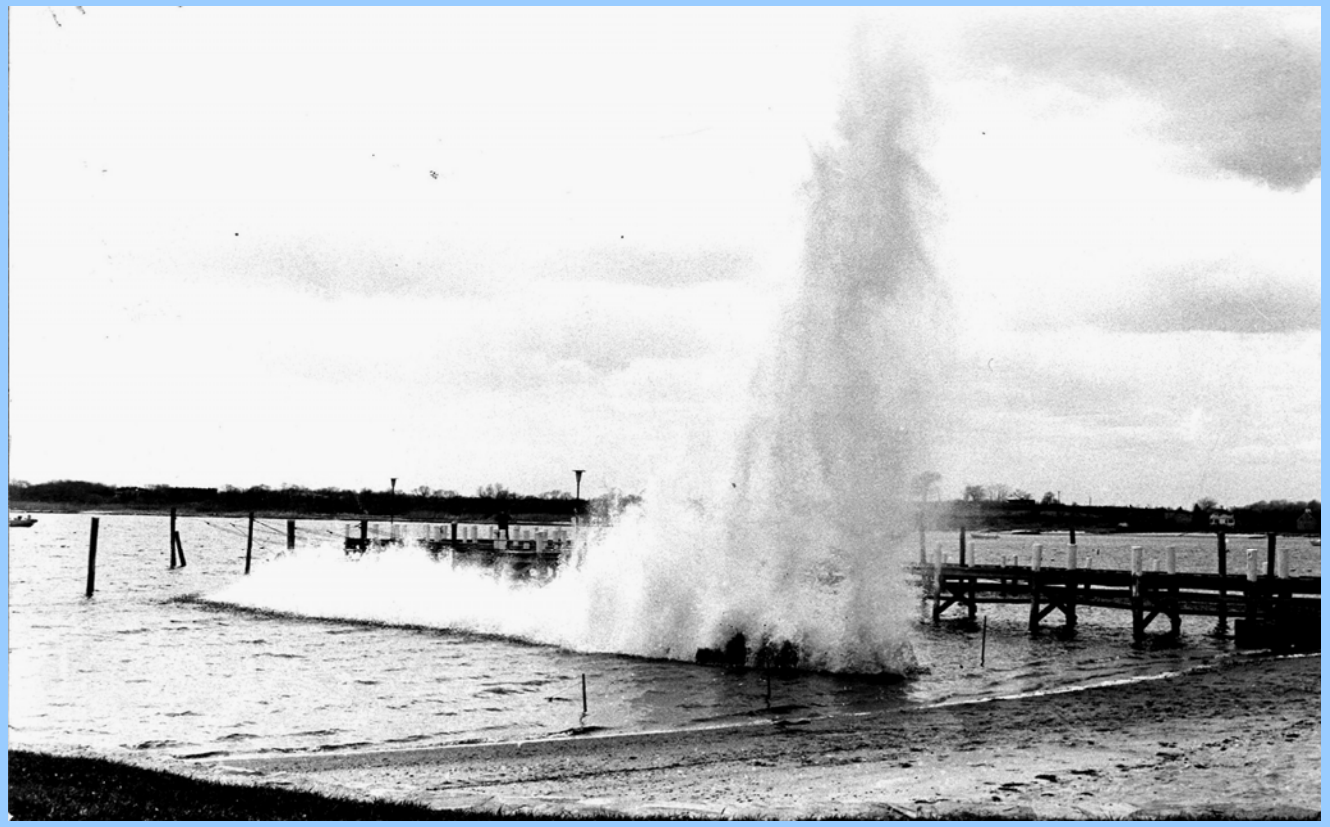
LONG-TERM (1985-2007) MONITORING STUDIES OF EELGRASS (*ZOSTERA MARINA* L.) POPULATION DYNAMICS IN EASTERN LONG ISLAND SOUND

John Swenarton and Milan Keser
Millstone Environmental Laboratory
Waterford, CT 06386
John.T.Swenarton@dom.com Milan.Keser@dom.com

Millstone Eelgrass Study

Historical Background

- **Widespread declines in 1930s slow were attributed to a ‘wasting disease’ now identified as *Labyrinthula***
- **Recovery was slow, but by the 1960s, beds in SE Connecticut were once again extensive, and considered by some a “nuisance”**

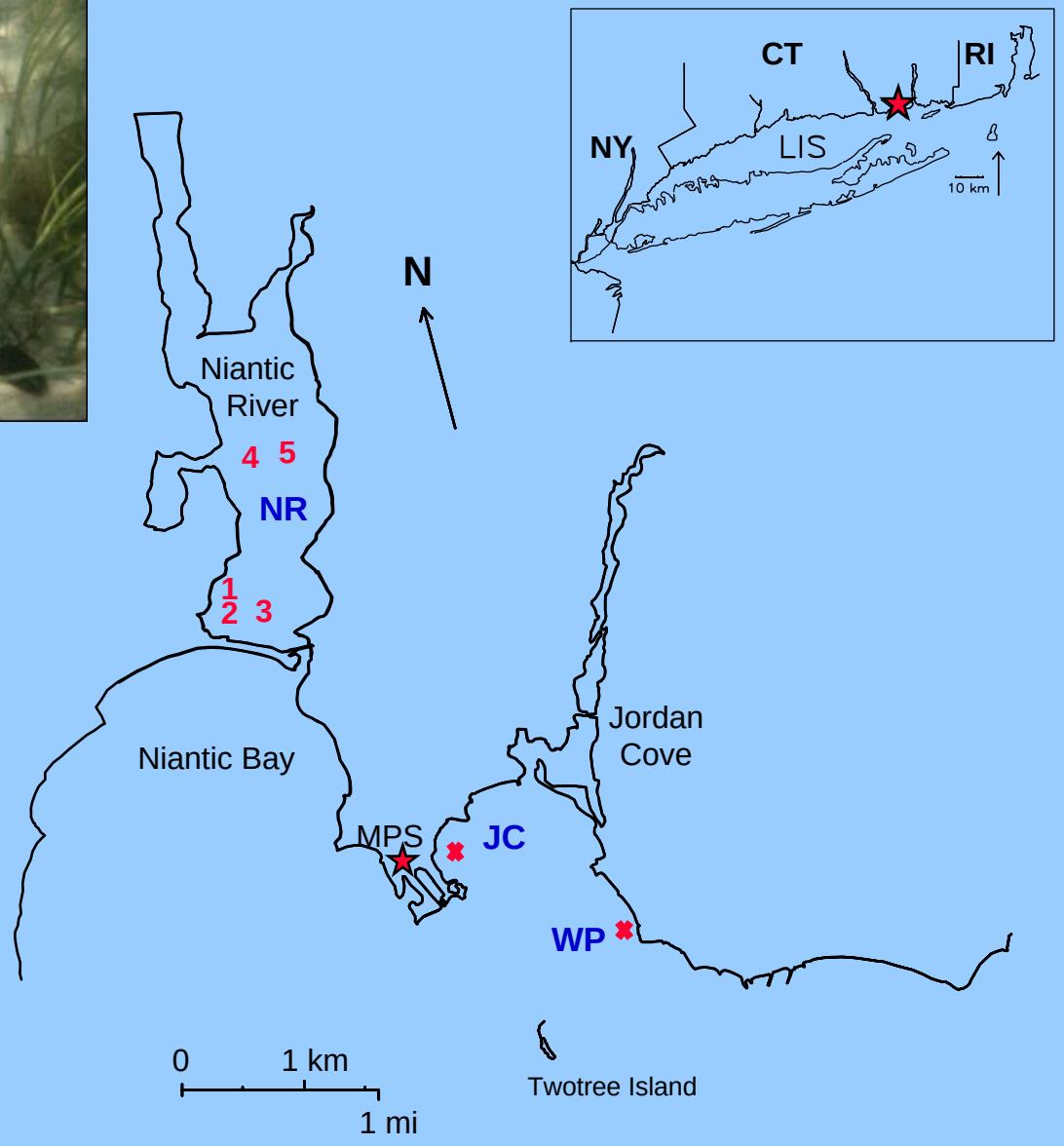


Eelgrass removal using explosives at a swimming beach in Stonington (CT) Harbor (ca. 1973)

Millstone Eelgrass Study

Historical Background

- **Large accumulations of eelgrass blades on local beaches in Jordan Cove in early 1970s raised concerns about possible MPS impacts**
- **Study sponsored by MPS showed no evidence of thermal plume effects under 2-unit operation, but suggested some could be observed in the future with 3 units operating**
- **Regional declines noted since the early 1980s have received much attention from researchers and environmental managers - degraded water quality suspected**
- **Present study initiated in 1985 prior to Unit 3 start-up**



Monitoring Stations

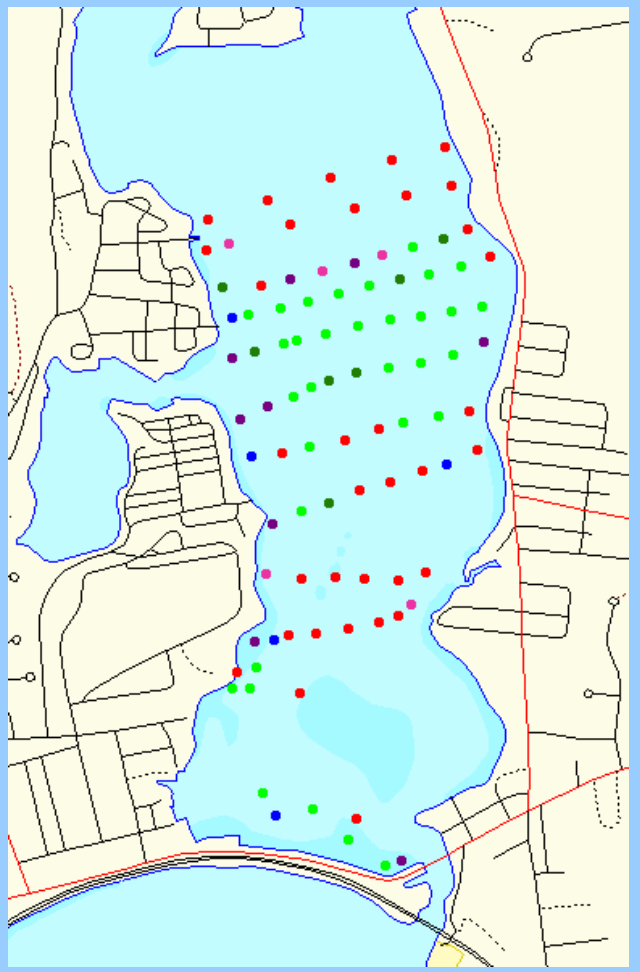
3 sites sampled monthly in summer (June – Sept.)

- **JC (1985-present)**
- **WP (1985-present)**
- **NR**
  - **1 (1985-86, 1993-94)**
  - **2 (1986)**
  - **3 (1987-92)**
  - **4 (1995-99)**
  - **5 (2000-present)**

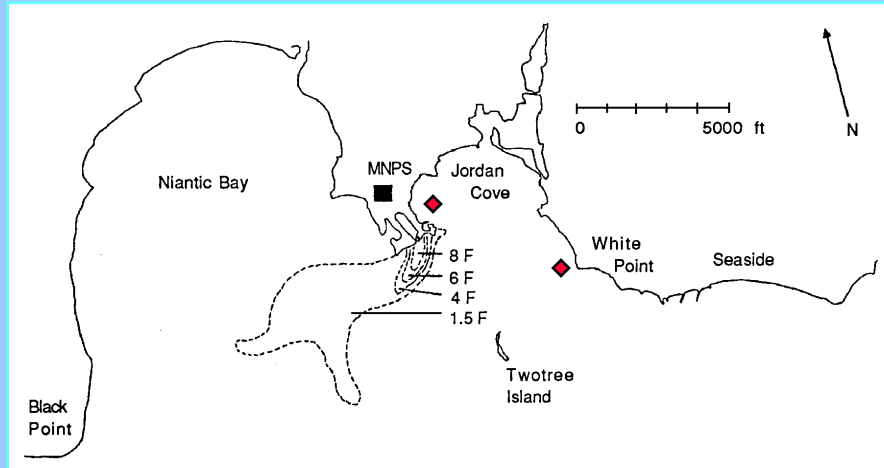
Niantic River site relocated 5x due to bed die-offs

Methodology

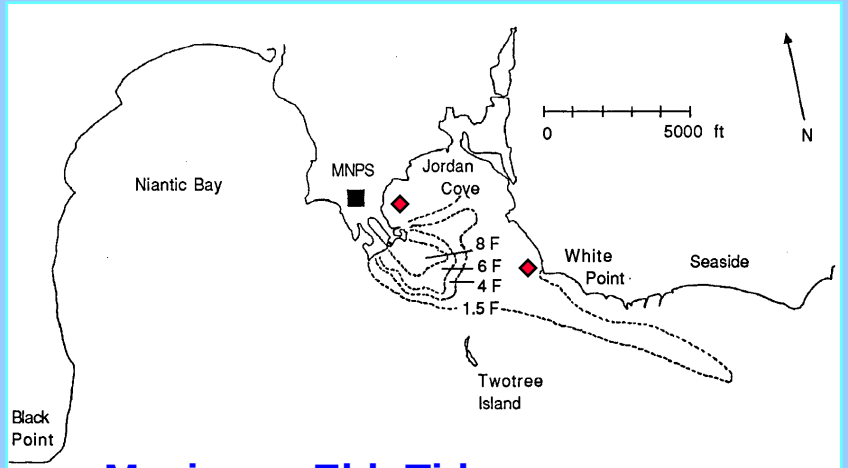
- 3 sites sampled monthly in summer (June – Sept.)
- Shoots harvested from 16 randomly placed quadrats (25x25 cm)
- Population parameter estimates include:
  - total shoot density
  - shoot length
  - standing stock biomass
  - seed-bearing shoot density
- Sediments characterized



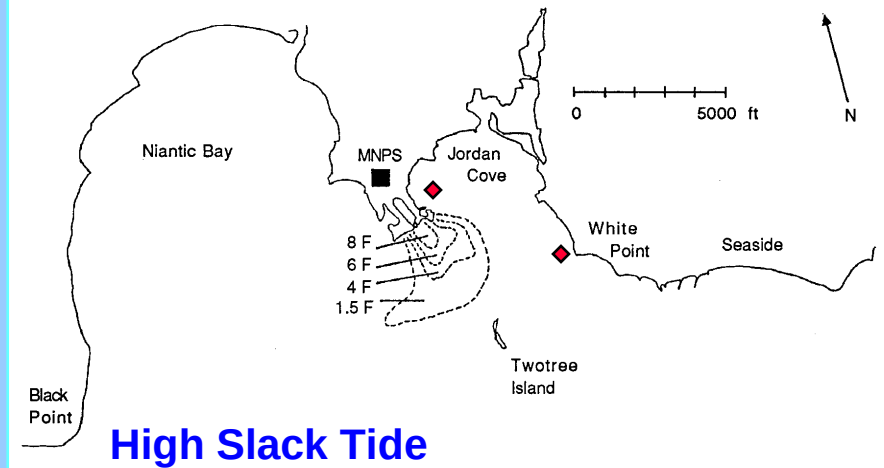
- Periodic distribution surveys
  - visual mapping (1985-2001)
  - GPS/GIS (2002-07)



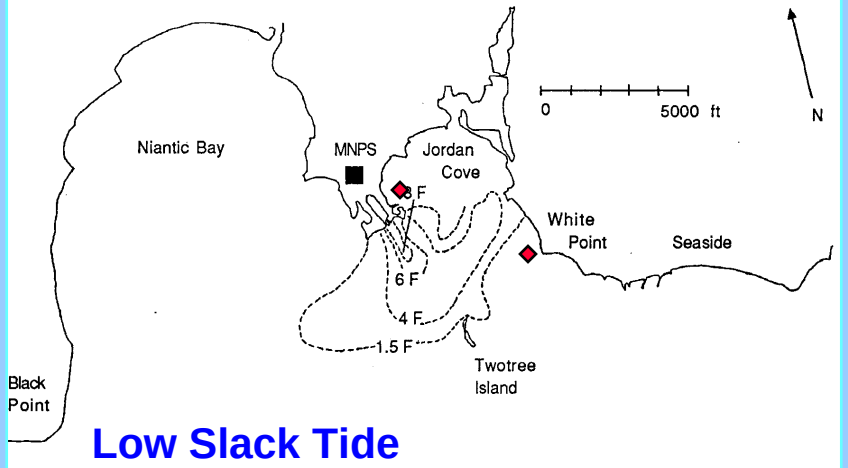
Maximum Flood Tide



Maximum Ebb Tide

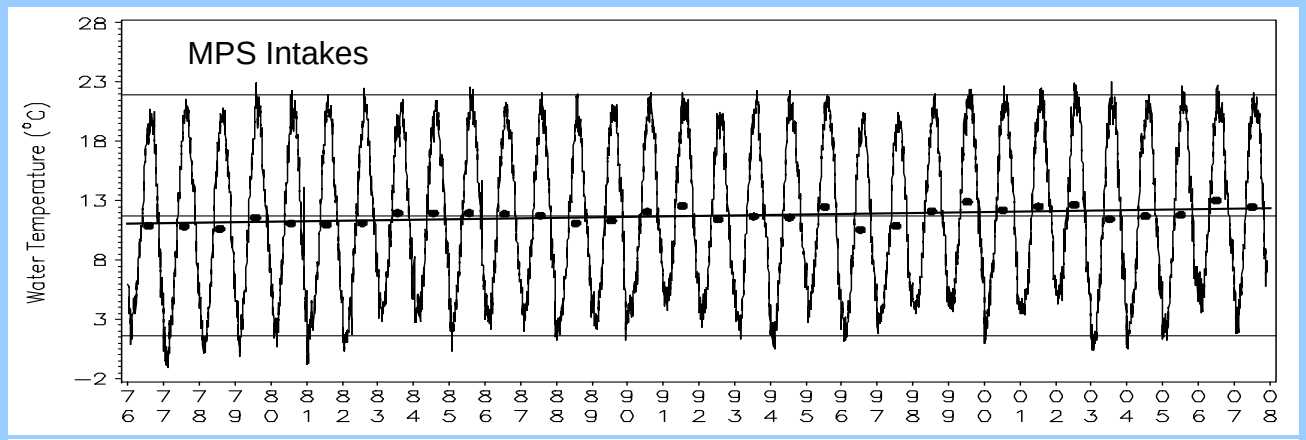


High Slack Tide

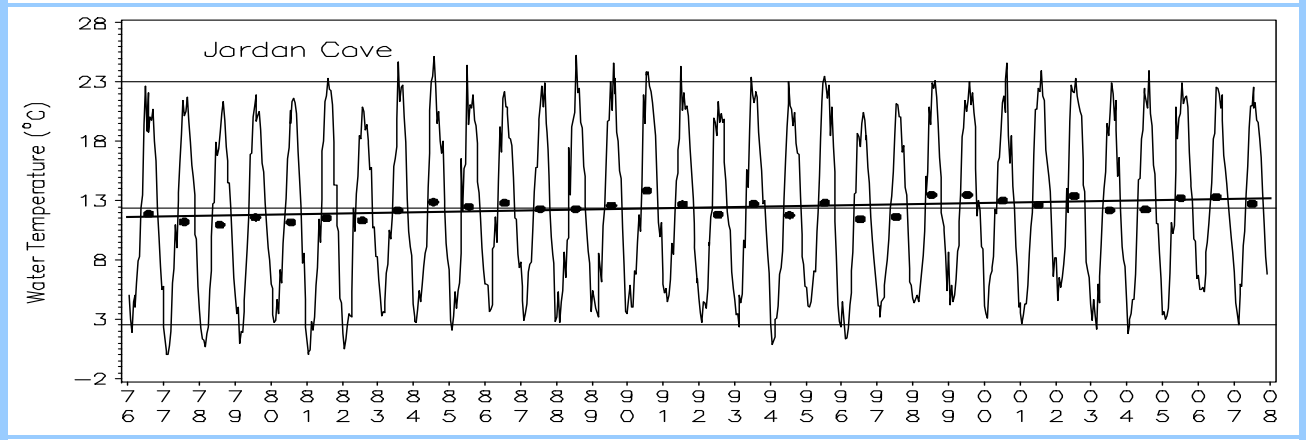


Low Slack Tide

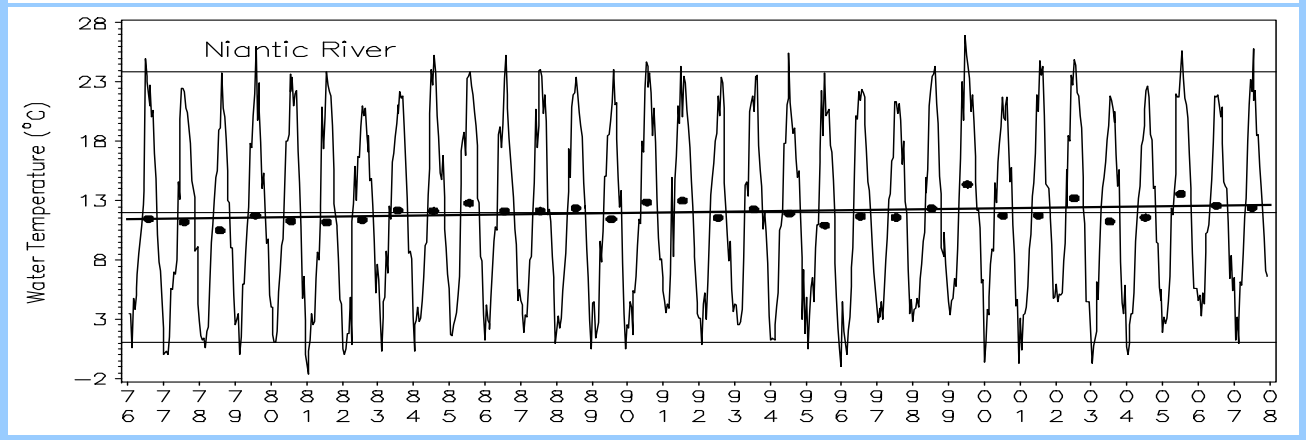
Locations of three-unit thermal plume isotherms (1.5°F, 4°F, 6°F, and 8°F) at four indicated tidal conditions.



Slope = 0.041°C/yr; p=0.0005*
1.3°C increase over 32-yr period

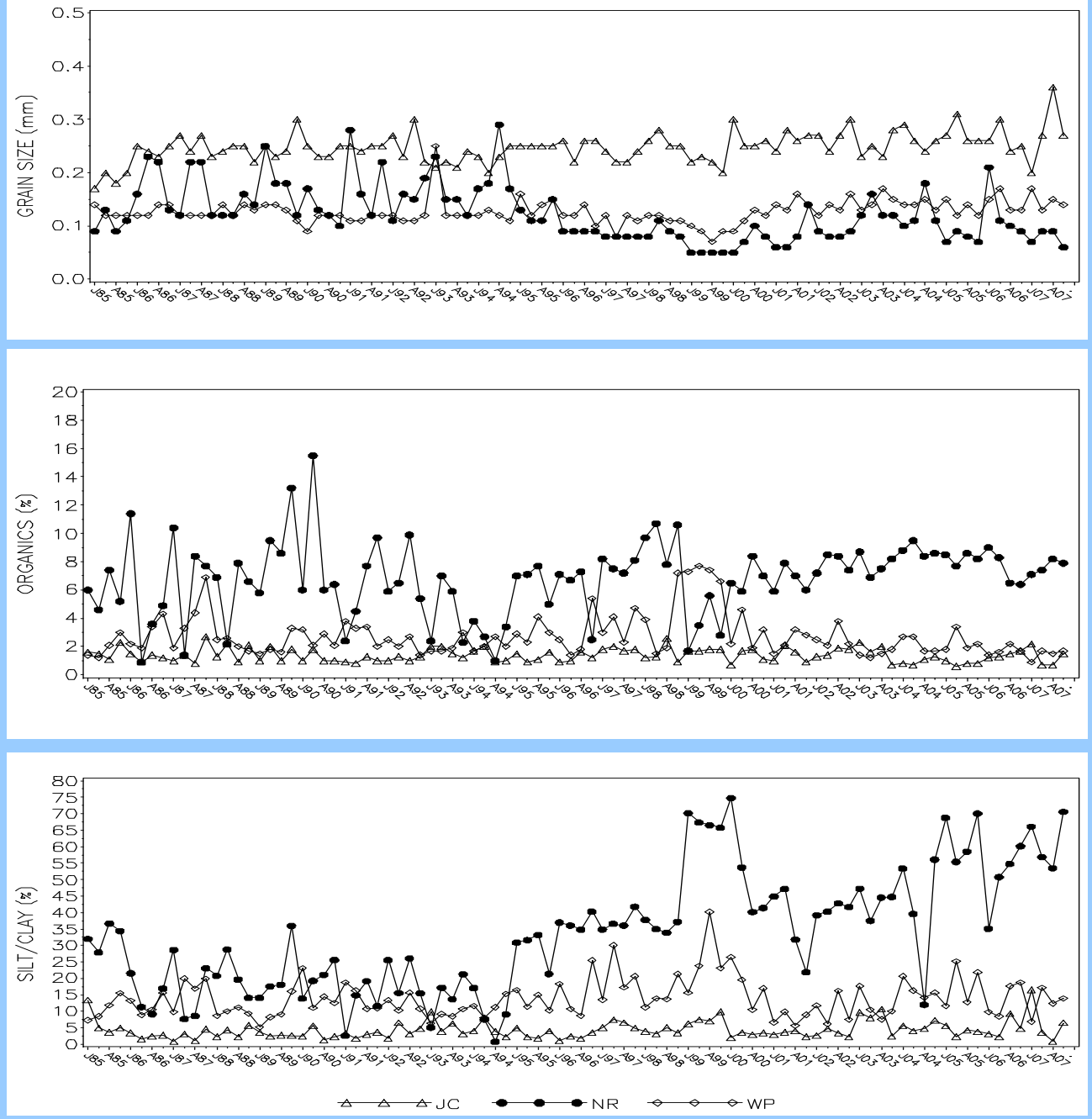


Slope = 0.048°C/yr; p=0.0004*
1.5°C increase over 32-yr period

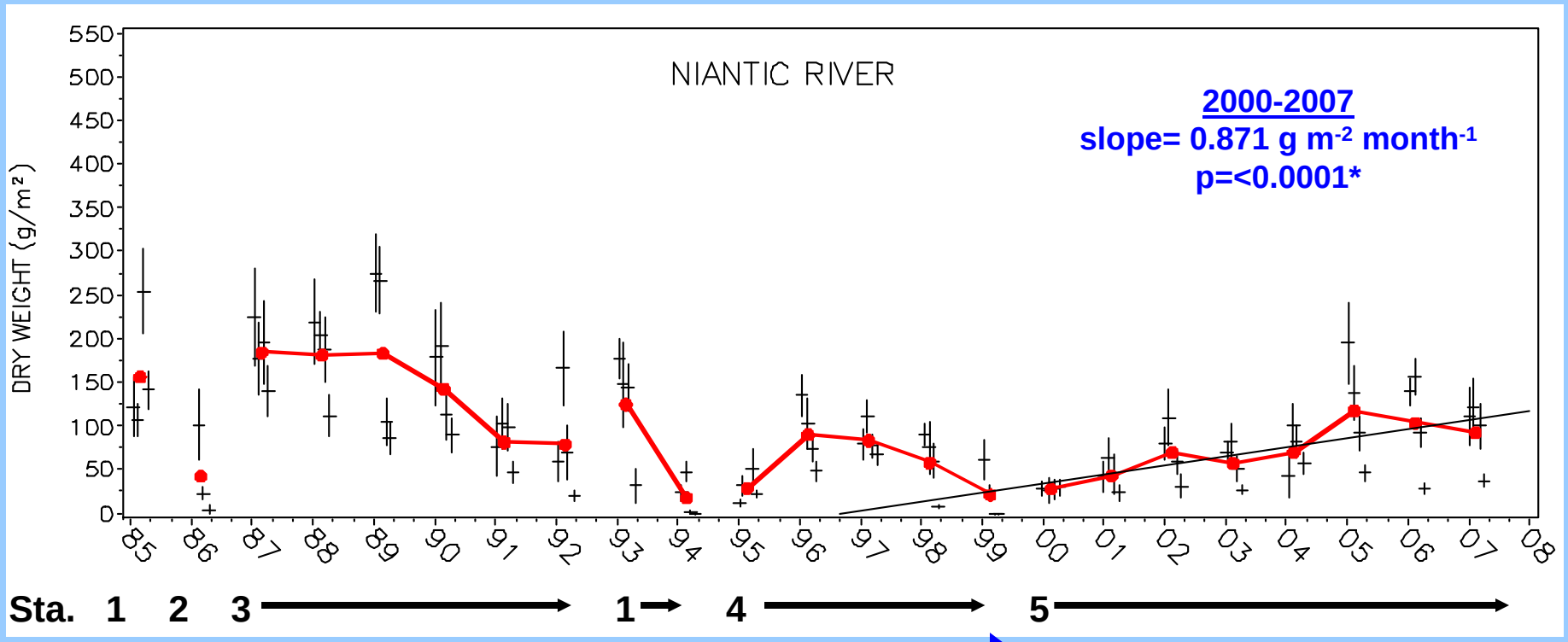


Slope = 0.036°C/yr; p=0.0193*
1.2°C increase over 32-yr period

Mean annual seawater temperatures (●) for the period 1976-2007, based on daily means at the MPS intakes and biweekly measurements made in Jordan Cove and the Niantic River. Horizontal reference lines represent the overall mean, and mean annual minimum and maximum temperatures at each site for the entire period.



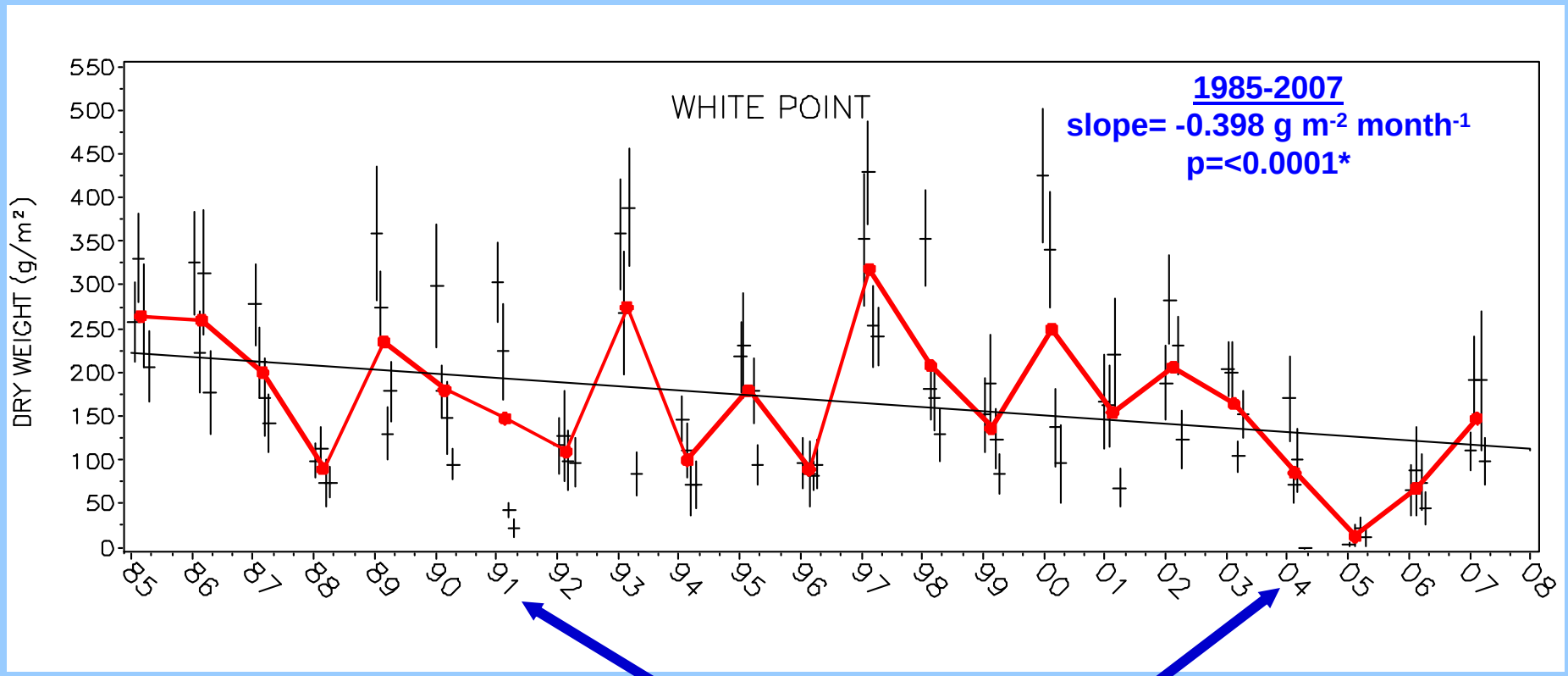
Sediment mean grain size, organic content, and silt/clay content at MPS eelgrass monitoring stations.

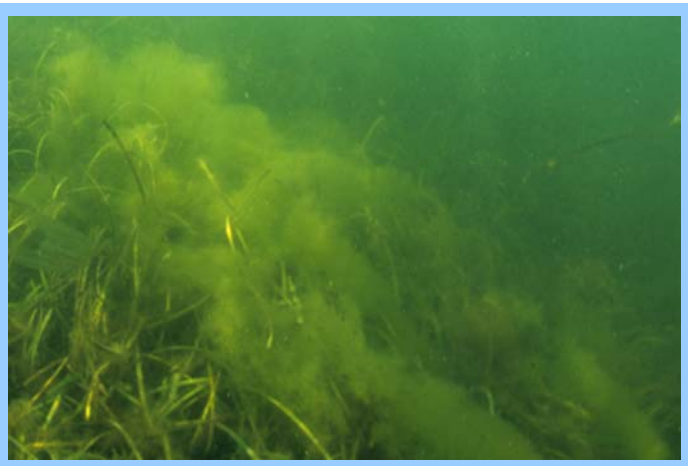


Blue mussel overgrowth

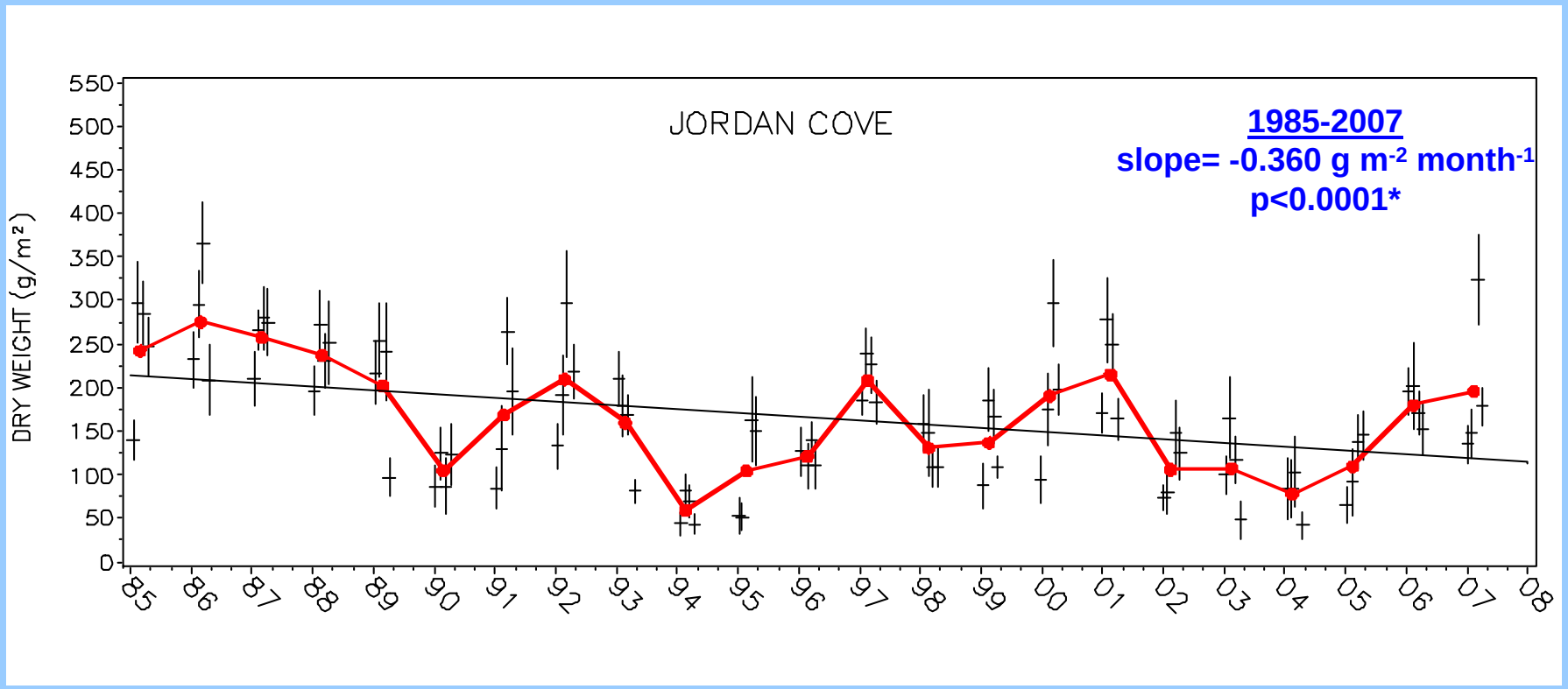
?
-Siltation
-*Agardhiella* bloom
-High temps. (25-27°C)

Monthly mean standing stock biomass (± 95% C.I.) and annual mean biomass at MPS eelgrass monitoring sites. Die-off events are indicated by arrows. Breaks in annual mean time series (red line) at NR indicate complete eelgrass bed mortality necessitating station relocation.



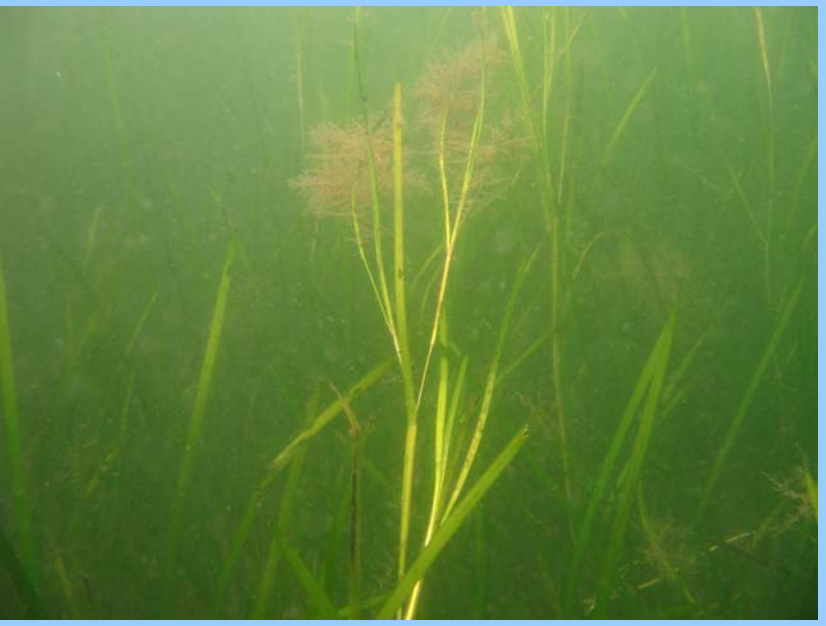


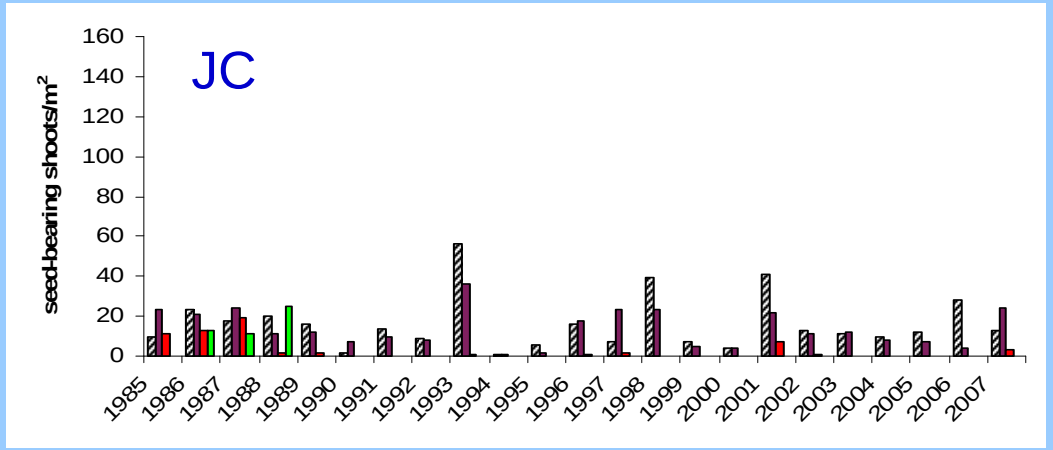
Cladophora
bloom/overgrowth

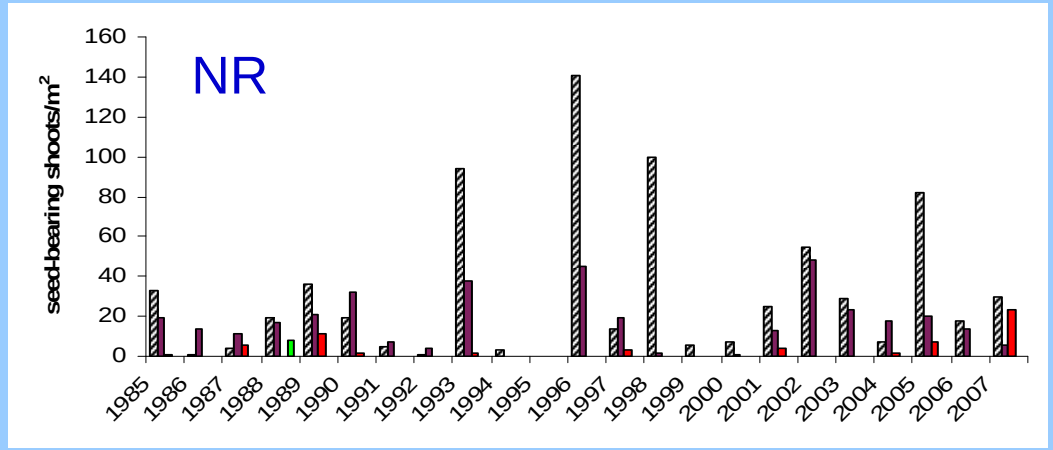

JORDAN COVE
1985-2007
slope= -0.360 g m-2 month-1
p<0.0001*
DRY WEIGHT (g/m²)
550
500
450
400
350
300
250
200
150
100
50
0
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
00
01
02
03
04
05
06
07
08

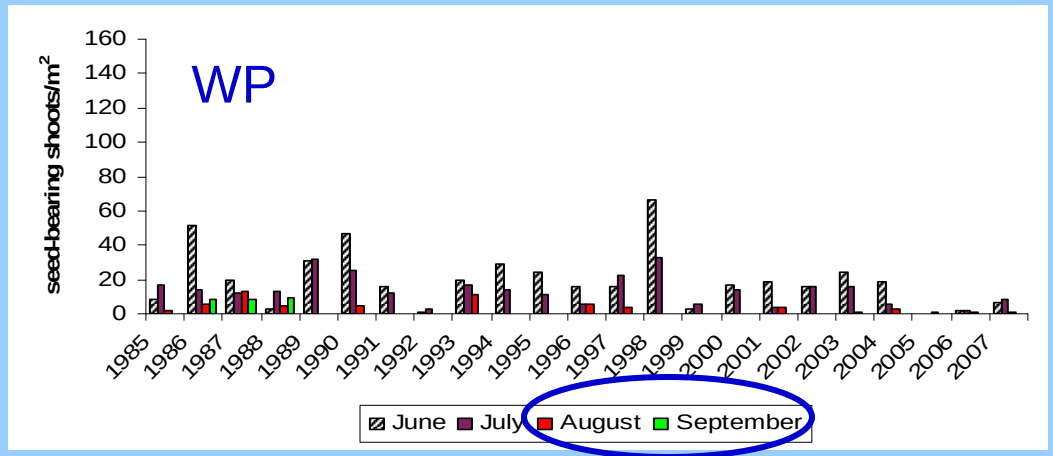
Seed-Bearing Shoots

- Found commonly throughout the summer until ~1990.
- Since then, rarely found in Aug., absent in Sept.
- Shift in reproductive season may be related to ambient seawater temperature rise.

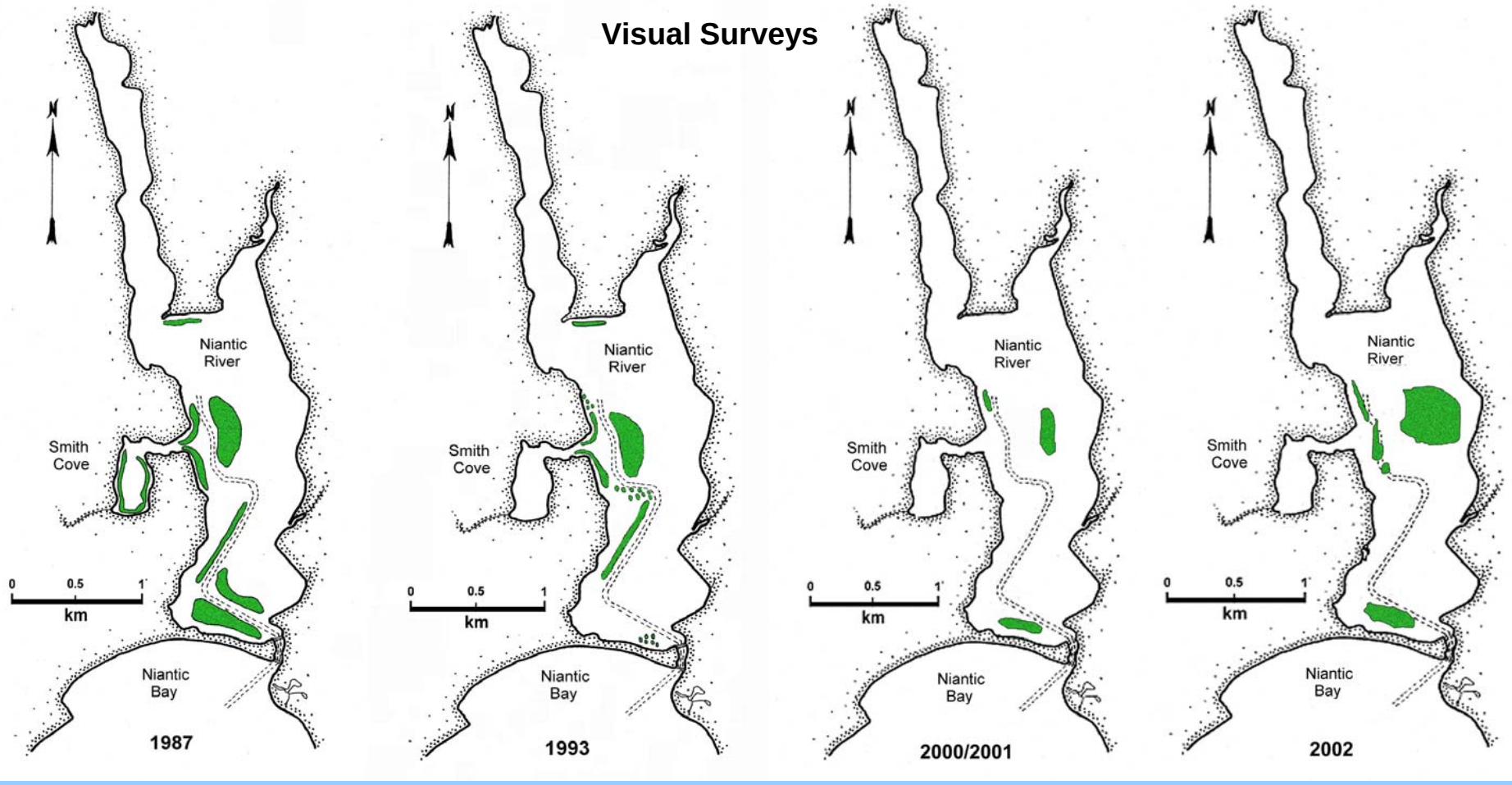




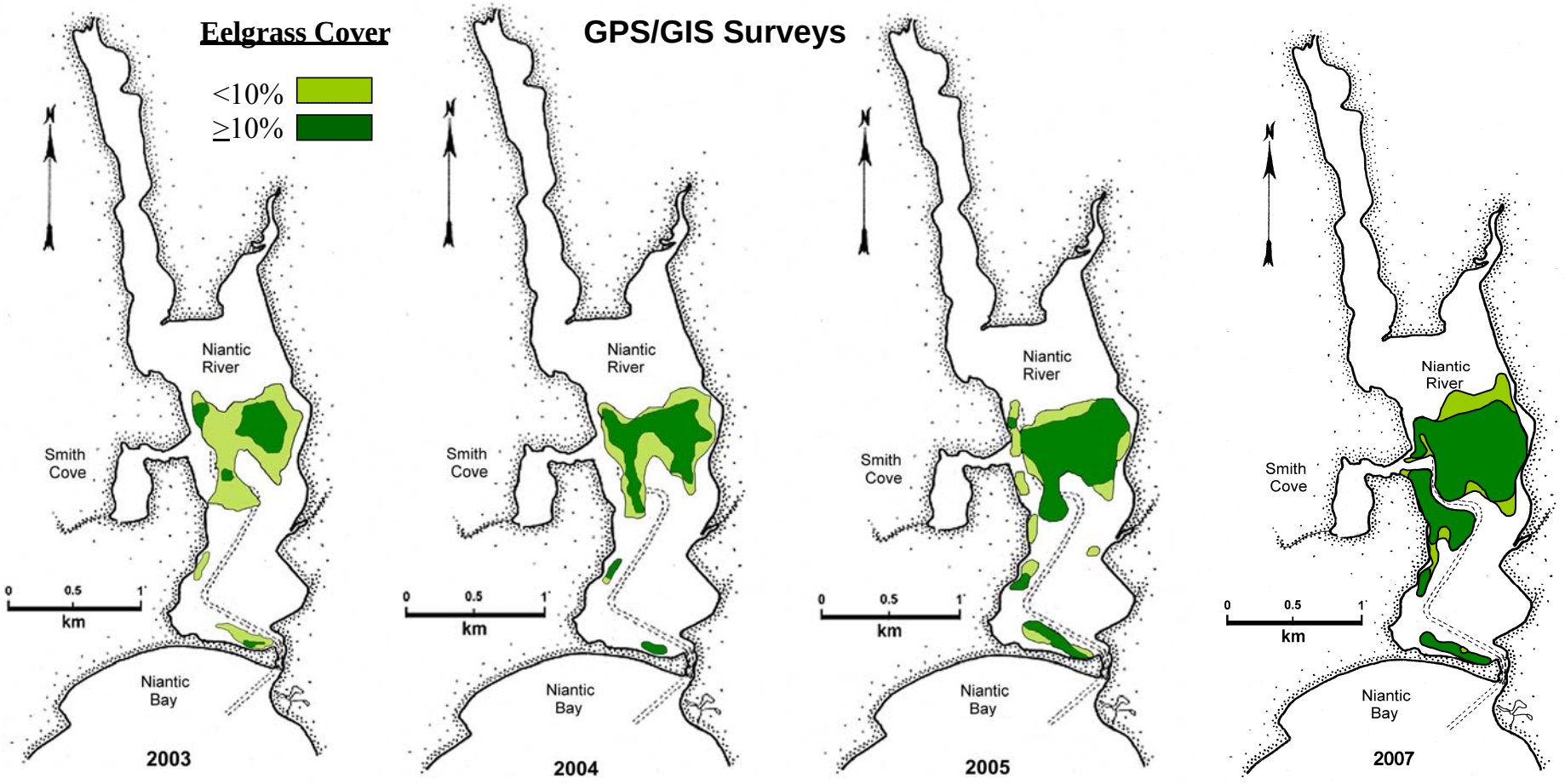


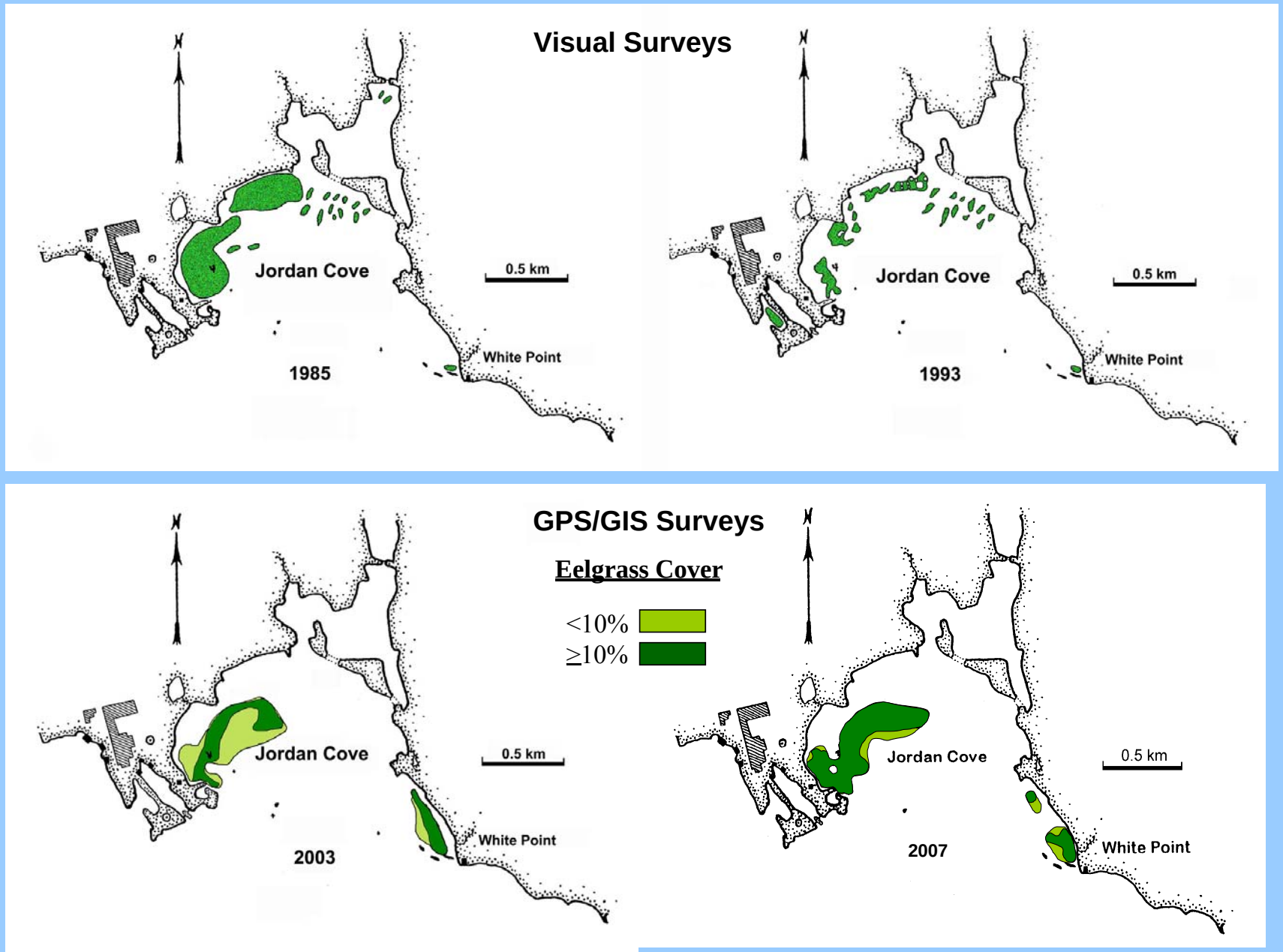


Visual Surveys

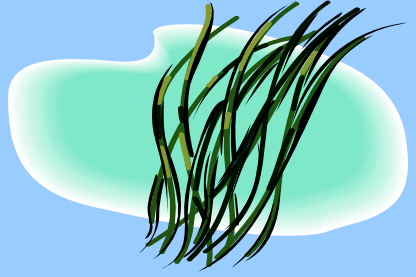


Eelgrass distribution in the Niantic River, Waterford and East Lyme, CT 1987-2007

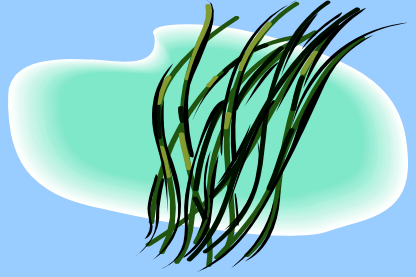

Eelgrass Cover
<10%
≥10%
GPS/GIS Surveys
N
Niantic River
Smith Cove
Niantic Bay
0
0.5
1
km
2003
2004
2005
2007



Eelgrass distribution in Jordan Cove, Waterford, CT, 1987-2007



Conclusions



- Most recent surveys (2007) revealed healthy populations at three monitoring locations
- While some indications of declines in biomass and/or shoot density over the study period seen at all sites, sites nearest MPS (JC and WP) support the most stable populations - no thermal plume effects observed
- NR population most variable, with long-term decline and bed die-offs noted through 2001 - expansion and increased density observed through 2007, possibly due to municipal sewer extensions within the watershed
- Some short-term declines attributed to fouling/macroalgal blooms, and possibly high summer seawater temperatures/siltation
- Ambient seawater temperature has increased by ~1.4^{o}C over last 30 yrs. – shift in reproductive season noted
- Causes of NR eelgrass instability (nutrients, waterfowl grazing, ambient temp. rise?) and its effect on other NR populations (winter flounder, scallop declines?) not fully understood - some studies are underway or proposed as NPDES permit conditions.