Massachusetts Estuaries Project

Science to Support Management and Restoration of Southeastern Massachusetts Estuaries

Eelgrass Status & Trends Conference

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DEP/SMAST Massachusetts Estuaries Project
Natural Resource Restoration/Management

- A partnership between
  - –DEP/EOEA (regulatory, TMDL's)
  - –SMAST/UMassD (science, assessment & modeling)
  - – with S.E. Mass. Municipalities, Barnstable County, Cape Cod Commission, MVCommission, SRPEDD), USGS, EPA, DMF
- Purpose:
  - – to develop nitrogen thresholds and target loads for the embayments of southeastern Massachusetts
  - – to bring new approaches & tools to watershed nitrogen management for estuarine restoration

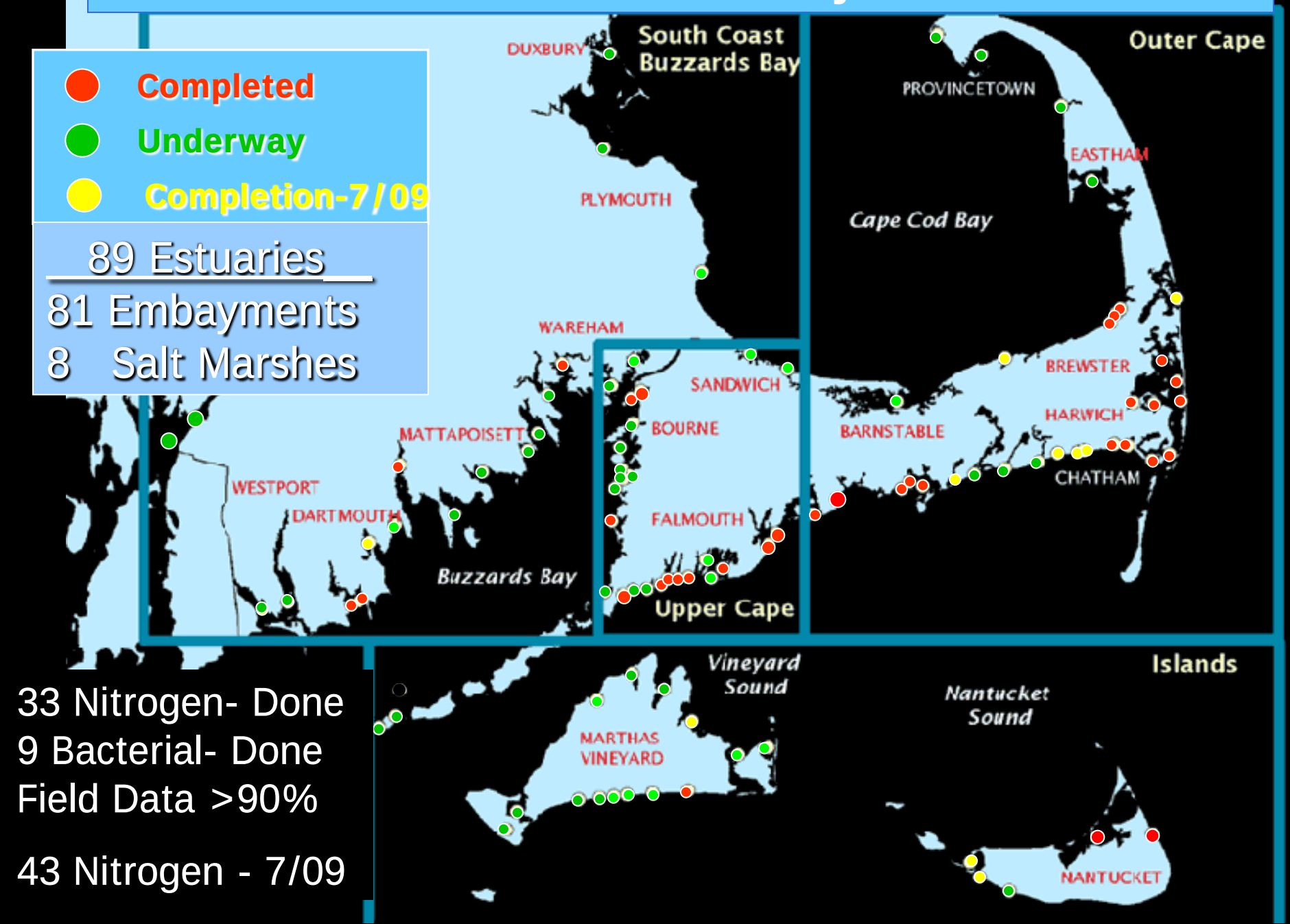
FOCUS: Major Problems Facing Embayments Throughout SE Mass

- ***The 2 primary issues:***

→increased nutrient loading to the estuary, resulting in wholesale decline in estuarine health from shifting land-use.

--> bacterial contamination resulting in shellfish bed closures.

Massachusetts Estuaries Project Estuaries



Massachusetts Estuaries Project

Common features of MEP estuaries:

- **Small systems, tributary to larger high quality water bodies**
- **Shallow, typically 1-3 meters depth**
- **Tide range typically 0.5-2 meters**
- **Groundwater dominated hydrology**
- **Light extinction primarily associated with organic particles (phytoplankton derived)**

Embayment Nutrient Related Health:

Degradation of Estuaries and Bays by nutrient enrichment is primarily through Nitrogen from surrounding watersheds.

Over-Fertilization results in declining health:

- ↑ *Phytoplankton Blooms and turbid waters*
- ↑ *Loss of eelgrass beds*
- ↑ *Decline in benthic animal populations, fish & shellfish*
- ↑ *Low Oxygen in bay waters, fish kills, possibly odors*
- ↑ *Macro-algal accumulations*
- ↑ *At highest levels → loss of aesthetics*

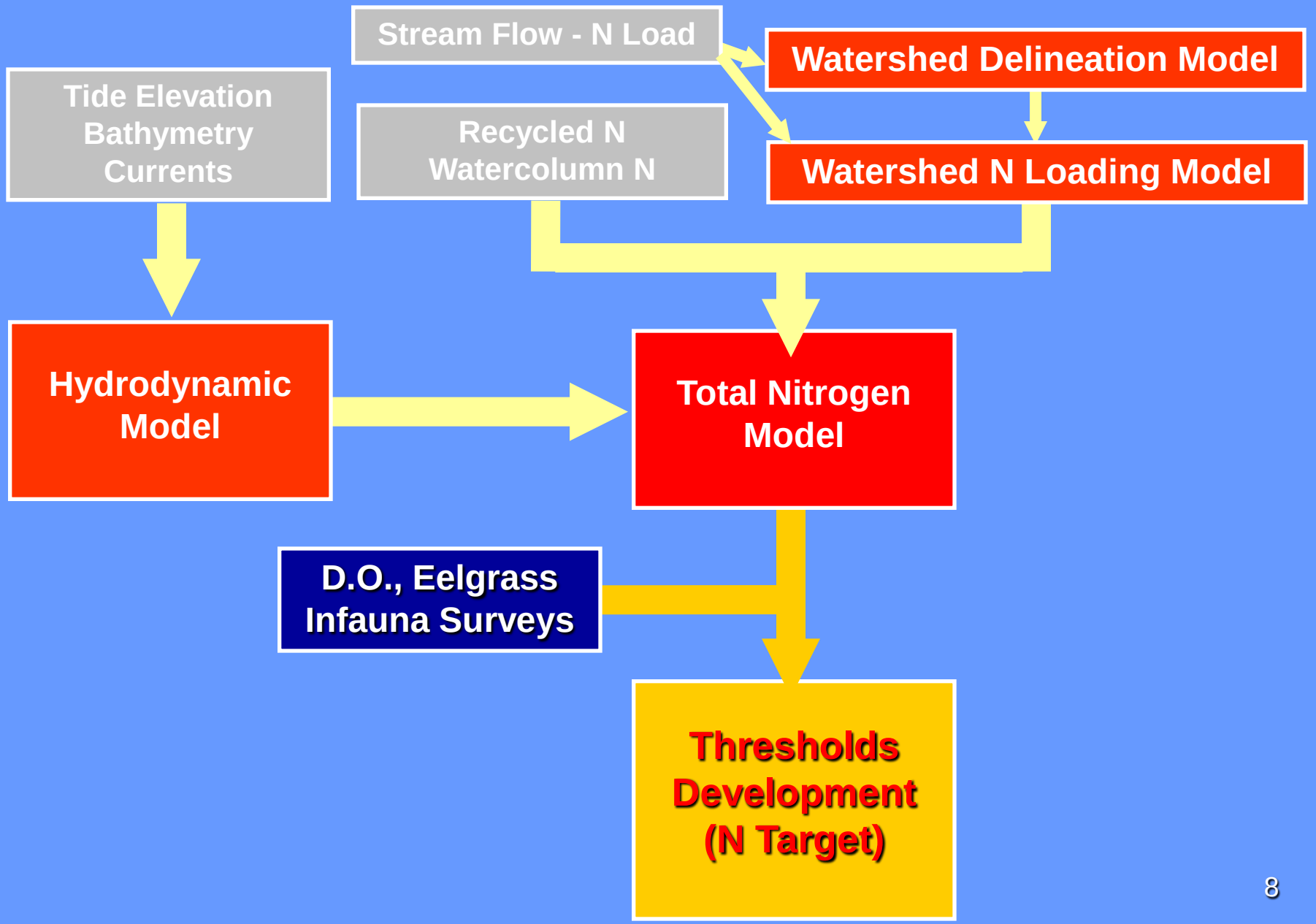
Linked Watershed-Embayment Management Modeling Approach used for Massachusetts Estuaries Project

Key Aspects:

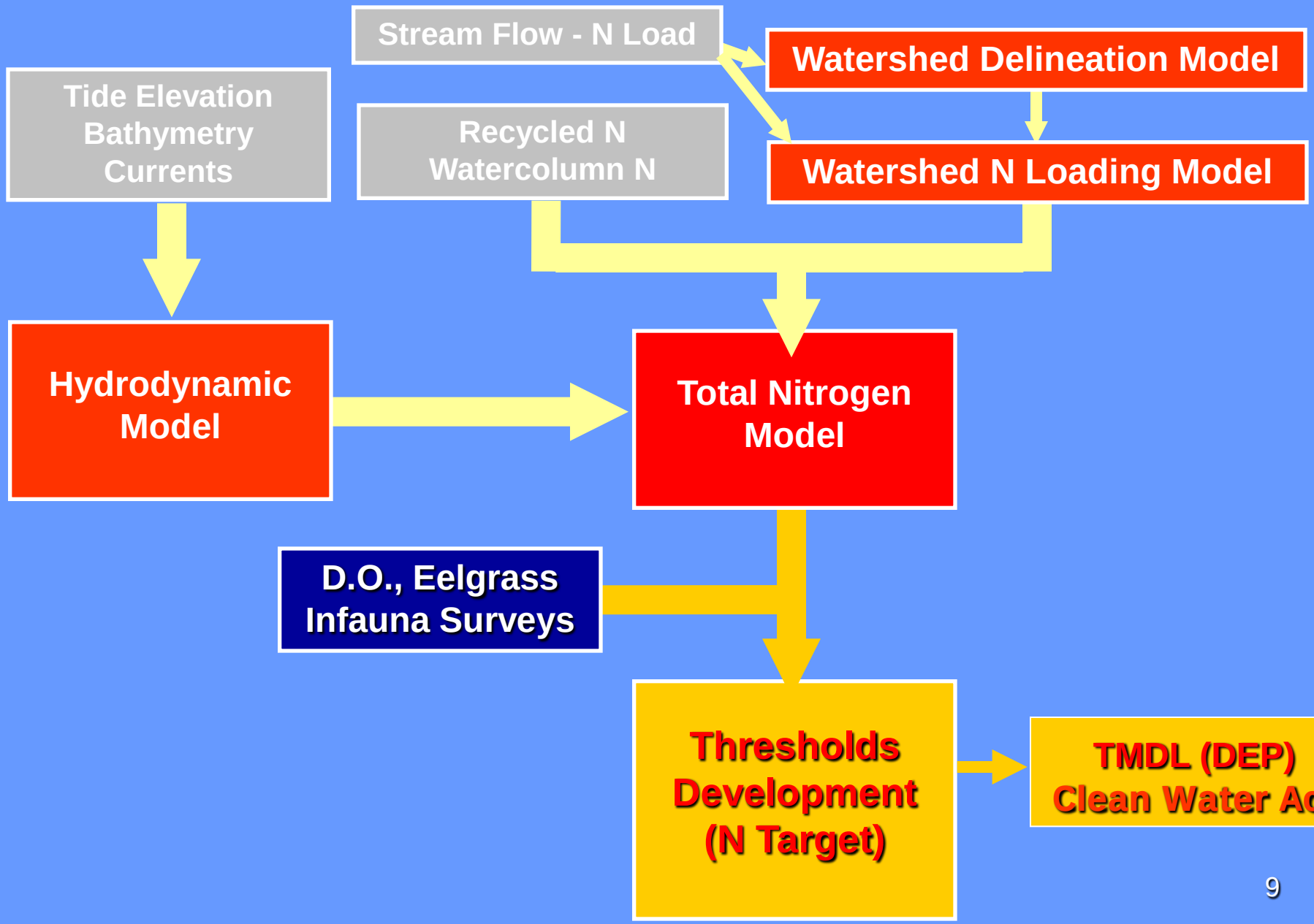
✓ Data-driven Approach with numerous validation steps

✓ Not a "push button model" but an "Approach" consisting of a series of models linked by scientists, conducting necessary reality checks and sub-routines;

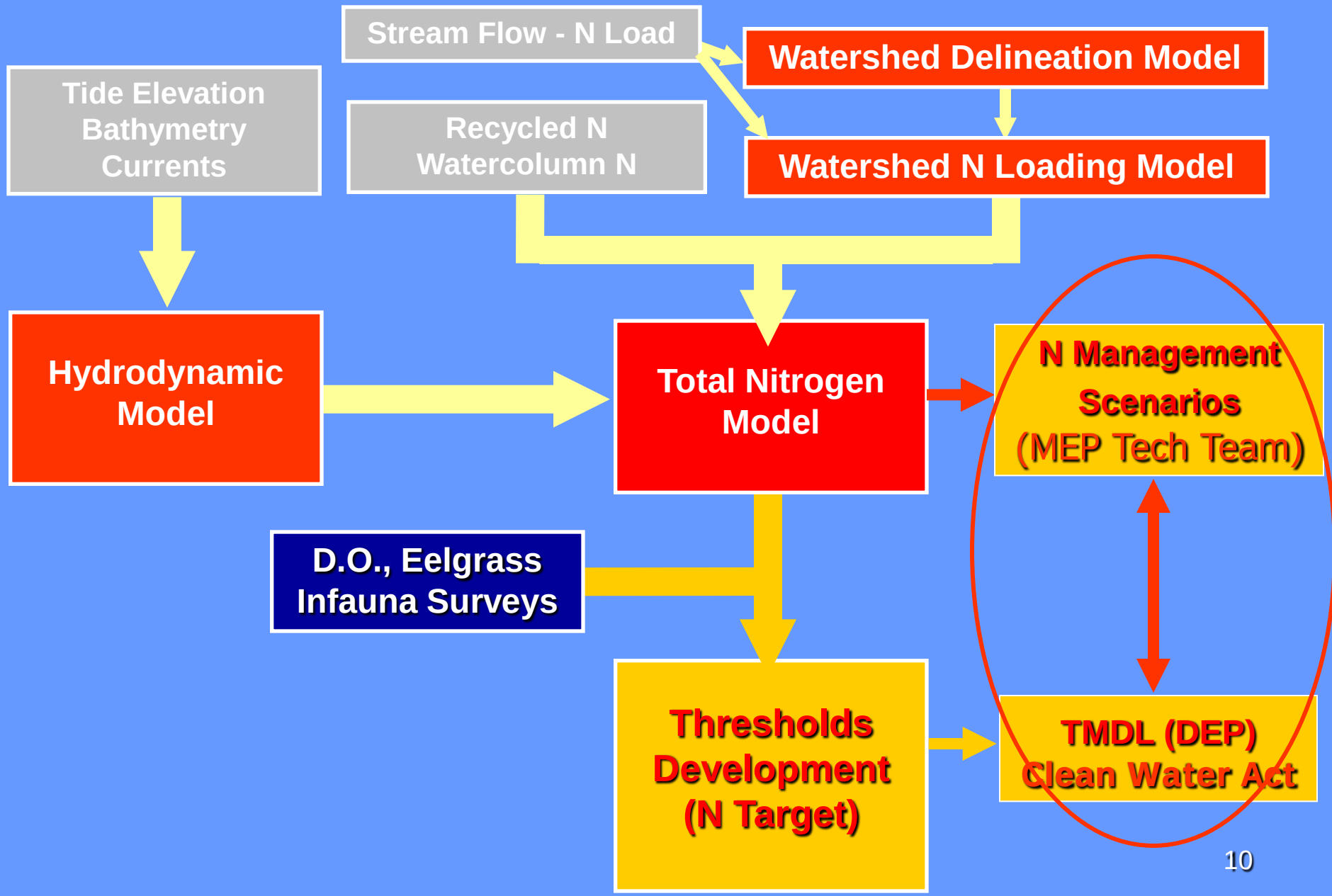
Linked Watershed-Embayment Approach



Linked Watershed-Embayment Approach



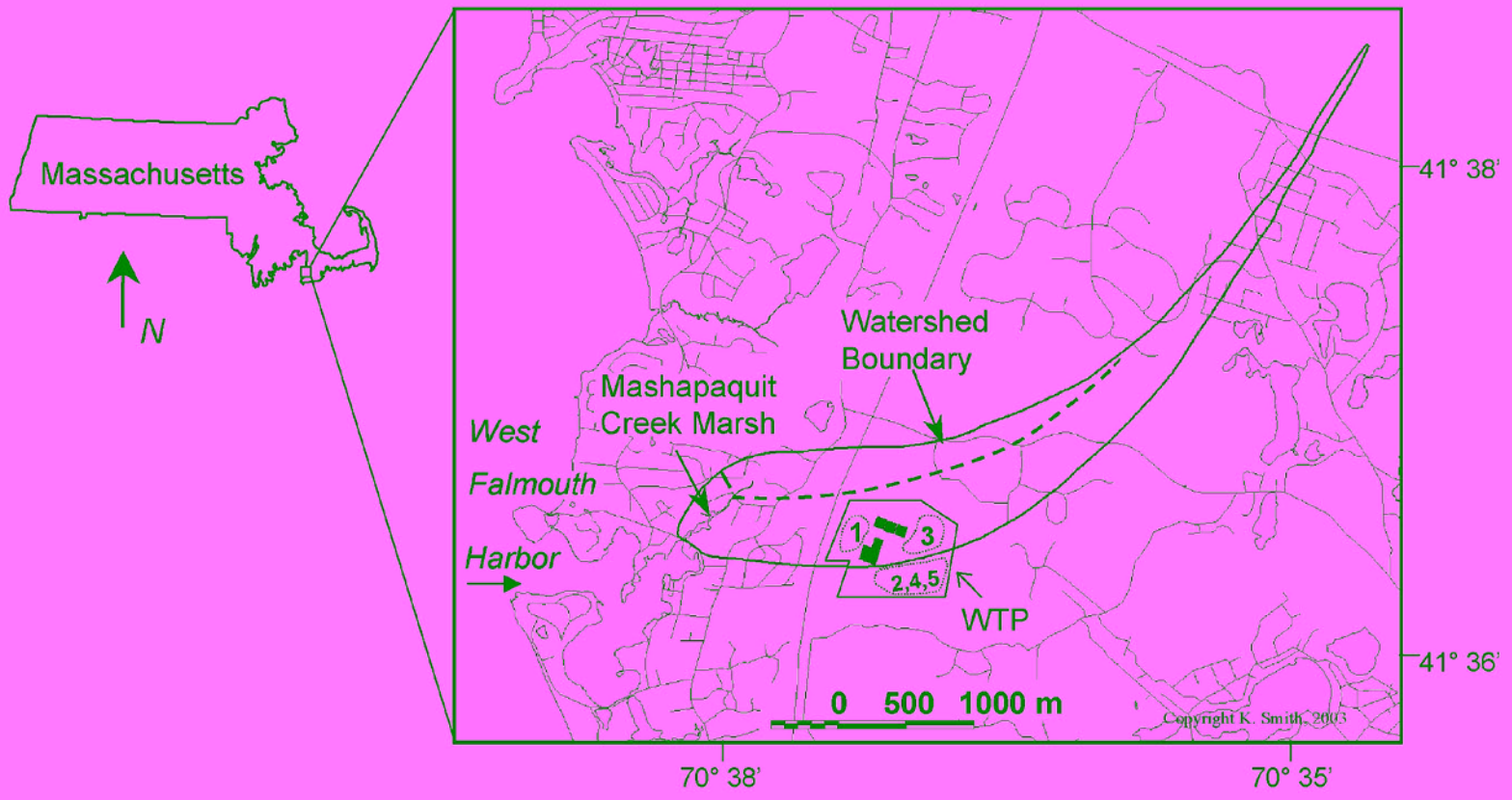
Linked Watershed-Embayment Approach



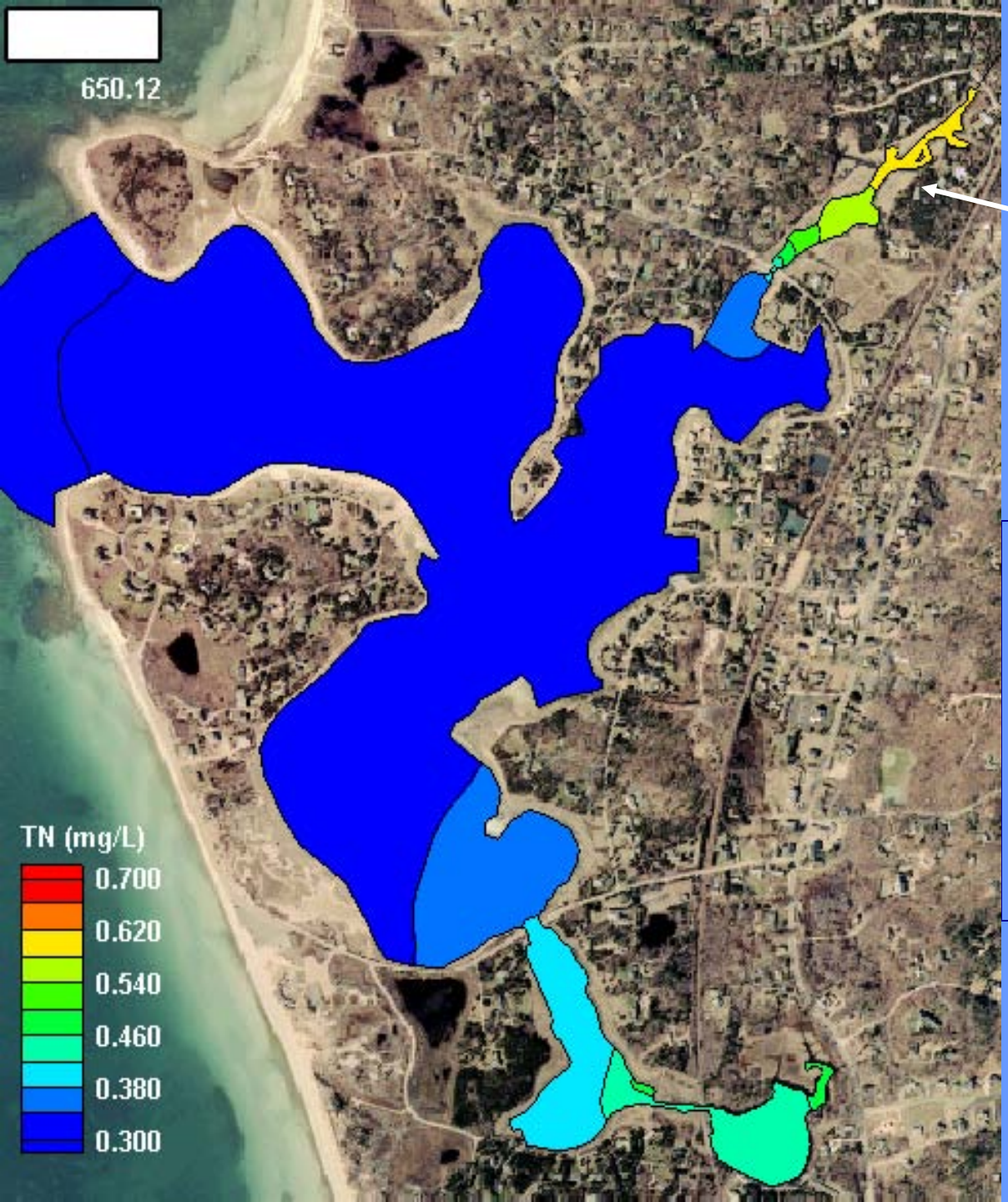
Massachusetts Estuaries Project Embayment Restoration

Pattern of Eelgrass Loss with increased N loading in s.e. Massachusetts estuaries

West Falmouth Harbor Wastewater Treatment Facility Effluent Groundwater Discharge Plume



Over a ~1 yr period (1993-94) the watershed nitrogen load to the Harbor more than doubled.

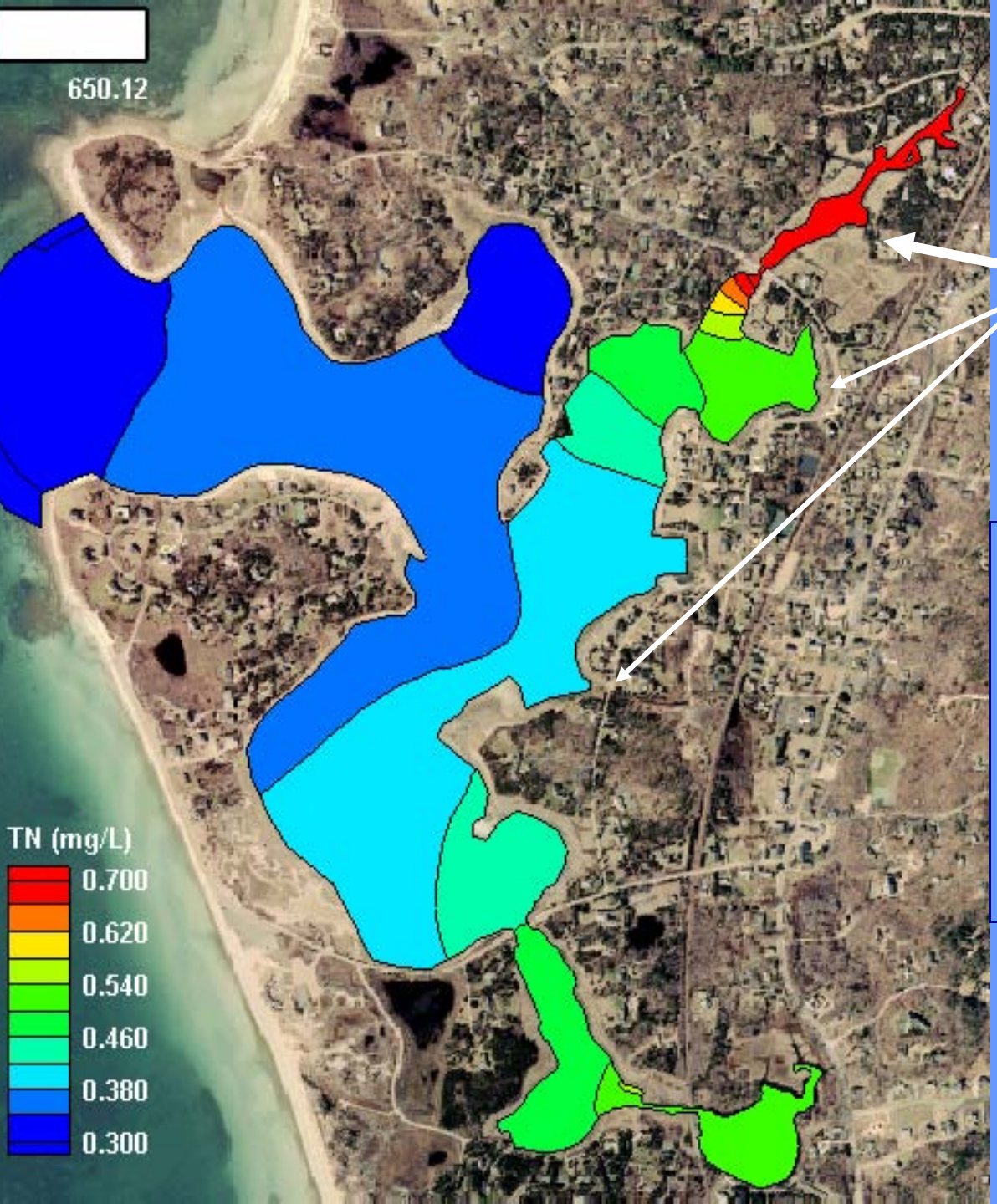


Tidal Salt Marsh

West Falmouth Harbor

Pre-WWTF Nitrogen Load

Nitrogen levels (mg/L) over tidal cycle

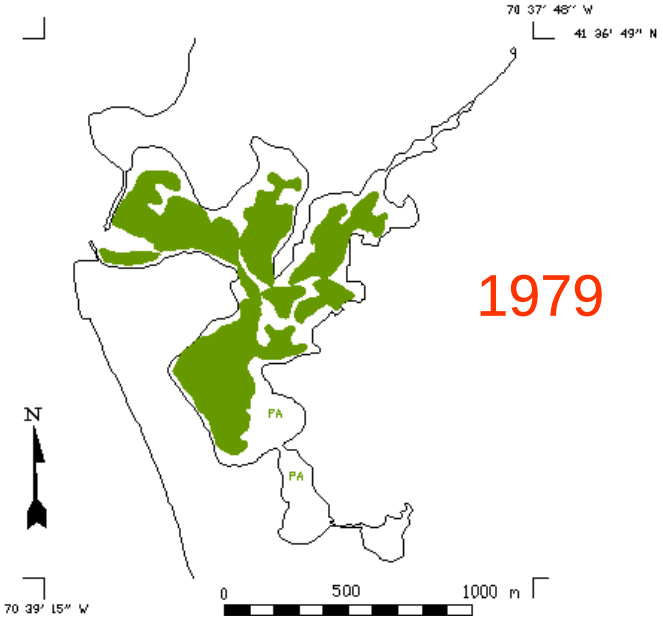


WWTF Plume Entry

West Falmouth Harbor

Post-WWTF Nitrogen Load

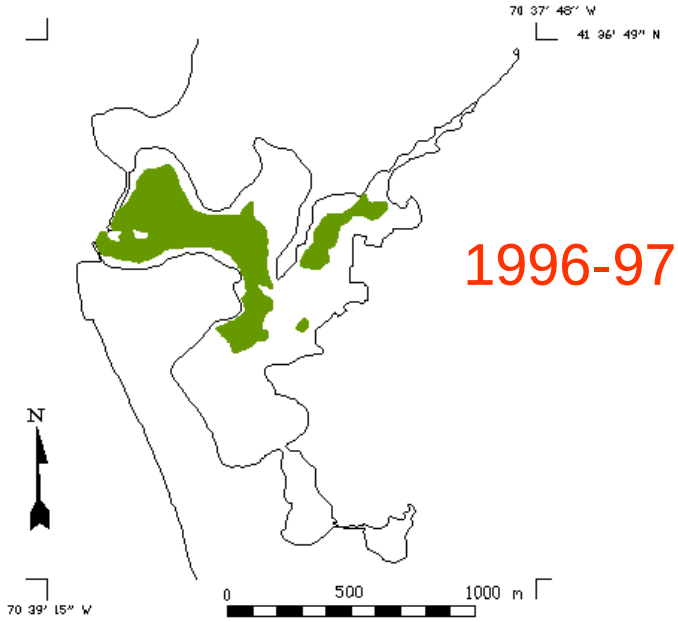
Nitrogen levels (mg/L) over tidal cycle.



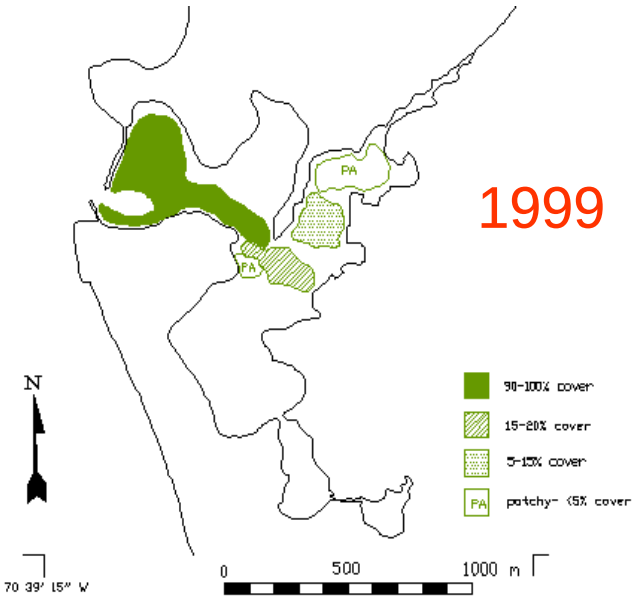
1979

Falmouth WWTF Nitrate Plume reached West Falmouth Harbor in 1993-94, doubling the Total Input of Watershed Nitrogen.

>50% eelgrass loss in 5 yrs

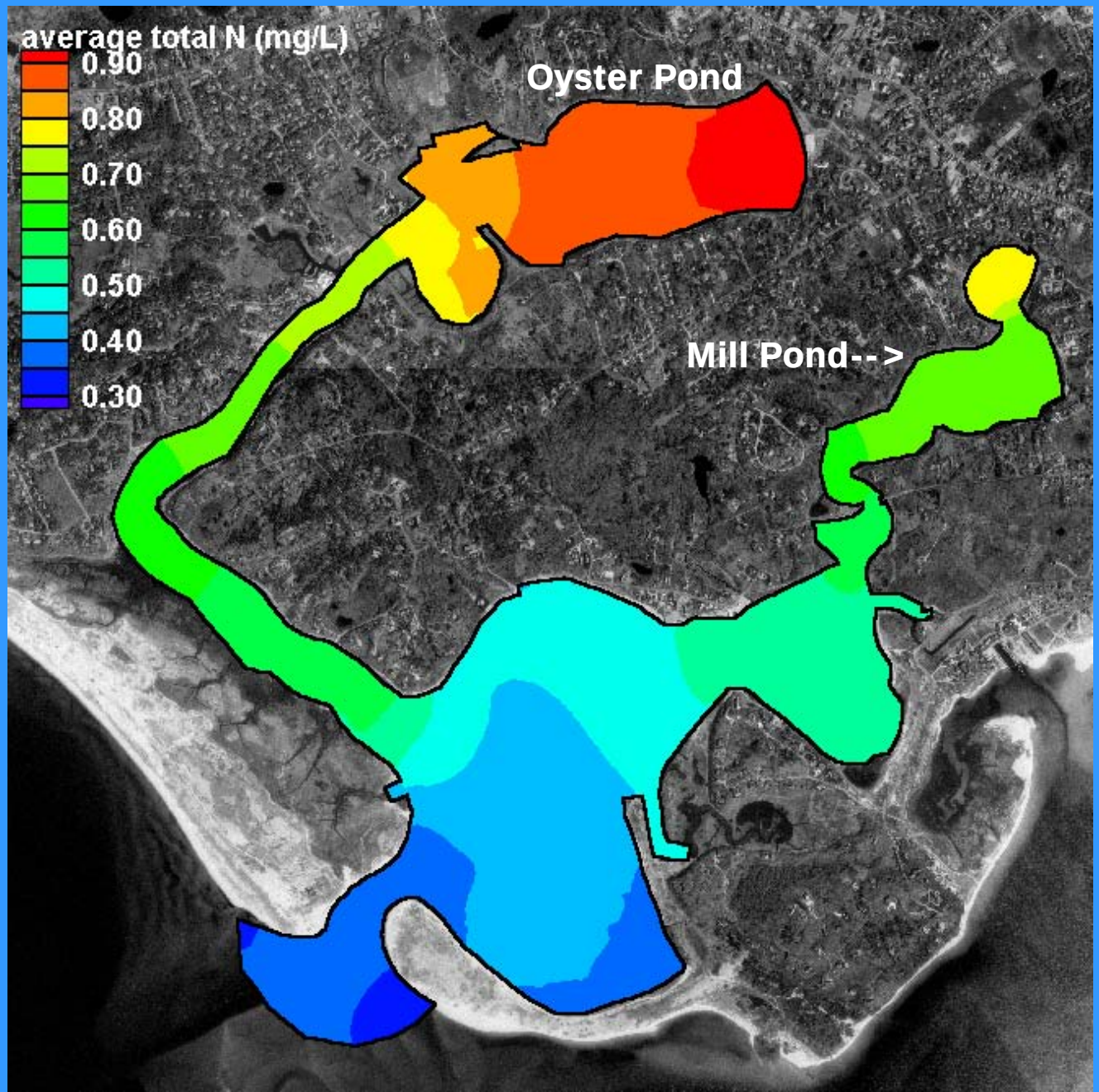


1996-97



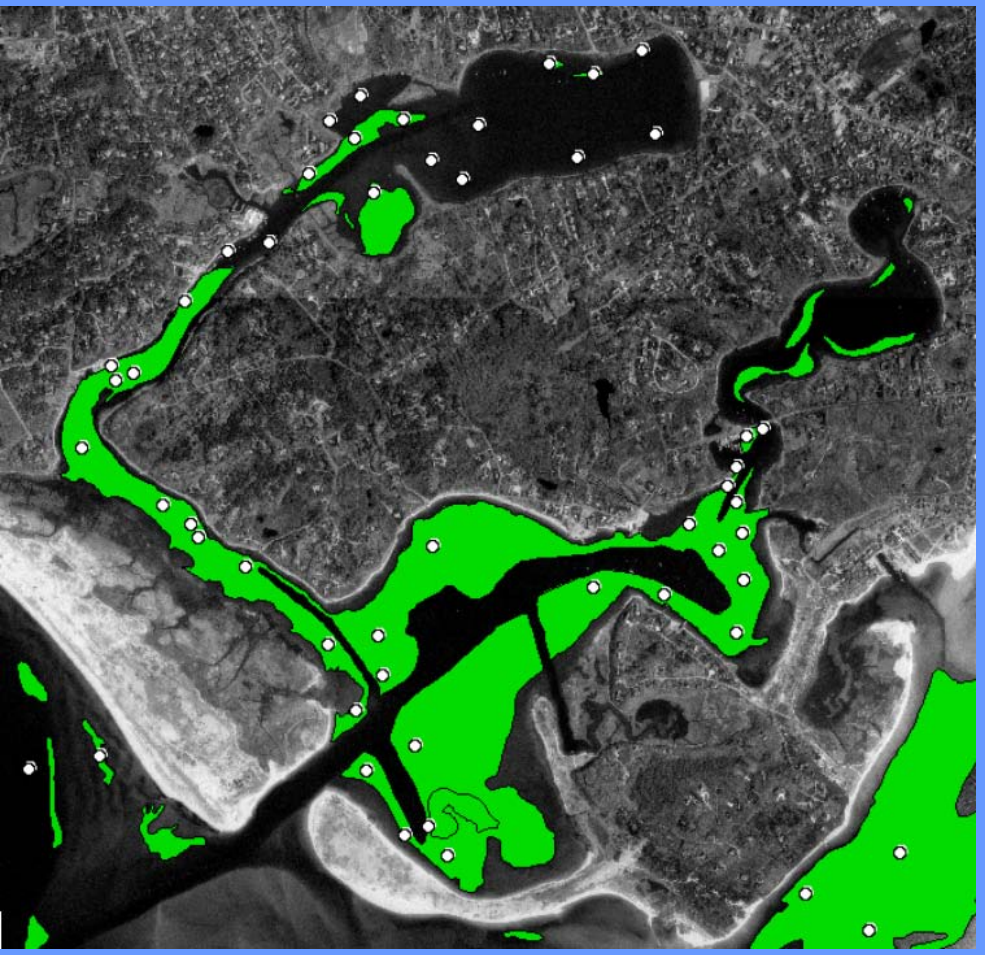
1999

N Concentration within Stage Harbor

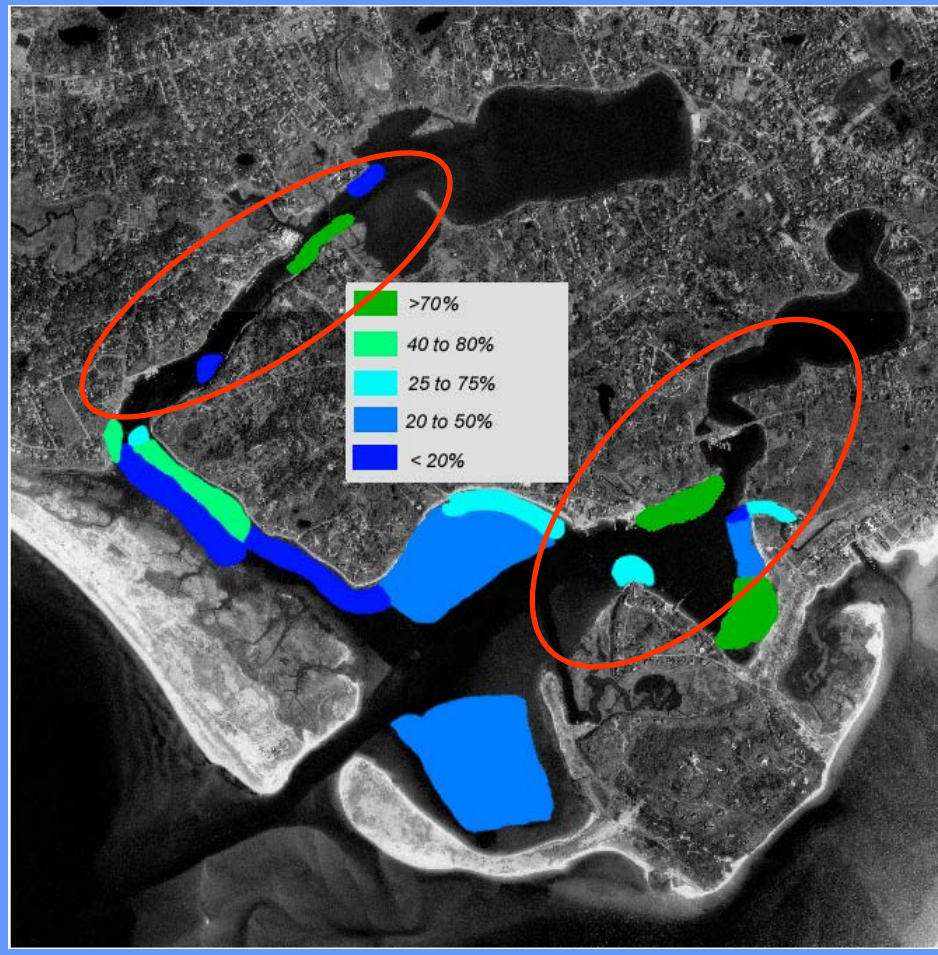


Historic Trends: Distribution vs Density

1994 DEP Mapping Project

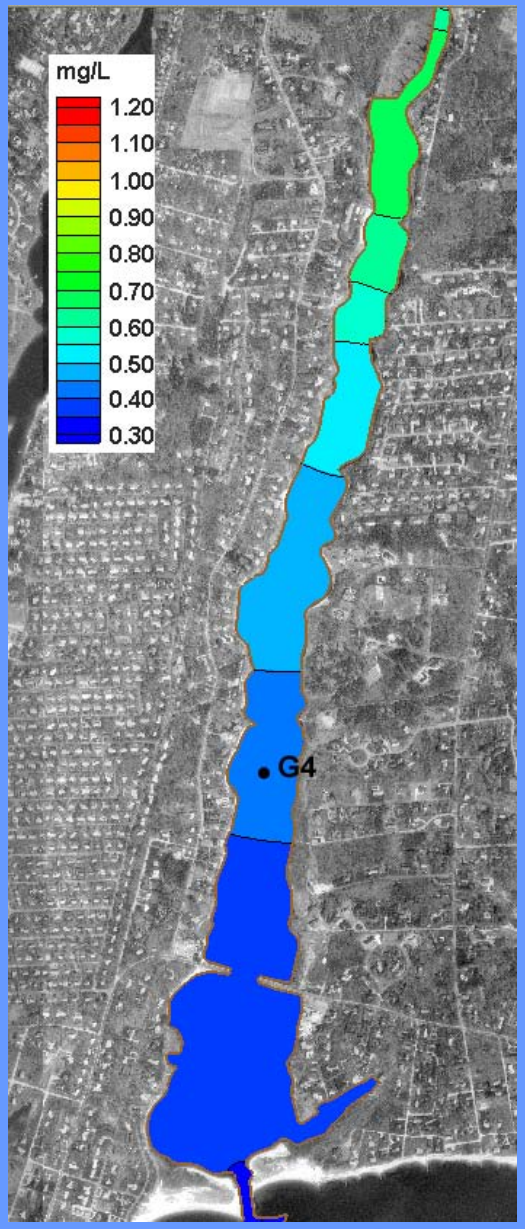


2000 Continuous Transects

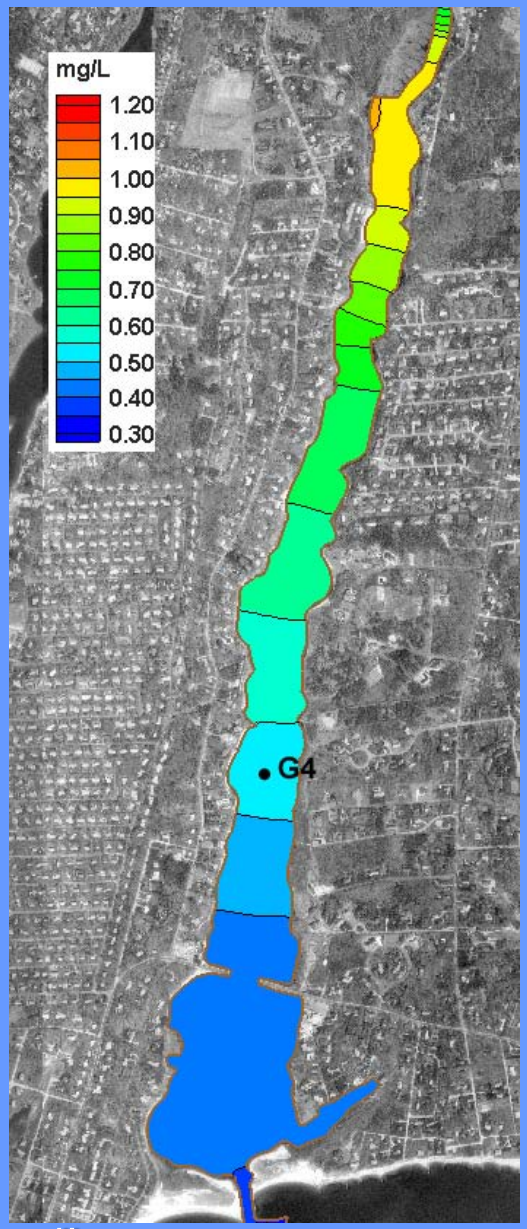


Estuaries Project: Stage Harbor, Chatham

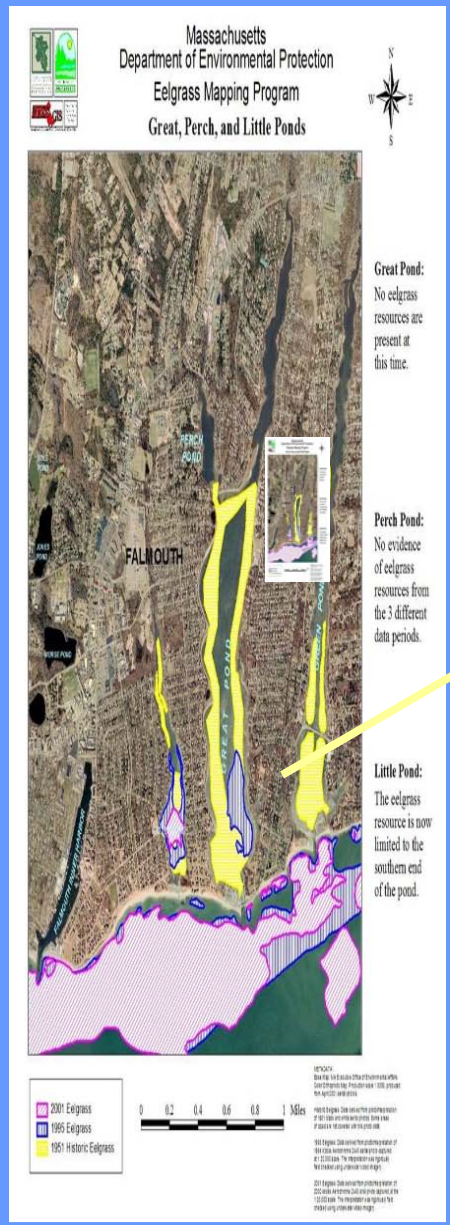
Projected 1951 N Load



Present N Loading



Eelgrass Distribution



1951 DEP

1995 DEP No beds

- *G4 TN=0.42mg/l*

Massachusetts Estuaries Project Embayment Restoration

MEP Approach to N Thresholds Analysis

Embayment-Specific Critical Nitrogen Loading Thresholds

Critical Habitats for Restoration: Eelgrass & Infauna

Components of Threshold Analysis:

1) Historical Trends in Eelgrass & Macroalgae (distribution & abundance)
2) Benthic Animal Communities (habitat quality)
3) Historical Trends in Water Quality
4) Dissolved Oxygen Record (summer, bottom water)

Embayment-Specific Critical Nitrogen Loading Thresholds

Threshold Approach relative to eelgrass:

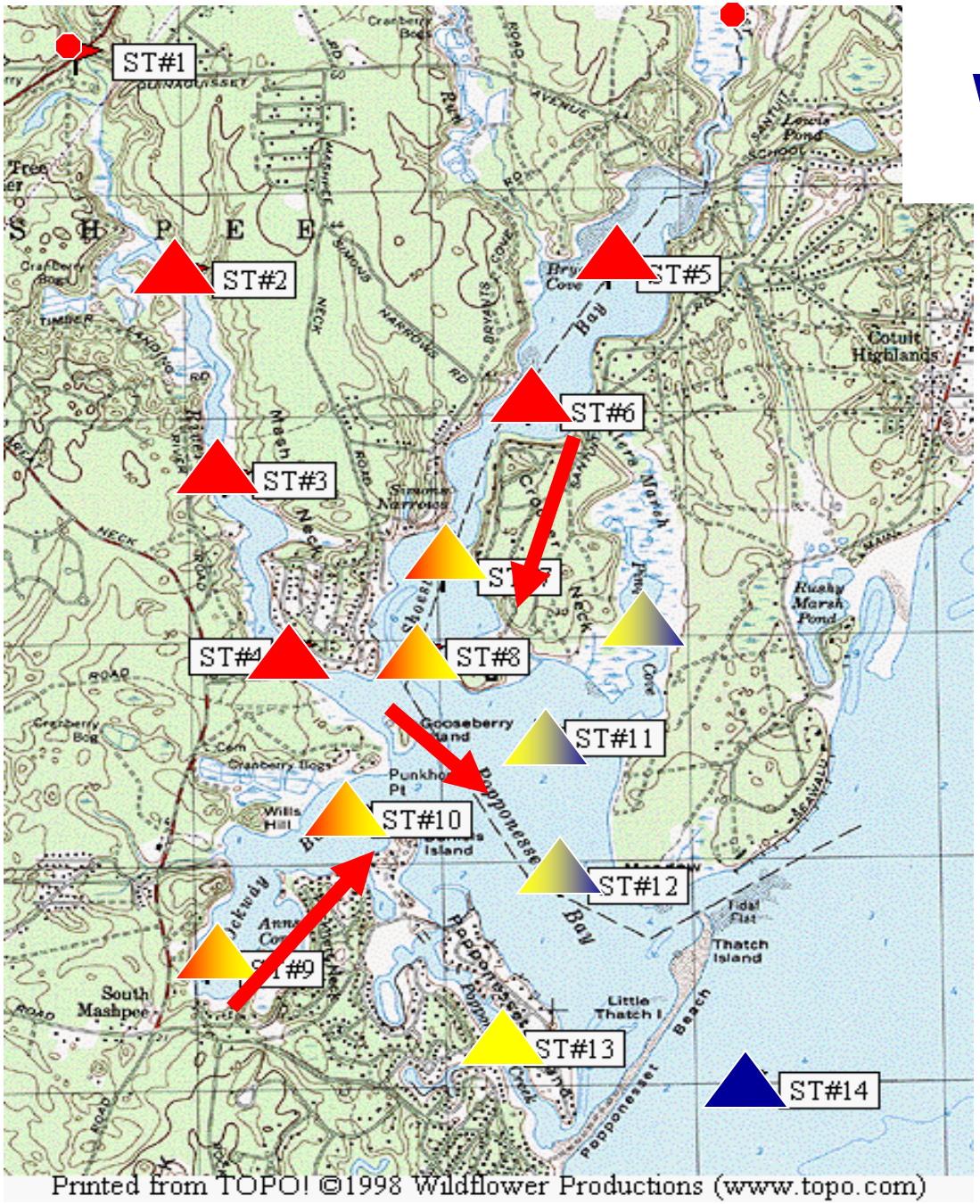
1) Confirm that eelgrass loss is nutrient loading related.

2) Do parallel records of eelgrass change and water quality exist

3) Do "reference" sites with stable eelgrass beds within the same estuary exist? How do they link to WQ?

4) Comparison to stable and unstable bed sites in similar estuaries (depth, tide range, hydrology, etc).

Nutrient Related Water Quality Monitoring



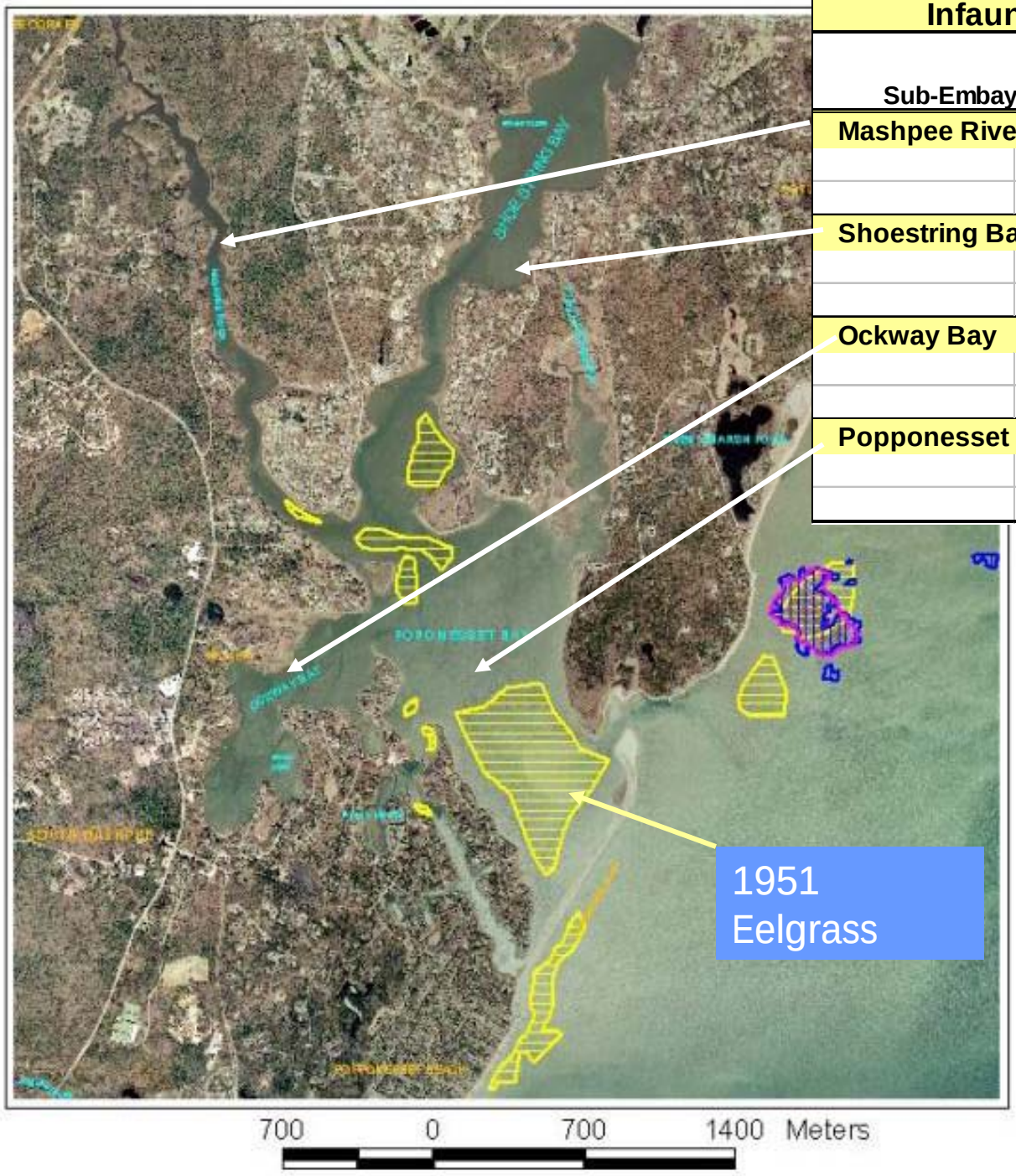
Popponesset Bay
1999-2005

Estuarine Quality Index

Red = Poor

Yellow = Moderate

Blue = High

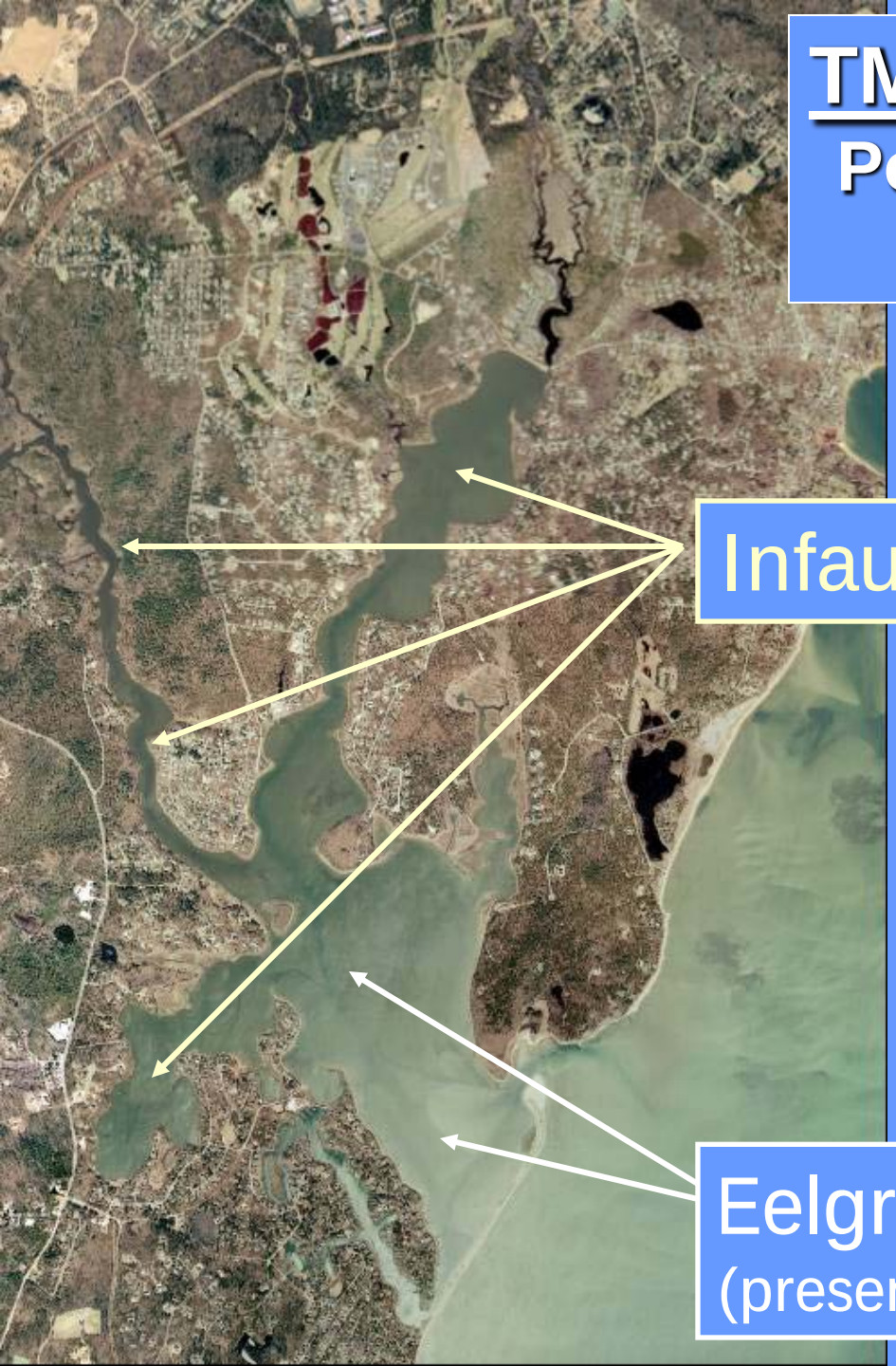


Infaunal Animal Communities

Sub-Embayment		Average # Species	Average # Individuals
Mashpee River			
	Mid	7	147
	Lower	12	223
Shoestring Bay			
	Inner	16	595
	Outer	15	534
Ockway Bay			
	Inner	2	16
	Mid	14	98
Popponesset Bay - Main Basin			
	Upper	9	548
	Lower	31	489

Historical Eelgrass Beds

Status: currently no beds in System



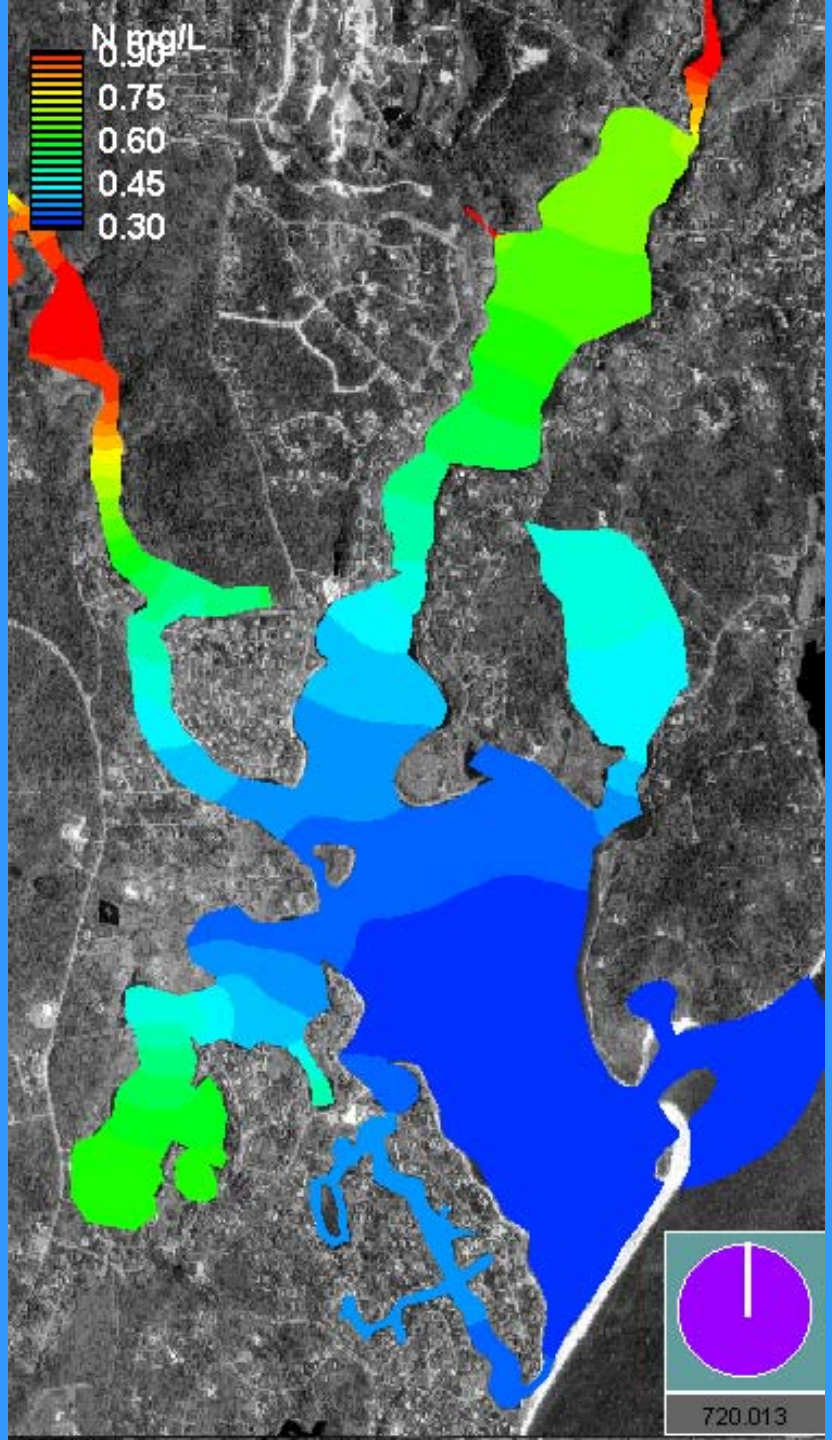
TMDL Restoration Goals

Popponesset Bay System

Infaunal Habitat

Eelgrass

(presently no eelgrass in bay)



Popponesset Bay System

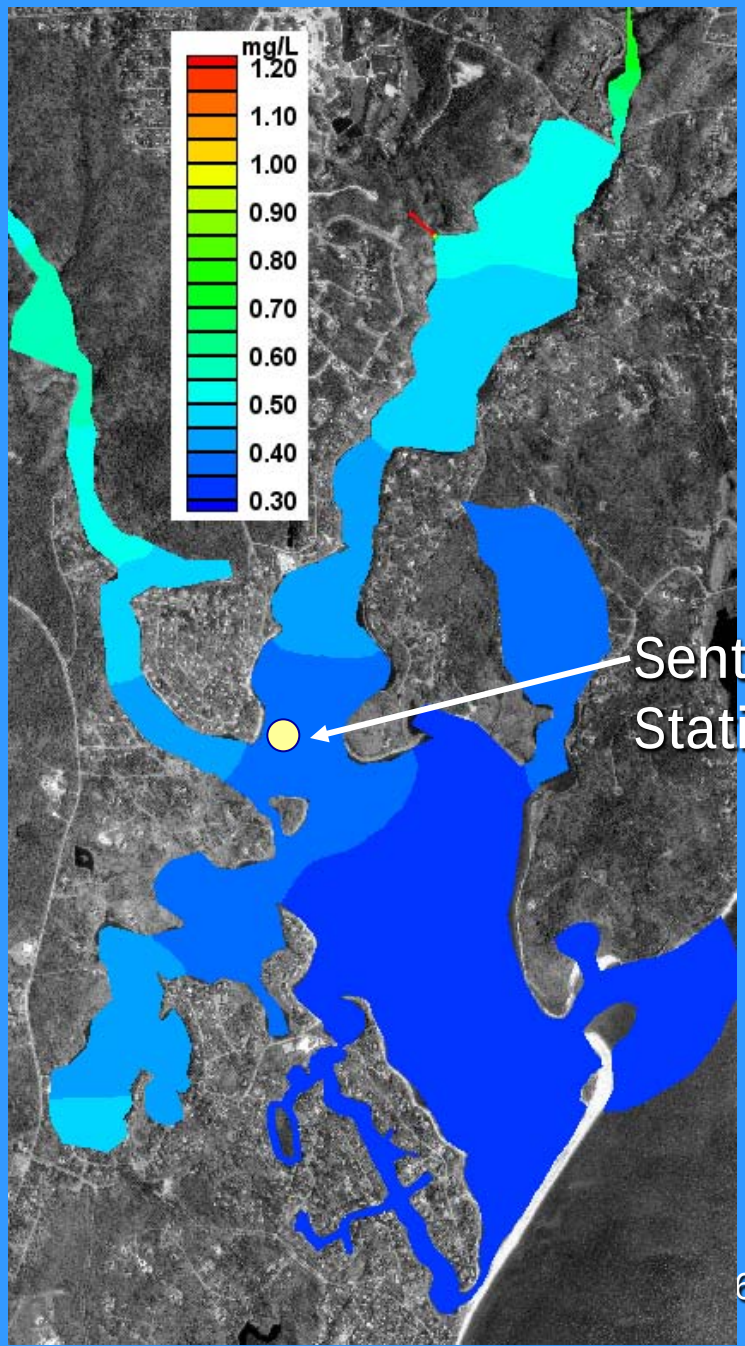
MEP Watershed-Embayment Nitrogen Model

Present Conditions

Variation in Nitrogen Gradients through a Tidal Cycle

Eelgrass 1951 - MassDEP

TMDL N Loading Scenario #1



N Management Alternatives to Improve Water Quality to Restore Eelgrass Habitat

- **Watershed N Loading Alternatives:**

  Approach: Reduction of N Source Loading to Estuary.

  - Sewering (sewersheds, cluster, I/A systems)
  - Existing Sewering with Improved N removal in Treatment
  - Discharge relocation (N discharges to Ocean)

- **Hydrodynamic Water Quality Alternatives:**

  Approach: increased tidal exchange and/or circulation

  - Inlet or channel alteration (widening, dredging)

- **Natural Attenuation Alternatives:**

  Approach: Increase N removal during transport

  - Restore “damaged” aquatic systems to full N removal
  - Locate N sources to allow for N removal in transport

MEP Planned Post-Nitrogen Management

- **Water Quality Monitoring to track improvement**
- **Periodic Mapping of Eelgrass Distribution (Tier 1 & 2)**
- **Periodic Infauna Surveys**
- **As Water Quality Improves, eelgrass “test” plantings**

Massachusetts Estuaries Project: Science to Support Estuarine Restoration and Management

Questions & Discussion

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