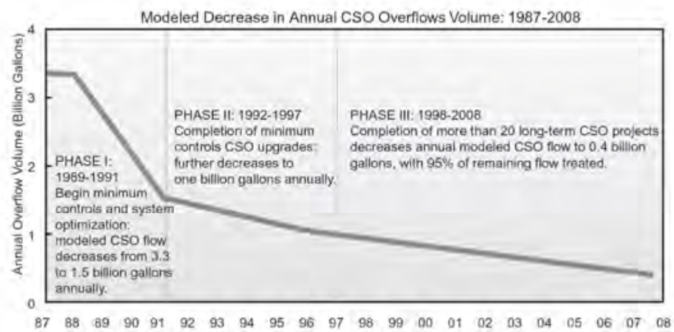




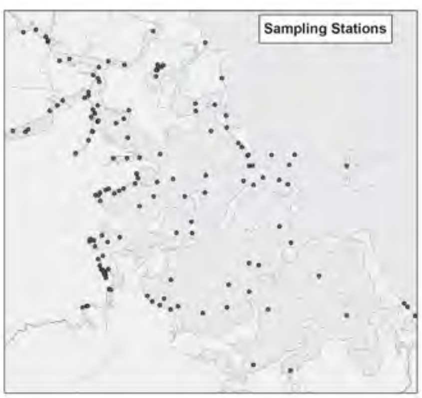
CSO Control began in 1989

- •25 Projects
- • 65 Federal Court milestones
- • 14 projects completed, 6 more in construction
- • $645 million capital budget

Modeled annual volume of CSO

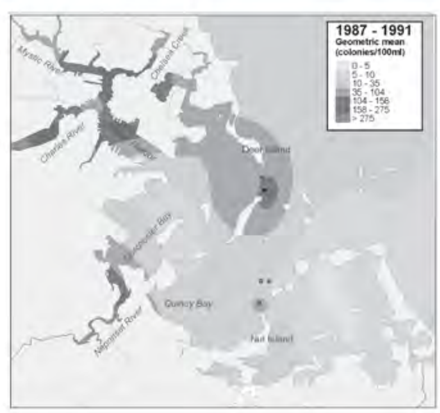


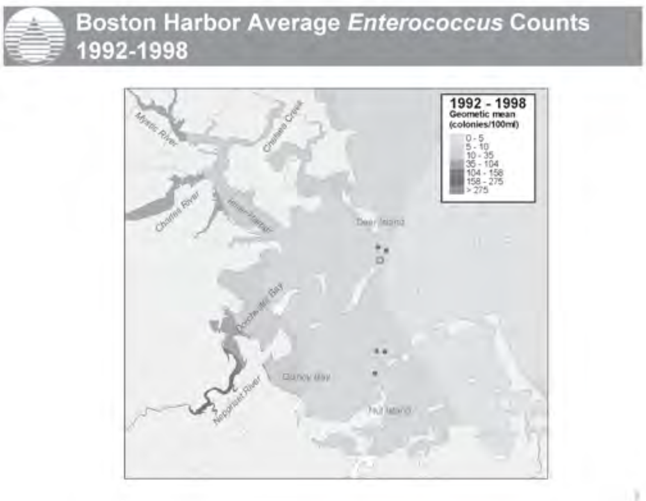
Harbor bacteria monitoring program: 161 stations and 40,477 samples since 1987

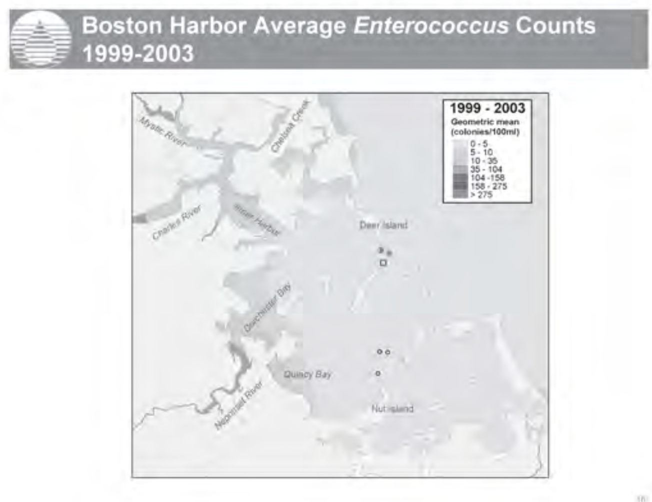


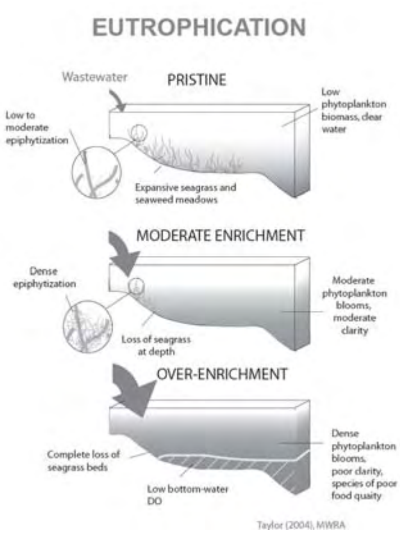
Data collected by MWRA and MDC

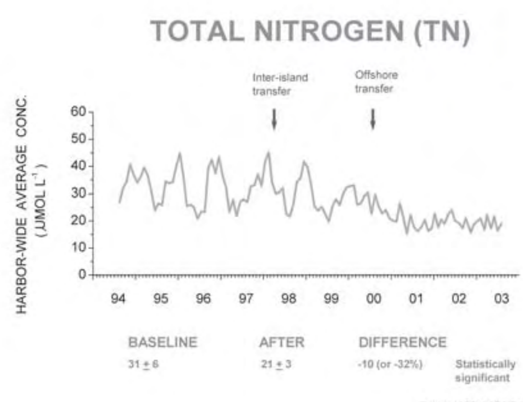
Boston Harbor Average *Enterococcus* Counts 1987-1991 (Wet weather)

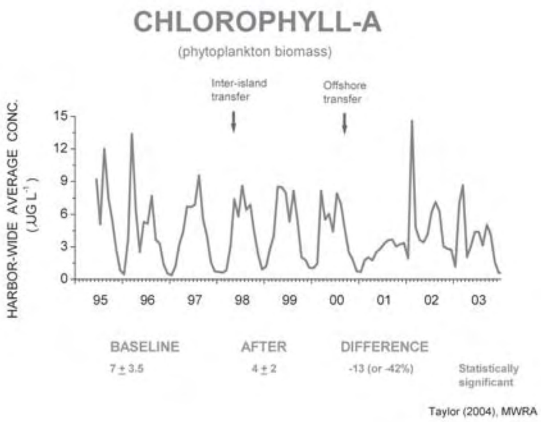


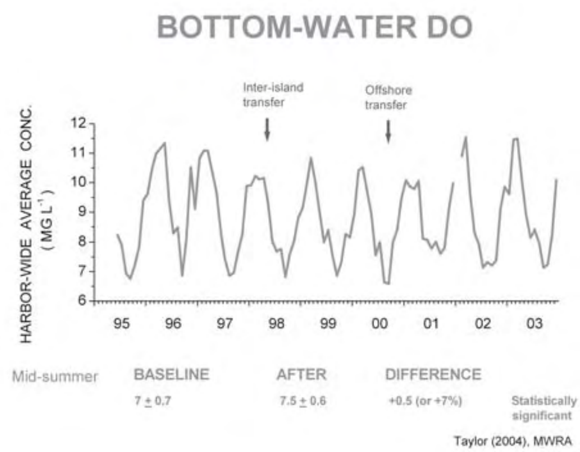

Boston Harbor Average *Enterococcus* Counts 1992-1998
1992 - 1998
Geometric mean (colonies/100ml)
0 - 5
5 - 10
10 - 35
35 - 104
104 - 158
158 - 275
> 275
Mystic River
Chelsea Creek
Charles River
Inner Harbor
Deer Island
Dorchester Bay
Quincy Bay
Neponset River
Nut Island

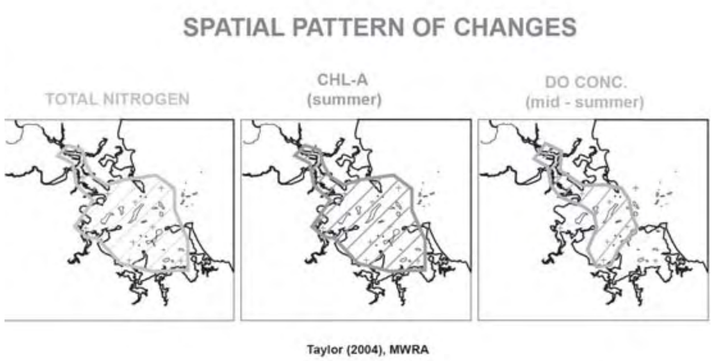

Boston Harbor Average *Enterococcus* Counts 1999-2003
1999 - 2003
Geometric mean (colonies/100ml)
0 - 5
5 - 10
10 - 35
35 - 104
104 -158
158 - 275
> 275
Mystic River
Chelsea Creek
Charles River
Inner Harbor
Deer Island
Dorchester Bay
Quincy Bay
Neponset River
Nut Island

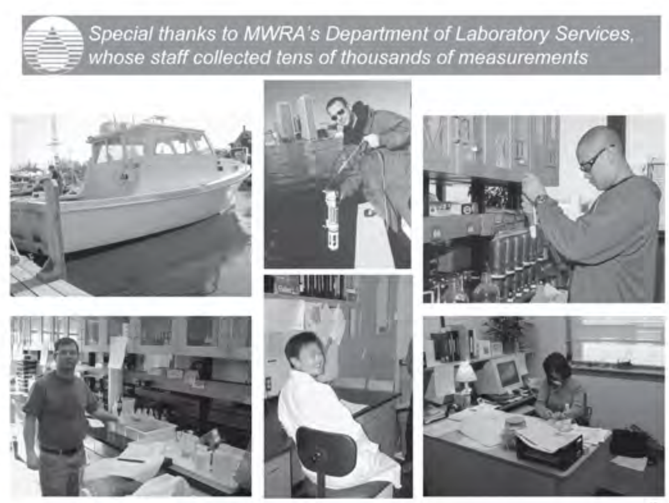

EUTROPHICATION
Wastewater
PRISTINE
Low to moderate epiphytization
Low phytoplankton biomass, clear water
Expansive seagrass and seaweed meadows
MODERATE ENRICHMENT
Dense epiphytization
Moderate phytoplankton blooms, moderate clarity
Loss of seagrass at depth
OVER-ENRICHMENT
Complete loss of seagrass beds
Dense phytoplankton blooms, poor clarity, species of poor food quality
Low bottom-water DO
Taylor (2004), MWRA


TOTAL NITROGEN (TN)
Inter-island transfer
Offshore transfer
HARBOR-WIDE AVERAGE CONC. (UMOL L⁻¹)
60
50
40
30
20
10
0
94 95 96 97 98 99 00 01 02 03
BASELINE
31 ± 6
AFTER
21 ± 3
DIFFERENCE
-10 (or -32%)
Statistically significant
Taylor (2004) MWRA


CHLOROPHYLL-A
(phytoplankton biomass)
Inter-island transfer
Offshore transfer
HARBOR-WIDE AVERAGE CONC.
(µG L-1)
95 96 97 98 99 00 01 02 03
BASELINE
7 ± 3.5
AFTER
4 ± 2
DIFFERENCE
-13 (or -42%)
Statistically significant
Taylor (2004), MWRA


BOTTOM-WATER DO
Inter-island transfer
Offshore transfer
HARBOR-WIDE AVERAGE CONC.
(MG L-1)
95 96 97 98 99 00 01 02 03
Mid-summer
BASELINE
7 ± 0.7
AFTER
7.5 ± 0.6
DIFFERENCE
+0.5 (or +7%)
Statistically significant
Taylor (2004), MWRA


SPATIAL PATTERN OF CHANGES
TOTAL NITROGEN
CHL-A
(summer)
DO CONC.
(mid - summer)
Taylor (2004), MWRA


Special thanks to MWRA's Department of Laboratory Services, whose staff collected tens of thousands of measurements

E s t u a r y

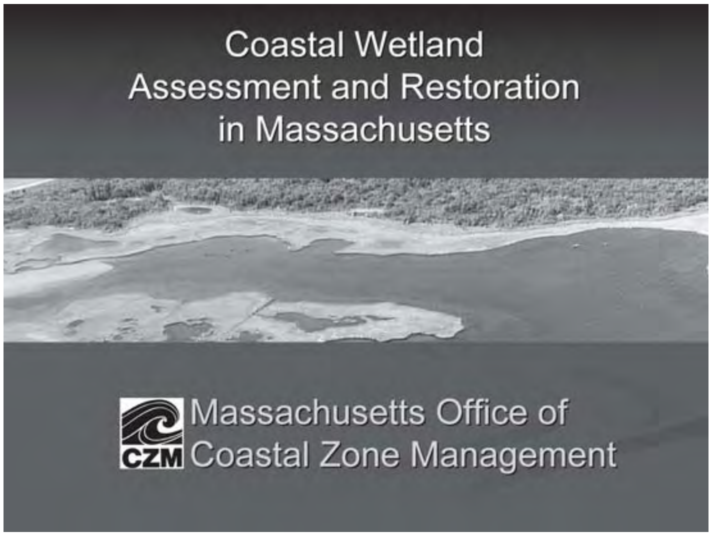
Coastal Wetland Assessment and Restoration in Massachusetts:

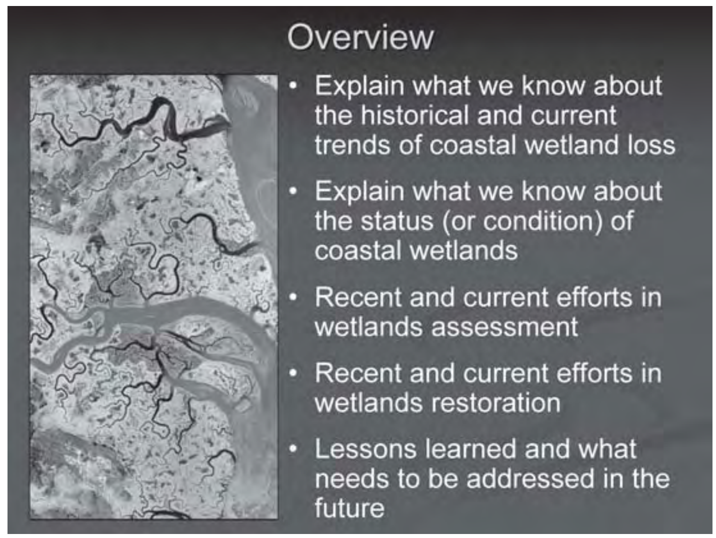
Bruce Carlisle
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114
(617) 626-1200
bruce.carlisle@state.ma.us

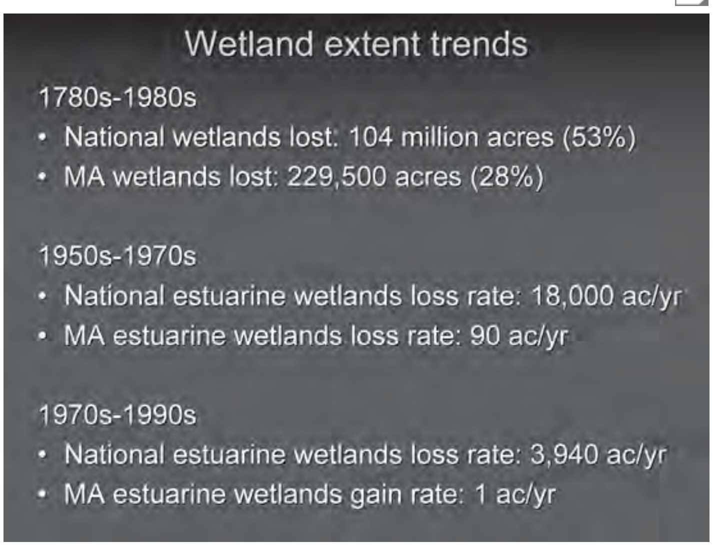
Wetlands have been particularly susceptible to destruction and degradation from direct and indirect human activities, especially estuarine marshes. Since the colonial era and through the 1950s, Massachusetts has suffered significant losses of estuarine wetlands, mostly due to urbanization. Rates of loss have slowed over the past 20 years, but human disturbance continues to adversely affect habitat quality, causing shifts in marsh community structure and function. Through its Wetlands Assessment and Wetlands Restoration Programs, the Massachusetts Office of Coastal Zone Management is working with a host of partners to address historic losses and ongoing degradation. The history of National wetland policy typically focused on quantity rather than quality. Over a 200-year window, 30 percent of wetlands have been lost in Massachusetts. Wetlands are important because they are the interface between land and water. Despite strong Federal and state wetlands programs and billions of dollars of public investment in wetland protection, there has been little systematic effort to measure and describe the condition of wetlands. Consequently, little is known about the condition or health of wetlands. For example, in a recent National Water Inventory Report, condition was reported for only four percent of the Nations' wetlands; only a small fraction of this assessment was derived from actual data, most was professional judgment.

The Wetland Assessment Program's goal is to develop techniques to assess the quality of coastal wetlands in order to identify wetland condition, inventory sites, evaluate restoration potential and monitor restoration response. The Wetlands Restoration Program works proactively within a network of public agencies and private partners for funding and coordination assistance. Mr. Carlisle described how the Wetlands Restoration Program helps to coordinate potential projects for restoration. He noted that many wetlands are in need of restoration but that many sites are not suitable for projects at this time based on their size or quality.

Mr. Carlisle identified several needs for the future of wetland restoration. For one, there is a need to improve connections with transportation agencies in order to get at opportunities associated with infrastructure work being planned. Second, although tidal restoration projects have been the backbone of much of wetlands restoration, these types of projects are getting fewer, harder, and more expensive. Furthermore, there is strong need to work to expand the scope of wetlands restoration to holistic and integrated projects, such as cross-habitats and addressing multiple impacts. Additionally, adaptive management should be more regularly practiced; as a concept and principle it is widely discussed, but in reality it is underused. This type of iterative management involves acquiring solid monitoring data and project implementation information and taking a hard look at the project efforts to date to see if additional changes are needed. Finally, the time has come to engage in more thought and dialogue regarding the concept of restoration banking (as opposed to mitigation banking) Restoration banking involves the pooling of resources, such as those generated by wetland enforcement, natural resources damages and other funds, to draw on and use to support the state, Federal and private funds on a project by project basis.


Coastal Wetland
Assessment and Restoration
in Massachusetts
CZM
Massachusetts Office of
Coastal Zone Management


Overview
• Explain what we know about the historical and current trends of coastal wetland loss
• Explain what we know about the status (or condition) of coastal wetlands
• Recent and current efforts in wetlands assessment
• Recent and current efforts in wetlands restoration
• Lessons learned and what needs to be addressed in the future


Wetland extent trends
1780s-1980s
• National wetlands lost: 104 million acres (53%)
• MA wetlands lost: 229,500 acres (28%)
1950s-1970s
• National estuarine wetlands loss rate: 18,000 ac/yr
• MA estuarine wetlands loss rate: 90 ac/yr
1970s-1990s
• National estuarine wetlands loss rate: 3,940 ac/yr
• MA estuarine wetlands gain rate: 1 ac/yr


150 years of change: Boston 1852 and 2001

Wetland status (condition)

- Wetland policy has been driven primarily by curbing losses: focus on quantity not quality
- Even with Federal and State protection programs with billions of dollars invested, there has been little systematic effort to measure and describe the condition of wetlands
- What we do know is that human development has been focused in coastal areas and has:
  - Fragmented marsh systems (road and RxR crossings)
  - Altered hydrology (esp. tide restrictions)
  - Increased inputs of nitrogen and other pollutants
  - Created barriers to landward migration

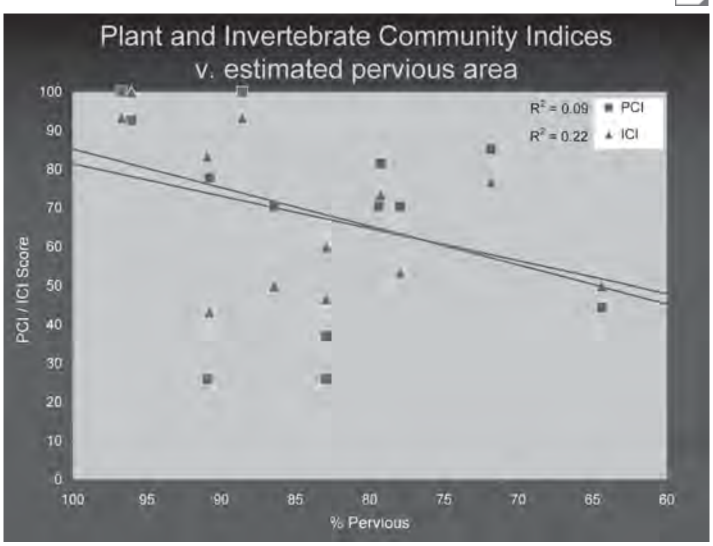
Wetland Assessment Program

- CZM began work in 1996 to develop and transfer techniques for assessing the condition of coastal wetlands
- Series of investigations from 1996-2000 examined the biotic condition of wetlands across a gradient of surrounding land use
- Working on a project to track long-term biotic and abiotic response to tidal restoration (2000-2007+)
- Just begun a project which uses systematic assessment at three scales:
  - » Landscape
  - » Rapid assessment
  - » Intensive site work

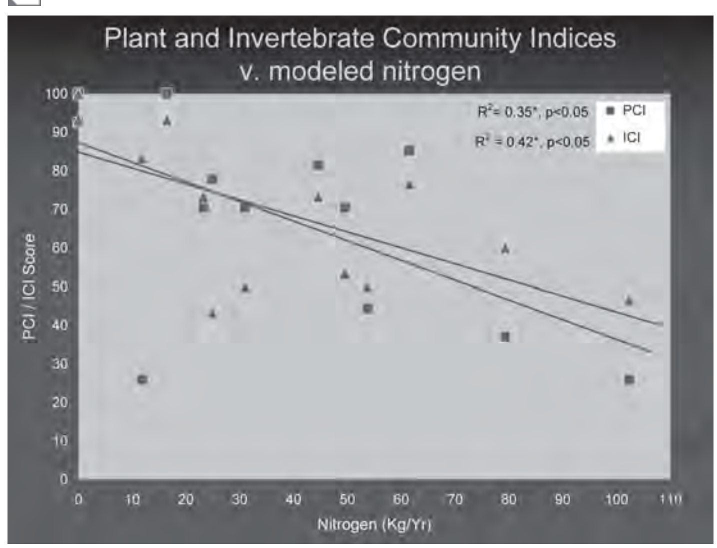
Land Use investigations

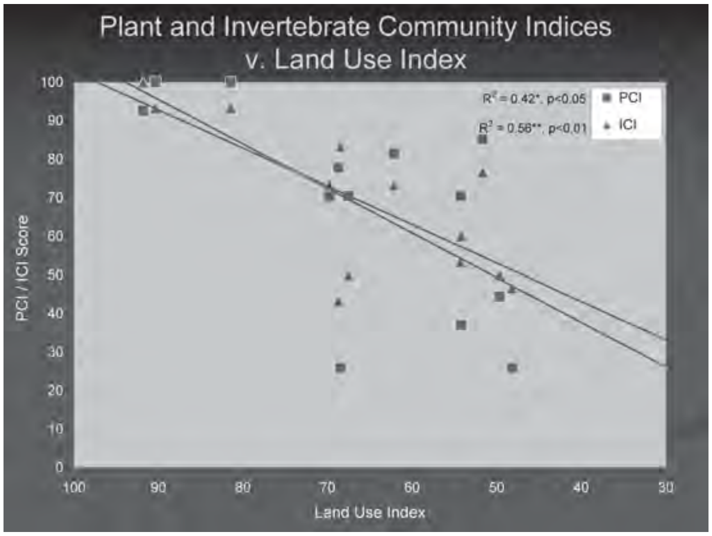
- Goal: To examine if biotic condition varied with human disturbance
- Sites were selected across a gradient of land use types and intensities: Land Use Index
- Measure of biotic condition: IBIs which integrate a number of attributes into a single rank or score
  - » Plant Community Index
  - » Invertebrate Community Index
- Compared 3 measures of land use (human disturbance)
  - » Nitrogen: driver of coastal eutrophication
  - » Impervious: surrogate for urbanization
  - » Land Use Index: method developed to quantify and integrate different stressors

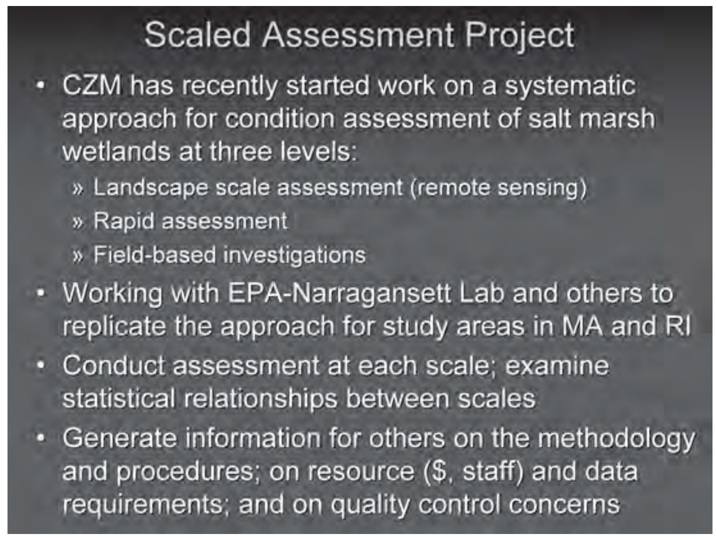

Site
DWR
N
W
E
S
300
0
300 Meters

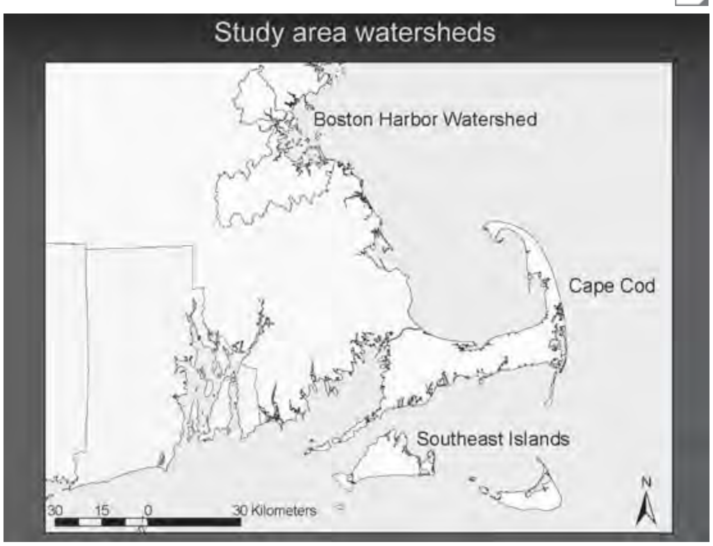

Plant and Invertebrate Community Indices
v. estimated pervious area
R^2 = 0.09 PCI
R^2 = 0.22 ICI
PCI / ICI Score
100
90
80
70
60
50
40
30
20
10
0
100
95
90
85
80
75
70
65
60
% Pervious

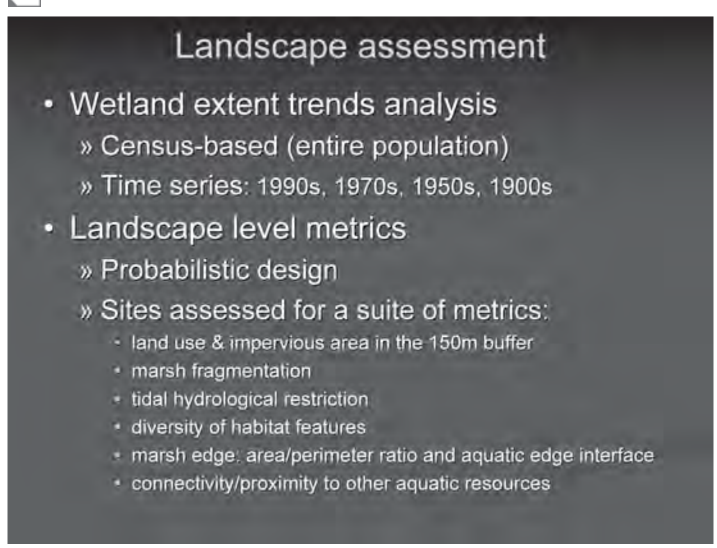

Site
IPB
N
W
E
S
300
0
300 Meters

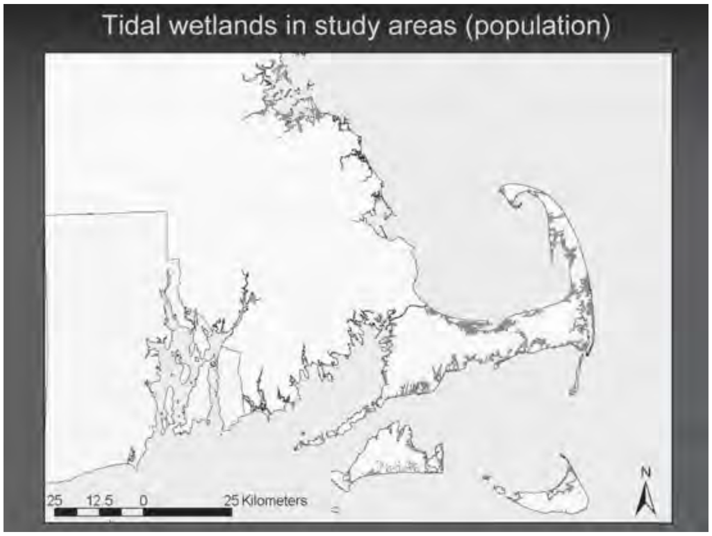

Plant and Invertebrate Community Indices
v. modeled nitrogen
R^2 = 0.35*, p<0.05 PCI
R^2 = 0.42*, p<0.05 ICI
PCI / ICI Score
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
110
Nitrogen (Kg/Yr)

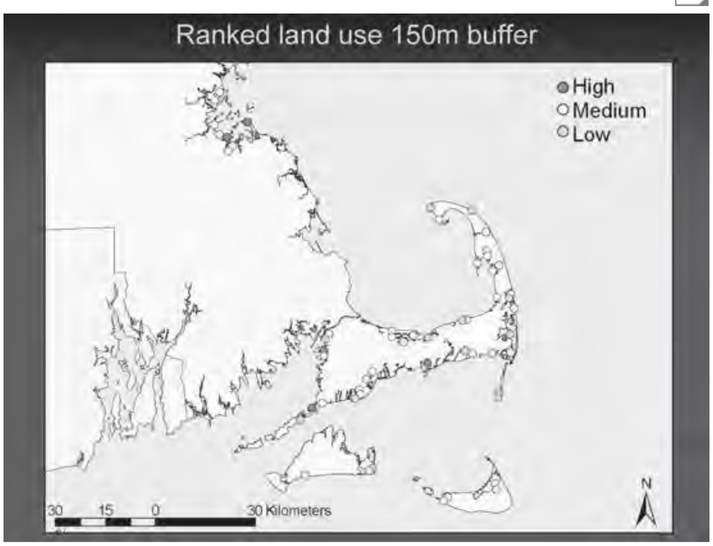

Plant and Invertebrate Community Indices
v. Land Use Index
R² = 0.42*, p<0.05
R² = 0.56**, p<0.01
PCI
ICI
PCI / ICI Score
Land Use Index
100 90 80 70 60 50 40 30 20 10 0
100 90 80 70 60 50 40 30

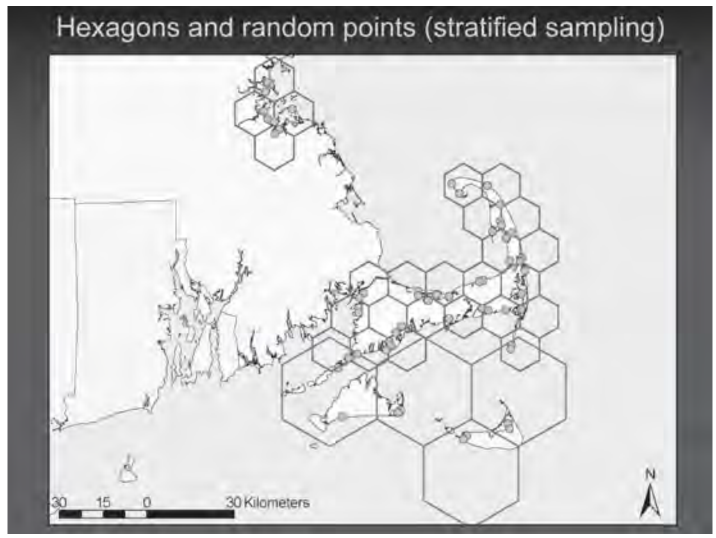

Scaled Assessment Project
• CZM has recently started work on a systematic approach for condition assessment of salt marsh wetlands at three levels:
» Landscape scale assessment (remote sensing)
» Rapid assessment
» Field-based investigations
• Working with EPA-Narragansett Lab and others to replicate the approach for study areas in MA and RI
• Conduct assessment at each scale; examine statistical relationships between scales
• Generate information for others on the methodology and procedures; on resource ($, staff) and data requirements; and on quality control concerns


Study area watersheds
Boston Harbor Watershed
Cape Cod
Southeast Islands
30 15 0 30 Kilometers
N

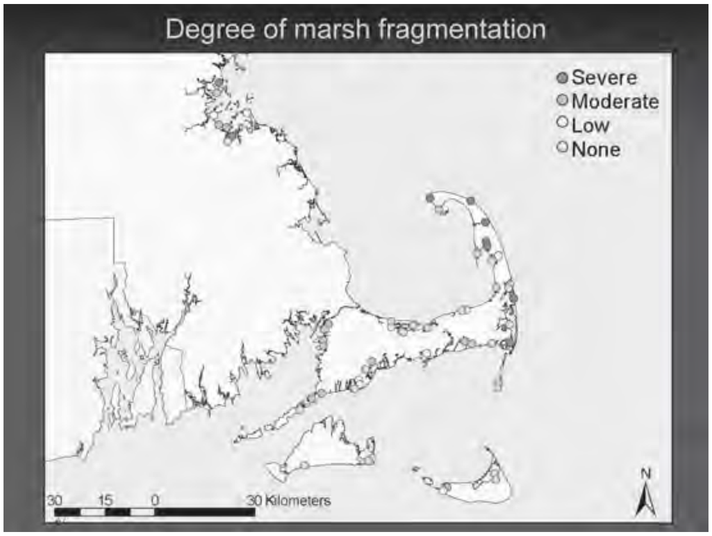

Landscape assessment
• Wetland extent trends analysis
» Census-based (entire population)
» Time series: 1990s, 1970s, 1950s, 1900s
• Landscape level metrics
» Probabilistic design
» Sites assessed for a suite of metrics:
• land use & impervious area in the 150m buffer
• marsh fragmentation
• tidal hydrological restriction
• diversity of habitat features
• marsh edge: area/perimeter ratio and aquatic edge interface
• connectivity/proximity to other aquatic resources


Tidal wetlands in study areas (population)
25 12.5 0 25 Kilometers
N


Ranked land use 150m buffer
High
Medium
Low
30 15 0 30 Kilometers
N


Hexagons and random points (stratified sampling)
30 15 0 30 Kilometers
N


Marsh fragmentation and tide restriction
220 Meters



Assessment lessons learned

- Wetland condition assessment is gaining significant attention, esp. at Federal level (US EPA)
- Through projects, we have confirmed that IBI approaches used for streams & rivers can be used to assess condition in coastal marshes
- Definite relationship between condition and landscape disturbance
- Remote sensing and rapid assessment have great potential for coarse condition evaluation
  - » Ability to assess large areas through either census or stratified random approach
  - » Validate these tools to biotic response

Assessment into the future

- Continue work on current scaled assessment project
  - » Continue working on and compiling existing data for landscape metrics
  - » Finalize the Rapid Assessment Method (RAM) and conduct assessments
  - » Compare RAM results to landscape outputs
  - » Conduct field-based investigations
  - » Compare results to rapid and landscape outputs
- Complete the wetlands loss trends work for remaining coast:
  - » 2005-2006: North Coastal, Ipswich and Parker
  - » 2006-2007: South Coastal, Buzzards Bay and Mt. Hope/Narragansett/Ten Mile

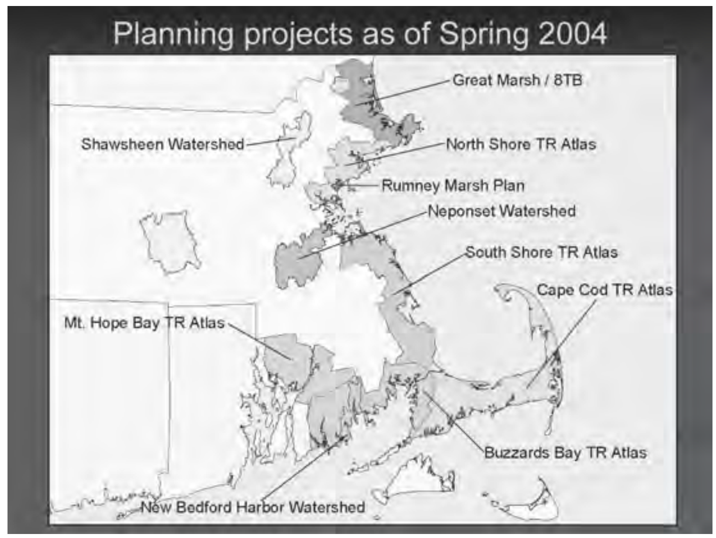
Wetlands Restoration Program

- Founded in 1994 with the goal to coordinate and support voluntary, pro-active restoration of degraded or former wetlands
- In 2003 the WRP was transferred to the Office of Coastal Zone Management CZM
- Program works in a network of partners, including:
  - » Federal agencies, such as NOAA, ACOE, EPA, NRCS
  - » Other state agencies: Riverways, DMF, DCR
  - » Corporate Wetlands Restoration Partnership), and project sponsors
- WRP provides (or provides for) a range of assistance:

-- ID restoration sites	-- develop plans
-- assess project feasibility	-- prepare engineering designs
-- obtain permits	-- oversee bids and construction
-- monitoring	-- delivering outreach and education

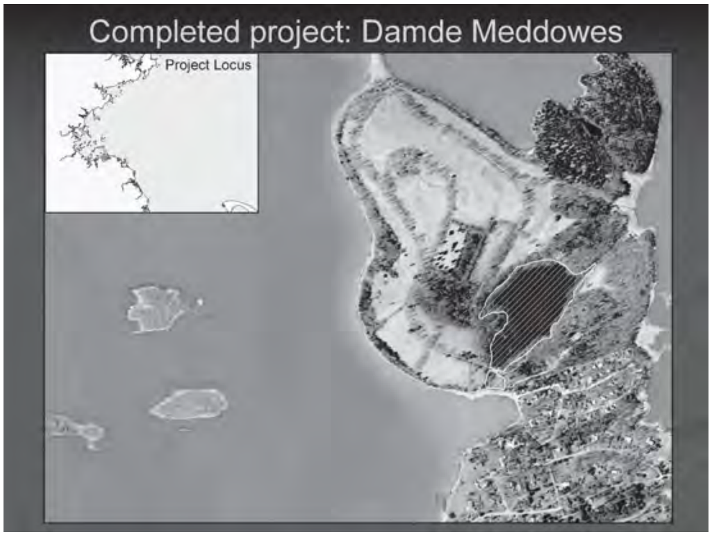
Restoration accomplishments

- Since 1994, the program has worked with a diverse array of partners to complete 34 projects, totaling more than 450 acres under restoration
- The WRP has leveraged over $13.6 million of non-State funds, largely Federal but with significant private and NGO contributions
- 11 comprehensive restoration planning projects have been completed:
  - » Tide restriction inventories for nearly the entire coast (Boston Harbor watershed and SE Islands remaining)
  - » Plans that identify other restoration opportunities: filled and drained sites
- Currently the Program has 33 active projects; approx.75% are tide-restriction restorations

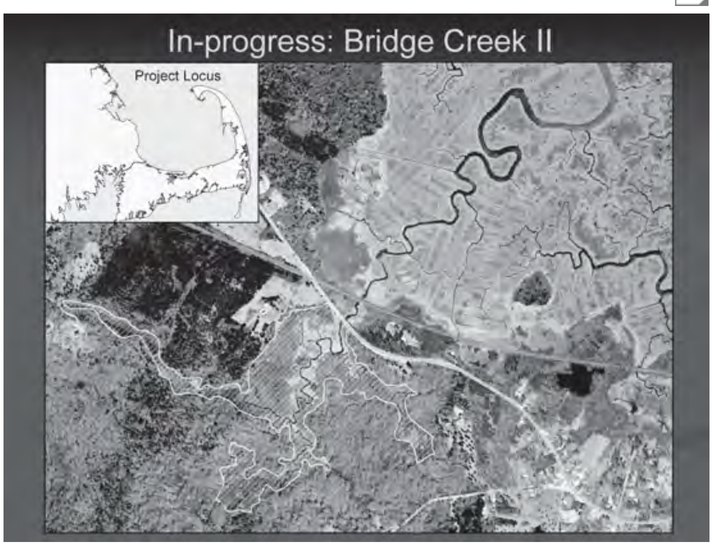


Planning project summaries

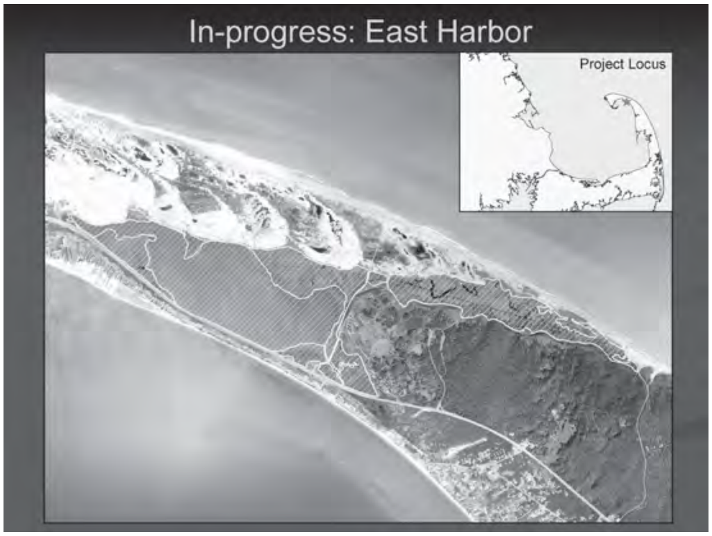
- 860 potential tide restriction sites
- 360 filled and drained sites
- Sites need further work to determine actual feasibility
- Many will not materialize into restoration projects due to:
  - » Minor tide restriction
  - » Presence of low-lying development or other infrastructure in tidal plain
  - » Unwilling landowner(s)
  - » Contaminated soils
  - » Scale, scope, and cost
- Small number of projects (approx. 10-20%) will emerge as excellent candidates for restoration

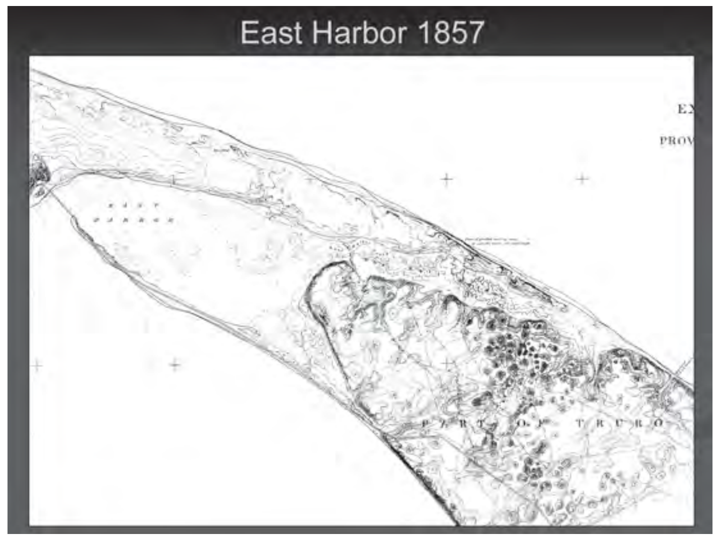

Completed project: Damde Meddowes
Project Locus


Completed project: Damde Meddowes


In-progress: Bridge Creek II
Project Locus


In-progress: Bridge Creek II


In-progress: East Harbor
Project Locus


East Harbor 1857
PART OF TRURO


In-progress: East Harbor
High Head Life Saving Station
Salt Meadow
Moon Pond Meadow
1887


Restoration lessons learned
Project development (between planning and implementation) is the missing link
No such thing as an easy project
All projects unique and need active project management
Involve stakeholders as early as possible and try to anticipate problems…they always happen
Permitting process though time-consuming (and $$) can be helpful, improve design

Restoration into the future

- Improve connections w/ transportation agencies
- Tide restrictions that have been the backbone of coastal wetland restoration will be fewer and get harder, more $$
- Expand scope to holistic and integrated projects: cross-habitat, address multiple impacts
- Adaptive management; using meaningful monitoring data to take a hard look at design and need for additional changes
- Restoration banking (v. mitigation banking): pooling and using settlement funds

Invasive Species

Dr. Judith Pederson
MIT Sea Grant
E38-300, 292 Main Street
Cambridge, MA 02139
(617) 253-7041
jpederso@mit.edu

Bioinvaders are taken from any region and brought to another. Dr. Pederson pointed out that evidence has shown that this is an economic issue as well as an ecological one. One example cited was the invasion of green crabs which originated in Europe, and have cost $44 million per year in shellfish and plant loss. MIT Sea Grant performed rapid assessment surveys in 2000 and 2003 to get a sense of the distribution of species throughout the Massachusetts coast. Generally ten percent of the populations in their surveys were introduced or "cryptogenic" species.

MIT Sea Grant compared areas within Massachusetts using similar rapid assessment surveys. In different areas results showed what appeared to be various underlying causes for the invasive species within the population on a specific site. Results also suggested that healthy communities have less biomass of invasives than disrupted areas. Ballast water is a growing issue for invasive species and, to be successful, coordination must take place between Canada and the United States, specifically for the Gulf of Maine and Massachusetts Bay to deal with this issue. Dr. Pederson also suggested that the legislature needs to be made aware of the problem and that early detection and monitoring is the key to prevention.

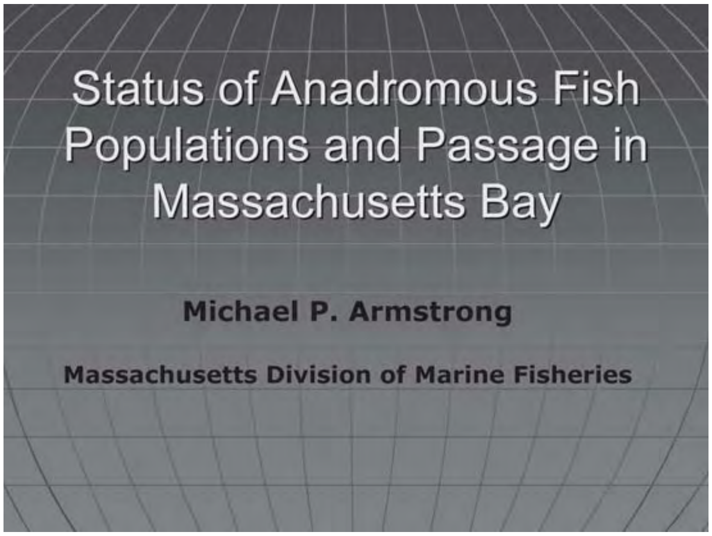
Estuary

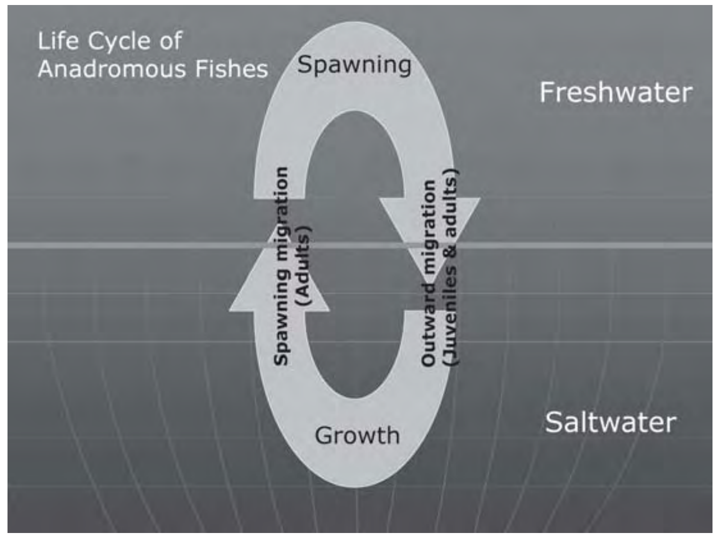
Anadromous Fish Runs

Dr. Michael Armstrong
Massachusetts Division of Marine Fisheries
30 Emerson Ave.
Gloucester, MA 01930
(978) 282-0308
michael.armstrong@state.ma.us

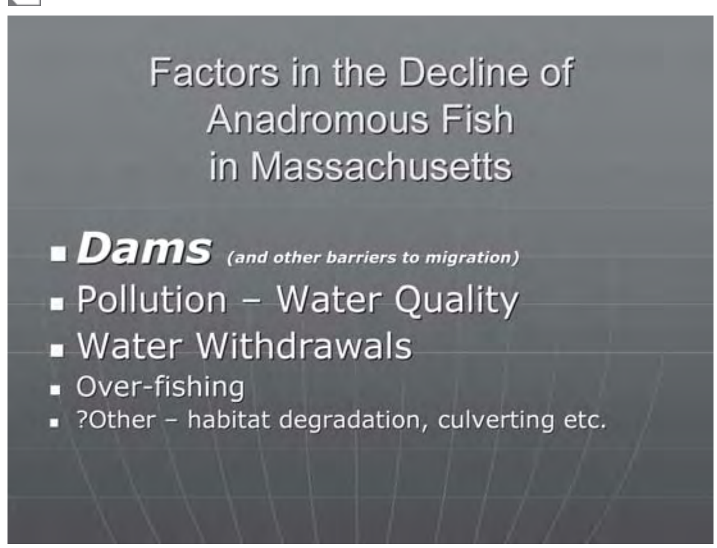
The destruction of spawning habitat through dam construction, water pollution and diversion, and overfishing depleted most anadromous fish species in the early 1900s. Anadromous fish come into fresh water to spawn, so it is critical to their survival that they can make it to fresh water and that juveniles can get out. Dr. Michael Armstrong noted that humans have done significant damage to fish runs, but restoration efforts have increased the population levels of many species. A recent survey of Massachusetts coastal streams documented 175 fish ladders of various types; the most of any state in the country. Fish ladders provide passage around dams and other obstructions and help restore spawning habitat for anadromous fish (there are 17 species in Massachusetts). About half of the ladders documented are in need of repair either because of deteriorating condition or because they do not provide efficient passage of fish. Further increases in population size will require repair of old and inefficient ladders and construction of new ladders where warranted. Many species of anadromous fish continue to have stressed populations. Alewife and blueback populations around the Massachusetts coast fluctuate widely within individual runs with many showing recent declines but others holding steady. American shad have shown a dramatic increase in abundance in the Merrimack River in recent years owing to an improvement in water quality and fish passage. However, only about ten percent of the fish pass through each of the ladders on the Merrimack River. Dr. Armstrong pointed out that much money has been spent on the survival of some of the anadromous species, especially salmon. Yet, throughout the state millions are put into the river each year but only about 150 make it back to spawn. The American eel populations appear to be in decline in Massachusetts. Variability of fish population numbers is tremendous among spawning runs and years. It is difficult to know how many fish are leaving, dying at sea, or not making it back for other reasons.

The Massachusetts Division of Marine Fisheries (DMF) has the authority to require anyone with a dam on his or her property to provide a pathway for fish, however this does not often happen on smaller waterways. In the past 30 years the DMF has worked on over 100 projects and continues to look for more.

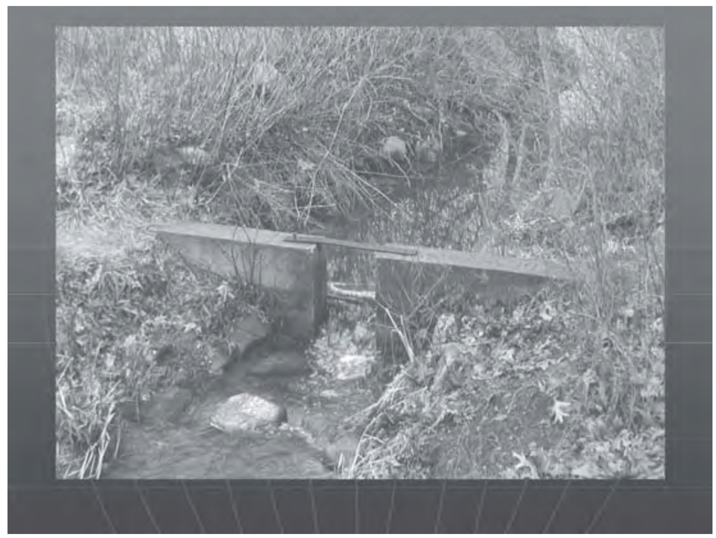

Status of Anadromous Fish Populations and Passage in Massachusetts Bay
Michael P. Armstrong
Massachusetts Division of Marine Fisheries

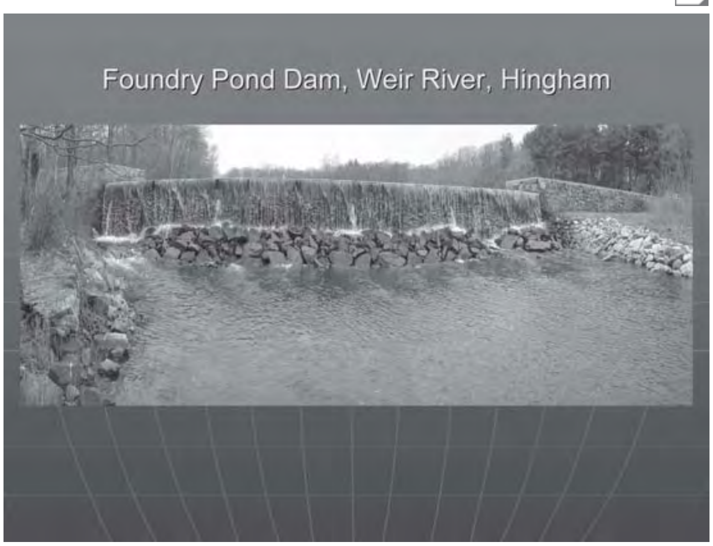

Life Cycle of Anadromous Fishes
Spawning
Freshwater
Spawning migration (Adults)
Outward migration (Juveniles & adults)
Growth
Saltwater


The Players
River Herring (Alewife and Blueback)
American Shad
Atlantic Salmon
Rainbow Smelt
Lamprey
Striped Bass
Atlantic and Shortnose Sturgeon
White Perch
Tomcod
(American Eel)
Status of Stocks
BAD
FAIR
GOOD
UNCERTAIN

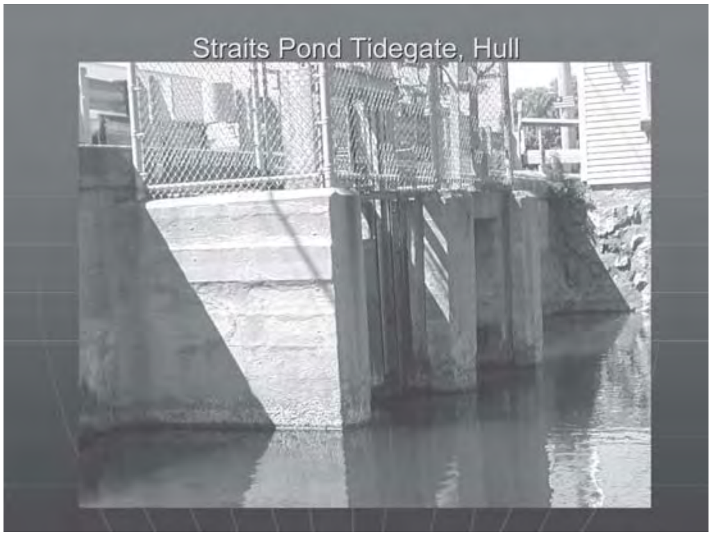

Factors in the Decline of Anadromous Fish in Massachusetts
Dams (and other barriers to migration)
Pollution – Water Quality
Water Withdrawals
Over-fishing
?Other – habitat degradation, culverting etc.

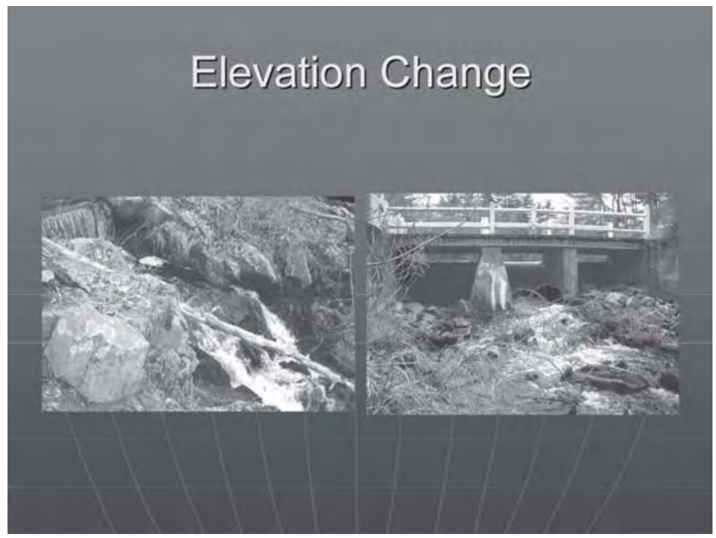

Dams
3000 in Massachusetts
Purposes
Power (electrical and mechanical)
Water supply (consumption and irrigation (esp. cranberry bogs))
Flood control
Recreation (fishing, boating, aesthetics)

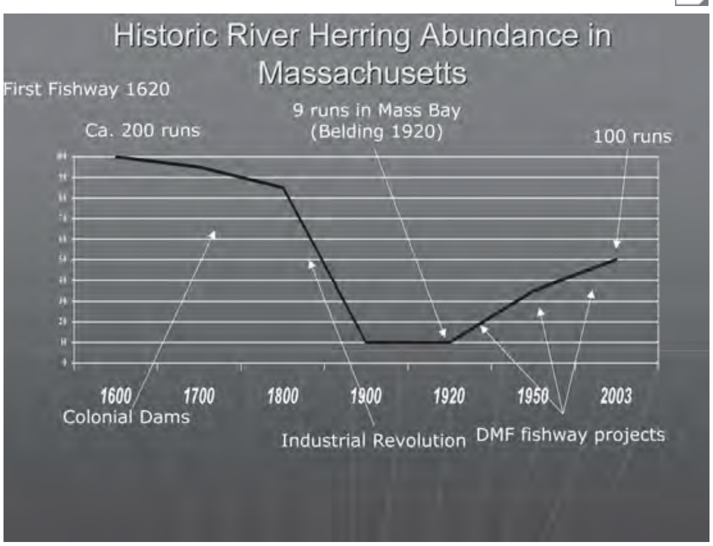



Foundry Pond Dam, Weir River, Hingham


Other Barriers to Migration

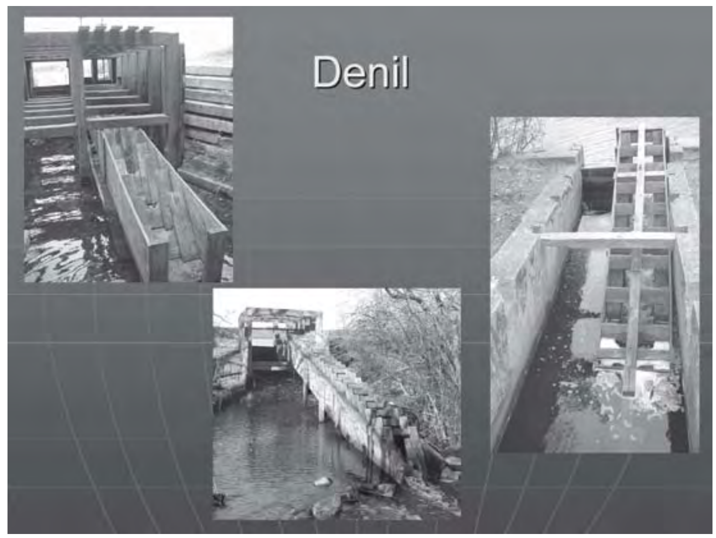

Straits Pond Tidegate, Hull


Elevation Change


Historic River Herring Abundance in Massachusetts
First Fishway 1620
Ca. 200 runs
9 runs in Mass Bay (Belding 1920)
100 runs
1600
1700
1800
1900
1920
1950
2003
Colonial Dams
Industrial Revolution
DMF fishway projects


Types of Fishways in Massachusetts
• Weir-Pool
• Denil
• Alaskan Steeppass
• Stream Baffle
• Lifts
• Other

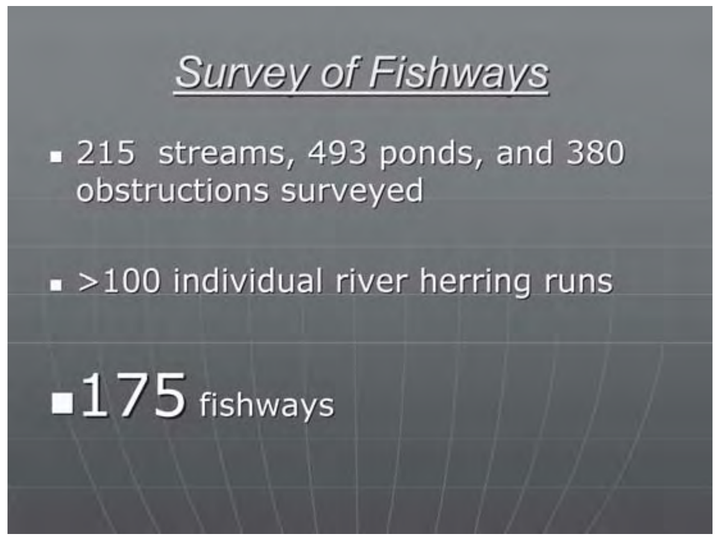

Weir - Pool
Jenny Grist Mill
Sandwich


Denil

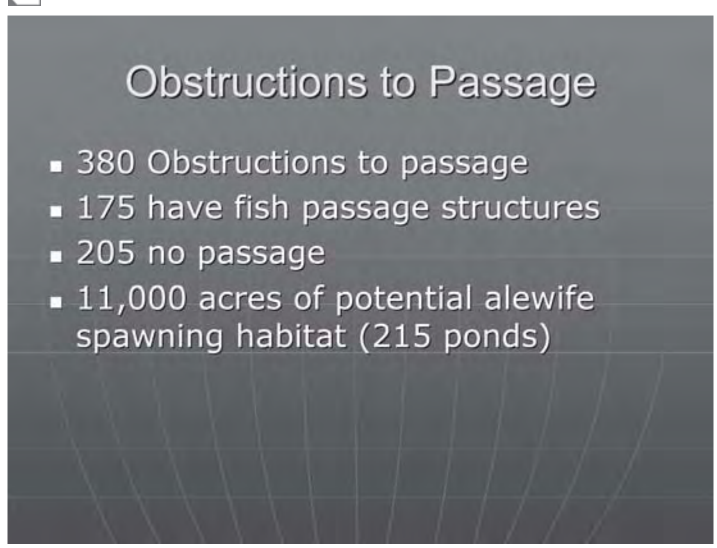

Alaskan Steeppass

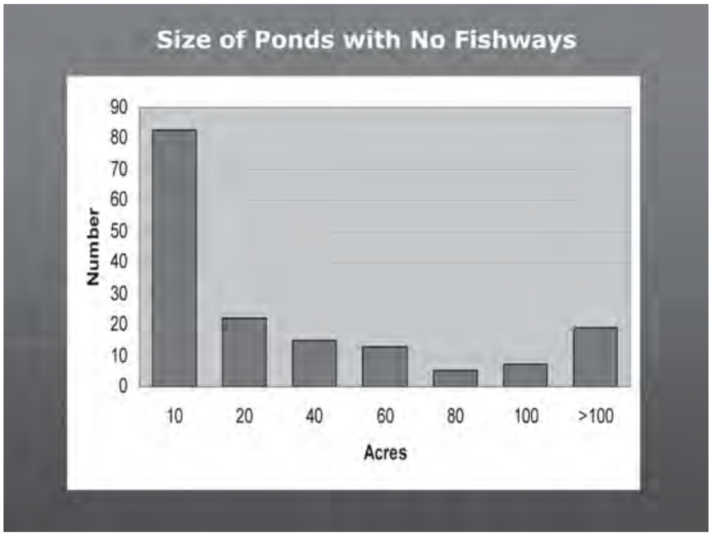

Stream Baffle

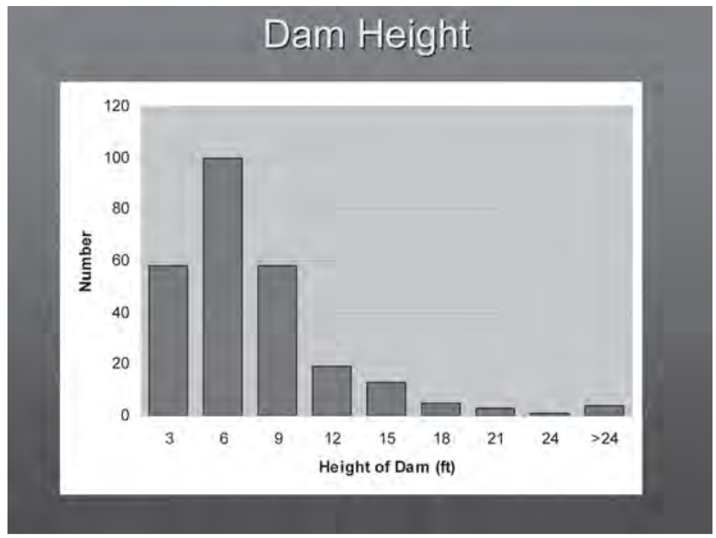

Status of Fish Passage

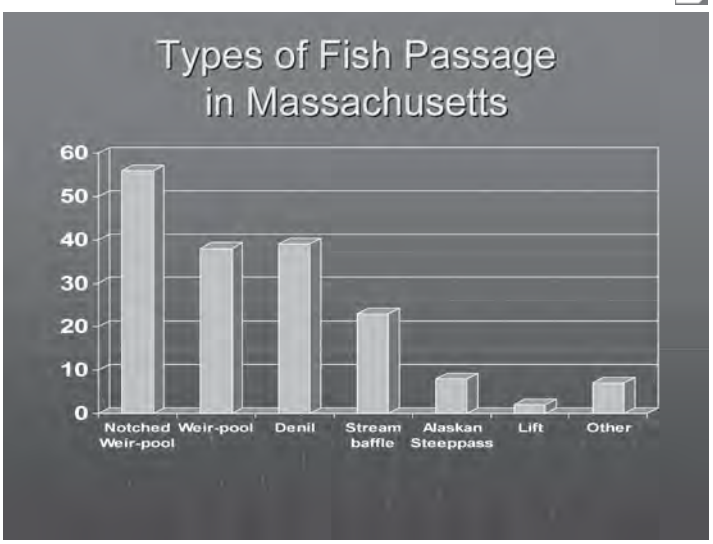

Survey of Fishways
215 streams, 493 ponds, and 380 obstructions surveyed
>100 individual river herring runs
175 fishways

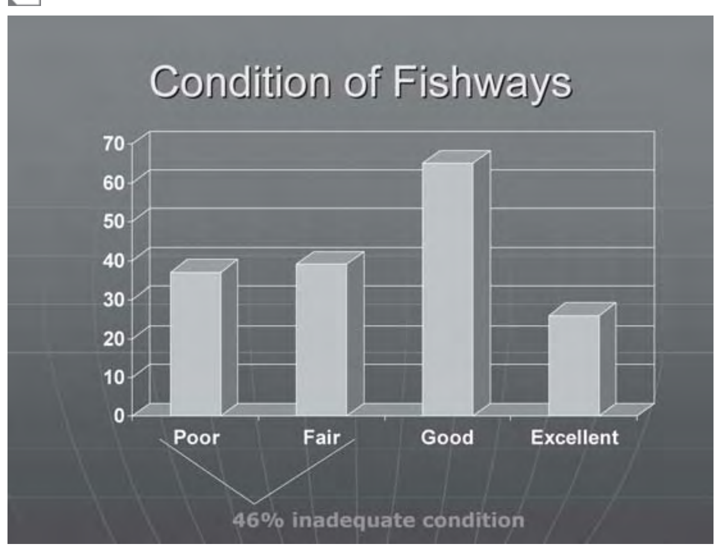

Obstructions to fish passage

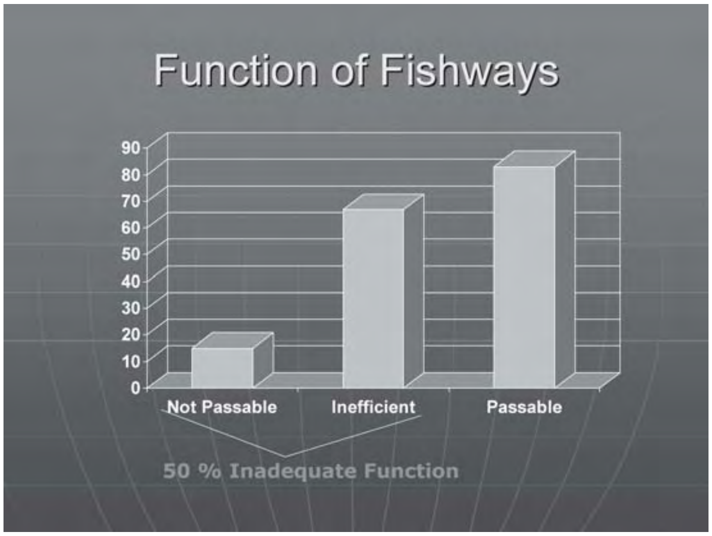

Obstructions to Passage
380 Obstructions to passage
175 have fish passage structures
205 no passage
11,000 acres of potential alewife spawning habitat (215 ponds)

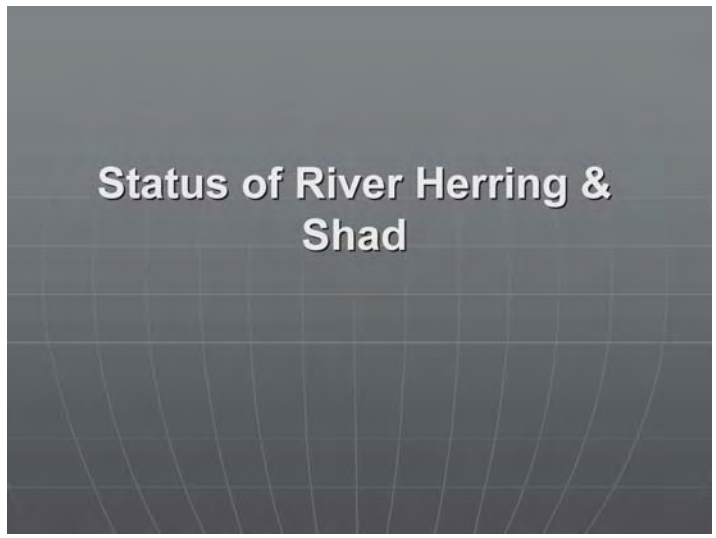

Size of Ponds with No Fishways
Number
Acres
10
20
40
60
80
100
>100

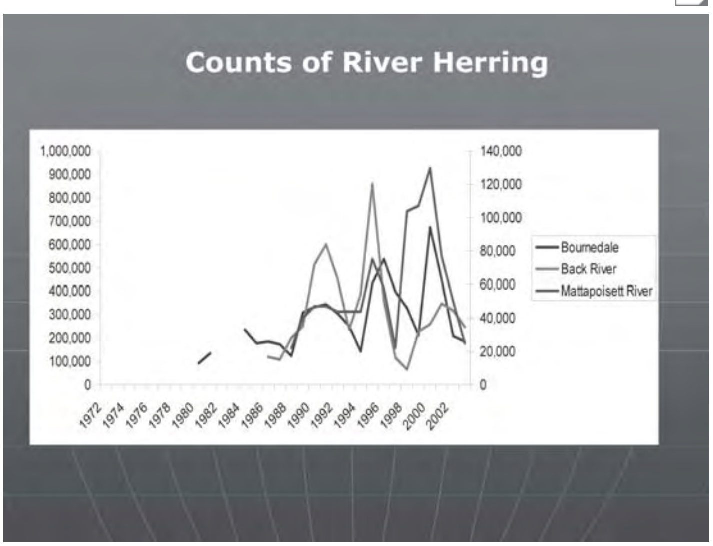

Dam Height
Number
Height of Dam (ft)
3
6
9
12
15
18
21
24
>24

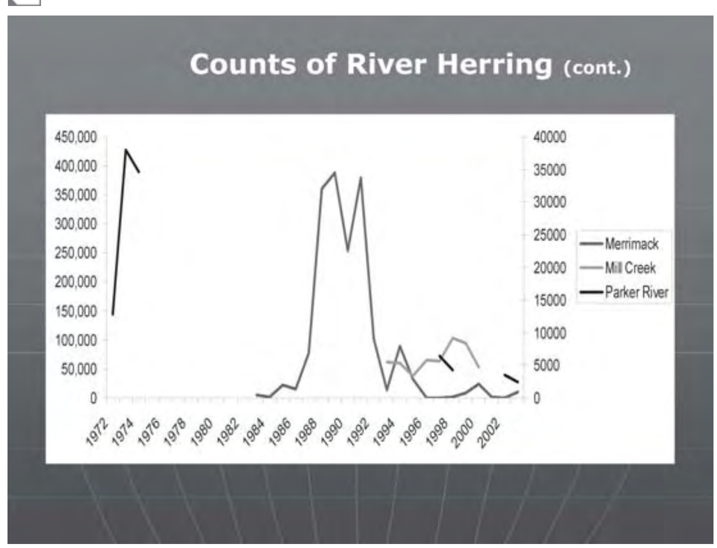

Types of Fish Passage in Massachusetts
Notched Weir-pool
Weir-pool
Denil
Stream baffle
Alaskan Steeppass
Lift
Other

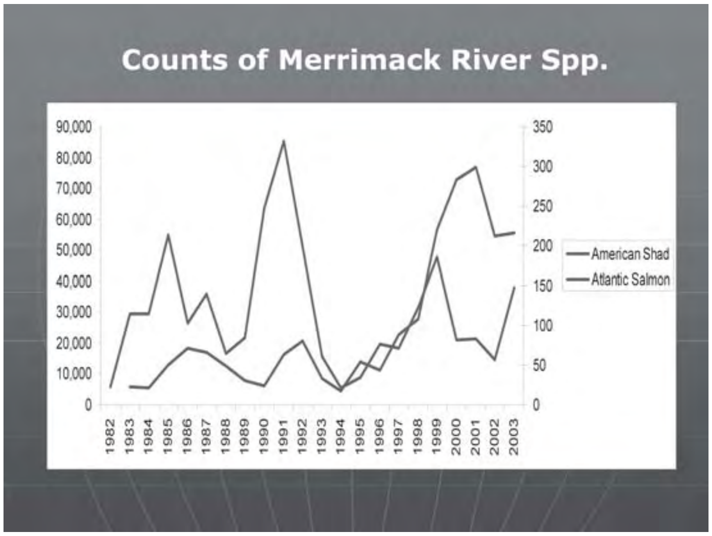

Condition of Fishways
Poor
Fair
Good
Excellent
46% inadequate condition


Function of Fishways
90
80
70
60
50
40
30
20
10
0
Not Passable
Inefficient
Passable
50 % Inadequate Function


Status of River Herring & Shad


Counts of River Herring
Bournedale
Back River
Mattapoisett River


Counts of River Herring (cont.)
Merrimack
Mill Creek
Parker River



Summary

Status of Fish Passage

- 175 fish passage structures to maintain and repair (50% in need of work)
- 30-40 major projects completed in last 10 years
- Still opportunity to improve and increase passage – survey-based prioritization

Summary

Status of Fish Populations

- Long-term increase in river herring; decrease in other species
- Last 10 years – No consistent trend for river herring; some recovery for shad
- Increasing threats – water diversion; overfishing
- Lack of information makes assessment difficult

Estuary

Embayment Water Quality

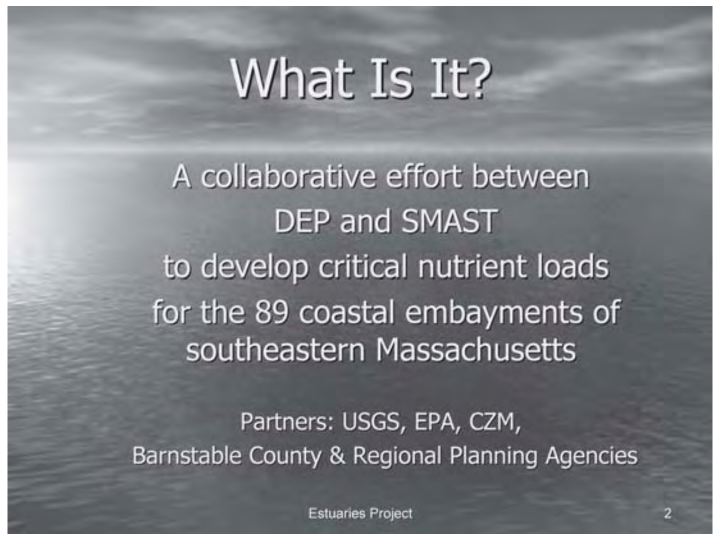
Andrew Gottlieb
Massachusetts Department of Environmental Protection
One Winter Street
Boston, MA 02108
617-292-5500
agottlieb@state.ma.us

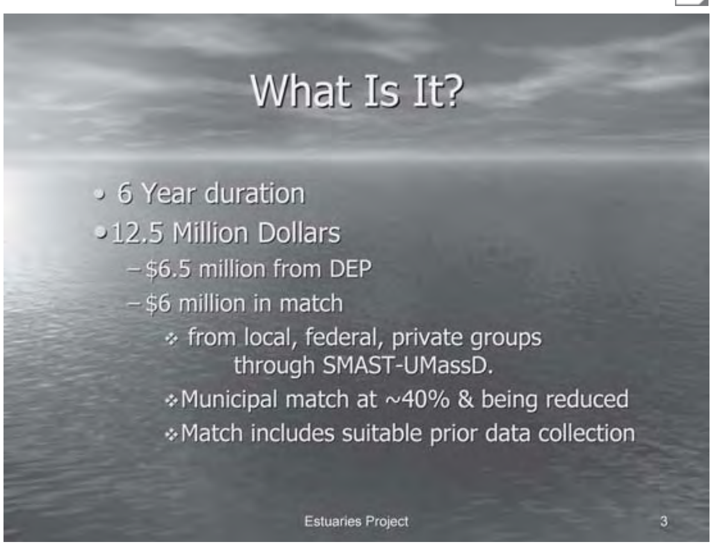
Mr. Andrew Gottlieb presented the Massachusetts' Estuaries Project as a collaborative effort between the MA Department of Environmental Protection (DEP) and the University of Massachusetts (UMASS)/ Dartmouth School of Marine Science and Technology (SMAST) for the restoration of coastal embayments along the southeast Massachusetts coast. The project involves developing critical nitrogen loads for 89 embayments and estuaries (from Duxbury south around Cape Cod, to Buzzards Bay and the Islands). Mr. Gottlieb stated that traditionally DEP presents communities with oversight on environmental problems and provides the direction for solving these perceived problems. The approach of the Estuaries Project is different, generally enrolling communities that have asked for the DEP's help. The communities identified issues with their water quality and want to know how to address it. The DEP created a plan that focused on the development of defining protective thresholds for each system and outlining meaningful alternatives in a manner that favors a more comprehensive approach to water resource planning. In these cases, municipalities are engaged in the processes at the beginning and most are willing to give of their resources.

Thus far, specific projects within the Estuaries Project have been initiated through a process that prioritizes, not by which estuaries have the worst water quality but by which estuaries that have the most water quality data, major projects such as wastewater facilities planning, the level of municipal and community engagement, and matching support. A ranking of the first 20 estuaries is provided in the accompanying slides. Much time was lost trying to figure out what watersheds were good for this effort.

Some possible wastewater solutions offered by Mr. Gottlieb involved consideration of water resource planning. Firstly, siting of wastewater facilities, alternatives to traditional discharge, and using many small facilities rather than one large one with infiltration beds should considered. Finally, Mr. Gottlieb presented a case study on West Falmouth Harbor where 75% of the nitrogen load to the harbor originated from local subterranean wastewater discharge.


The Estuaries Project
Southeastern Massachusetts
Embayment Restoration
Estuaries Project
1


What Is It?
A collaborative effort between
DEP and SMAST
to develop critical nutrient loads
for the 89 coastal embayments of
southeastern Massachusetts
Partners: USGS, EPA, CZM,
Barnstable County & Regional Planning Agencies
Estuaries Project
2


What Is It?
• 6 Year duration
• 12.5 Million Dollars
– $6.5 million from DEP
– $6 million in match
from local, federal, private groups
through SMAST-UMassD.
Municipal match at ~40% & being reduced
Match includes suitable prior data collection
Estuaries Project
3


Why Is It?
1. "Grass Roots" genesis
• Community groups see impacts
• Want to protect their natural assets
2. Communities are asking for help!
• Nutrient loads are degrading water quality
• Impacting natural resources
• Impacting economic resources
Estuaries Project
4


Why Is It?
3. Comprehensive Water Resources Planning
Nitrogen thresholds set acceptable loading
Provides scientific basis for nitrogen management
Is the core of nitrogen and bacterial TMDL's
Helps define load allocations
Helps identify wastewater management options
Helps identify water resource priorities
Estuaries Project
5

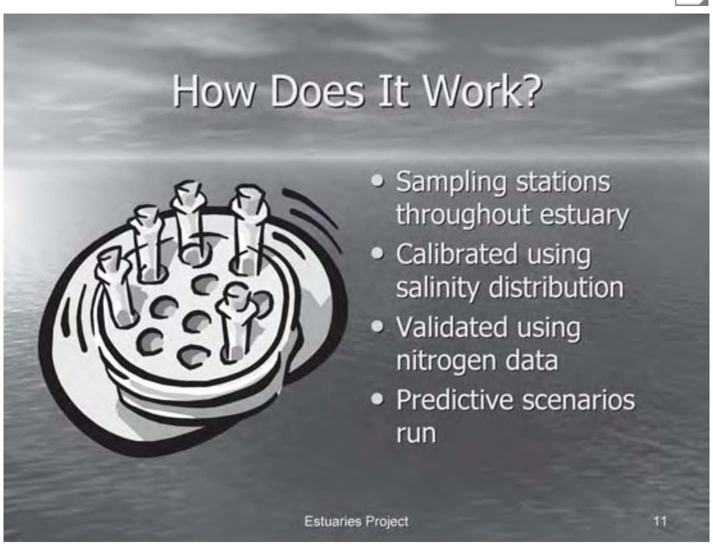

Why Is It?
Declining habitat quality within coastal embayments due to increasing nitrogen loading resulting from changes in watershed land uses.
Estuaries Project
6

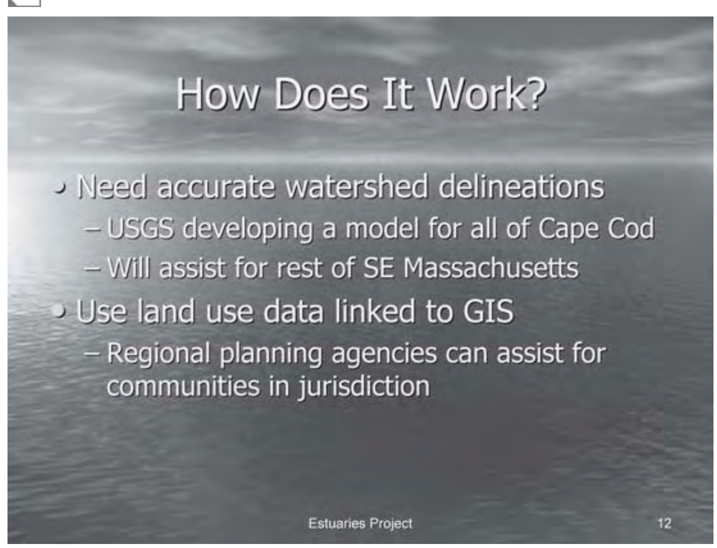

Prioritization Rankings
Existing Data
Wastewater Facilities Planning, Major Projects
Level of municipal & community engagement
Matching support
Existing Data
Estuaries Project
7


Ranking of Initial Set of Estuaries -
Town
Estuary
1. Mashpee/Barnstable: Popponesset Bay
2. Chatham: Sulfur Springs/Bucks Creek
3. Chatham: Muddy Creek
4. Chatham: Bassing Harbor/Ryders Cove/Frost Fish Creek
5. Chatham: Stage Harbor System
6. Chatham: Taylors Pond
7. Falmouth: Bournes Pond
8. Falmouth/Mashpee: Hamblin/Jehu Ponds, Quashnet River
9. Falmouth: Great/Perch Ponds
10. Falmouth: Green Pond
Estuaries Project
8


Ranking of Initial Set of Estuaries -
Town
Estuary
11. Wareham: Agawam/Wareham/Broad Marsh Rivers, Marks Cove
12. Falmouth: Little Pond
13. Nantucket: Nantucket Harbor
14. Falmouth: West Falmouth Harbor
15. Barnstable: Three Bays
16. Martha's Vineyard: Edgartown Great Pond
17. Falmouth: Oyster Pond
18. Nantucket: Sesachacha Pond
19. New Bedford: Acushnet River, New Bedford Inner Harbor
20. Bourne: Eel Pond, Back River
Estuaries Project
9


How Does It Work?
A Linked Model Approach
– Nitrogen Loading Model
• Land use inputs: natural and anthropogenic
• Natural attenuation of nitrogen
• Recycled nitrogen
– Hydrodynamic Model
• Flushing characteristics
– Water Quality Model
• Nitrogen species, salinity
– Site Specific Thresholds Analysis
• chlorophyll, DO, benthic animals, eelgrass
Estuaries Project
10

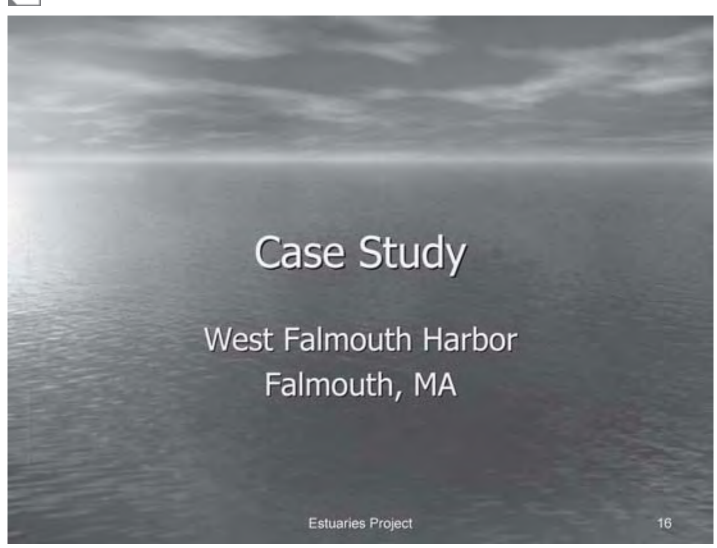

How Does It Work?
• Sampling stations throughout estuary
• Calibrated using salinity distribution
• Validated using nitrogen data
• Predictive scenarios run
Estuaries Project
11

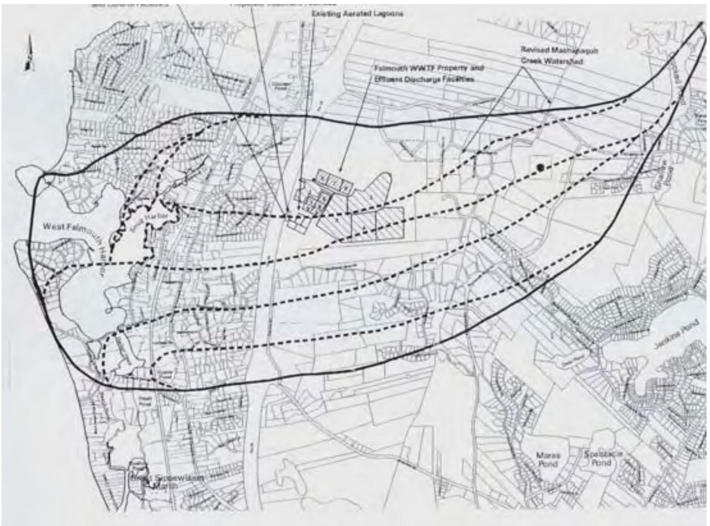

How Does It Work?
• Need accurate watershed delineations
– USGS developing a model for all of Cape Cod
– Will assist for rest of SE Massachusetts
• Use land use data linked to GIS
– Regional planning agencies can assist for communities in jurisdiction
Estuaries Project
12

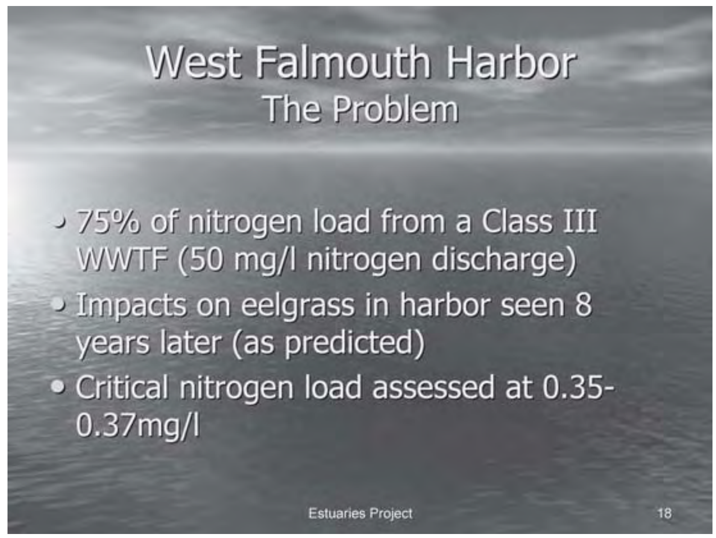

Developing Thresholds
Use historical data, if available
– e.g. eelgrass distribution and water quality data
If no historical data
– Run "no load" scenarios
Water Quality data
Oxygen time series data
Benthic animal data
Estuaries Project
13

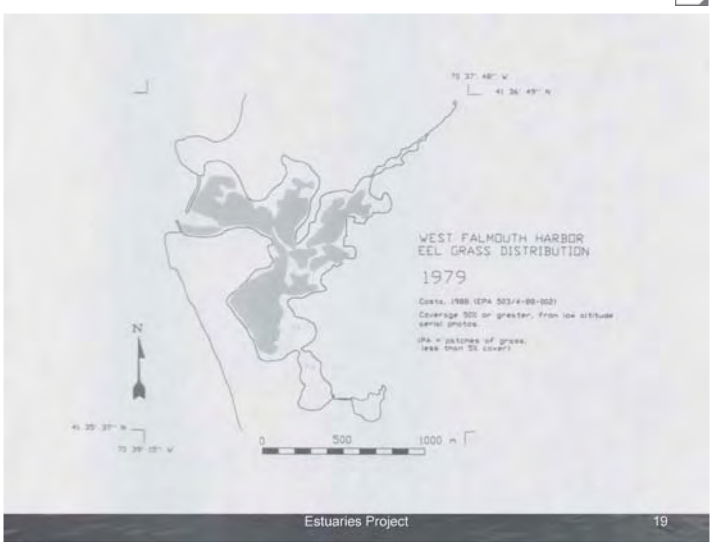

What is needed at local/regional level
by embayment
– municipal partnering and liaison
– municipal/community advisory committees
– identification of specific site issues
by region
– continuing community education
– development of guidance for communities
– integration of effort
Estuaries Project
14

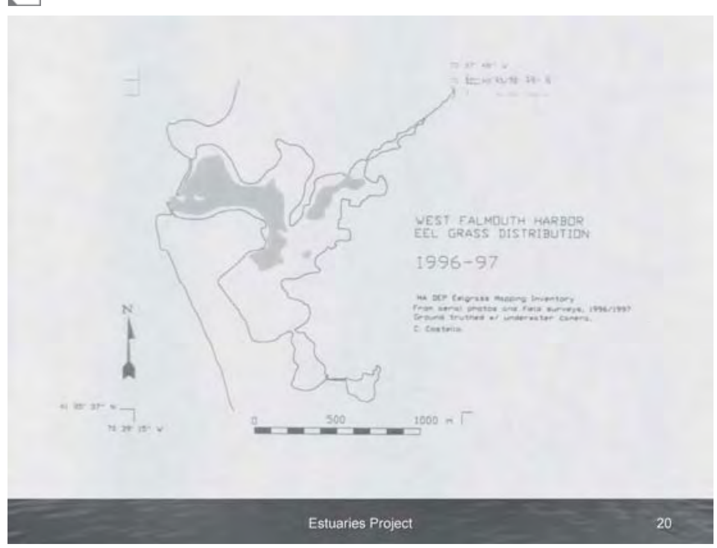

Where Do We Go From Here?
Nutrient management planning
Comprehensive water resources planning
All include community involvement, education and commitment from citizens' groups and municipal, state and federal officials!!
Estuaries Project
15

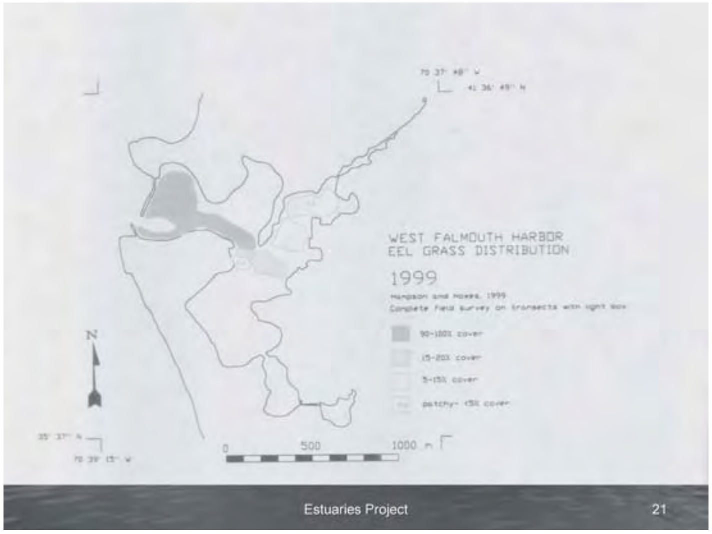

Case Study
West Falmouth Harbor
Falmouth, MA
Estuaries Project
16

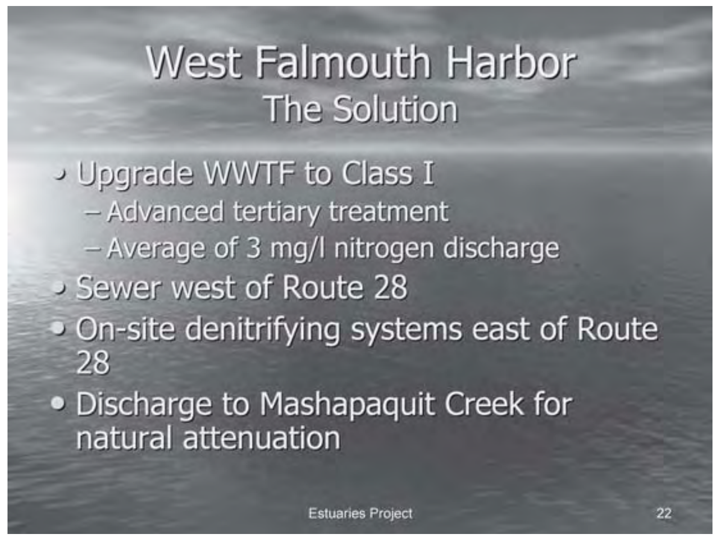

Existing Aerated Lagoons
Falmouth WWTF Property and Effluent Discharge Facilities
Revised Mashapaquit Creek Watershed
Jenkins Pond
Mares Pond
Spectacle Pond

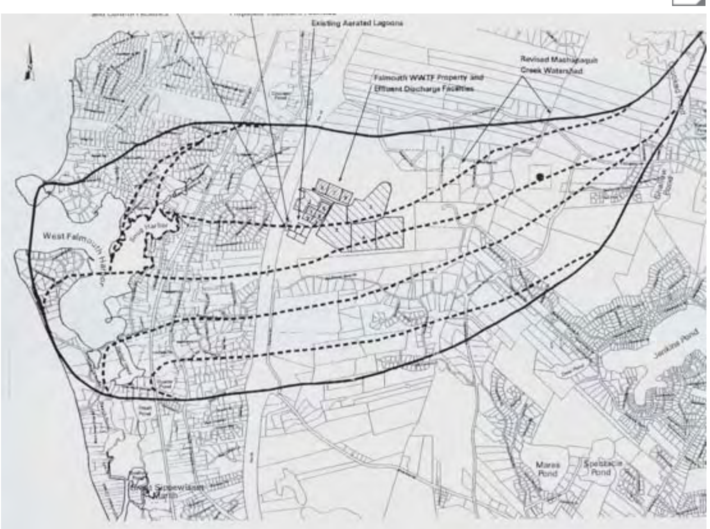

West Falmouth Harbor
The Problem
75% of nitrogen load from a Class III WWTF (50 mg/l nitrogen discharge)
Impacts on eelgrass in harbor seen 8 years later (as predicted)
Critical nitrogen load assessed at 0.35-0.37mg/l
Estuaries Project
18


WEST FALMOUTH HARBOR
EEL GRASS DISTRIBUTION
1979
N
0
500
1000 m
Estuaries Project
19


WEST FALMOUTH HARBOR
EEL GRASS DISTRIBUTION
1996-97
N
0
500
1000 m
Estuaries Project
20


WEST FALMOUTH HARBOR
EEL GRASS DISTRIBUTION
1999
90-100% cover
15-20% cover
5-15% cover
N
0
500
1000 m
Estuaries Project
21


West Falmouth Harbor
The Solution
• Upgrade WWTF to Class I
– Advanced tertiary treatment
– Average of 3 mg/l nitrogen discharge
• Sewer west of Route 28
• On-site denitrifying systems east of Route 28
• Discharge to Mashapaquit Creek for natural attenuation
Estuaries Project
22


Existing Aerated Lagoons
Falmouth WWTF Property and Effluent Discharge Facilities
Revised Mashapaquit Creek Watershed
West Falmouth Harbor
Jenkins Pond
Mares Pond
Spectacle Pond

Estuary

Contaminants in Boston Harbor

Christian Krahforst
Massachusetts Bays Program
251 Causeway Street, Suite 800
(617) 626-1216
christian.krahforst@state.ma.us

Boston Harbor has been touted as one of the filthiest urban harbors in the nation. The sources of contaminants were largely attributed to the legacy of growing urbanization, which by 1990 contributed nearly 300 million gallons of effluent and 450 thousand gallons of sludge to the narrow confines of Boston Harbor. Sludge loading to the harbor has been altogether removed and since 2000 and the effluent discharge has been moved out into western Massachusetts Bay. Mr. Krahforst
said it is important to keep in mind that the contemporary source loads are significantly changing and, in many cases, being reduced - even though the amount of freshwater entering the Harbor remains relatively unchanged. Important to contaminant fate and transport in Boston Harbor is the
consideration of harbor flushing and the amount of harbor water returned with each incoming tide. As tides exchange harbor water with Massachusetts Bay, some of the "old" harbor water is returned and the harbor is not fully refreshed with new clean Bay water.

The extent to which Boston Harbor is or was polluted is open for debate. Monitoring scientists distinguish between contamination and pollution by the degree to which the health of biota is adversely affected. Contamination is the presence of noxious material at readily detectable amounts, either in sediments, the air, the water, or accumulated in the biota. Clear signs of the biological degradation have been shown. Recent assessments of the benthic community have shown markedly improved communities. Has the Harbor moved from polluted to "merely contaminated" status? This question remains unanswered. Recent (and past) data in all the compartments of the ecosystem (i.e., sediments, water, organisms) is lacking for meaningful assessment on the condition of the Harbor. What important contaminant sources remain or are emerging? New, more recent data from Boston Harbor is becoming available. However, this data must be interpreted in light of changing source loads and re-equilibrium with contaminated Harbor sediments. By logical progression, the state of the Harbor is therefore rapidly changing as well.

Silver levels in both the water column and sediments may be relatable to understanding the state of the Harbor since its source is essentially from municipal wastewater discharges. What is the Harbor's influence on Massachusetts Bay? There is a need to understand how contaminants move from the watershed to Boston inner harbor and out into the Bay. Before the wastewater effluent was removed from the Harbor, selected contaminant levels in water, sediment, and biota were elevated. Following recent management initiatives, changes in the benthic communities have been shown, trace metal levels in Harbor water may have decreased (though not dramatically), and contaminant loading may be undergoing readjustment between the water column and underlying sediment. Recent assessments, such as the National Coastal Conditions report and from regional blue mussel data, indicate that Boston Harbor still remains one of the most polluted estuaries in New England.

Mr. Krahforst stated that he feels the difference between pollution and contamination is very relevant. Toxicity testing is important to viewing transport throughout the harbor. Today, Boston Harbor receives a good amount of fresh water and relatively no effluent discharges and it is believed that contaminant loading from fresh water sources are becoming more important than previous assessments. He suggested that the research community needs to be pulled in closer to management and that better assessment tools need to be devised to address the issues.

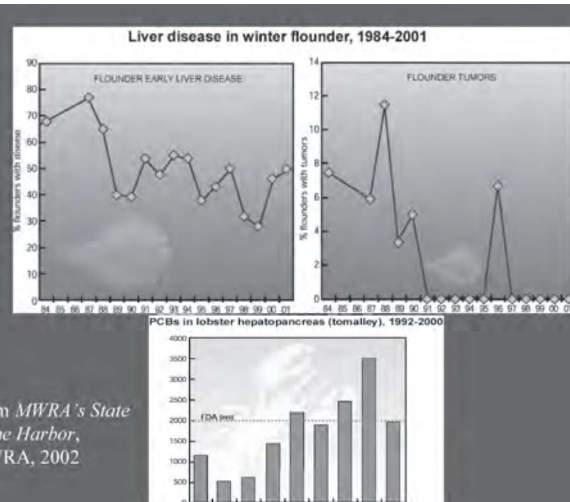
Outline

- Polluted or "just contaminated"?
- Physical Setting of Boston Harbor
- Source of Contamination
- Contaminant Distributions
- State of the Harbor

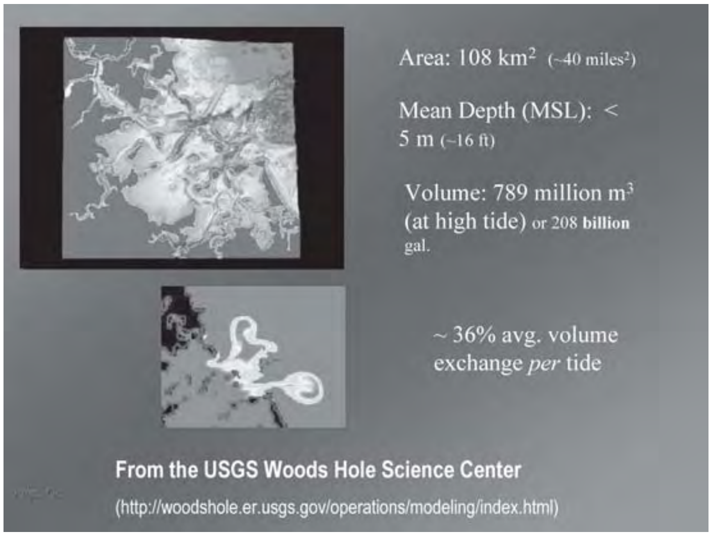
Boston Harbor, from polluted to just contaminated? (getting better??)

- Contaminated – having material (compounds) considered poisonous or noxious at levels *readily detectable (significant) levels*
- Polluted – when these noxious materials are at levels that measurably harm the plants and/or animals living there.

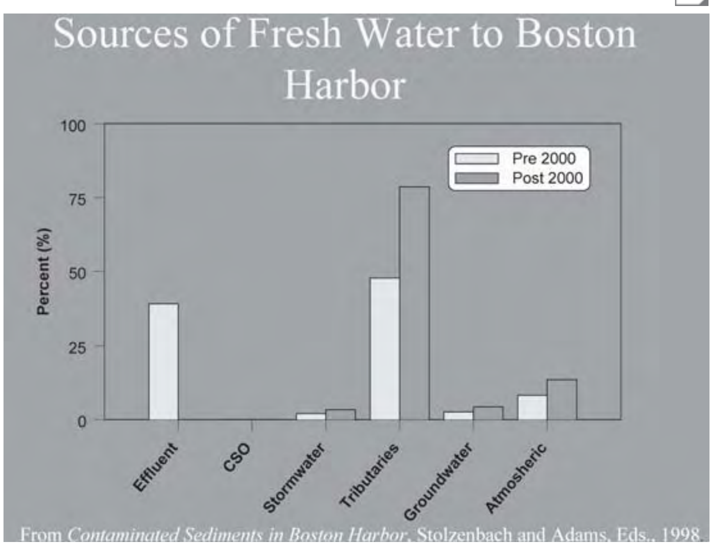
Paraphrased from discussions with Dr. Peter Wells, Environmental Canada

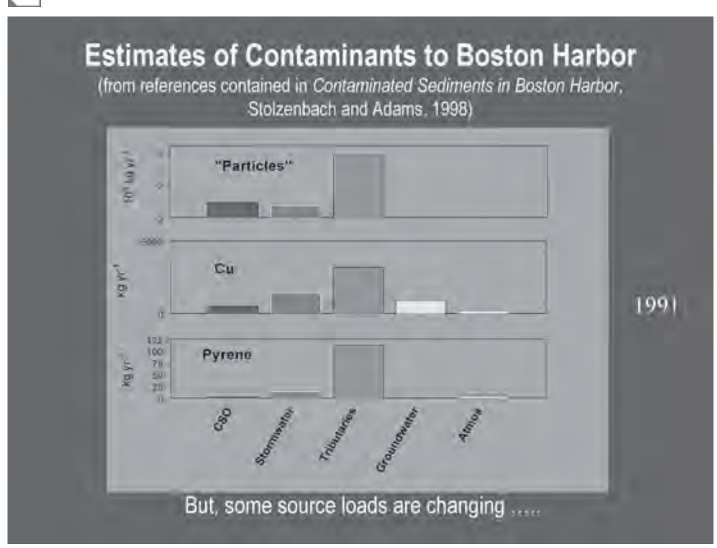


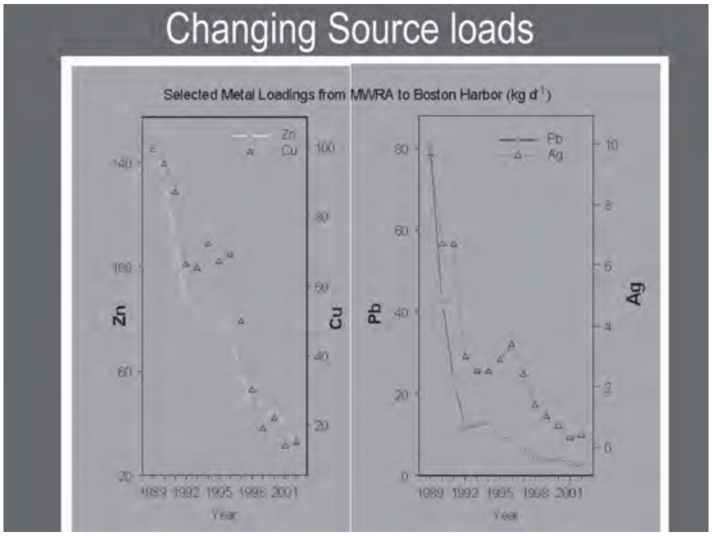
From *MWRA's State of the Harbor*, MWRA, 2002

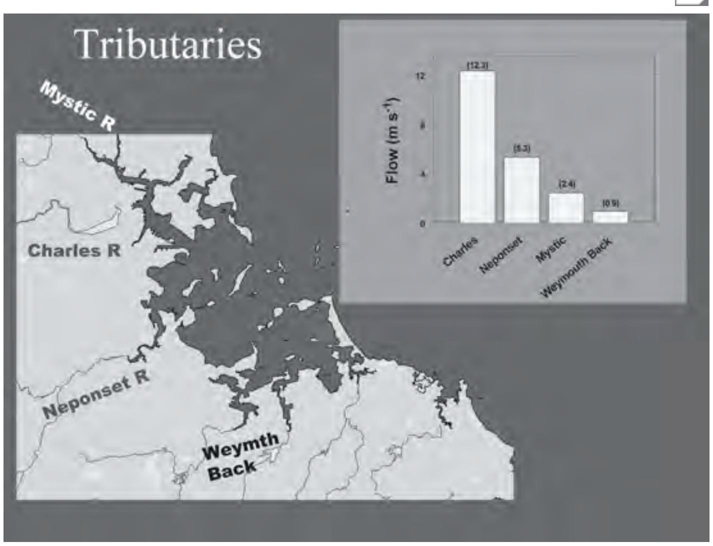

Area: 108 km² (~40 miles²)
Mean Depth (MSL): < 5 m (~16 ft)
Volume: 789 million m³ (at high tide) or 208 billion gal.
~ 36% avg. volume exchange per tide
From the USGS Woods Hole Science Center
(http://woodshole.er.usgs.gov/operations/modeling/index.html)

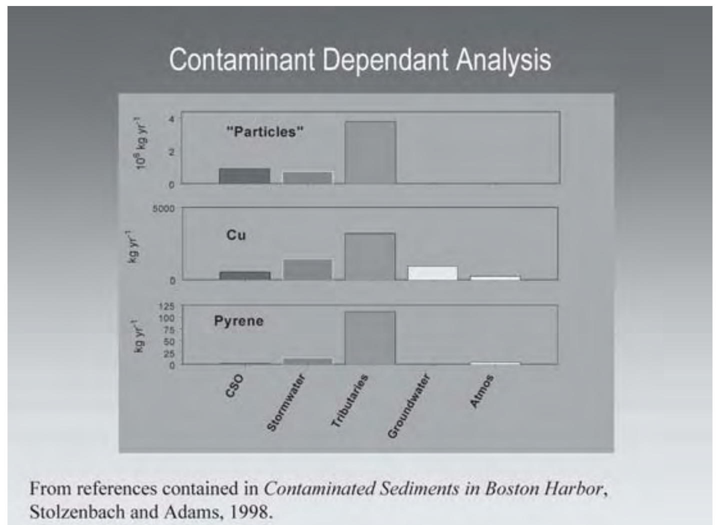

Municipal Waste and Stormwater Sources, pre - 2000

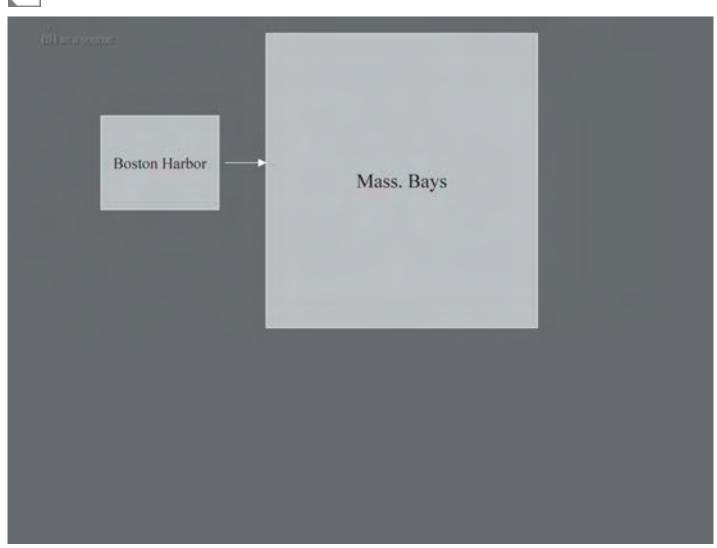

Sources of Fresh Water to Boston Harbor
100
75
50
25
0
Percent (%)
Pre 2000
Post 2000
Effluent
CSO
Stormwater
Tributaries
Groundwater
Atmospheric
From Contaminated Sediments in Boston Harbor, Stolzenbach and Adams, Eds., 1998


Estimates of Contaminants to Boston Harbor
(from references contained in Contaminated Sediments in Boston Harbor, Stolzenbach and Adams, 1998)
"Particles"
Cu
Pyrene
CSO
Stormwater
Tributaries
Groundwater
Atmos
1991
But, some source loads are changing .....

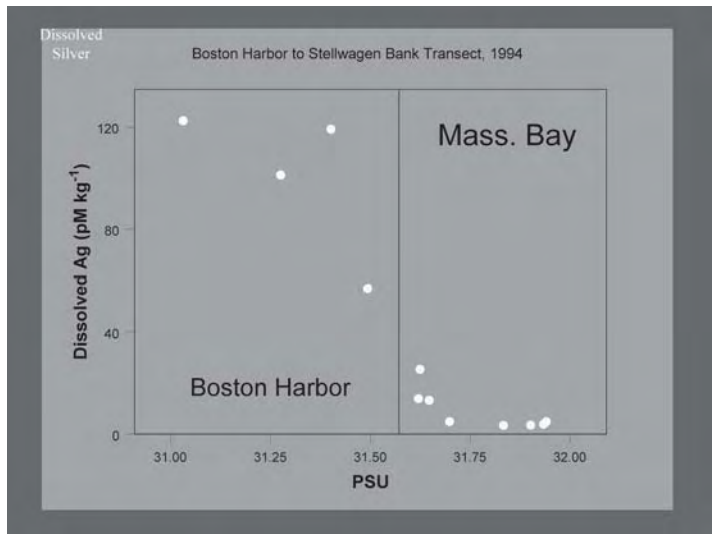

Changing Source loads
Selected Metal Loadings from MWRA to Boston Harbor (kg d-1)
Zn
Cu
Pb
Ag
Year
Year

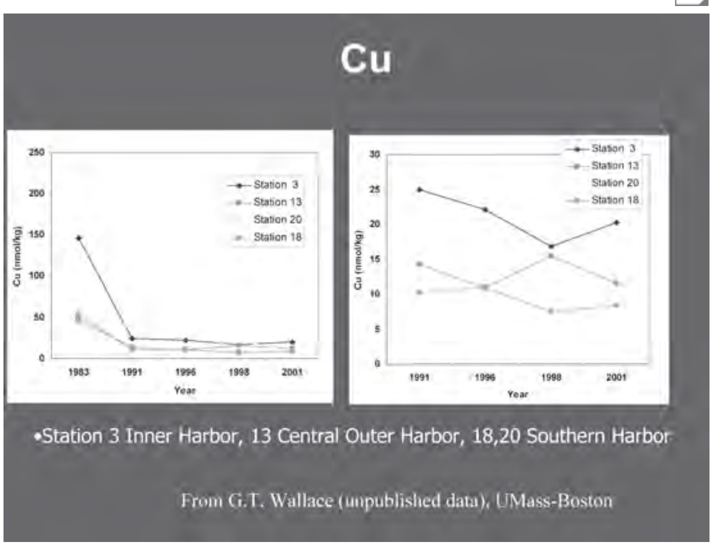

Tributaries
Mystic R
Charles R
Neponset R
Weymth Back
Flow (m s-1)
(12.3)
(5.3)
(2.4)
(0.9)
Charles
Neponset
Mystic
Weymouth Back

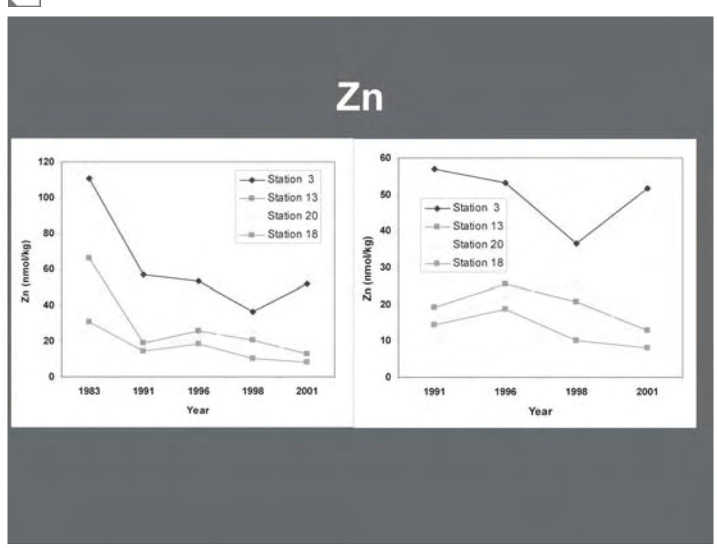

Contaminant Dependant Analysis
"Particles"
Cu
Pyrene
CSO
Stormwater
Tributaries
Groundwater
Atmos
From references contained in *Contaminated Sediments in Boston Harbor*, Stolzenbach and Adams, 1998.

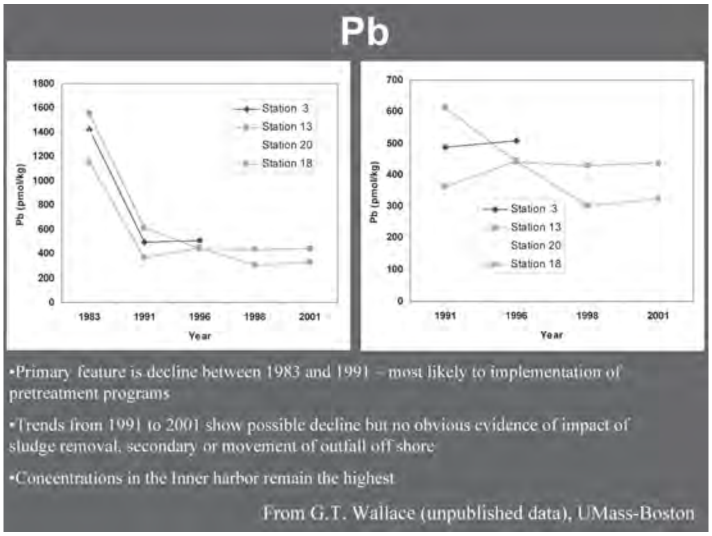

Boston Harbor
Mass. Bays

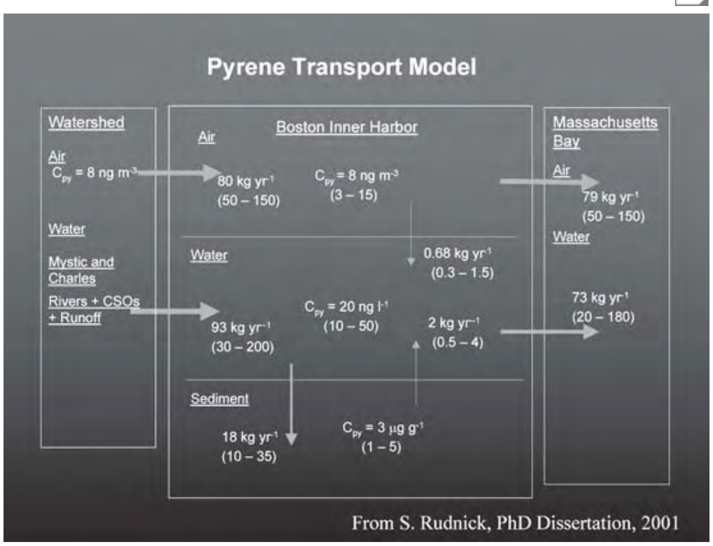
> The normalized concentrations of lead in surface sediments decreased by 46±12 percent during the 16-year period beginning in 1976. The concentrations of other heavy metals (Ag, Cr, Cu, Hg, and Zn) showed similar trends with time.
>
> - From USGS Fact Sheet: 150-97, M. Bothner

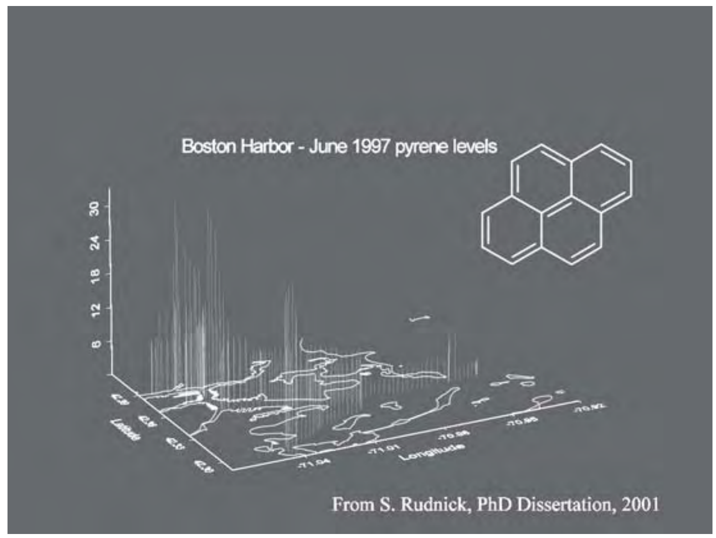


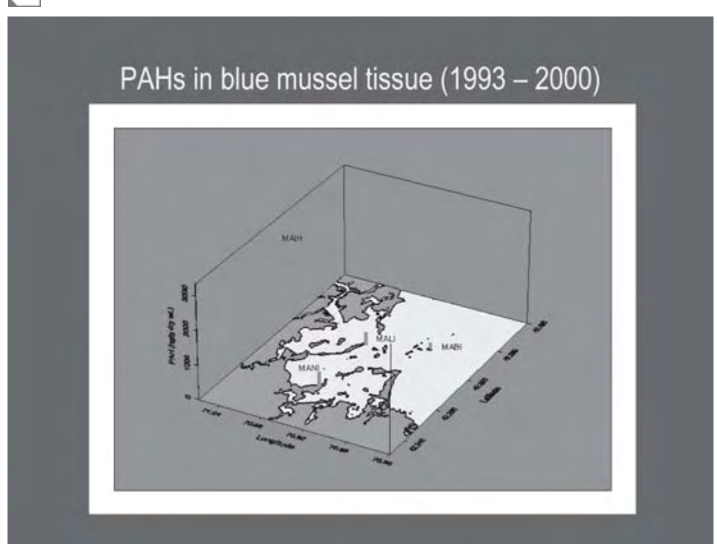


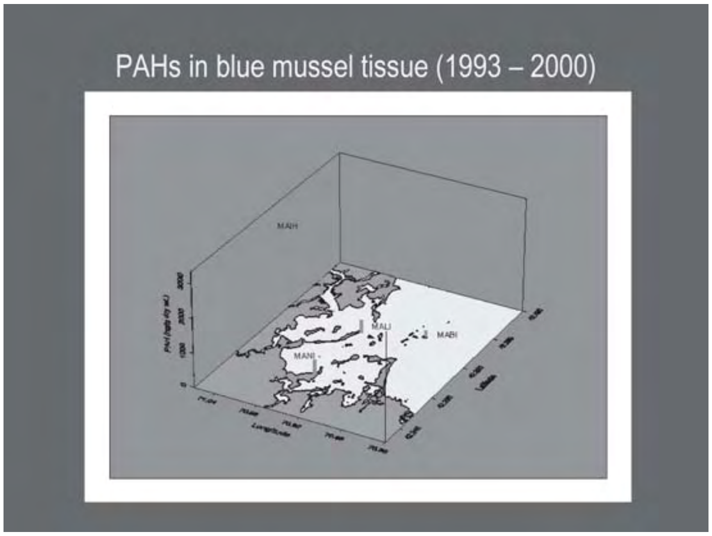


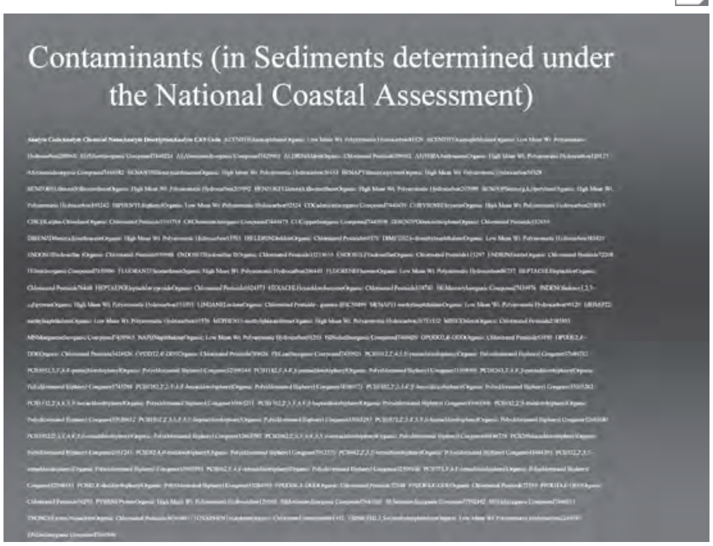

Pb
Pb (pmol/kg)
Year
Station 3
Station 13
Station 20
Station 18
•Primary feature is decline between 1983 and 1991 – most likely to implementation of pretreatment programs
•Trends from 1991 to 2001 show possible decline but no obvious evidence of impact of sludge removal, secondary or movement of outfall off shore
•Concentrations in the Inner harbor remain the highest
From G.T. Wallace (unpublished data), UMass-Boston

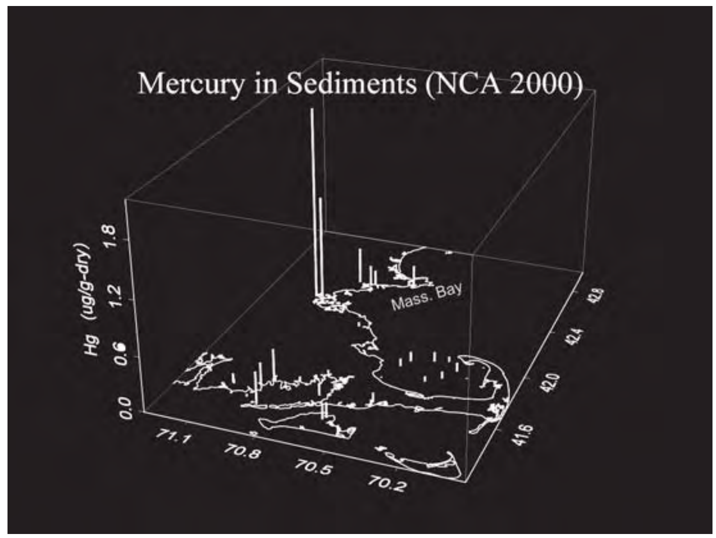

Pyrene Transport Model
Watershed
Air
C_{py} = 8 ng m^{-3}
Water
Mystic and Charles
Rivers + CSOs + Runoff
Boston Inner Harbor
Air
80 kg yr^{-1} (50 – 150)
C_{py} = 8 ng m^{-3} (3 – 15)
Water
0.68 kg yr^{-1} (0.3 – 1.5)
C_{py} = 20 ng l^{-1} (10 – 50)
93 kg yr^{-1} (30 – 200)
2 kg yr^{-1} (0.5 – 4)
Sediment
18 kg yr^{-1} (10 – 35)
C_{py} = 3 µg g^{-1} (1 – 5)
Massachusetts Bay
Air
79 kg yr^{-1} (50 – 150)
Water
73 kg yr^{-1} (20 – 180)
From S. Rudnick, PhD Dissertation, 2001

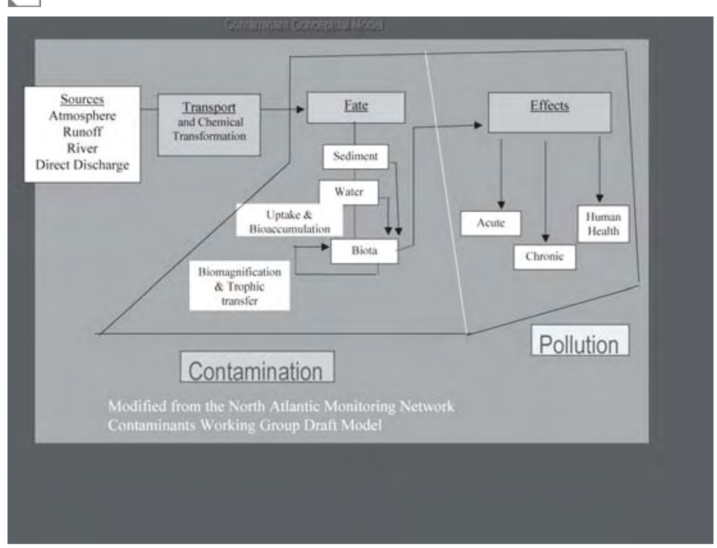

Boston Harbor - June 1997 pyrene levels
Latitude
Longitude
From S. Rudnick, PhD Dissertation, 2001

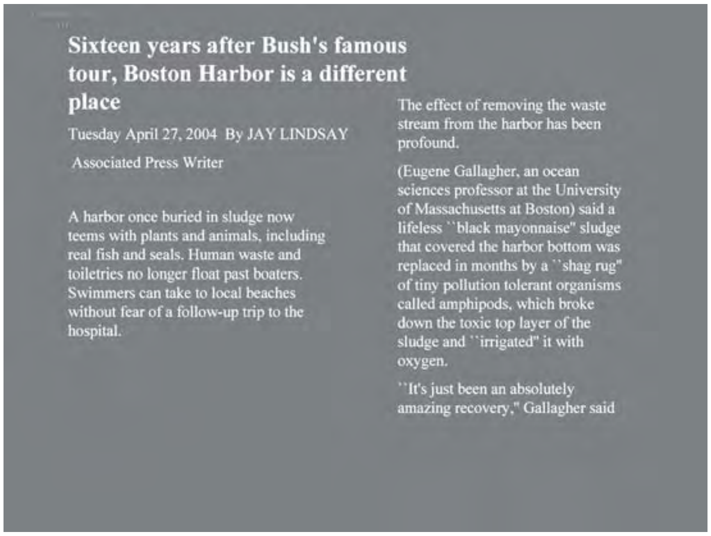

PAHs in blue mussel tissue (1993 – 2000)
Longitude
Latitude

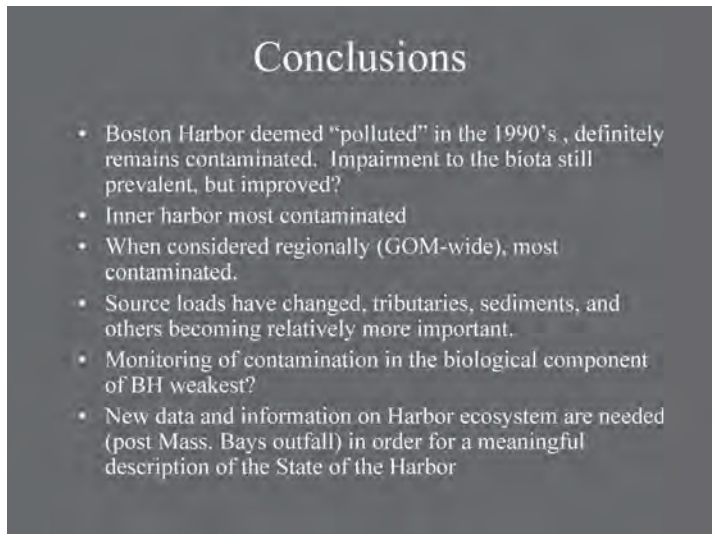

PAHs in blue mussel tissue (1993 – 2000)
MAH
MALI
MABI
MANI


Contaminants (in Sediments determined under the National Coastal Assessment)


Mercury in Sediments (NCA 2000)
Hg (ug/g-dry)
0.0
0.6
1.2
1.8
Mass. Bay
71.1
70.8
70.5
70.2
41.6
42.0
42.4
42.8


Sources
Atmosphere
Runoff
River
Direct Discharge
Transport
and Chemical
Transformation
Fate
Sediment
Water
Uptake &
Bioaccumulation
Biota
Biomagnification
& Trophic
transfer
Effects
Acute
Chronic
Human
Health
Contamination
Pollution
Modified from the North Atlantic Monitoring Network
Contaminants Working Group Draft Model


Sixteen years after Bush's famous tour, Boston Harbor is a different place
Tuesday April 27, 2004 By JAY LINDSAY
Associated Press Writer
A harbor once buried in sludge now teems with plants and animals, including real fish and seals. Human waste and toiletries no longer float past boaters. Swimmers can take to local beaches without fear of a follow-up trip to the hospital.
The effect of removing the waste stream from the harbor has been profound.
(Eugene Gallagher, an ocean sciences professor at the University of Massachusetts at Boston) said a lifeless ``black mayonnaise'' sludge that covered the harbor bottom was replaced in months by a ``shag rug'' of tiny pollution tolerant organisms called amphipods, which broke down the toxic top layer of the sludge and ``irrigated'' it with oxygen.
``It's just been an absolutely amazing recovery,'' Gallagher said


Conclusions
Boston Harbor deemed "polluted" in the 1990's , definitely remains contaminated. Impairment to the biota still prevalent, but improved?
Inner harbor most contaminated
When considered regionally (GOM-wide), most contaminated.
Source loads have changed, tributaries, sediments, and others becoming relatively more important.
Monitoring of contamination in the biological component of BH weakest?
New data and information on Harbor ecosystem are needed (post Mass. Bays outfall) in order for a meaningful description of the State of the Harbor

The Next Decade: Emerging Issues for the Massachusetts Bays

Christian Krahforst, Massachusetts Bays Program *(moderator)*
Dr. Robert Buchsbaum, Massachusetts Audubon Society
Dr. Judith Pederson, MIT Sea Grant
Ms. Susan Snow-Cotter, Massachusetts Office of Coastal Zone Management
Dr. Gordon Wallace, UMASS-Boston

Following the presentations, the second panel discussion of the workshop was held. The focus of the panel discussion was The Next Decade: Emerging Issues for the Massachusetts Bays. Mr. Christian Krahforst, Massachusetts Bays Program served as the moderator. Panel members included Dr. Gordon Wallace, UMASS-Boston, Ms. Susan Snow-Cotter, Massachusetts Office of Coastal Zone Management, Dr. Judith Pederson, MIT Sea Grant and Dr. Robert Buchsbaum, Massachusetts Audubon Society. The format of the panel involved brief responses to the question by the members and then group discussions.

The panel group reached a consensus on priorities of emerging issues within the Massachusetts Bays to focus the discussion. The priorities are:

- Shellfish issues
- Protect and restore coastal habitat
- Manage wastewater
- Manage stormwater
- Land use planning issues
- Invasive species
- Marine monitoring

Dr. Gordon Wallace.
Dr. Wallace identified source identification as a major concern. Good quality data can assist managers towards gauging acceptable contaminant loading levels. In order to do so toxicity testing needs to be improved and then integrated into monitoring programs. Sediment geochronology and contaminant profiles can be used to relate long-term change with changes in land use and population growth. Dr. Wallace stated that there is often an inability to think in the long-term (>50 yrs, about population growth, climate change, and other major causes of ecosystem change) when assessing and anticipating anthropogenic perturbations of coastal ecosystems. Monitoring needs to have a close relationship with research. The state needs to consider modeling as a tool to examine the potential impacts of anthropogenic activities on coastal watersheds and nearshore waters as a whole. Models can be used to develop scenarios and explore sensitivities of the system to perturbations, natural and man-made. The state of the coastline can be examined by efforts such as the EPA's National Coastal Assessment (NCA) Program. These programs may be able to commit to long-term monitoring and could establish trends but also need to demonstrate flexibility in their design and implementation. Data sharing has also been an emerging issue. To fully utilize data, there must be an infrastructure developed so that data can be easily shared between managers and scientists. Intimate involvement from non-governmental organizations (NGOs), researchers, and academics in all phases of ecosystem management is important. All groups need federal support, but such support has been substantially reduced in recent years and may reduce or even reverse progress in these efforts.

Ms. Susan Snow-Cotter.

Ms. Snow-Cotter stated that she felt subtidal habitat management is an emerging issue. The scientific and political support has grown regarding this little seen habitat. Habitat below the waterline traditionally has not received much attention but it is significantly affected by coastal development, fossil fuel exploration, and pipelines. Ms. Snow-Cotter also suggested that developers need to take sub-tidal habitats into consideration when they build on the coast and should look at projects from a regional approach with restoration, research, and data management in mind.

Dr. Judith Pederson.

Dr. Pederson emphasized that Marine Protected Areas (MPAs) are an emerging issue of concern. Currently there does not appear to be standard criteria for setting them up or for how to deal with issues affecting them. Dr. Pederson also discussed invasive species and the need for cause/effect monitoring with a strong science focus. Included in this is the identification of global warming's effects on biota and educating the public on invasive species issues. Information that has been obtained should be presented in a way that will change minds to look at local extinction and other factors affecting the environment. Another issue that was identified is the great need for public education but the focus has often been on preparing another fact sheet which are not always the best solution for educating the public. Newspapers, media, signs, and word of mouth is where the focus needs to be taken, rather than the standard fact sheet. Dr. Pederson ended her statement with an emphasis on a regional management approach. Massachusetts Bay is part of a much larger region but local issues can be addressed while taking a larger view.

Dr. Robert Buchsbaum.

Dr. Buchsbaum opened his discussion with the notion that we should not necessarily focus on emerging issues but work on old issues because many have not been solved yet. Following this statement, Dr. Buchsbaum noted a number of issues of concern, beginning with the idea of ecosystem management that links terrestrial researchers/managers with marine researchers/managers. He reiterated the need to address MPAs and touched on a number of other issues that were previously mentioned during the workshop including: habitat diversity, fishing gear impacts, land-use patterns and their links to ecosystem processes, smart growth, buffers around wetlands, wind farms, aquaculture, monitoring and restoration. All of these issues would benefit from having guiding principles. Thinking bay-wide is important, beyond town and state borders, which although challenging, is of ongoing importance. Dr. Buchsbaum closed with the suggestion that public education and outreach is extremely important. The general public should understand the science and know what is being done.

Management Panel II - Discussion.

Following the responses to the prioritization exercise, the Management Panel addressed questions and comments from the moderator and audience.

What incentives can you suggest to get people/industry to do the right thing?

The discussion was opened with examples of monetary incentive programs that have proven successful - such as the EnergyStar program which offers rebates for buying energy efficient products and a fish tag return program in the Bahamas where fishermen get money for returning the tags. It was further suggested that a key to preserving habitat is allowing access to it. If it is not readily available people are less likely to make an effort to protect the marine environment. The Panel also recommended fee or fine programs as an incentive option. In the case of ballast water, boats are supposed to be assessed for compliance and be able to supply a form to prove it. If you cannot supply the form you can be fined. This has proven to be a successful program.

Incentives for developers were advised in order to get them to use green-landscaping/green-neighborhood techniques and smart growth ideas. In return they could find it easier to get permits or be allowed to build more. Cultural changes also need to be made. The panel recommended making university students aware that meshing academic, research, and management into their academic training can result in many unique and interesting opportunities as these fields are connected in practice. Another option would be that teachers could spend a year in a training program with graduate students to learn how to inspire children to be interested in science.

Conclusions and Next Steps

The workshop closed with a final discussion of the management panel on action items for the next meeting. The group made a number of suggestions including:

- Create an advisory committee or working group that can focus on biodiversity and eco-management.
- Create and distribute outreach materials that let the public and other organizations know what has been accomplished and to know how the efforts of the Massachusetts Bays Program work fits in to the broader picture.
- Revive the Marine Science Advisory Board
- Bring academics into manager and policy-making decisions to find out what state of the art approaches or priorities should be. Most academics would not refuse a request to be involved in the process.

Finally, the group discussed a schedule and focus for future Massachusetts Bays Symposiums. All panel members agreed that it is now important to shift the focus from the bay-wide onto the local level. Topics to explore were best management practices, Smartgrowth, program evaluations, public involvement/outreach and education.

Appendix A

Symposium Attendees

Symposium Attendee List
May 6 and 7, 2004

Name	*Affiliation*
Armstrong, Michael	Massachusetts Division of Marine Fisheries
Baker, Jay	Massachusetts Office of Coastal Zone Management
Barker, Claire	Massachusetts Department of Environmental Protection
Barry, Kara	Milton Conservation Commission
Bistany, Andrea	Massachusetts Office of Coastal Zone Management
Boelke, Chris	National Marine Fisheries Service
Borrelli, Peter	Center for Coastal Studies
Buchsbaum, Robert	Massachusetts Audubon
Burtner, Jason	Massachusetts Office of Coastal Zone Management
Callaghan, Todd	Massachusetts Office of Coastal Zone Management
Caniaris, Cathy	Massachusetts Department of Environmental Protection
Carlisle, Bruce	Massachusetts Office of Coastal Zone Management
Clarke, Jack	Massachusetts Audubon
Correia, Steven	Massachusetts Division of Marine Fisheries
Costa, Joe	Buzzards Bay Project
Darling, John	Boston University
Dominuez, Jessica	Earth Tech Inc.
Donovan, Anne	Massachusetts Office of Coastal Zone Management
Ducsik, Dennis	Massachusetts Office of Coastal Zone Management
Duff, Elizabeth	Massachusetts Audubon
Franenthaler, Victor	Earth Tech Inc.
Frawley, Austine	US Environmental Protection Agency Region 2
Garpow, Wendy	Massachusetts Bays Program
Gatewood, Rob	Town of Barnstable Conservation
Gersh, Stephen	Eight Towns and the Bay
Glaub, Gretchen	Americorps Cape Cod
Goldman, Maynard	Massachusetts Environmental Trust
Gottlieb, Andrew	Massachusetts Department of Environmental Protection
Gough, Rob	Salem Sound Coastwatch
Griffin, Mary	Massachusetts Office of Coastal Zone Management
Hanlon, Peter	Massachusetts Bays Program
Herzfelder, Ellen Roy	Massachusetts Executive Office of Environmental Affairs
Hill, Mike	US Environmental Protection Agency Region 1
Hunt, Amy	Massachusetts Environmental Trust

Name	*Affiliation*
Hunt, Carlton	Battelle
Jewell, Paula	Massachusetts Bays Estuary Association
Jiang, Mingshun	University of Massachusetts, Boston
Johnson, Michael	National Marine Fisheries Service
Joor, Sarah	Massachusetts Office of Coastal Zone Management
Kalman, Marcia	US Environmental Protection Agency Region 1
Keane, Julie	Massachusetts Office of Coastal Zone Management
Keay, Kenneth	Massachusetts Water Resource Authority
Killerlain, Kate	Massachusetts Office of Coastal Zone Management
Krahforst, Christian	Massachusetts Bays Program
Lacey, Robin	Massachusetts Office of Coastal Zone Management
Laursan, Nancy	US Environmental Protection Agency Headquarters
Lenci, Alicia	New England Aquarium Dive Club
Levin, Reva	Town of Milton
Li, Vivien	The Boston Harbor Association
Liebman, Mathew	US Environmental Protection Agency Region 1
Lipman, John	Cape Cod Commission
Loeb, George	US Environmental Protection Agency
Lund, Katie	Massachusetts Office of Coastal Zone Management
Macintosh, Alan	Merrimack Valley Planning Commission
Magnuson, Britta	Massachusetts Audubon
Manley, Melissa	Battelle
Mayo, Stormy	Center for Coastal Studies
Mickelson, Michael	Massachusetts Water Resources Authority
Peach, Robin	Massachusetts Environmental Trust
Pederson, Judith	MIT Sea Grant
Pillsbury, Martin	Metropolitan Area Planning Council
Portman, Michelle	University of Massachusetts, Boston
Purinton, Tim	Massachusetts Audubon
Redlich, Susan	Corporate Wetlands Restoration Partnership
Reitzel, Adam	Boston University
Rex, Andrea	Massachusetts Water Resources Authority
Ricci, Heidi	Massachusetts Audubon
Riner, Ed	US Environmental Protection Agency
Rogers, Jeff	Geosyntec
Sampson, Daniel	Massachusetts Office of Coastal Zone Management

Name	***Affiliation***
Schenk, Max	Massachusetts Bays Estuary Association
Schwartz, Jack	Massachusetts Division of Marine Fisheries
Scott, Marcy	National Marine Fisheries Service
Short, Lynda	Battelle
Shumway, Linda	BSC Group
Skinner, Tom	Massachusetts Office of Coastal Zone Management
Smith, Jan	Massachusetts Bays Program
Snow-Cotter, Susan	Massachusetts Office of Coastal Zone Management
Soreson, Liz	DCR/ACEC Program
Stewart, Ellie	Massachusetts Environmental Trust
Stickney, Christine	Planning Director, Town of Duxbury
Stone, Thomas	Woods Hole Research Center
Tarr, Ted	Eight Towns & the Bay
Tarricone, Kristan	Town of Danvers Planning Department
Taylor, David	Massachusetts Water Resources Authority
Tucker Steve	Massachusetts Bays Program
Tyrrelle, Megan	Massachusetts Office of Coastal Zone Management
Wallace, Gordon	University of Massachusetts, Boston
Warren, Barbara	Salem Sound Coastwatch
Watanabe, Allison	US Environmental Protection Agency, Region 1
Whitten, Jerrard	Merrimack Valley Planning Commission
Wiggin, Jack	Urban Harbors Institute
Williams, Tony	The Coalition for Buzzards Bay
Williams, Vesper	Massachusetts Office of Coastal Zone Management
Wohlers, Elza	Bentley College
Wynn, Brion	City of Quincy

Appendix B

Symposium Agenda

Thursday, May 6

8:00-9:00......Coffee and Sign-In

9:00-9:45
Welcome, Introduction, and Setting the Stage

- Welcome
  Jan Smith, Massachusetts Bays Program Executive Director

- Opening Message:
  Robert W. Varney, U.S. EPA New England Regional Administrator

  Ellen Roy Herzfelder, Massachusetts EOEA Secretary

- Introduction to the *State of the Bays 2004* report

9:45-11:00
Offshore I
- Physical Oceanography of Massachusetts Bay
  (Christian Krahforst, Massachusetts Bays Program)

- Modelling the Massachusetts Bay system: An Overview
  (Dr. Mingshun Jiang, ECOS, University of Massachusetts Boston)

- Twelve Years of Water Quality Monitoring in Massachusetts and Cape Cod Bays
  (Scott Libby and Carlton Hunt, Battelle; Dr. Michael Mickelson, MWRA)

11:00-11:15......Break

11:15-12:30
Offshore II
- Offshore Benthic Habitat
  (Kenneth Keay, Massachusetts Water Resources Authority)

- Endangered Right Whales
  (Dr. Stormy Mayo, Center for Coastal Studies)

- Massachusetts Marine Fisheries' Inshore Bottom Trawl Survey
  (Steven Correia, Massachusetts Division of Marine Fisheries)

12:30-1:30......Lunch

Thursday, May 6 *cont'd*

1:30-3:30
Land Use
- Regional Overview: *What is the Massachusetts Bays Region?*
  (Peter Hanlon, Massachusetts Bays Program)

- *Losing Ground: At What Cost?*
  (Jack Clarke, Massachusetts Audubon Society)

- Integrating Land Use and Water Quality Data to Assess Status and Trends in Nonpoint Source Pollution in the Parker Watershed
  (Jay Baker, Massachusetts Office of Coastal Zone Management)

- Beyond Buildout: One Community's Call to Action
  (Alan Macintosh and Jerrard Whitten, Merrimack Valley Planning Commission)

3:30-3:45......*Break*

3:45-4:45
Management Panel I

Can we link the discussion of managing offshore waters and land-use? Have we tried to make that link, and how successful have we been?
Moderated by Dr. Carlton Hunt, Battelle
Participants:
- Dr. Joe Costa, The Buzzards Bays Project
- Vivien Li, The Boston Harbor Association
- Jack Wiggin, Urban Harbors Institute

Friday, May 7

8:00-9:00......Coffee and Sign-In

9:00-9:45
Welcome, Introduction and Setting the Stage
- Welcome and Review of Previous Day by Jan Smith, Massachusetts Bays Program Executive Director

- The Ocean Management Task Force
  (Susan Snow-Cotter, Massachusetts Office of Coastal Zone Management)

9:45-11:00
Estuary I
- Boston Harbor: What a Change a Decade Makes
  (Dr. Andrea Rex and Dr. David Taylor, MWRA)

- Coastal Wetland Assessment and Restoration in Massachusetts
  (Bruce Carlisle, Massachusetts Office of Coastal Zone Management)

- Invasive Species
  (Dr. Judith Pederson, MIT Sea Grant)

11:00-12:15
Estuary II
- Anadromous Fish Runs
  (Michael Armstrong, Massachusetts Division of Marine Fisheries)

- Embayment Water Quality
  (Andrew Gottlieb, Massachusetts Department of Environmental Protection)

- Contaminants in Boston Harbor
  (Christian Krahforst, Massachusetts Bays Program)

12:15-1:15......Lunch

1:15-3:15
.**Management Panel II**
The Next Decade: Emerging Issues for the Massachusetts Bays
Moderated by Christian Krahforst, Massachusetts Bays Program
Participants:
- Dr. Robert Buchsbaum, Massachusetts Audubon Society
- Dr. Judith Pederson, MIT Sea Grant
- Susan Snow-Cotter, Massachusetts Office of Coastal Zone Management
- Dr. Gordon Wallace, University of Massachusetts - Boston

3:15-3:30......**Conclusions and Next Steps**

Massachusetts Bays Program
251 Causeway Street, Suite 800
Boston, MA 02114

(617) 626-1230

www.massbays.org