Eelgrass: The Big Picture

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Eelgrass

Zostera marina L.

A seagrass:

- vascular plant
- flowering
- root system

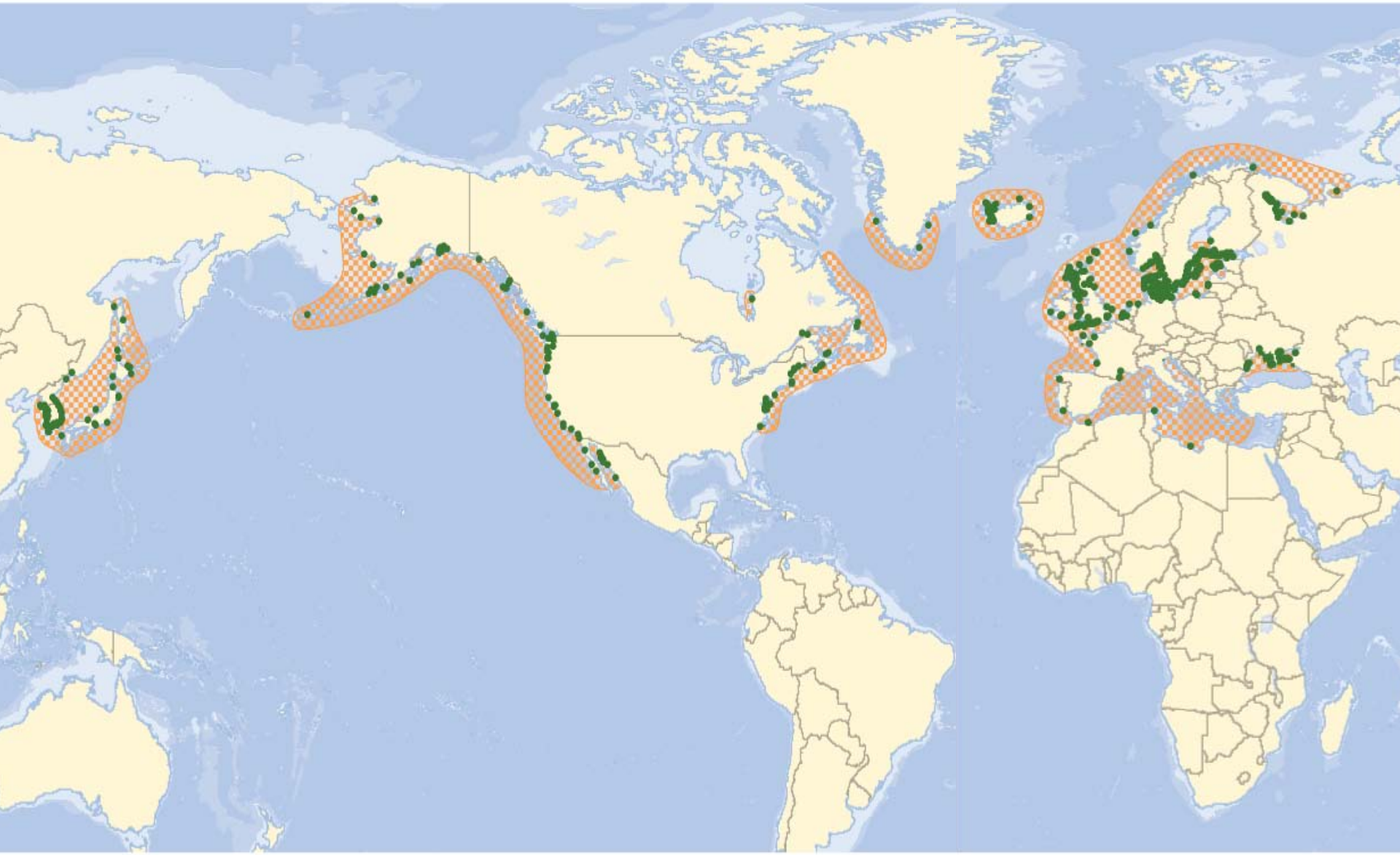
Eelgrass and its role

- Form and physiology make eelgrass plants unique
- Functions and values make the habitat important
- Indicator of the health of the Coastal Zone
- Critical maintenance of the coastal waters
- Many current threats
  - most of human origin
- Major stress factors
  - poor water clarity
  - overuse of coastal zone
- Conservation and protection needed
  - improve water clarity
  - reduce nitrogen inputs
  - reduce physical damage

Eelgrass Plant

- What eelgrass requires
  - Clear water (a lot of light)
- What eelgrass prefers
  - Cool temperatures 0 - 25 C
  - Seawater to estuarine salinities
  - Sandy to muddy bottom
- And what eelgrass tolerates
  - Moderate pollution
  - Many human activities

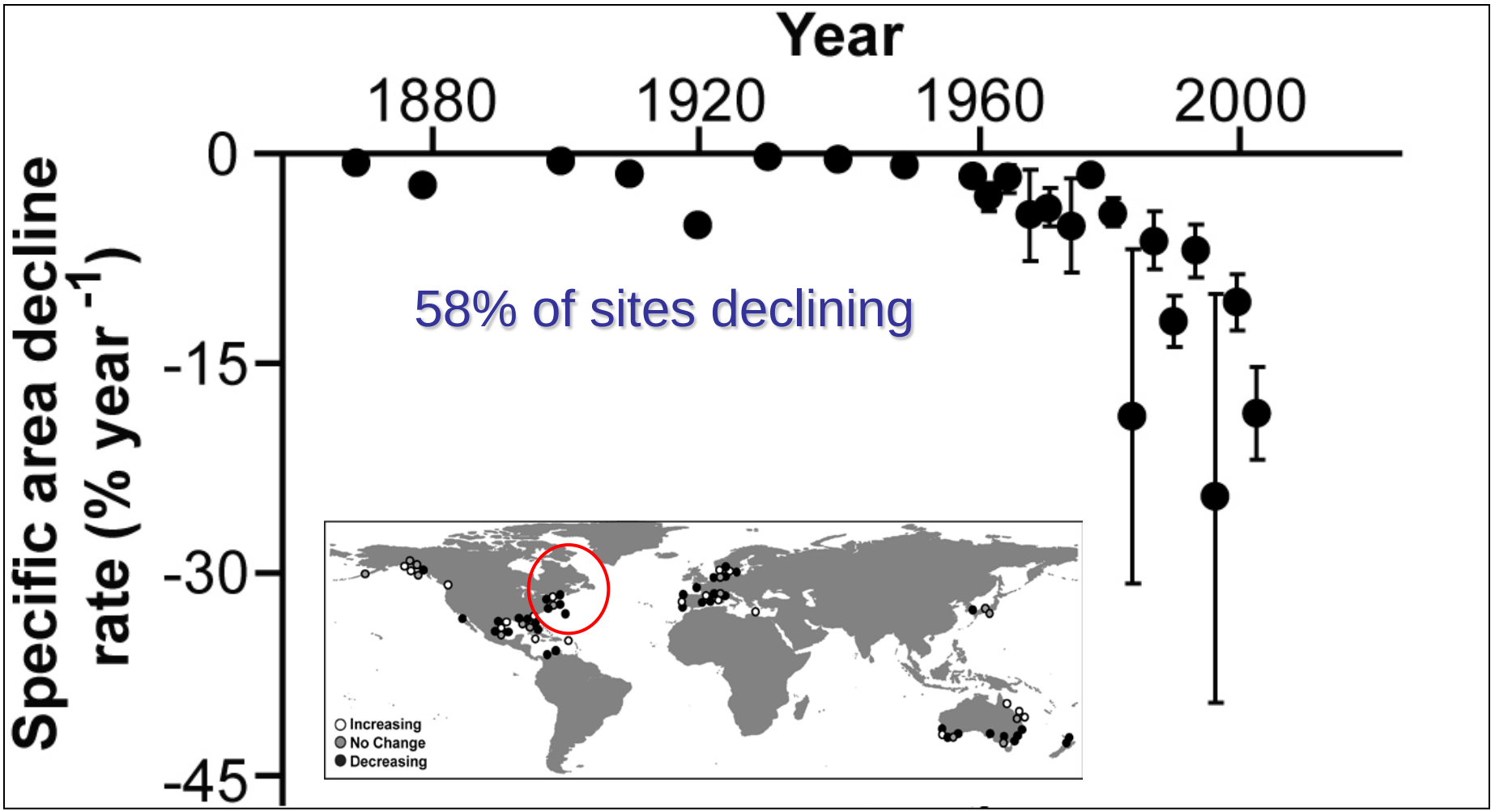
Global Distribution of *Zostera marina* L.



Global Seagrass Atlas 2003


Great Bay, New Hampshire

Global seagrass decline



Duarte, CM, TJB Carruthers, WC Dennison, JW Fourqurean, KL Heck, R Hughes, G Kendrick, WJ Kenworthy, S Olyarnik, RJ Orth, FT Short, M Waycott, SL Williams. In prep. Global seagrass trajectories show accelerating decline..

Ecology of Eelgrass

SUBMERGED
- Subtidal and
- Intertidal

MARINE
- Low Salinity to
- Ocean Water

FLOWERING
- Pollination, Fruits
- and Seeds

DISTRIBUTION
- Temperate to
- Arctic

NUTRIENT CYCLING
- In Sediment and
- In Water Column

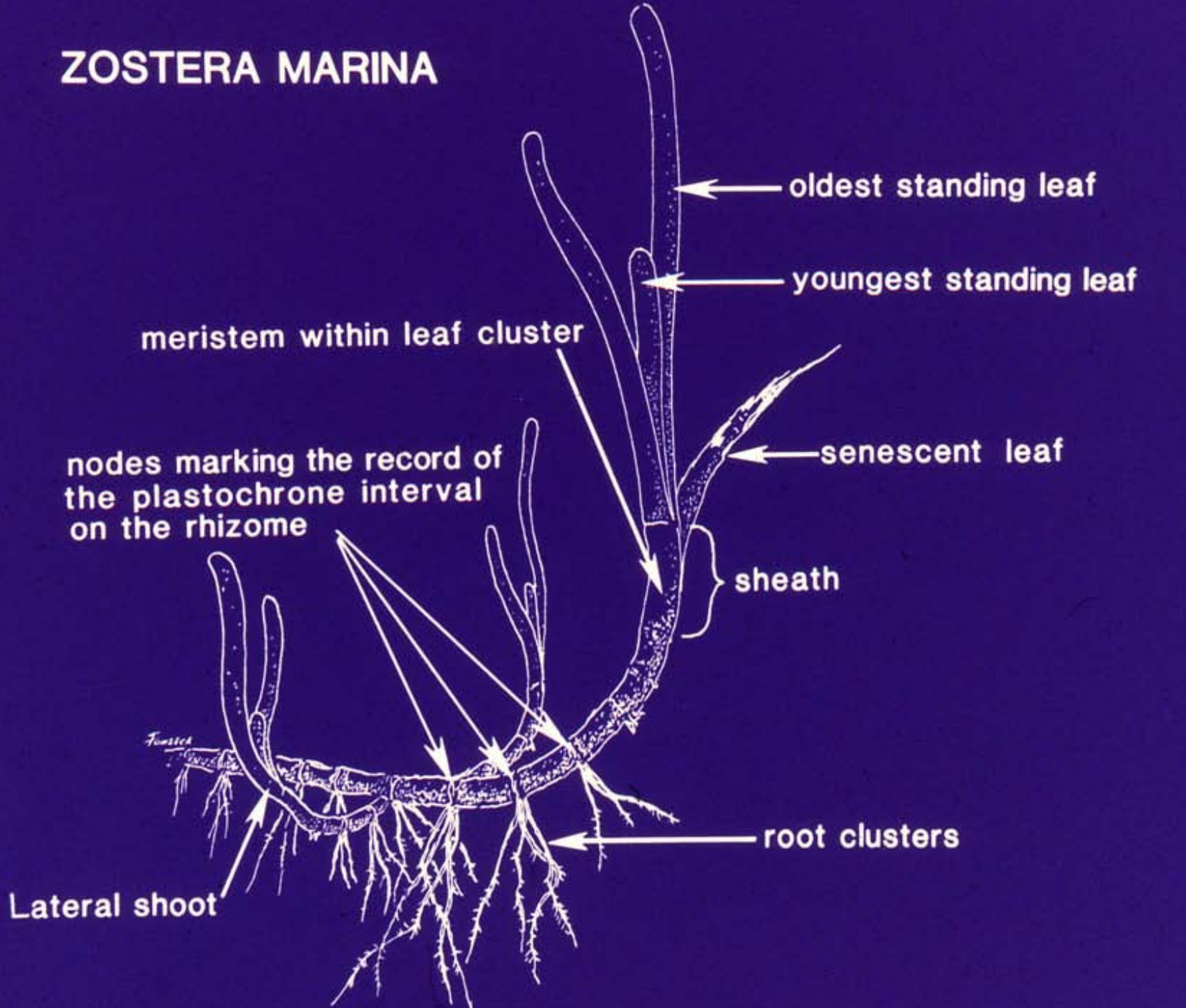
ESTUARINE FILTRATION
- Nutrients and
- Sediments

FOOD RESOURCE
- Waterfowl
- Invertebrates

HABITAT
- Breeding
- Nursery
- Feeding
- Protection

INDICATOR
- Ecosystem Stress
- Pollution
- Environmental Health

ZOSTERA MARINA




New Bedford Harbor, MA

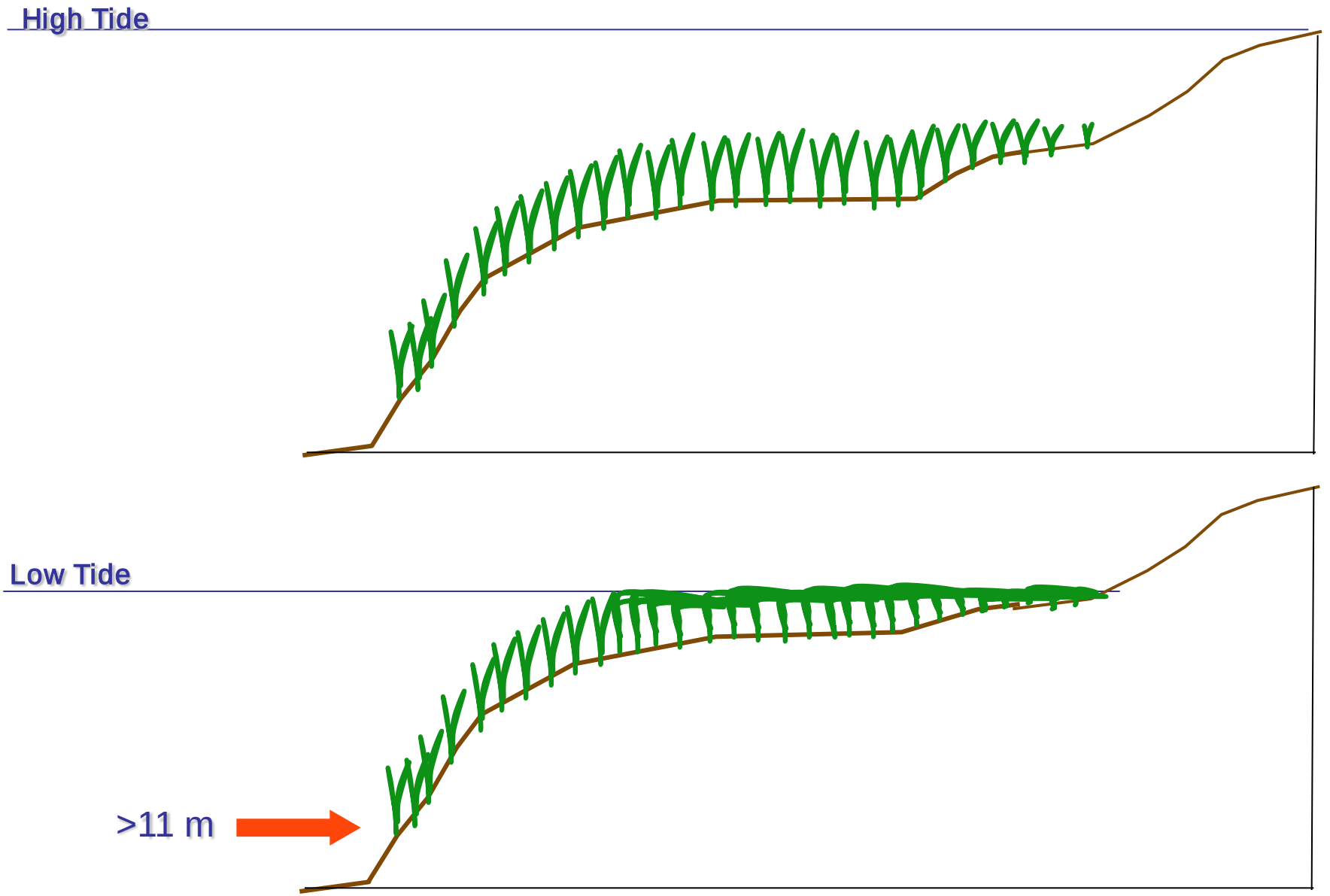

Piscataqua River. NH 2004

Eelgrass

Reproduction from Seeds


7 months of growth

Tidal Range of Eelgrass Meadows

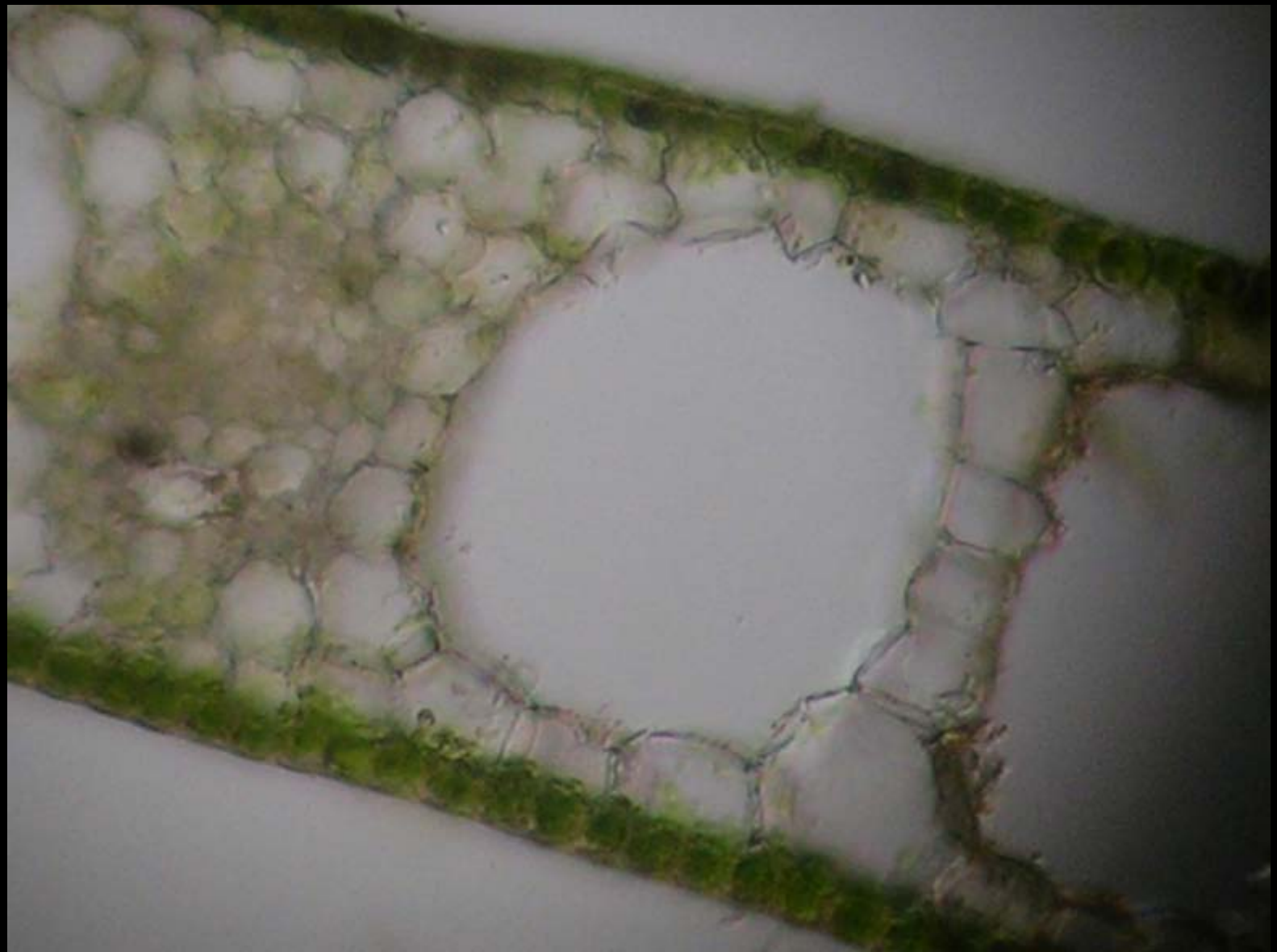



Cape Cod, MA

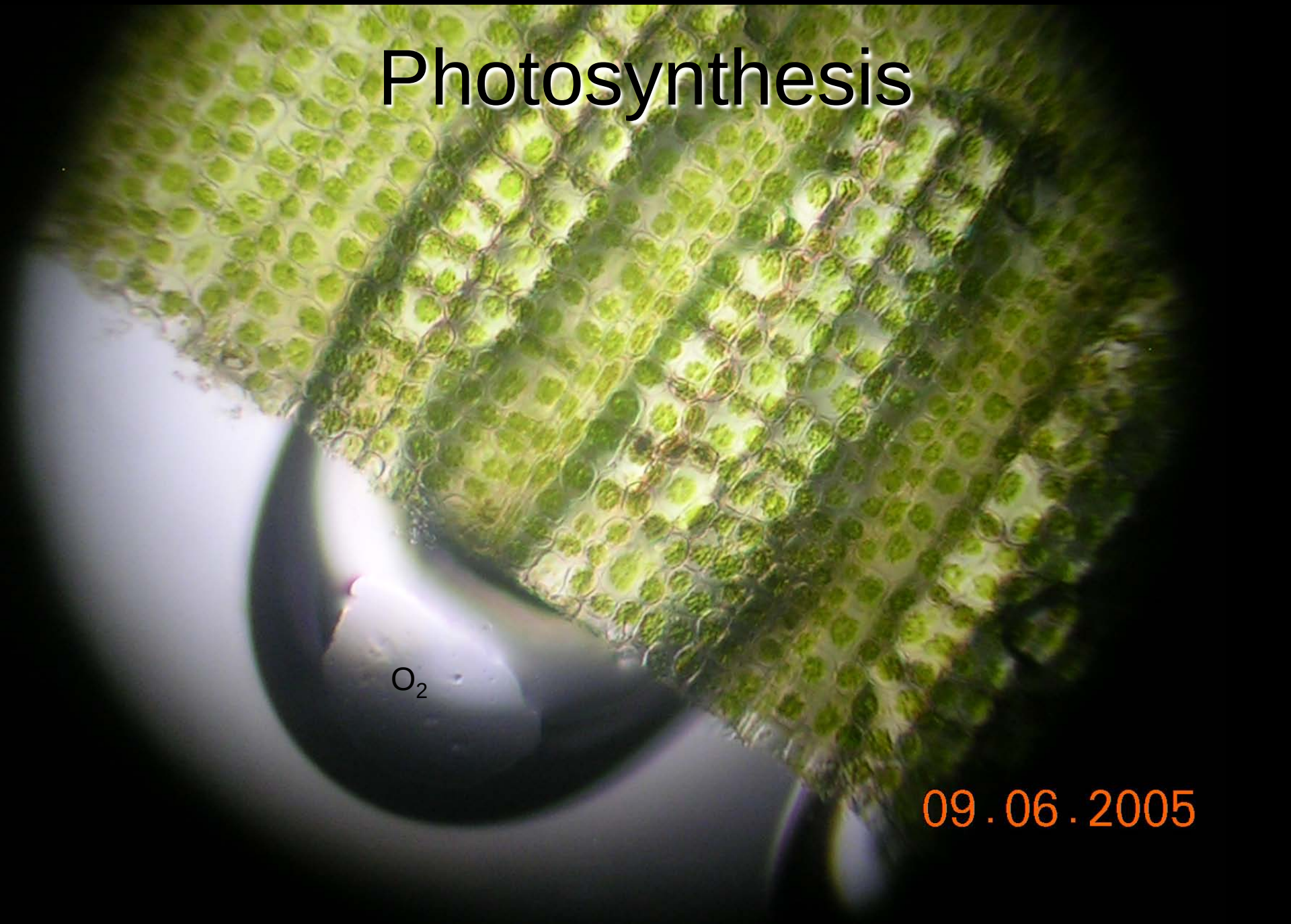

Maquoit Bay, ME

World Atlas of Seagrasses 2003

Cell Structure



Photosynthesis

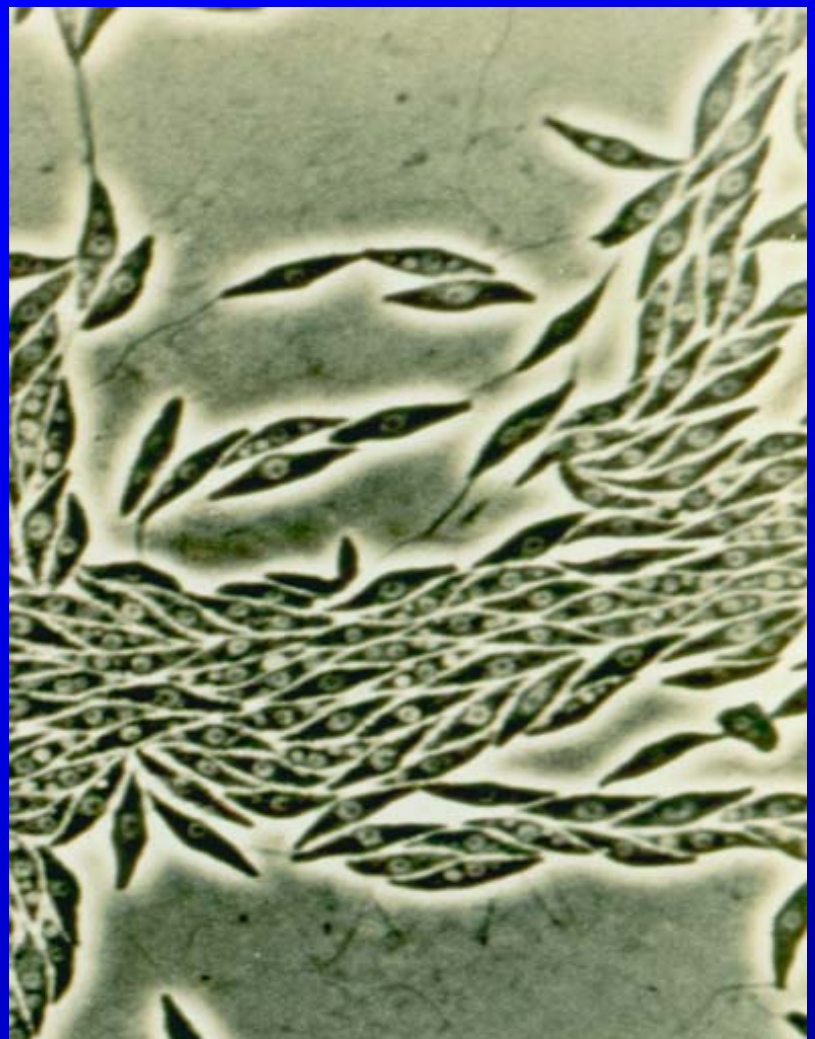



Penobscot Bay, ME

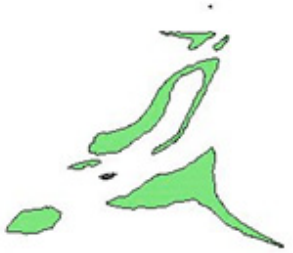
THREATS to Eelgrass	IMPACTS to Eelgrass	Result of Impact to Eelgrass
Water clarity	poor light	REDUCED PRODUCTIVITY / DEATH
Turbidity -- TSS	poor light	REDUCED PRODUCTIVITY / DEATH
Nutrient overenrichment	poor light	REDUCED PRODUCTIVITY / DEATH
Siltation	poor light /smothering	REDUCED PRODUCTIVITY / DEATH
Contaminant exposure	metabolic stress	REDUCED PRODUCTIVITY / DEATH
Climate change	metabolic stress	REDUCED PRODUCTIVITY / DEATH
Disease	metabolic stress	REDUCED PRODUCTIVITY / DEATH
Bioturbation	uprooting/burial	REDUCED DENSITY / DEATH
Increased wave exposure	uprooting/burial	REDUCED DENSITY / DEATH
Dredge/ fill	uprooting/burial/shading	REDUCED DENSITY/ AREA/ DEATH
Fishing Activity	uprooting/burial/shading	REDUCED AREA / DEATH
Boating Activity & Docks	uprooting/shading	REDUCED AREA / DEATH

WASTING DISEASE LOSS

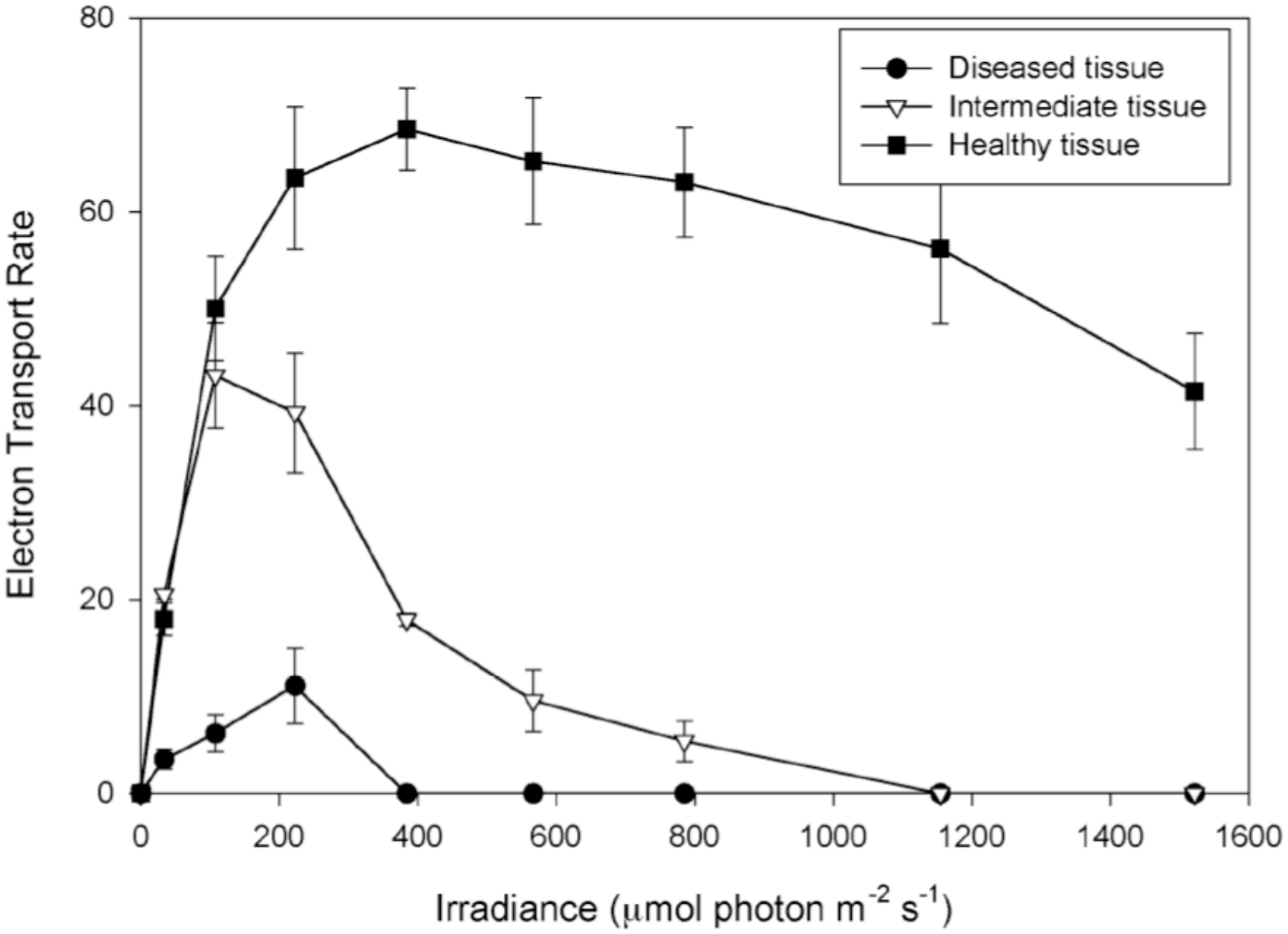
Labyrinthula zosterae



Great Bay Eelgrass Distribution
1986 to 1998



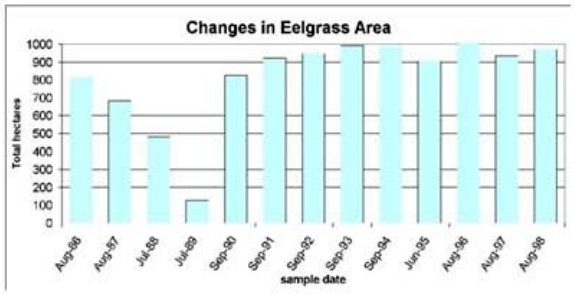
Wasting Disease Effect on Photosynthesis



Ralph and Short 2002, MEPS

Great Bay Eelgrass Distribution
1986 to 1998

August 86



August 87

July 88

July 89

September 90

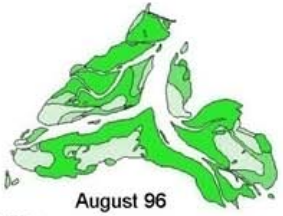
September 91

September 92

September 93

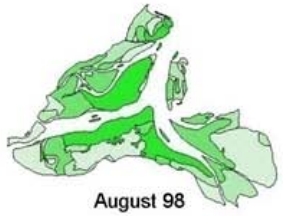
September 94

June 95



August 96

August 97



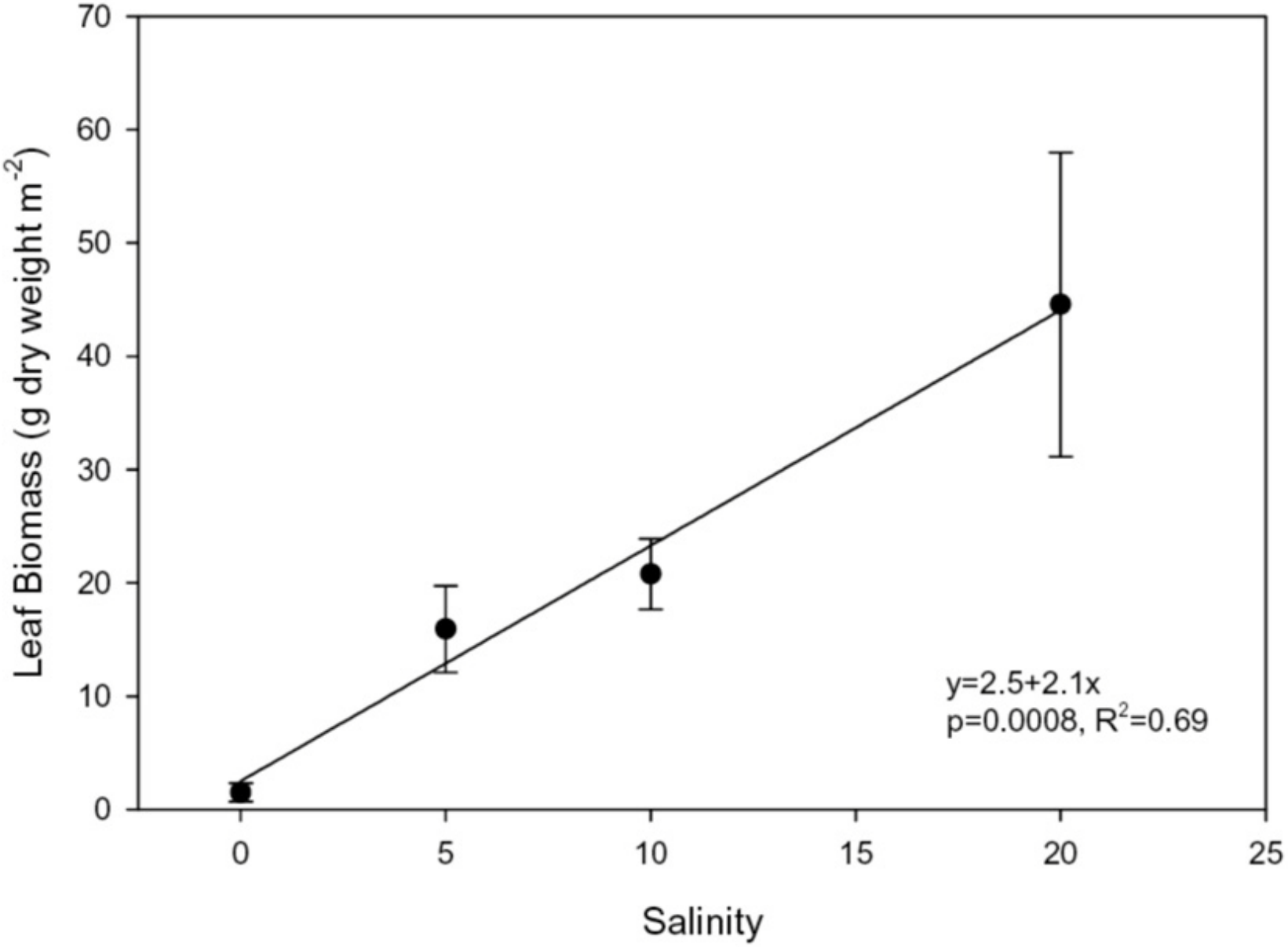
August 98

1:125000

Low salinity impact on leaves

Low Salinity Impact

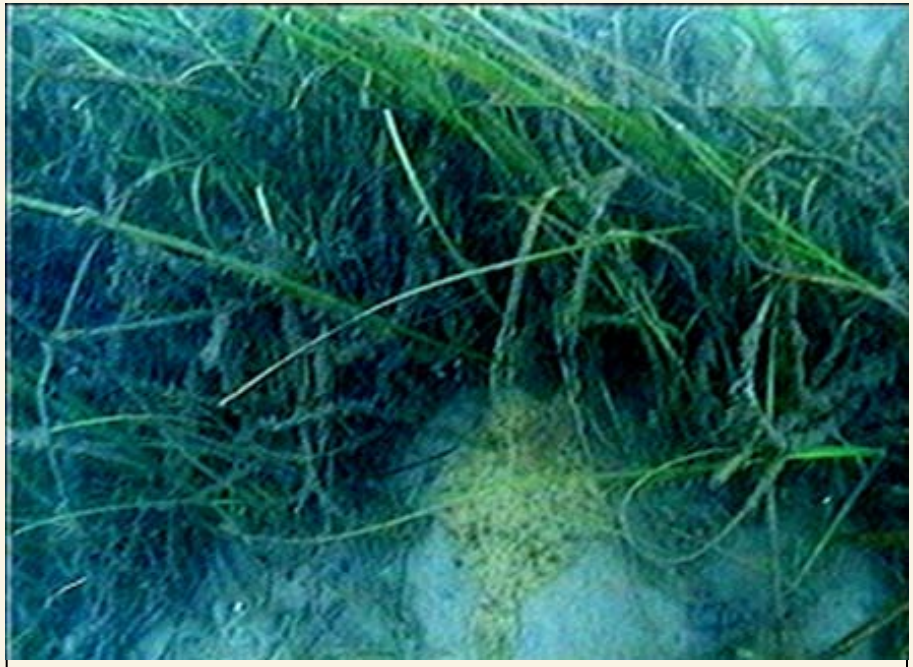
Impact of Salinity on Eelgrass Biomass



Moore, et al. in review

FUNCTIONS & VALUES

1) primary production
2) nutrient uptake & storage
3) oxygen production
4) habitat structure
5) benthic production
6) filtration

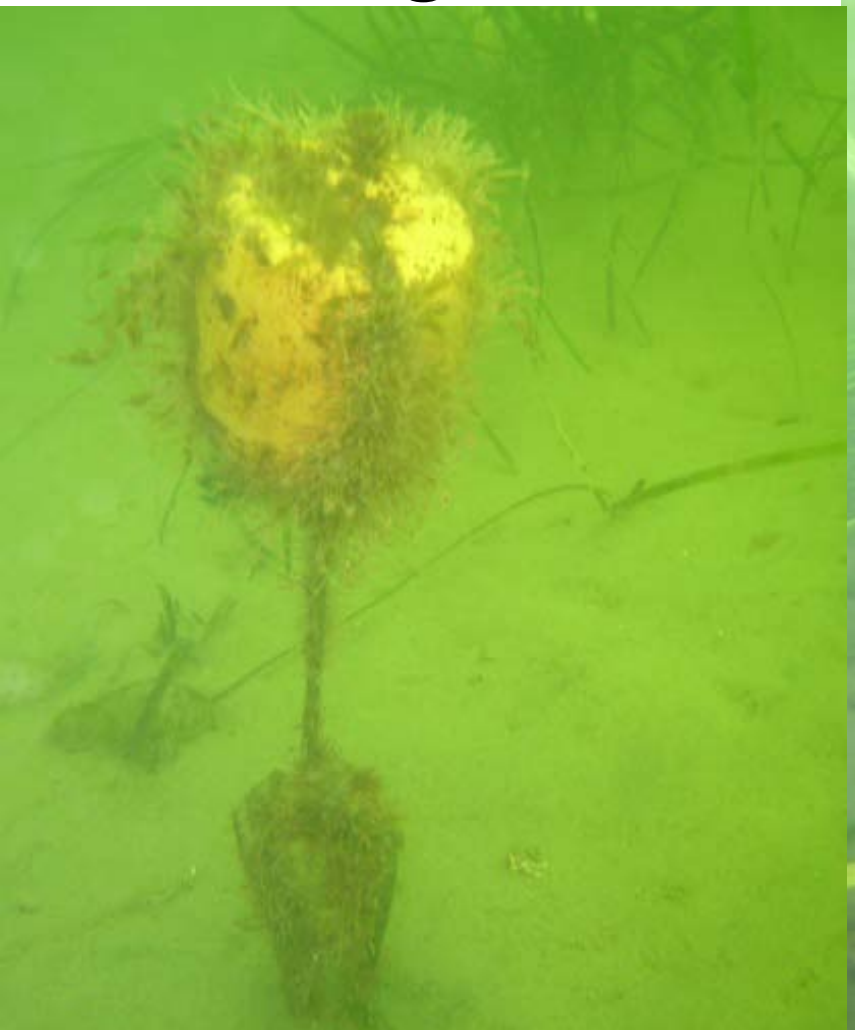


1) improves water quality
2) provides nursery habitat
3) shelter from predation
4) supports food web
5) supports fisheries

Lasell Island, Maine


Fishing Island, Maine

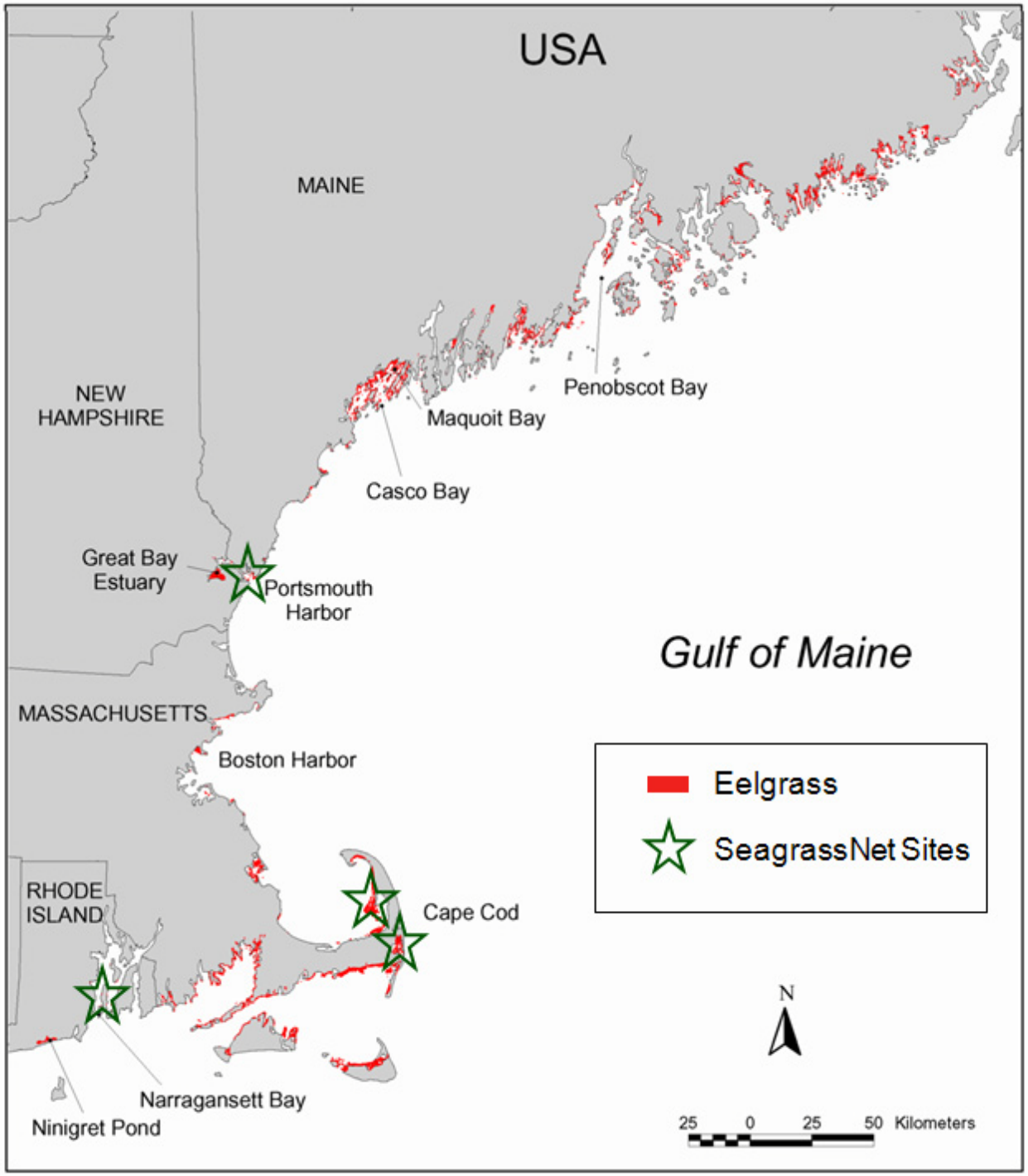
Eelgrass at deep edge



SET

(sediment elevation table)

Measurements



World Atlas of Seagrasses

Year 1: Typical Year

20 August 2002

Fishing Island Eelgrass Meadow, Portsmouth Harbor

Year 2: Habitat Loss

8 September 2003

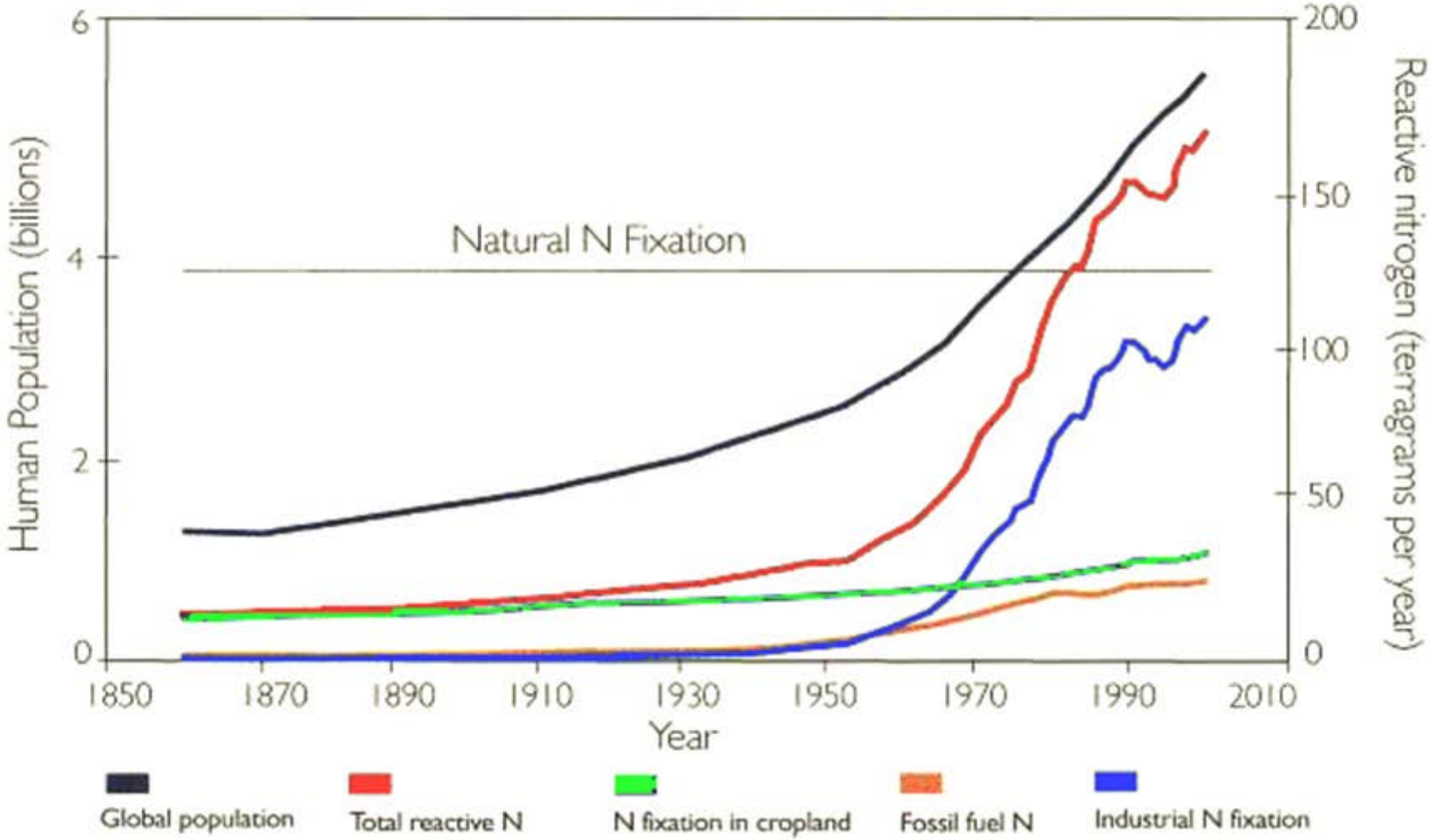
Fishing Island Eelgrass Meadow one year later

Geese eating eelgrass

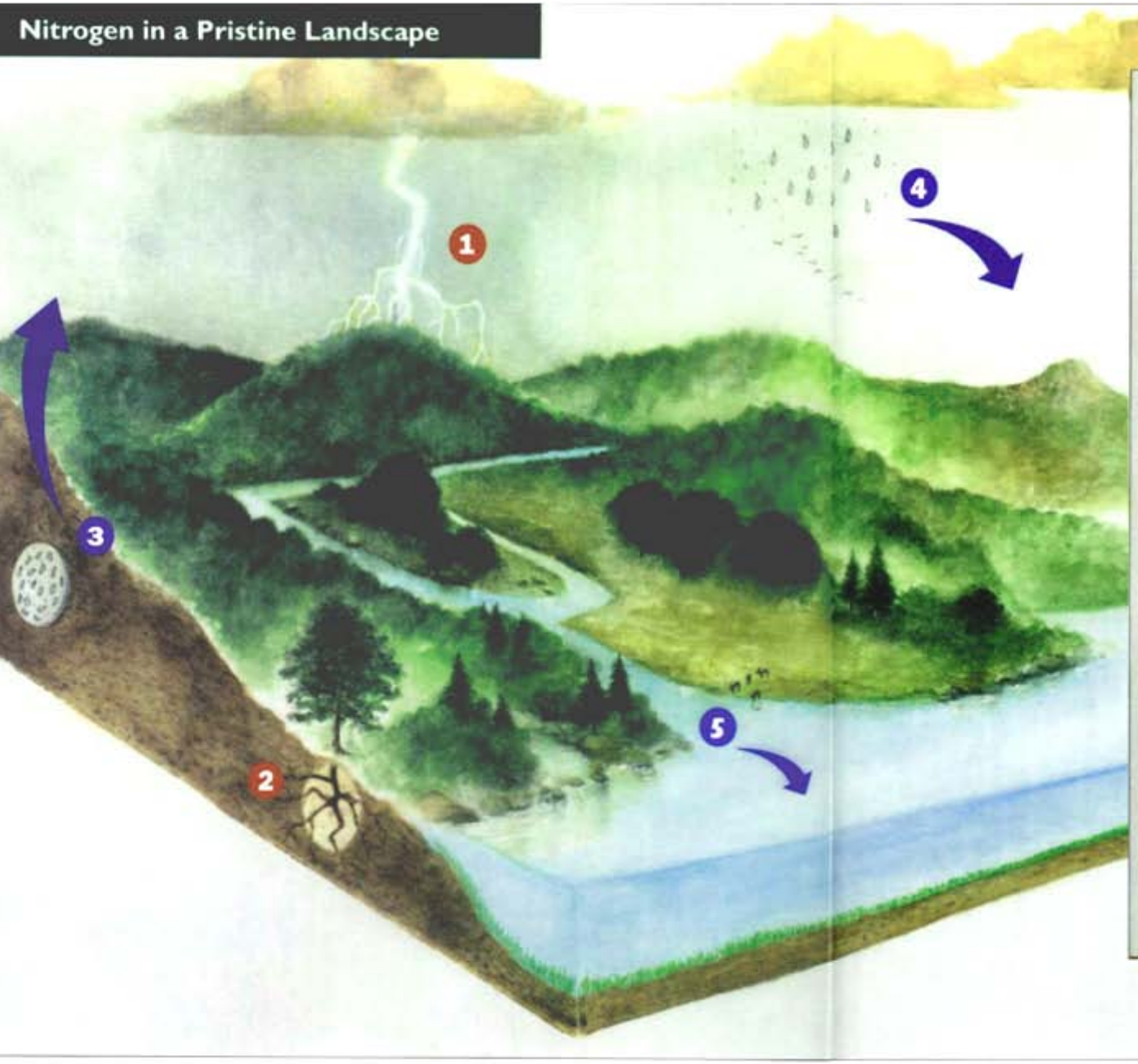
Causes of Current Eelgrass Decline

- **Reduced water clarity**
  - **Nutrient loading**
  - **Sediment loading**
  - **Siltation from dredging**
  - **Cumulative impacts**
- **Physical Damage**
  - **Fishing**
  - **Aquaculture**
  - **Dredge and Fill**

GLOBAL POPULATION & REACTIVE NITROGEN TRENDS



Nitrogen in a Pristine Landscape



Nitrogen Sources:

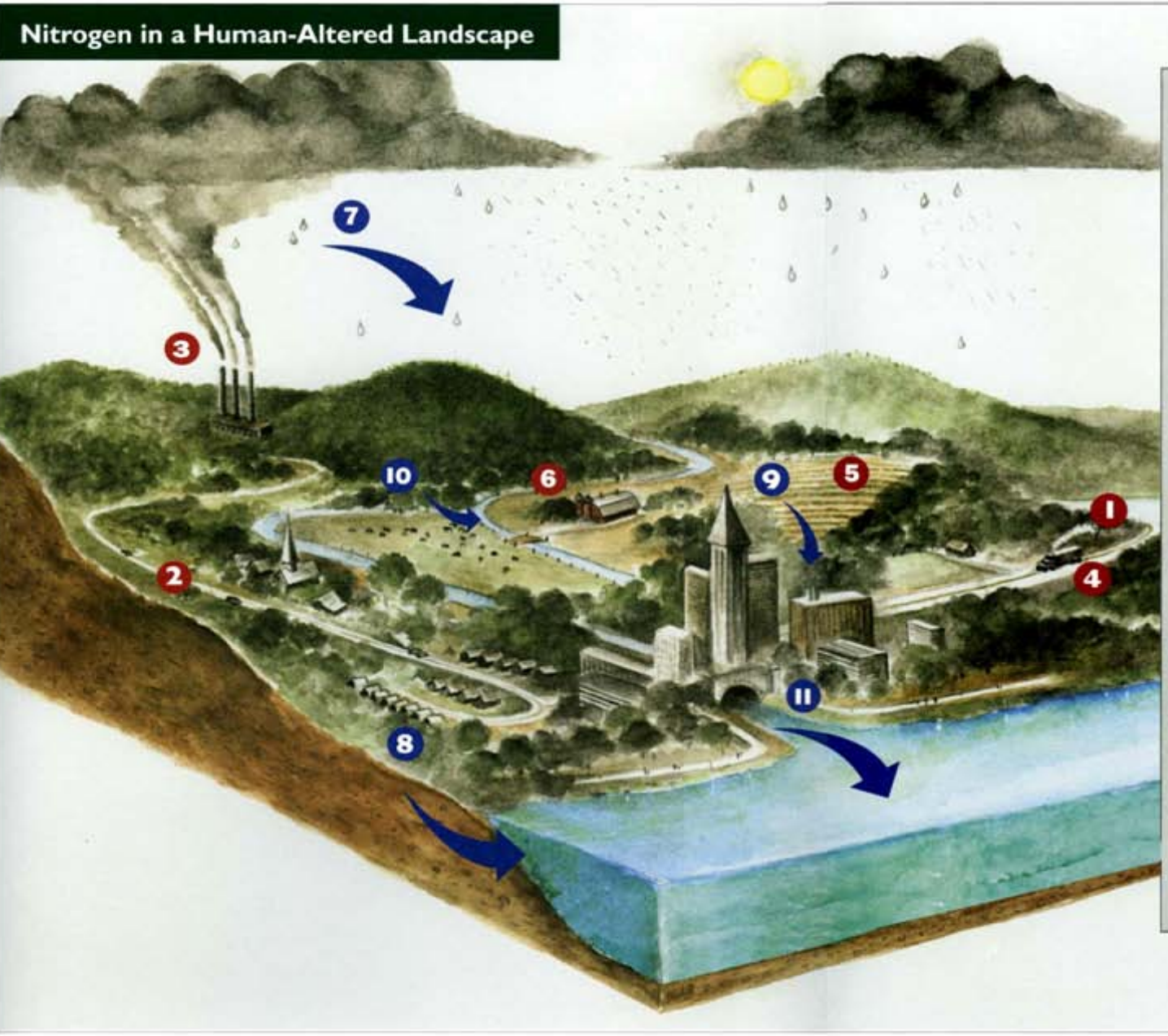
1. Lightening strikes
2. Fixation by plant-associated and soil bacteria

Nitrogen Fluxes:*

3. Denitrification by bacteria
4. Atmospheric deposition
5. Watershed runoff

*A flux is the movement of nitrogen from one component of the ecosystem to another.

Nitrogen in a Human-Altered Landscape



Nitrogen Sources:

1. Imported food and feed
2. Vehicle emissions
3. Powerplant emissions
4. Fertilizer imports
5. Fixation in croplands
6. Agricultural emissions

Nitrogen Fluxes:*

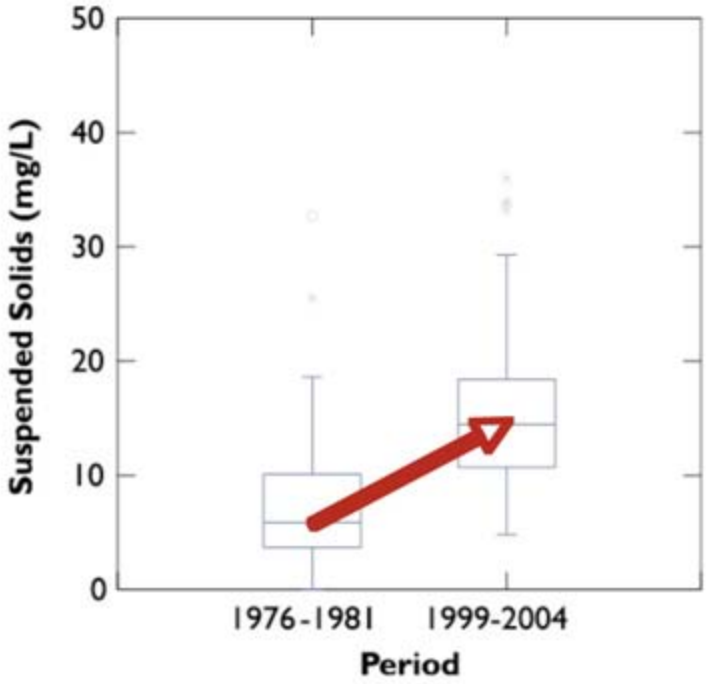
7. Atmospheric deposition
8. Wastewater from septic tanks and treatment plants
9. Agricultural runoff
10. Forest runoff
11. Urban runoff

* A flux is the movement of nitrogen from one component of the ecosystem to another.

NH State of the Estuary Report 2006

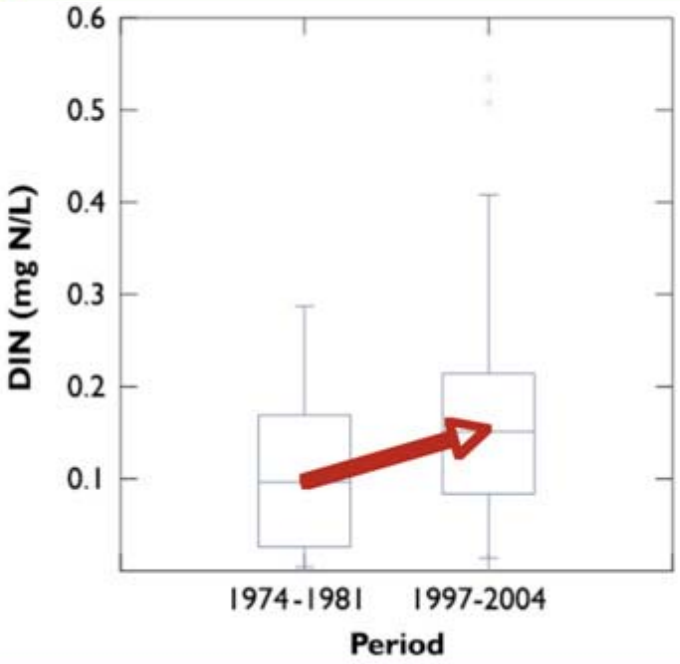
Suspended solids concentrations measured at Adams Point at low tide (Figure 7)

Data Source: UNH Jackson Estuarine Laboratory

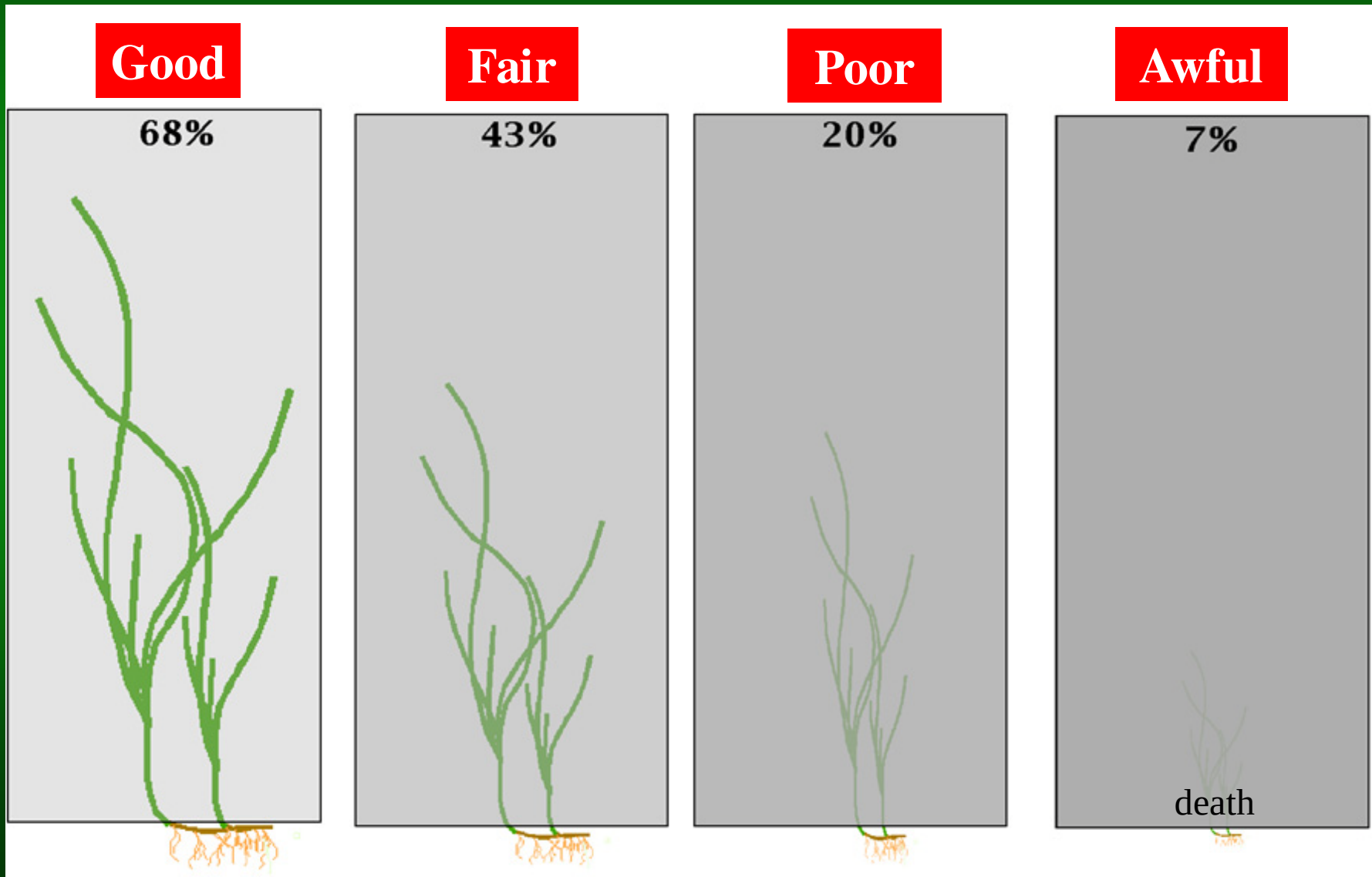


Dissolved inorganic nitrogen concentrations measured at Adams Point at low tide (Figure 6)

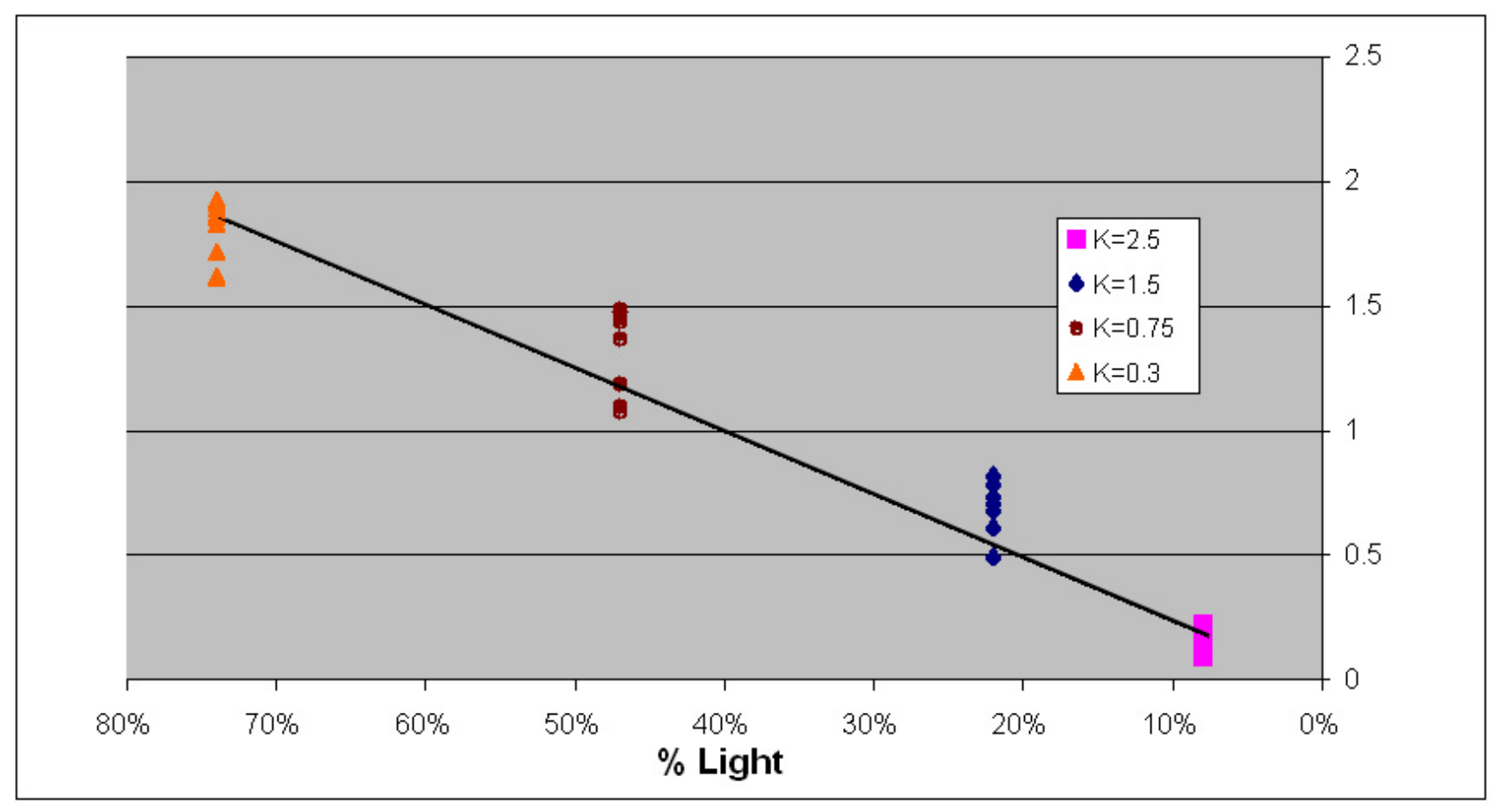
Data Source: UNH Jackson Estuarine Laboratory



Water quality and light



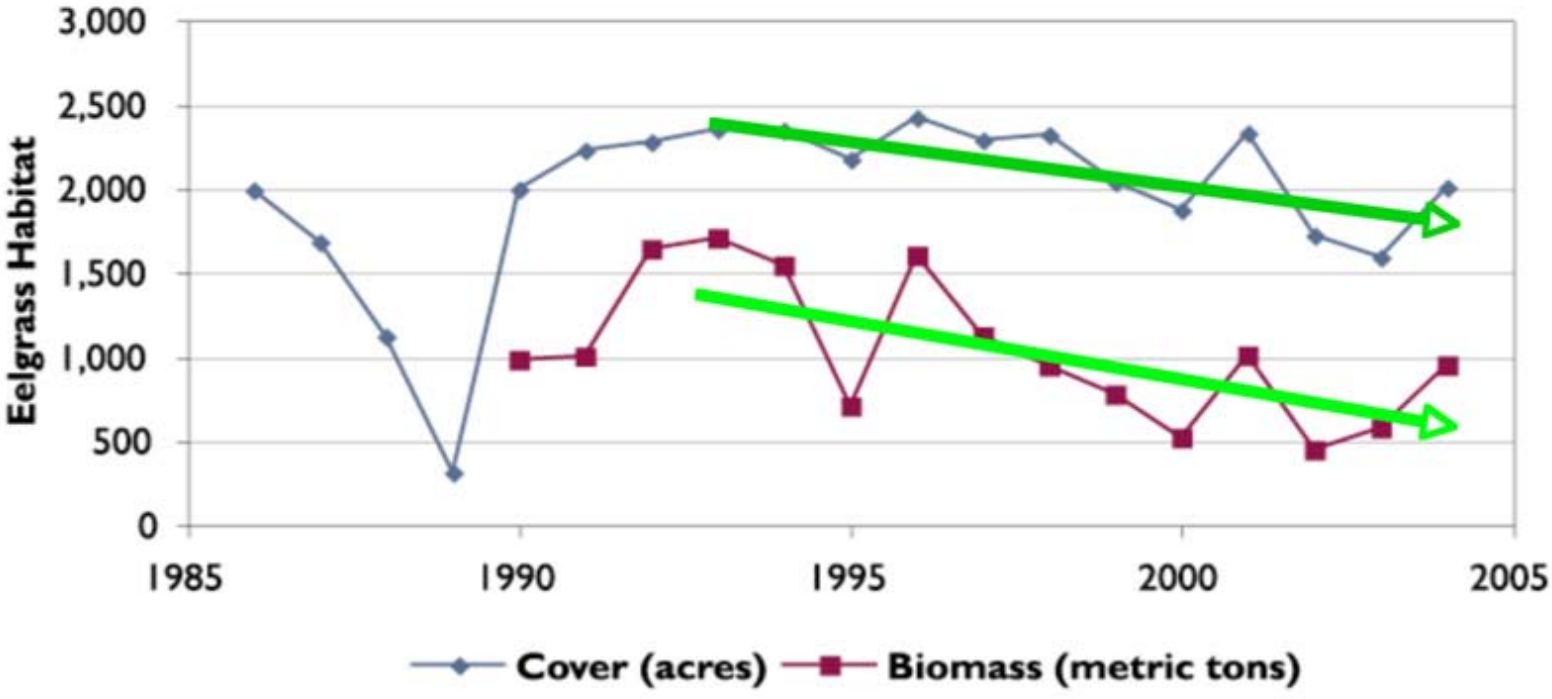
Eelgrass daily growth at 2 meters depth for 9 days in July with different light extinction values (K) replotted vs. % light.



Short, F.T., D.M. Burdick and J.E. Kaldy. 1995. Mesocosm experiments quantify the effects of eutrophication on eelgrass, *Zostera marina* L., Limnology and Oceanography 40:740-749

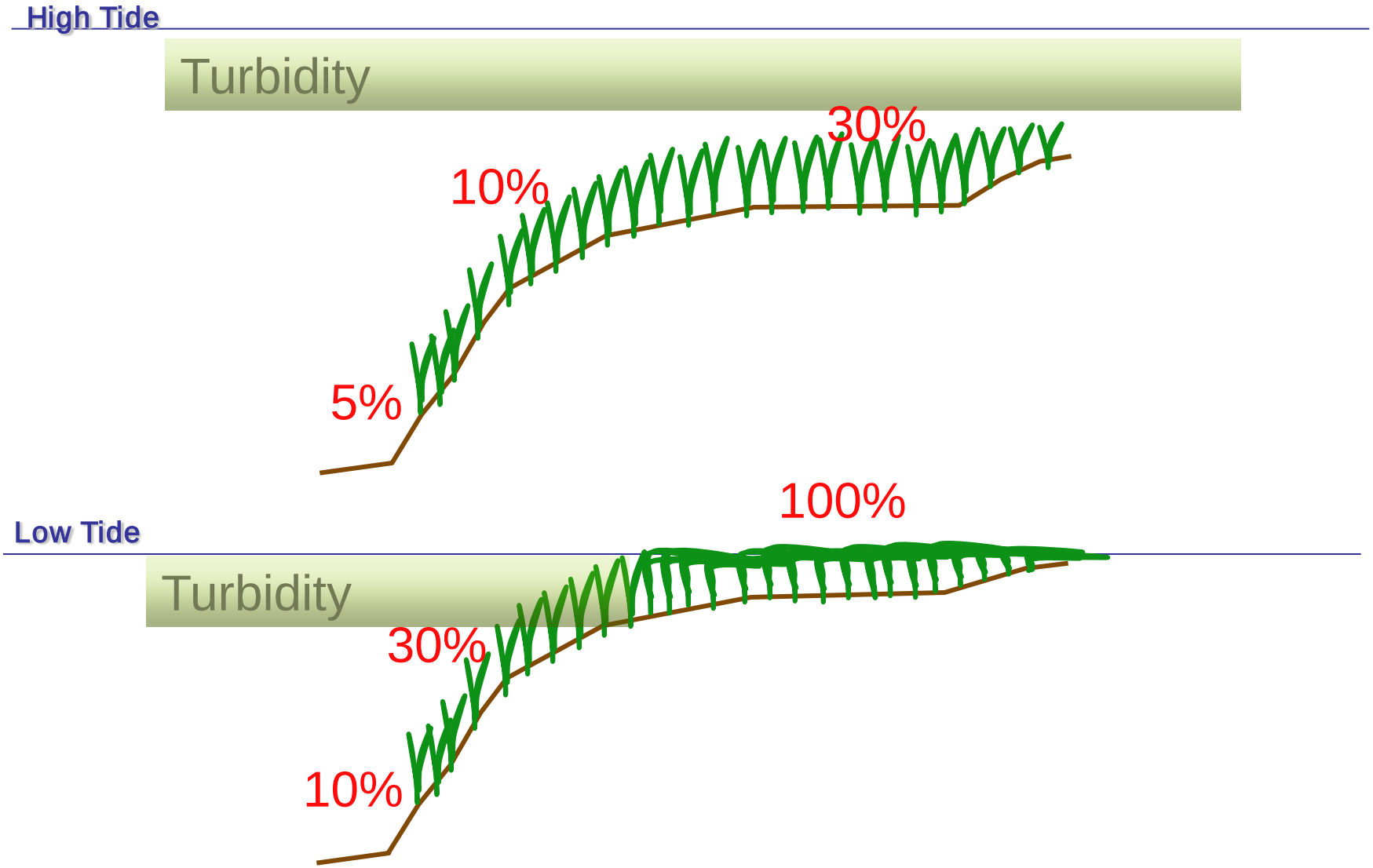

Poor Water Clarity

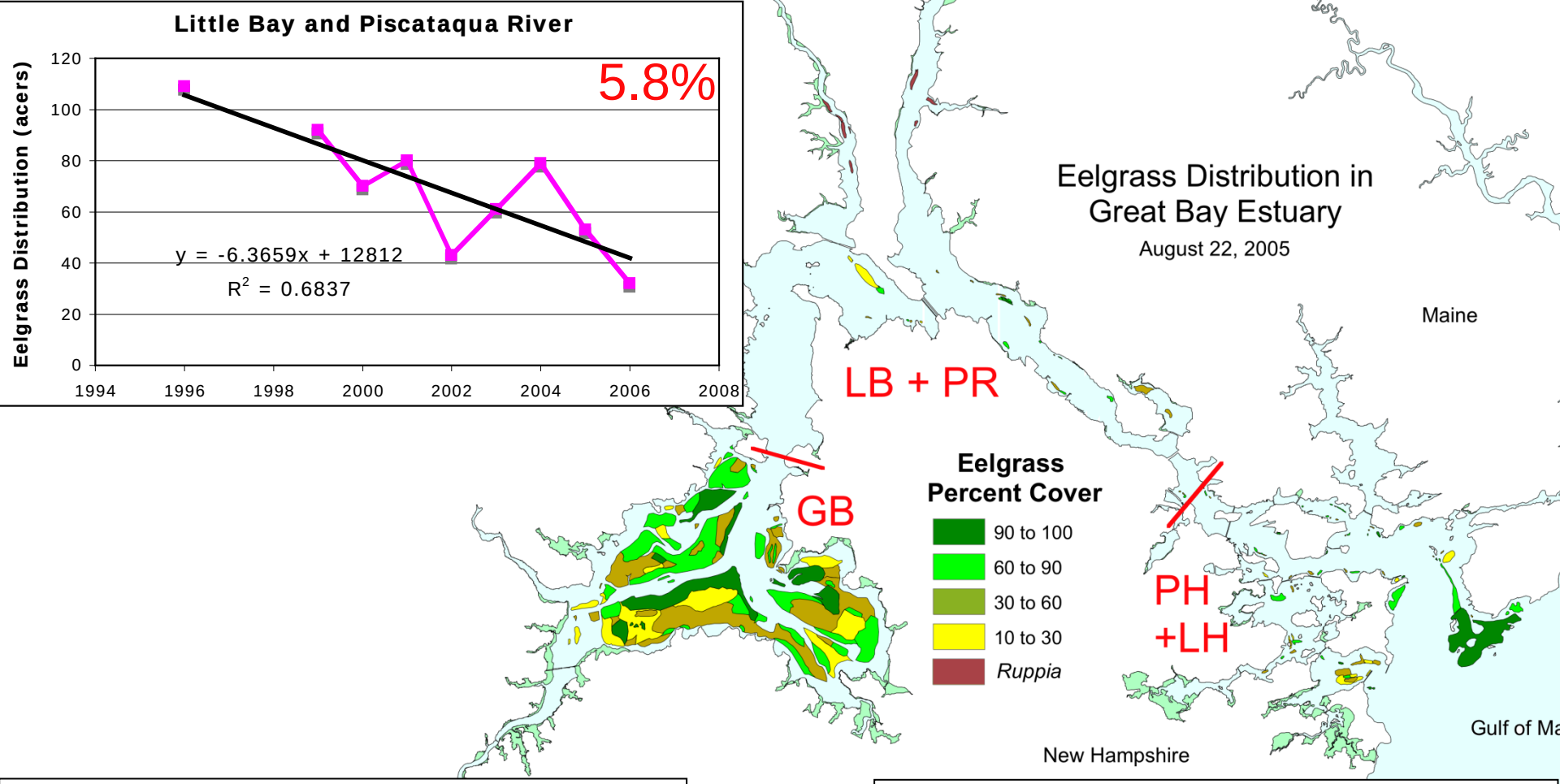
Eelgrass Monitoring Shows Decline in Spatial Coverage and Biomass

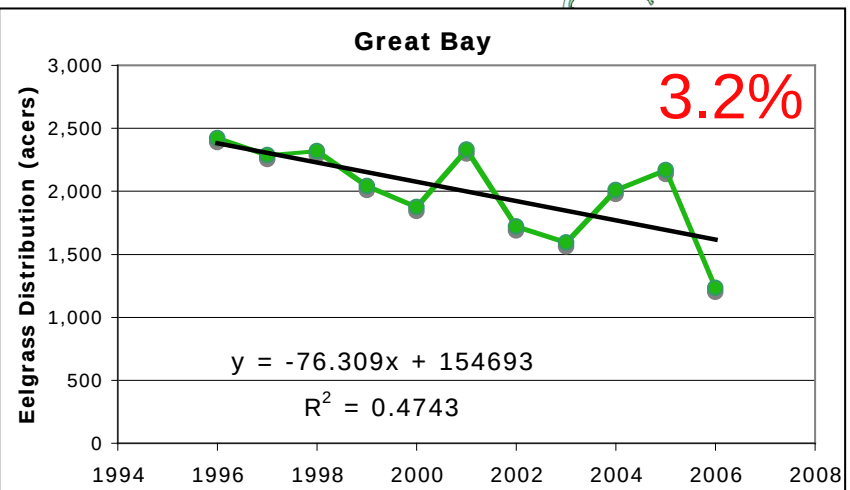


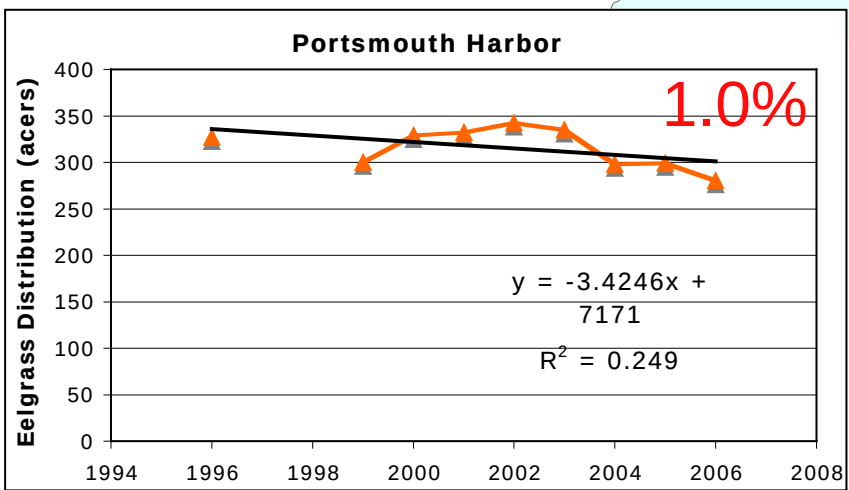
Data Source: UNH Seagrass Ecology Group

Tidal Effects on Light Reaching Eelgrass

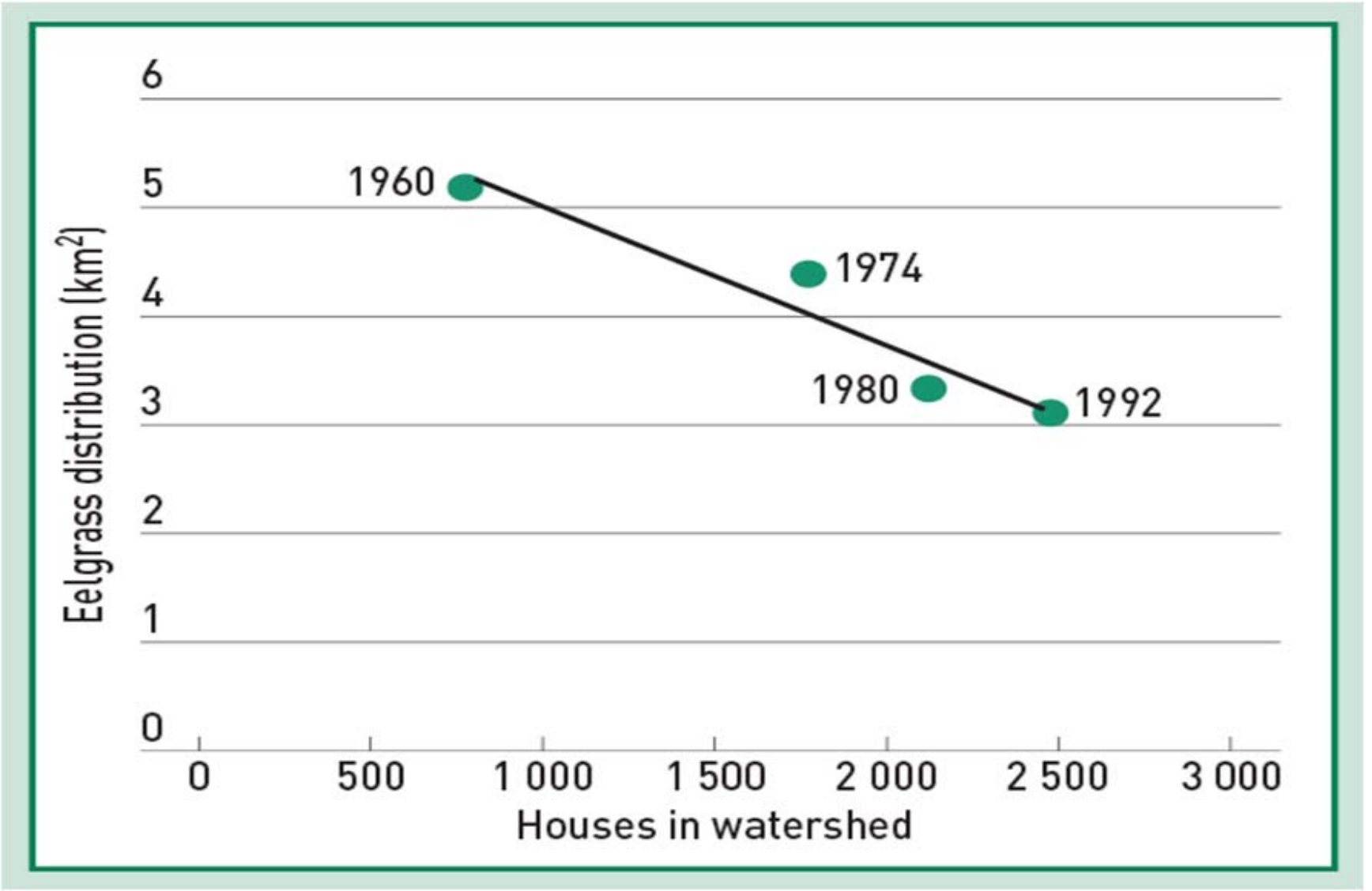



Little Bay and Piscataqua River
Eelgrass Distribution (acers)
120
100
80
60
40
20
0
1994
1996
1998
2000
2002
2004
2006
2008
5.8%
y = -6.3659x + 12812
R2 = 0.6837
Eelgrass Distribution in
Great Bay Estuary
August 22, 2005
Maine
LB + PR
GB
PH
+LH
Eelgrass
Percent Cover
90 to 100
60 to 90
30 to 60
10 to 30
Ruppia
New Hampshire
Gulf of Ma


Great Bay
Eelgrass Distribution (acers)
3,000
2,500
2,000
1,500
1,000
500
0
1994
1996
1998
2000
2002
2004
2006
2008
3.2%
y = -76.309x + 154693
R2 = 0.4743


Portsmouth Harbor
Eelgrass Distribution (acers)
400
350
300
250
200
150
100
50
0
1994
1996
1998
2000
2002
2004
2006
2008
1.0%
y = -3.4246x +
7171
R2 = 0.249

Eelgrass Decline in Ninigret Pond, RI vs. Number of Houses



World Atlas of seagrasses 2003

Nutrient Enrichment > Algae

Great Bay Estuary Restored Eelgrass

Causes of Current Eelgrass Decline

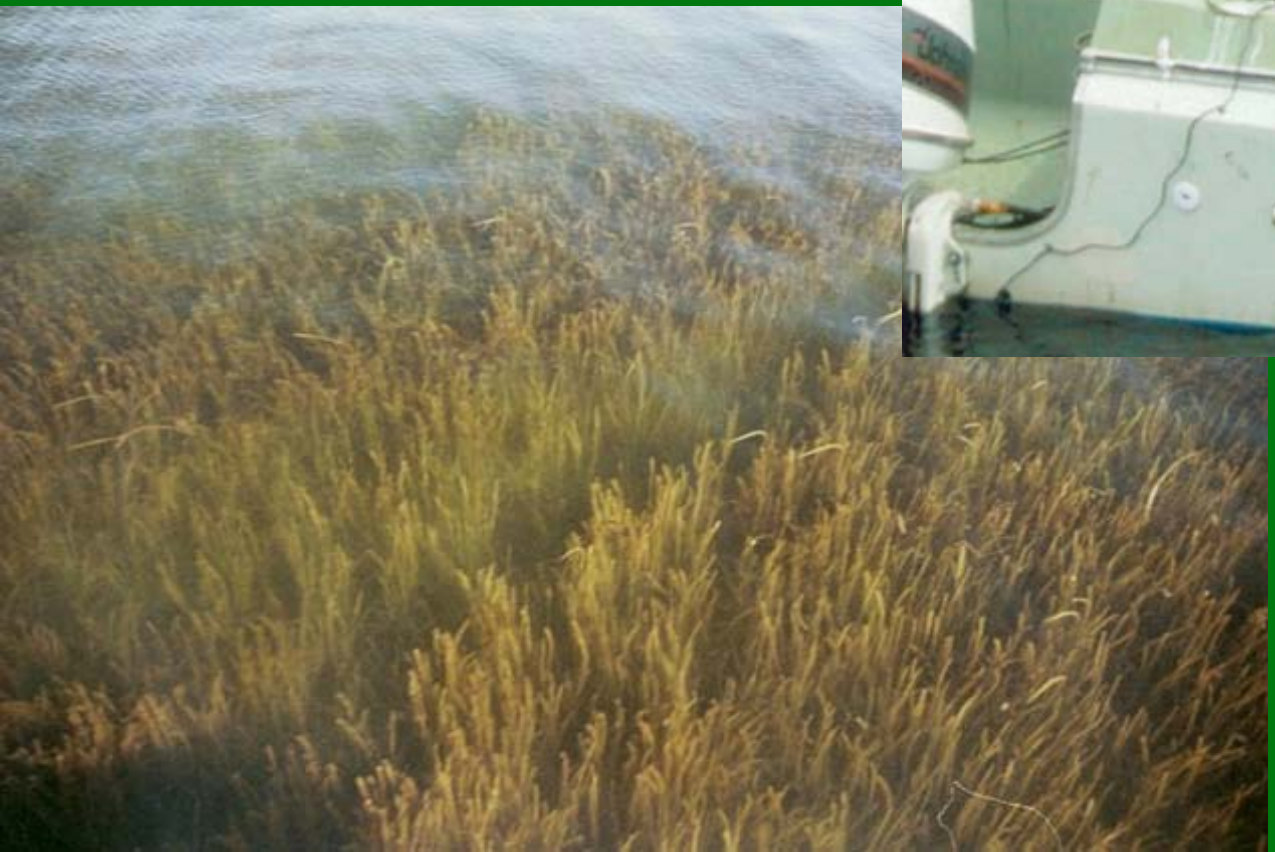
- **Reduced water clarity**
  - **Sediment loading**
  - **Nutrient loading**
  - **Siltation from dredging**
  - **Cumulative impacts**
- **Physical Damage**
  - **Fishing**
  - **Aquaculture**
  - **Dredge and Fill**

Moorings and dredging

Little Harbor, New Hampshire

Sept 2003

Fishing & boating activities



Narragansett Bay

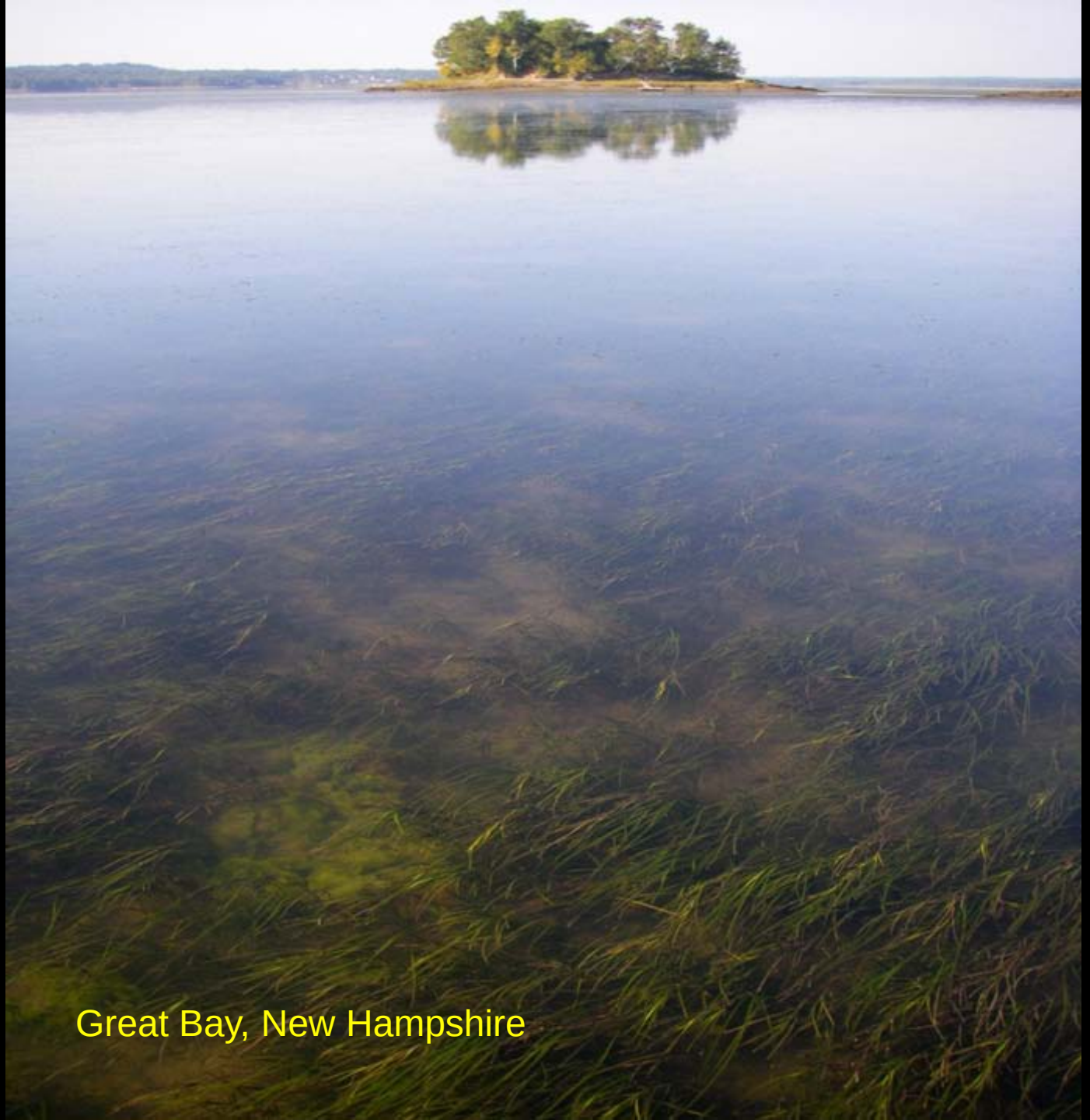

Great Bay, New Hampshire

Trawling

Maquoit Bay, Maine

PORT EXPANSION / DREDGING

New Hampshire



Great Bay, New Hampshire

Eelgrass and its role

- Eelgrass is a unique plants
- Functions and values make important habitat
- Indicates the health
- Critical maintenance of the coastal waters
- Many current threats
  - most of human origin
- Major stress factors
  - poor water clarity
  - overuse of coastal zone
- Conservation and protection needed
  - improve water clarity
  - reduce nitrogen inputs
  - reduce physical impacts

Now we must
move from
science
to
policy & politics
if
we want to save
the eelgrass
resource.