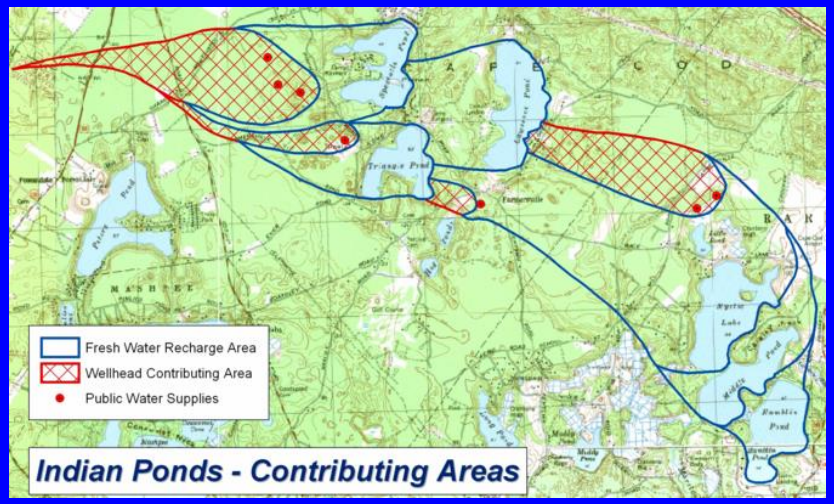
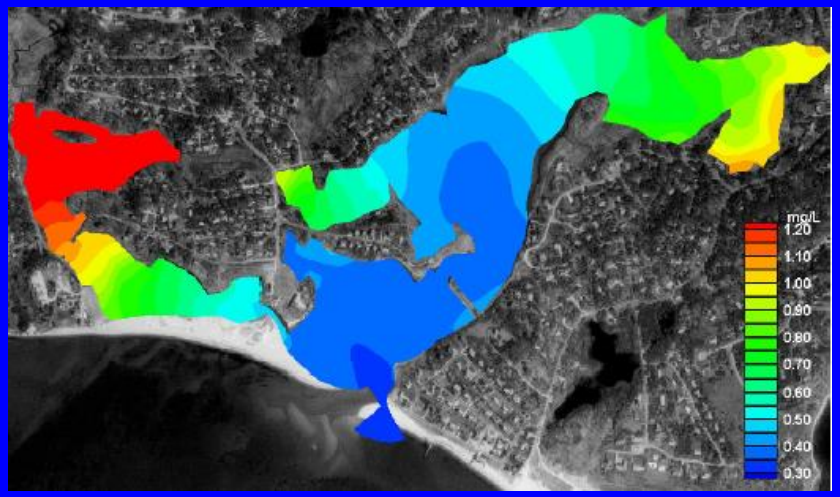
Implementing Cape Cod Water Quality Protection

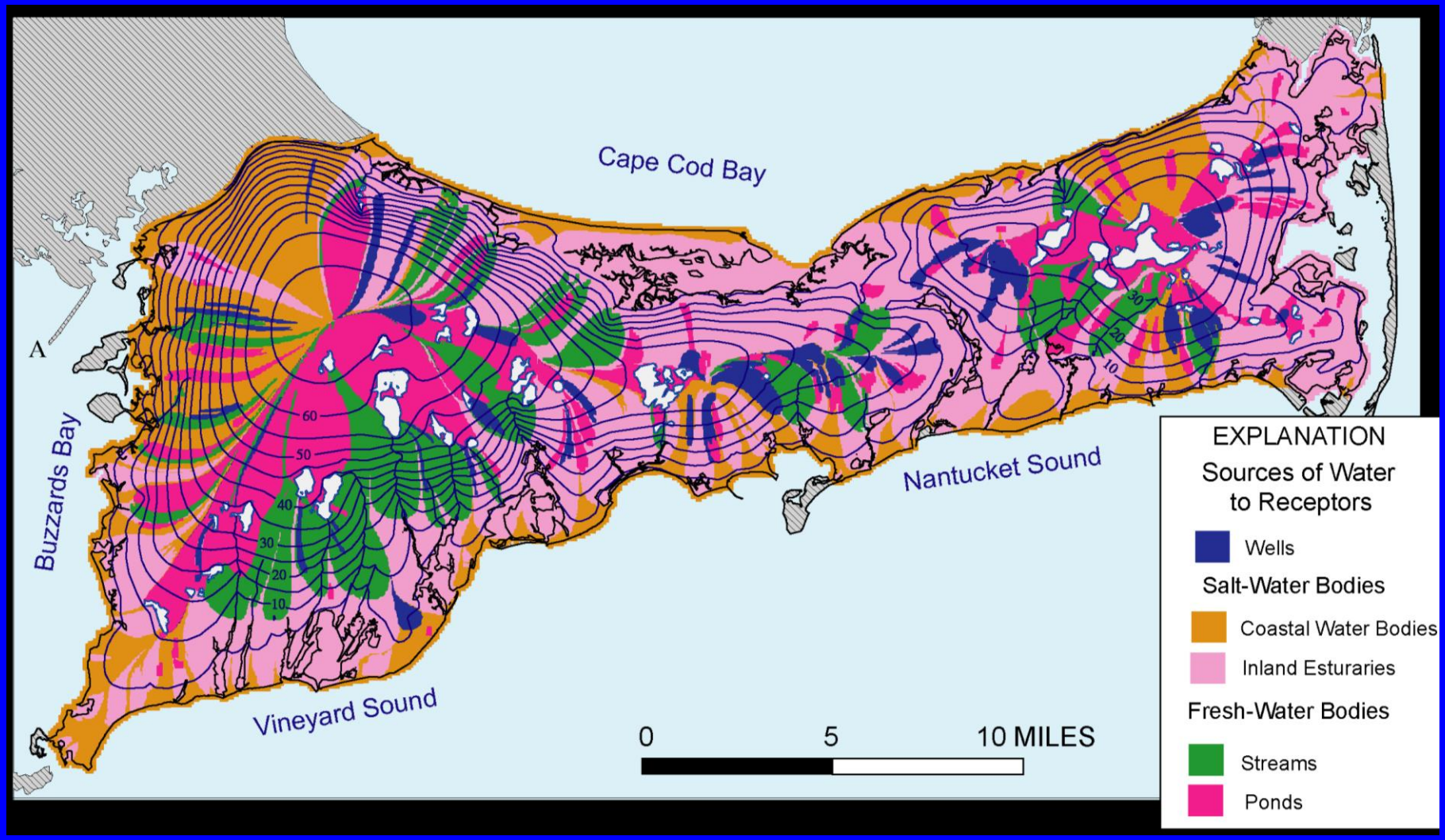




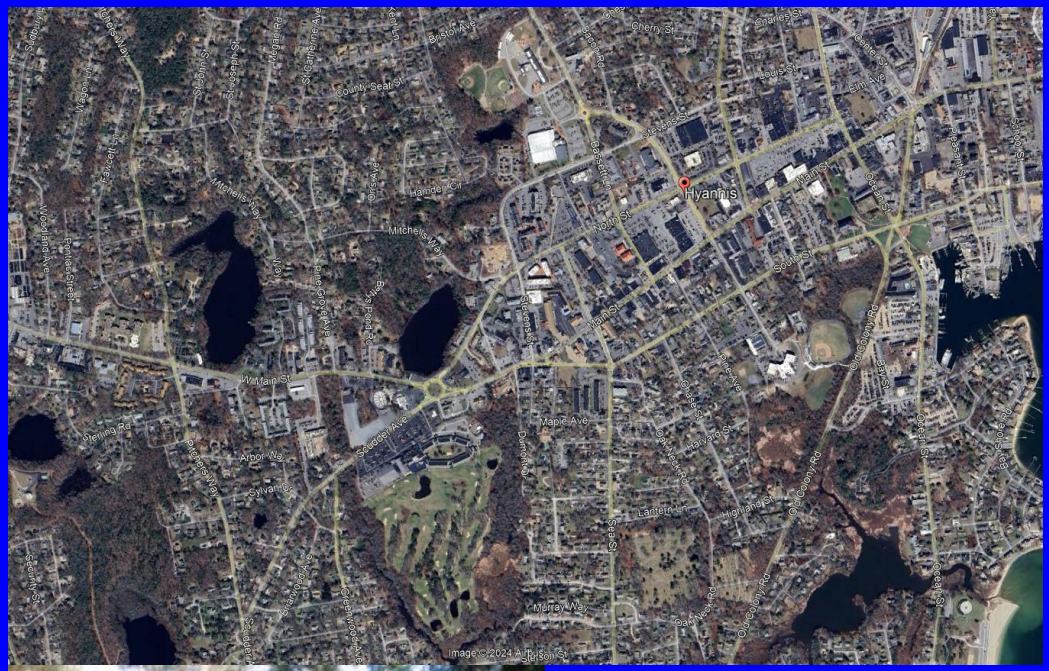
Eduard Eichner
Principal/Water Scientist, TMDL Solutions
Adjunct Professor, Coastal Systems Program
School for Marine Science And Technology
University of Massachusetts Dartmouth

TMDL Solutions

Groundwater: Flows through ponds, wells, streams on way to estuaries



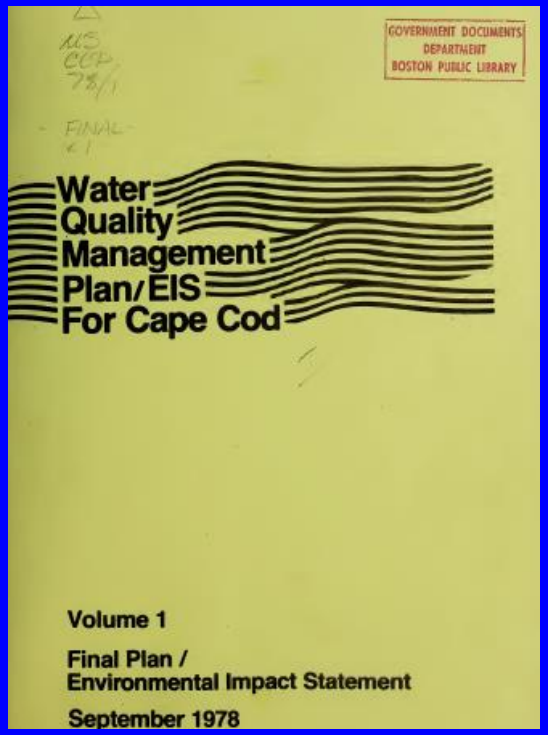
USGS Scientific Investigations Map I-2857



Land Use and Wastewater Treatment

1. ~90% of wastewater on Cape Cod treated by septic systems
2. Wastewater is major source of all water nutrients and contaminants (N moves with GW; P moves ~20X slower)
3. Everything we build on land impacts water

1978 – CAPE COD WATER QUALITY PLAN



RESULT:
~90% of wastewater treated by septic systems and adoption of 1 acre zoning

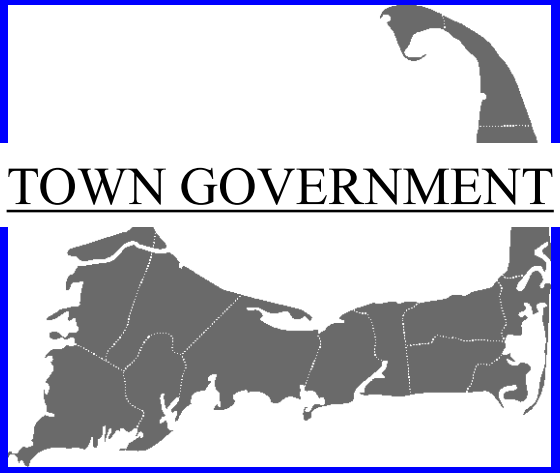
Clean Water Act (1972 amendments)

<u>Cape Cod 208 Plan Recommends:</u>

1) Rely on septic systems
2) Limit sewering ("Decentralized approach of avoiding future sewer needs is compatible with the area's economic, social and political structure.")
3) Towns retain authority for comprehensive wastewater planning
4) CCPEDC responsible for regional water quality planning & monitoring
5) <u>Monitor of ponds, lakes, and estuaries with review every 5 years</u>
6) Limit density to protect drinking water quality; federal $ provided for contributing area modeling/nitrogen loading

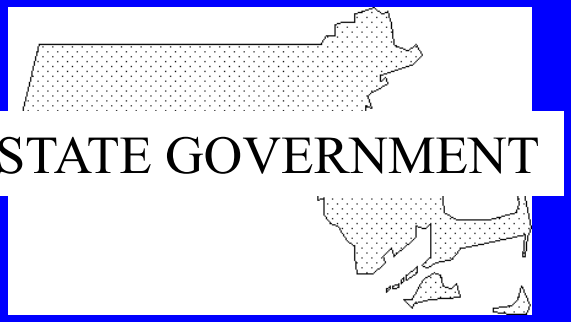
CAPE COD WATER QUALITY: PLANNING/REGULATORY

TOWN GOVERNMENT



Title 5 Septic Systems
Municipal Treatment Plants
Wellhead Protection Areas
Zoning/Planning
Wetlands

STATE GOVERNMENT



CAPE COD COMMISSION

Cape Cod Commission Act (1990)
Integrated Water Quality Management
- Drinking Water
- Estuaries
- Ponds and Lakes

Dept. of Environmental Protection
Exec. of Office of Environmental Affairs

Federal laws including:
- Safe Drinking Water Act
- Clean Water Act

Management Limit: Little to No Info in 1990

1. Cape Ponds: what WQ standards should apply?
   - Little WQ monitoring, Low nutrients, low pH
   - 5 Assessments of Individual Ponds had been completed
   - Attempts to apply high pH, off-Cape standards (limestone)
2. Cape Estuaries: what WQ standards should apply?
   - Falmouth had begun citizen WQ monitoring in 1987 – Howes, WHOI
3. What are their watersheds?
4. What impacts are caused by land use?

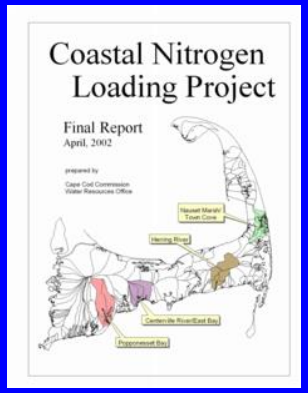
CCC Began Developing Surface Water Baseline Estuary Information:

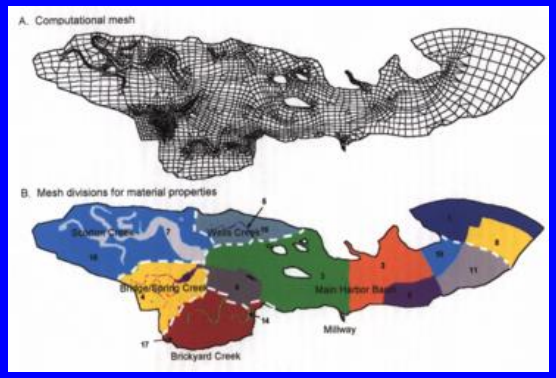
1991-1995

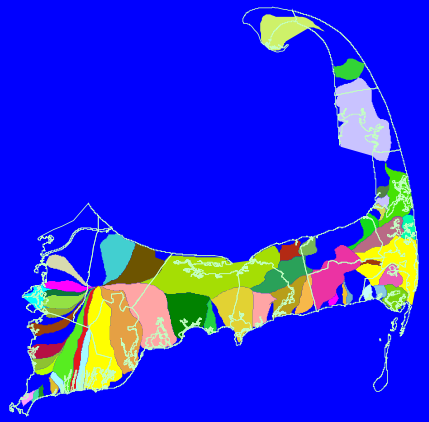
- Watershed delineations based on available GW contours
- Nitrogen loading method (regulatory projects and watersheds)
- Worked with Buzzards Bay Project to design protective stnds

1996-2001

- Began funding tidal flushing studies
- Completed watershed nitrogen loading assessments
- Nitrogen Summits: worked with area scientists to define WQ stnds







2000: Comprehensive/Integrated Surface Water Management Begins

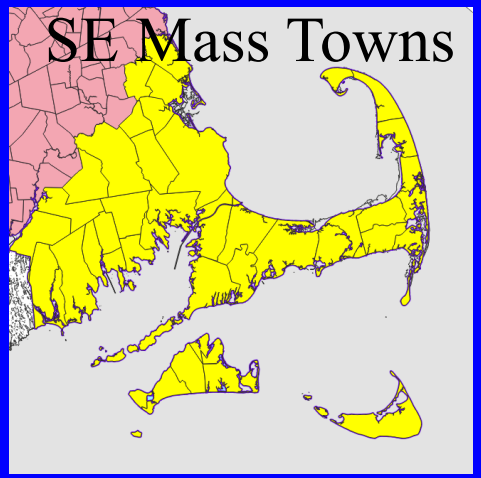
Massachusetts Estuaries Project

SMAST

MassDEP

COUNTY OF BARNSTABLE MASSACHUSETTS
CAPE COD COMMISSION

USGS
science for a changing world

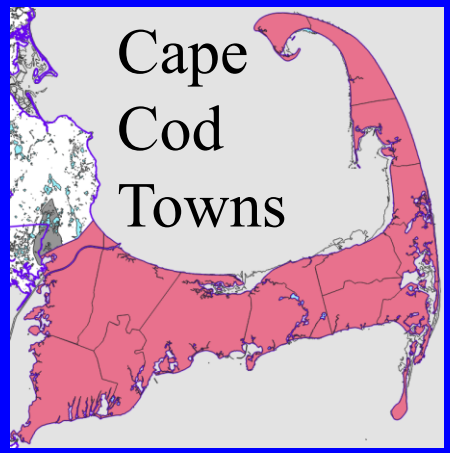


Cape Cod Pond and Lake Stewards

COUNTY OF BARNSTABLE MASSACHUSETTS
CAPE COD COMMISSION

SMAST

COMMUNITY FOUNDATION OF CAPE COD



2000: Massachusetts Estuaries Project

The MEP will provide ecosystem health assessments for 89 estuaries in Southeastern Massachusetts (Cape Cod, Martha's Vineyard, Nantucket, Plymouth, and along Buzzards Bay). Water quality, watershed nitrogen loading, and tidal hydrodynamics will be combined through the use of refined, individualized, linked watershed/estuary models that can then be used to predict the water quality changes from proposed management decisions.

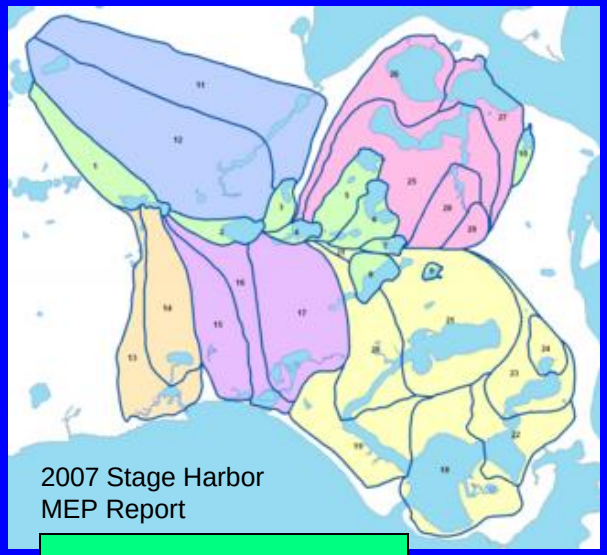
Estimated cost for six year project: $12 million

<u>Coordination and funding among:</u>

UMASS-Dartmouth, School of Marine Science and Technology
Department of Environmental Protection
Barnstable County/Cape Cod Commission
US Geological Survey
Towns of Southeastern Massachusetts
Citizen volunteers collecting monitoring data

QAPP approved by state and EPA

Massachusetts Estuaries Project



2007 Stage Harbor
MEP Report

Watershed Delineation

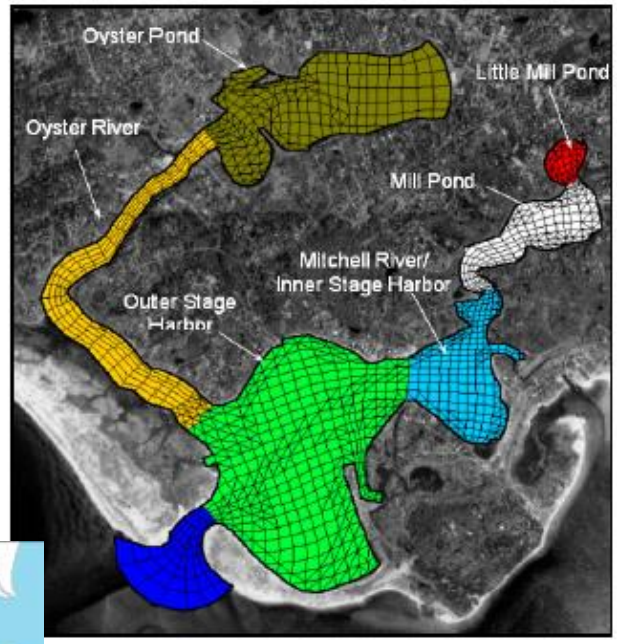
USGS Modeling

Subwatersheds to Ponds, Subestuaries, 10 yr Time of Travel

CCC modeling

Watershed N loads
Individual Parcels
Water Use, WWTF
Fertilizers (GC, homes)
Pond N Attenuation

Nitrogen Loading

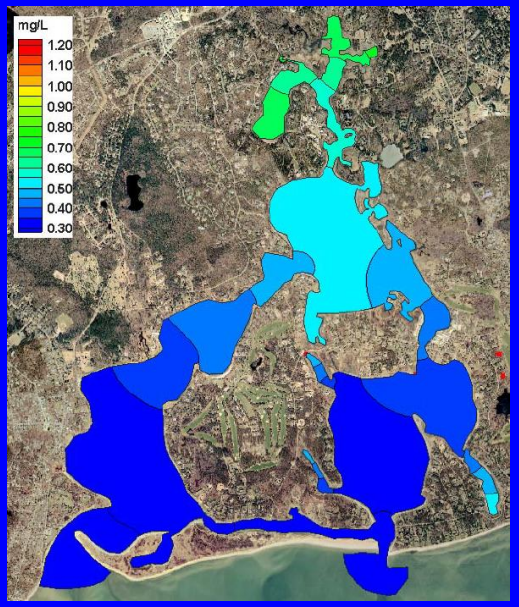


Flushing Studies

SCS modeling

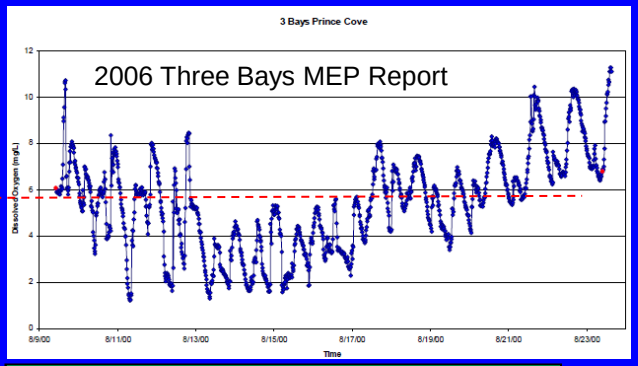
Tidal measurements
Bathymetry
Match measurements

Massachusetts Estuaries Project



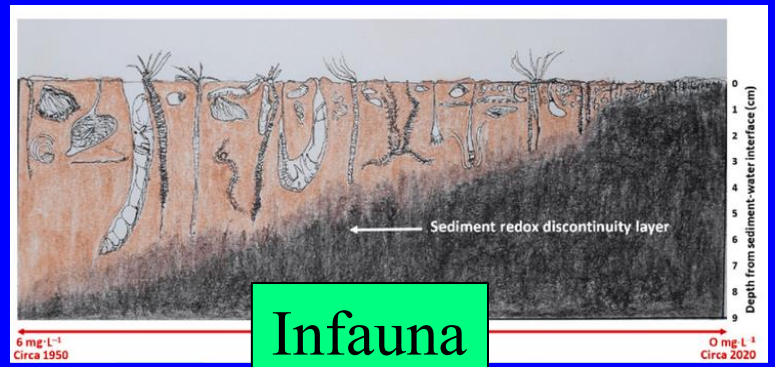
Ecosystem Assessments (CSP/SMAST)

- Benthic infauna: species, diversity
- Eelgrass: historic and current (keystone species, sensitive to N inputs)
- Continuous DO, CHL-a, Salinity (DO link to current MA standards)
- Water quality data: min 3 yrs (usually citizen volunteer monitoring)



Dissolved Oxygen

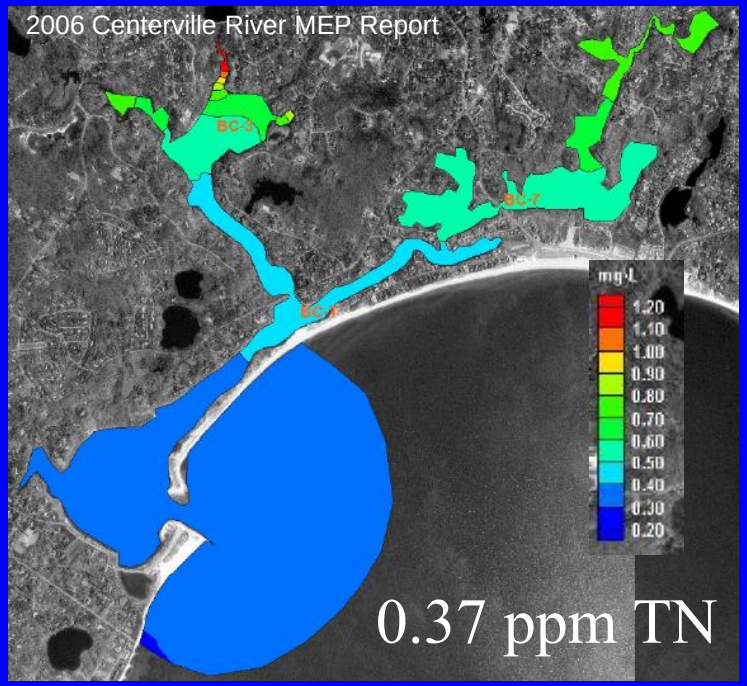
Eelgrass

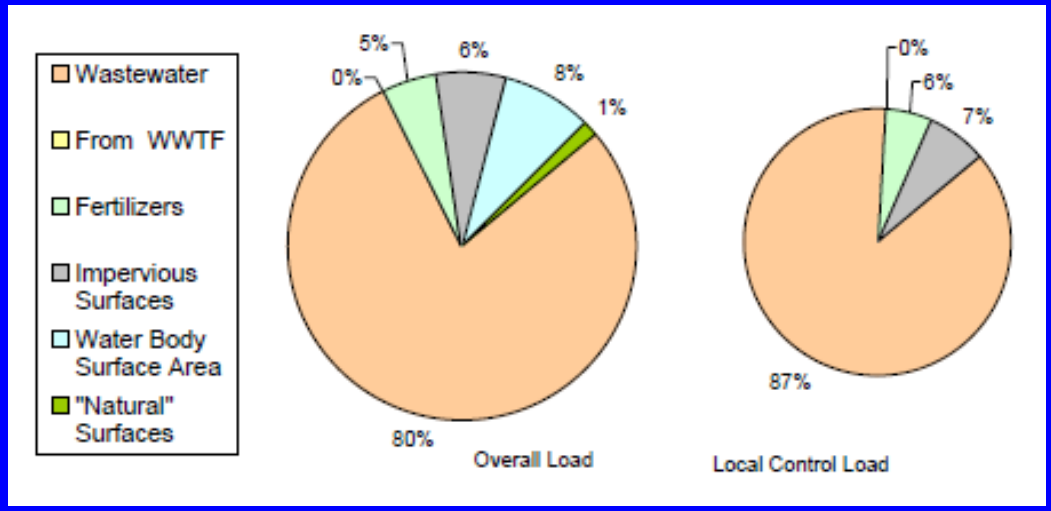


Infauna

Massachusetts Estuaries Project

Create Validated Linked Watershed/Tidal Water Quality Model for Each Individual System





Sources of N: Management Targets

Threshold Modeling: N TMDLs

Provides the reliable tools to evaluate "What if" management options:

- improved wastewater treatment
- relocating wastewater discharge
- system or inlet dredging
- evaluate internal bridge openings
- refine N removal by marsh/ponds

Massachusetts Estuaries Project

Management Results for Government

DEP:

- System-specific Assessments
- Integrated List (Info for CWA required list of surface waters status, required every 2 yrs)
- Nitrogen TMDLs for Estuaries (CWA requires TMDLs for listed impaired waters)

Towns:

- Reliable models for evaluating wastewater planning (CWMP)
- Planning targets for future growth
- Prioritization of management funding

Massachusetts Estuaries Project

Post-MEP Efforts

Towns/NGOs:

1. Monitoring: On-going water column monitoring, tracking whether conditions are changing
2. Scenarios: use of MEP models to assess CWMP management options
3. Updates/Refinements: use of models to evaluate ecosystem changes or look at smaller portion of the systems
4. New Studies: MEP-style assessments of systems not previously addressed

To date: No estuary has met its TMDL

2000: Cape Cod Pond and Lake Stewards (PALS)

Concerns across agencies/NGOs:

1. Pond water quality worsening
2. Need coordinated regional effort
3. Need to be part of comprehensive wastewater management
4. Actively involve citizens

SMAST

County of Barnstable Massachusetts
CAPE COD COMMISSION

AMERICORPS NATIONAL SERVICE

NATIONAL PARK SERVICE

Association to Preserve Cape Cod

EXECUTIVE OFFICE of ENVIRONMENTAL AFFAIRS

Compact for Cape Cod Conservation Trusts

Cape Cod P.A.L.S. Pond and Lake Stewards

Massachusetts Department of Fisheries, Wildlife and Environmental Law Enforcement

COMMUNITY FOUNDATION OF CAPE COD

Pond and Lake Stewards

2000: Start of freshwater pond citizen monitoring

- Overflow crowd of concerned citizens at kickoff meeting
- Intro to Monitoring: Secchi Disk give away/2000 Dip In

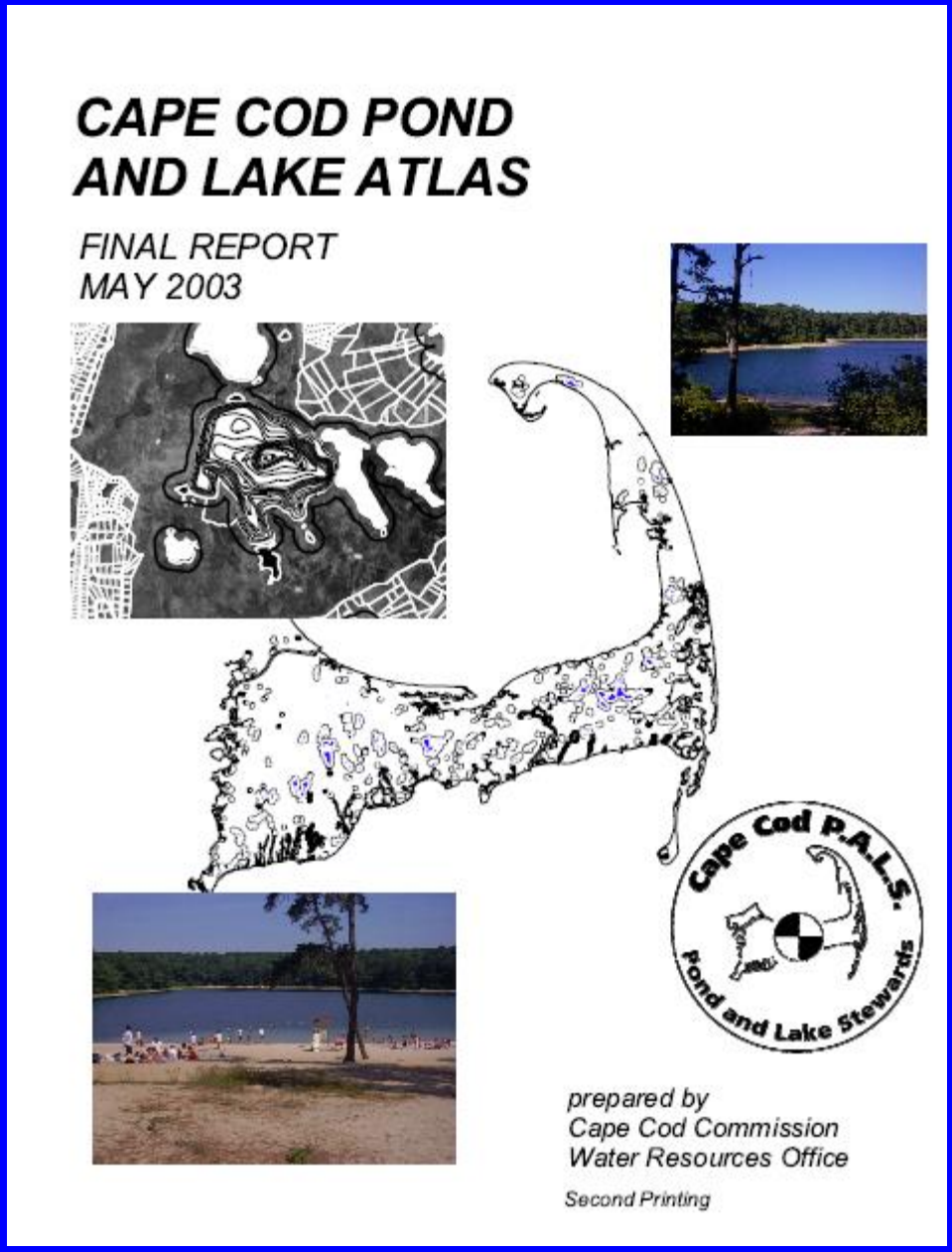
2001: 1st PALS Water Quality Snapshot

- SMAST donated lab services; CCC coordinated bottle delivery and distribution
- Same depth-dependent sampling protocol and late summer sampling window
- 196 ponds sampled in the first year

Cape Cod Pond Atlas

2003

- 1st identification of all ponds on Cape Cod
- Review and summary of 2001 PALS Snapshot data (>190 ponds)
- Development of Cape-specific nutrient thresholds



Town Sampling

2002 - present

- Continued PALS Snapshots (>20 years of data)
- Added Spring sampling to establish annual baseline
- Some towns sampled ponds over whole summer using PALS protocols

Town-wide Data Review

Using data for prioritization

- 2003 Chatham reviews two years of data for CWMP effort
- 2005-2009 Brewster, Orleans, Harwich, Dennis, Eastham citizens and Towns lobby county to have CCC review collected pond water quality data
- 2008 Barnstable Pond WQ Database and Review
- 2016 Dennis Pond WQ Database and Review
- 2017 Orleans Pond WQ Database and Review
- 2021 Barnstable Pond WQ Database and Review
- 2023 Brewster Pond WQ Database and Review

Individual Pond Assessments

- 1979 Barnstable: Red Lilly
- 1989 Barnstable: Wequaquet, Long
- 1991 Barnstable: Shallow
- 1993 Barnstable: Hamblin
- 1997 Barnstable: Lovells
- 2006 Barnstable: Mystic, Middle, Hamblin
- 2009 Barnstable: Wequaquet
- 2011 Barnstable: Mystic
- 2013 Barnstable: Lovells
- 2022 Barnstable: Shubael
- 2022 Barnstable: Long (MM)
- 2024 Barnstable: Lovells (planned)
- 2025 Barnstable: Wequaquet (planned)
- 2026 Barnstable: Long (Cville) (planned)

Gathering pond-specific data necessary for developing management options

Look at all factors creating water column conditions:

- Sediments
- Watershed land use
- Phytoplankton
- Stream inputs/outputs
- Plants & mussels

Pond Management Implemented

- 1995 Barnstable: Hamblin: Sediment Alum Treatment
- 2010 Barnstable: Mystic: Sediment Alum Treatment
- 2010-2012 Barnstable: Lovells: Circulation System Operation
- 2002-2023 Barnstable: Long (Cville): Hydrilla Herbicide Treatment
- 2014 Barnstable: Lovells: Sediment Alum Treatment
- 2015 Barnstable: Hamblin: Sediment Alum Treatment
- 2016 Barnstable: Mystic: Hydrilla Herbicide Treatment
- 2016 Barnstable: Middle: Hydrilla Herbicide Treatment
- 2017 Barnstable: Long (Cville): Hydrilla Herbicide Treatment
- 2023 Barnstable: Shubael: Sediment Alum Treatment
- 2024 Barnstable: Long (MM): Experimental Floating Wetland

Proven nutrient management techniques:

- Alum
- Aeration
- Dredging
- Wastewater P treatment

Invasives plants:

- herbicides

Complete Diagnostic Assessment, then Implement preferred management strategy(-ies) to address identified impairments

Lessons Learned
Pond Assessments

A. Reliable management strategies require refined data about the pond

- Watershed review
- Stream measurements
- Sediment P contributions
- Rooted plant coverage
- Phytoplankton population changes
- Water column data
- Mussel Coverage
- Bathymetry

B. Holistic assessments/management strategies are needed; may need to consider multiple management goals

C. Education about pond ecosystems, functions, and management strategies is an on-going need for advocates and policymakers

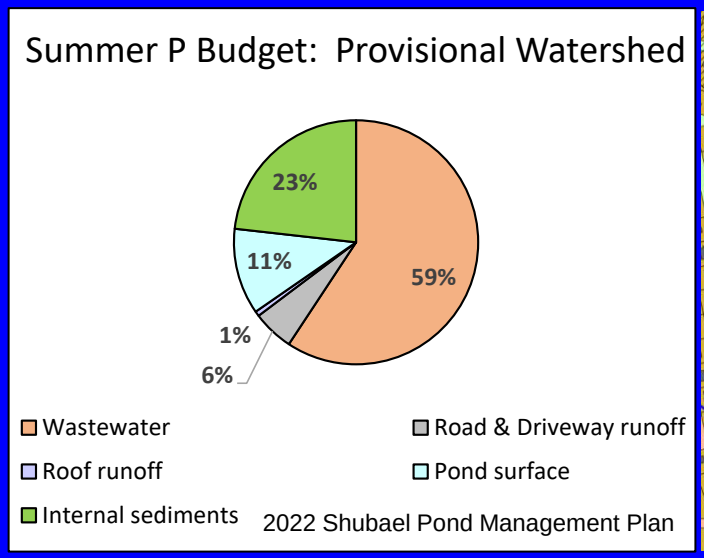
Lessons Learned
Pond Assessments

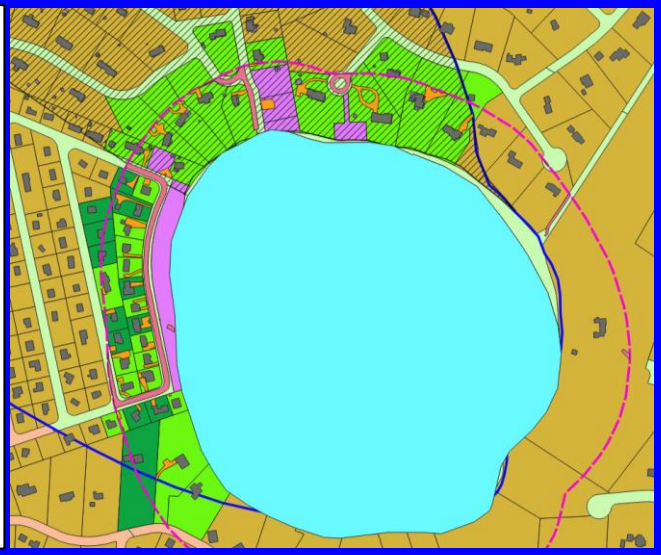
A. Development of successful management strategies often require development of additional refined data

Shubael Pond

Collection of:

- Water column data
- Stormwater runoff
- Phytoplankton
- Rooted plants
- Mussels
- Bathymetry
- Watershed land use





Best Mgmt option: Sewer parcels contributing P

Watershed sewering not planned until Phase 3 (21-30 yrs)

Strategies: Interim Alum, Sewer sooner

Lessons Learned
Pond Assessments

B. Holistic assessments/management strategies are needed

Mystic Lake in Barnstable
significantly impaired; only 22% of the water column clear; high hypolimnetic oxygen demand; TP in surface waters 16 ppb

2007 - Alum treatment proposed and rejected by regulators based on concern that alum would harm protected mussel species by reducing food sources

2009 – Blue-green algal bloom/rise of anoxia into mussel habitat results in killing of 94% of the protected mussels

Lessons Learned
Pond Assessments

C. Pond education is an on-going need for advocates and policymakers (good understanding creates good policy)

- PALS Snapshot data are useful, but not sufficient for management
- Cyanobacteria are part of phytoplankton community and are usually present
- Impact of phosphorus sources will vary from pond to pond

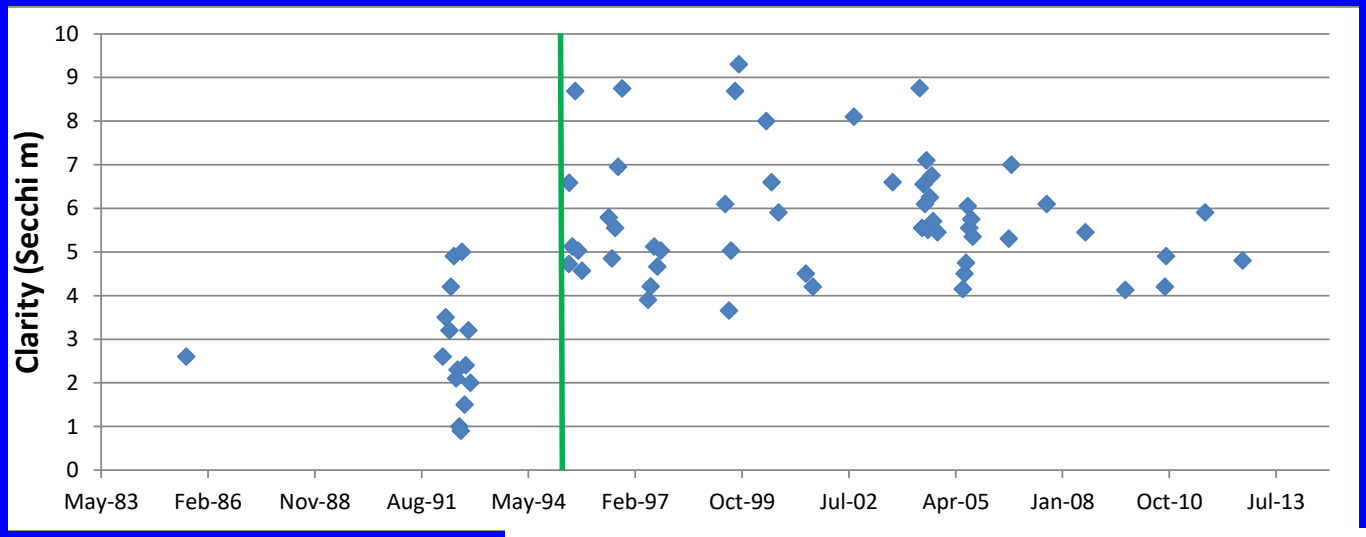
Ponds: Town-wide Management

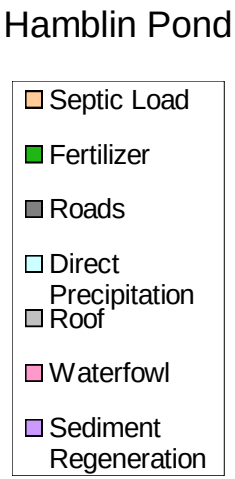
A. Assessments and management of ponds needs to be addressed comprehensively and individually
B. Incorporate pond water quality needs into CWMPs
C. Focus on Great Ponds (>10 acres; 25 in Barnstable, total of 180 ponds)
D. Continue regular water quality monitoring and update review of data every 3-5 years
E. Keep local control of management, consider avoiding TMDL listing until goals achieved

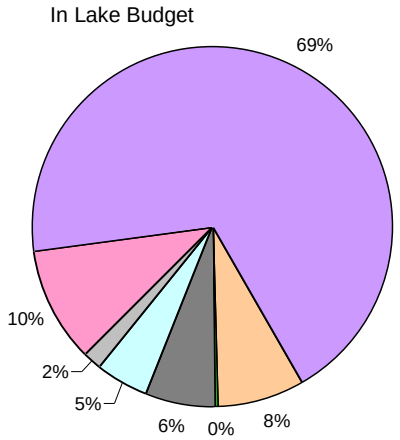

QUESTIONS?
Plans to protect air and water, wilderness and wildlife are in fact plans to protect man.
- Steward Udall
I believe in a sound, strong environmental policy that protects the health of our people and a wise stewardship of our nation's natural resources.
- Ronald Reagan
TMDL Solutions

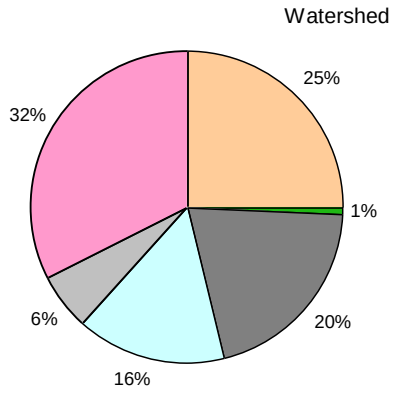
Alum Treatments

1995 Barnstable: Hamblin Pond









Lessons Learned
Pond Assessments

- Regular review of volunteer data: helps provide feedback to volunteers and guidance to policymakers

- Statistically significant ($\rho<0.05$) decreasing trend

- Trend = -0.45 ft every year