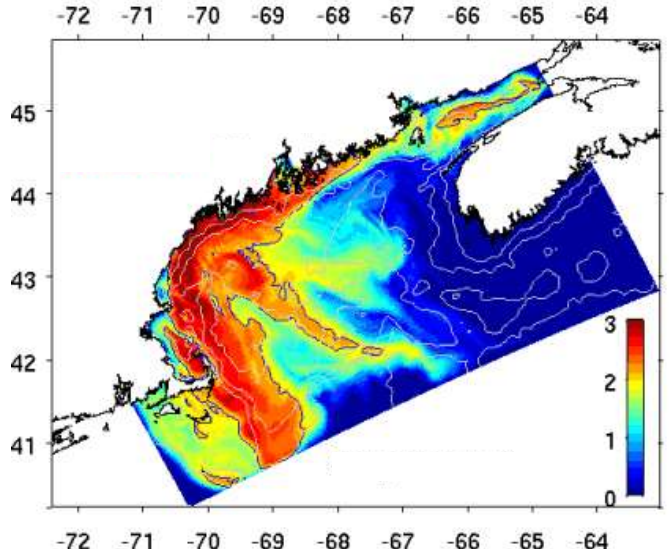
Red Tide Blooms in Casco Bay

Battelle
The Business of Innovation



Casco Bay Estuary Partnership's

2010 State of the Bay Conference

Scott Libby, Battelle, Brunswick, ME

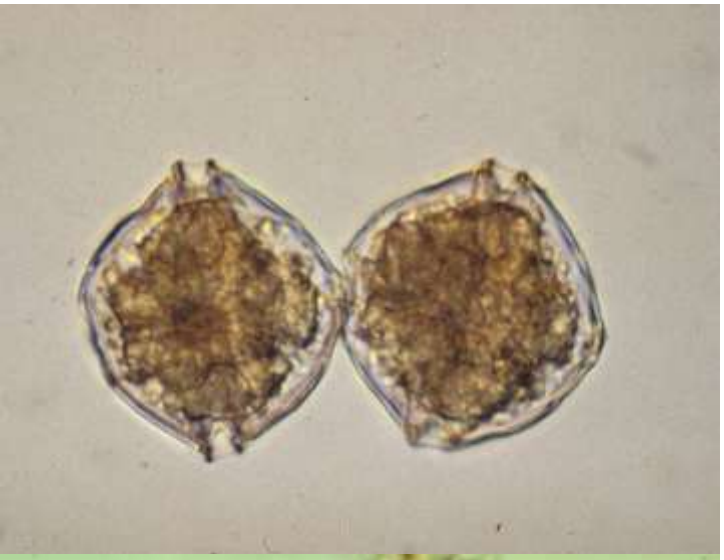
Don Anderson, WHOI, Woods Hole, MA

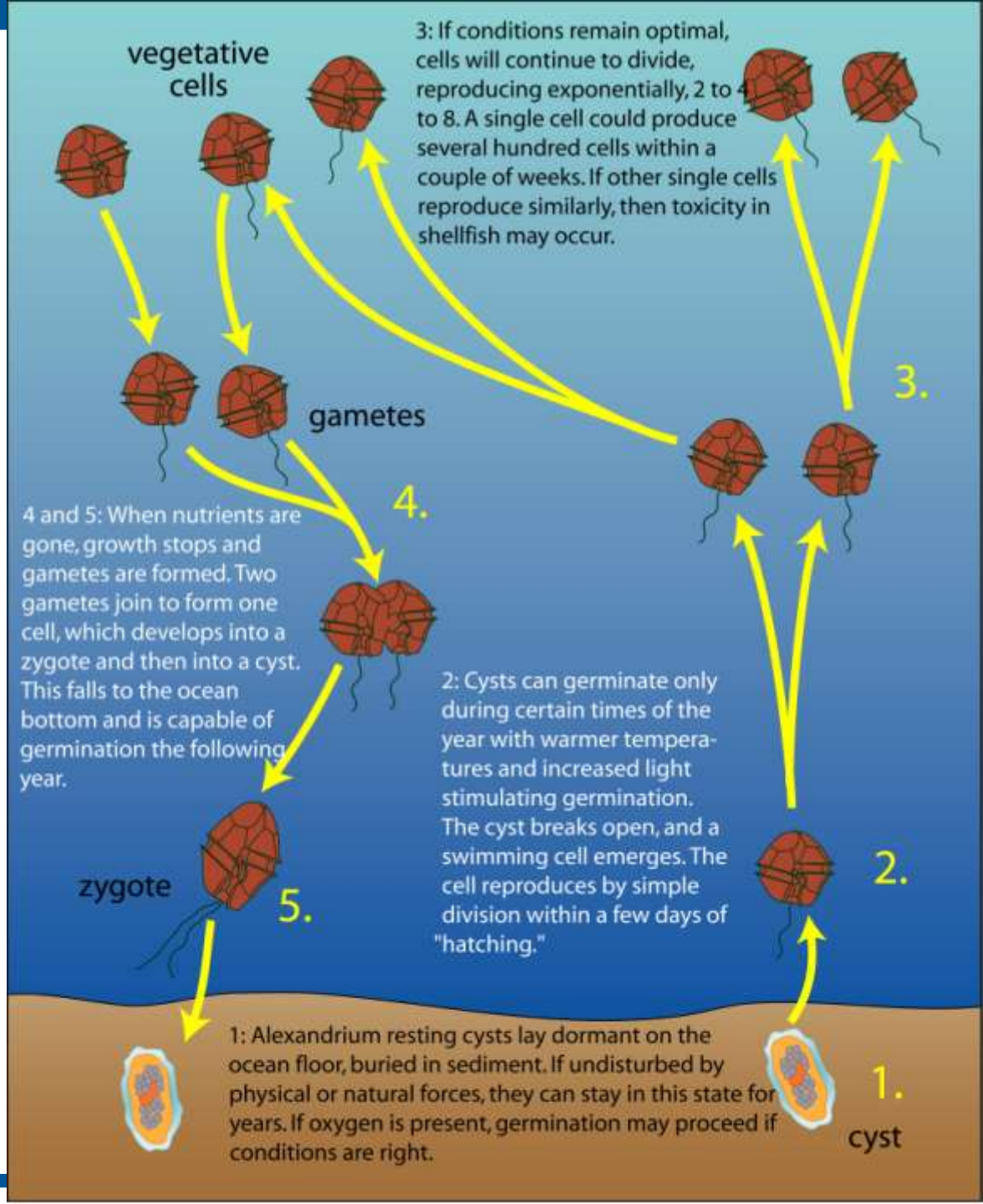
Talk Overview

- *Alexandrium* blooms in greater Casco Bay region
- CBEP Intensive Paralytic Shellfish Poisoning (IPSP) monitoring program
- IPSP 2006-2008 Results
- Summary

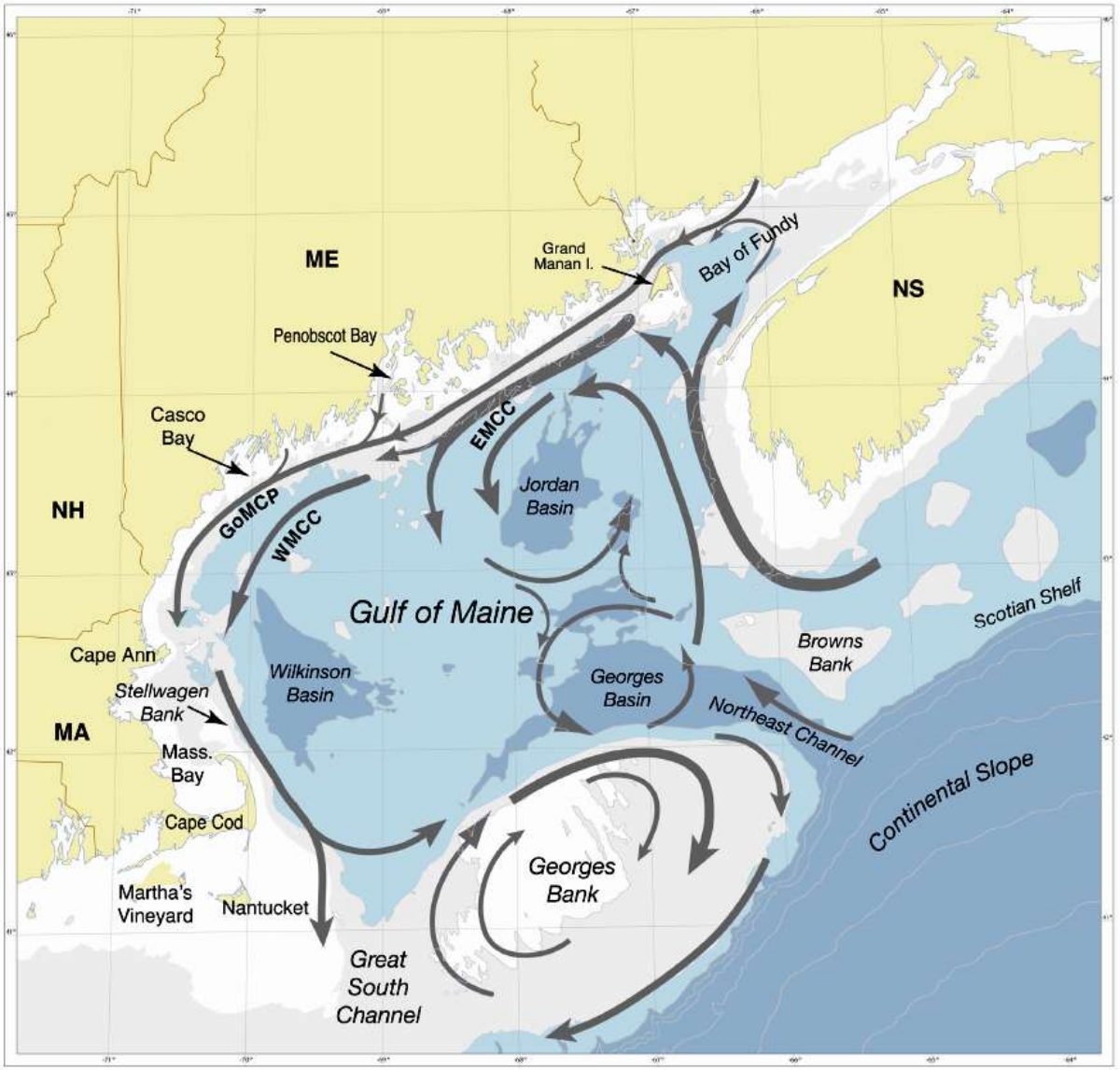

DANGER
Area Closed
Shellfish (oysters, clams, mussels and other bivalve molluscs) in the area described below contain paralytic toxins and are not safe for use as food.
Secteur fermé
Les mollusques (huîtres, clams, moules et autres mollusques bivalves) provenant du secteur décrit ci-après contiennent des toxines paralysantes et sont donc impropres a la consommation.

Alexandrium fundyense

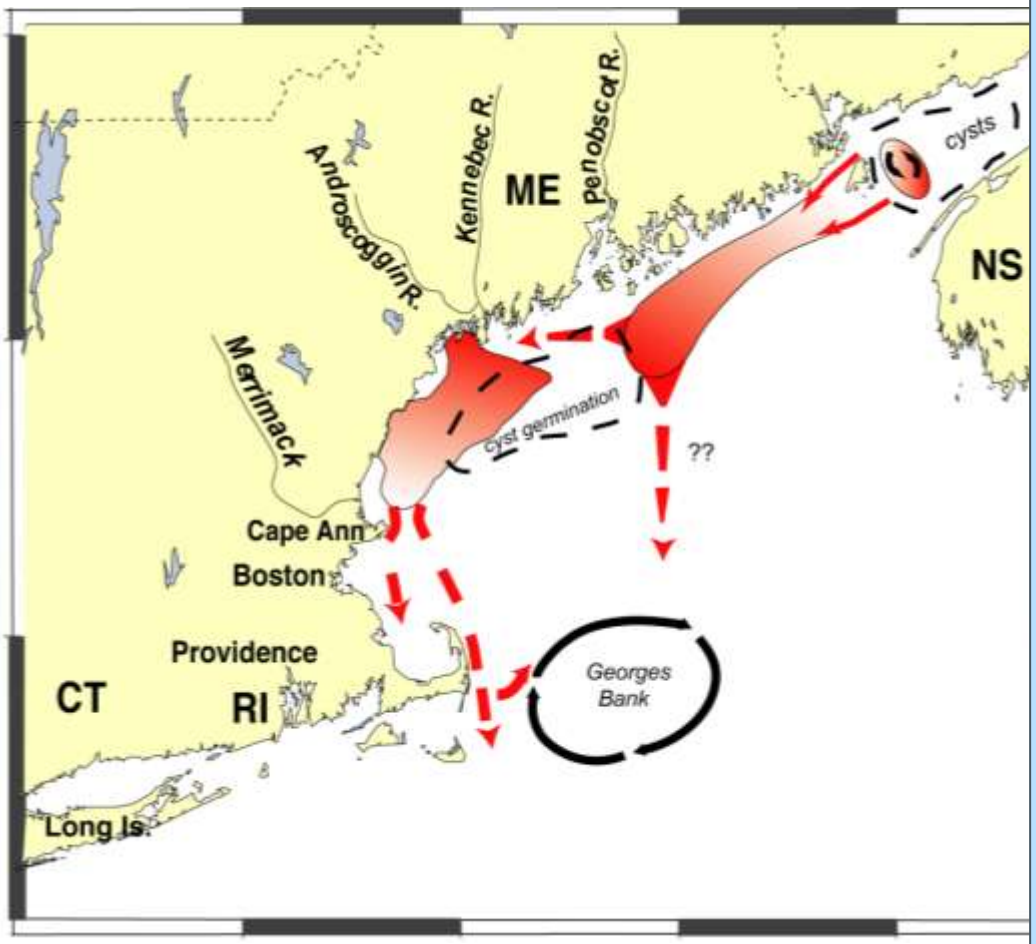




Alexandrium fundyense bloom dynamics in the Gulf of Maine and Casco Bay

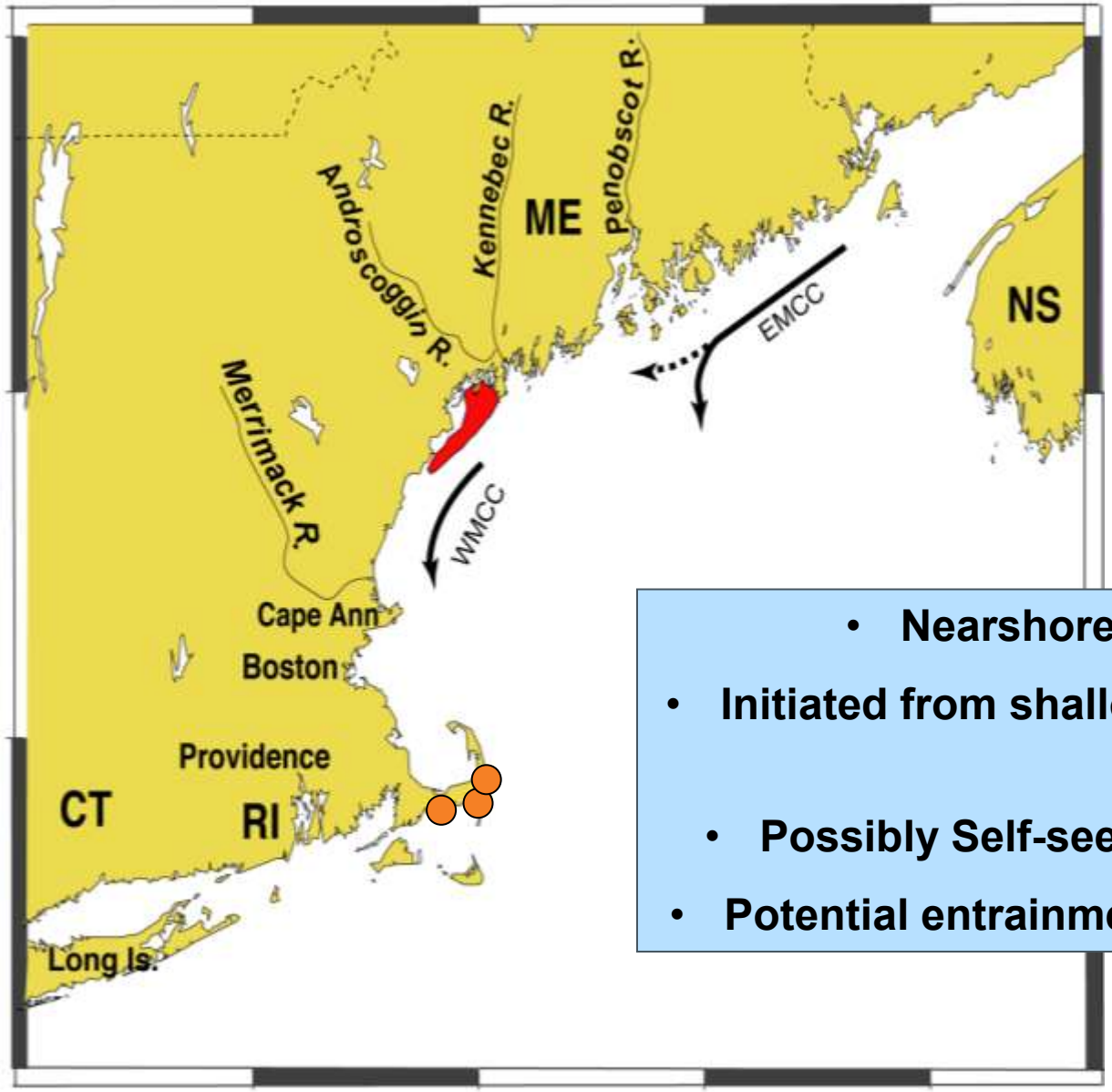


Gulf of Maine Blooms



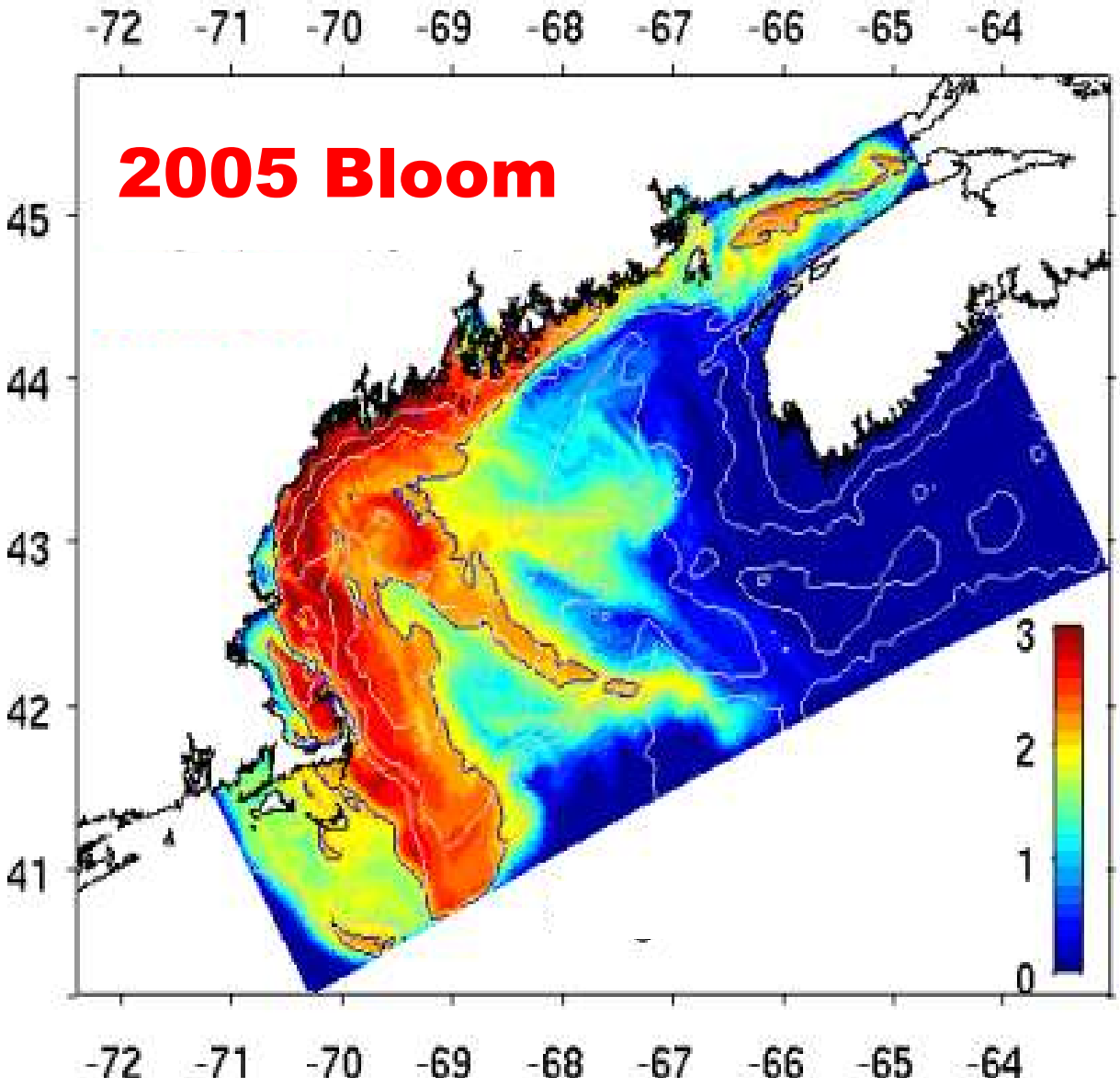
- **Bay of Fundy - cell retention zone, self seeding**
- **Some cells exit BOF and seed EMCC blooms**
- **Large cyst seedbed forms off Penobscot and Casco Bays - initiates WMCC blooms in subsequent years**
- **Episodic (wind-driven), intrusion from EMCC to WMCC (or offshore toward Georges Bank)**
- **Direct supply of cells to WMCC from offshore cyst germination**
- **Potential delivery of cells into Casco Bay - wind/current driven and eventually Massachusetts Bay and Cape Cod via WMCC**

Localized blooms in western Maine (and Cape Cod)



- Nearshore, localized blooms
- Initiated from shallow water cysts in bays and sounds
- Possibly Self-seeding (annually recurrent)
- Potential entrainment and transport in WMCC

CBEP IPSP Monitoring Program



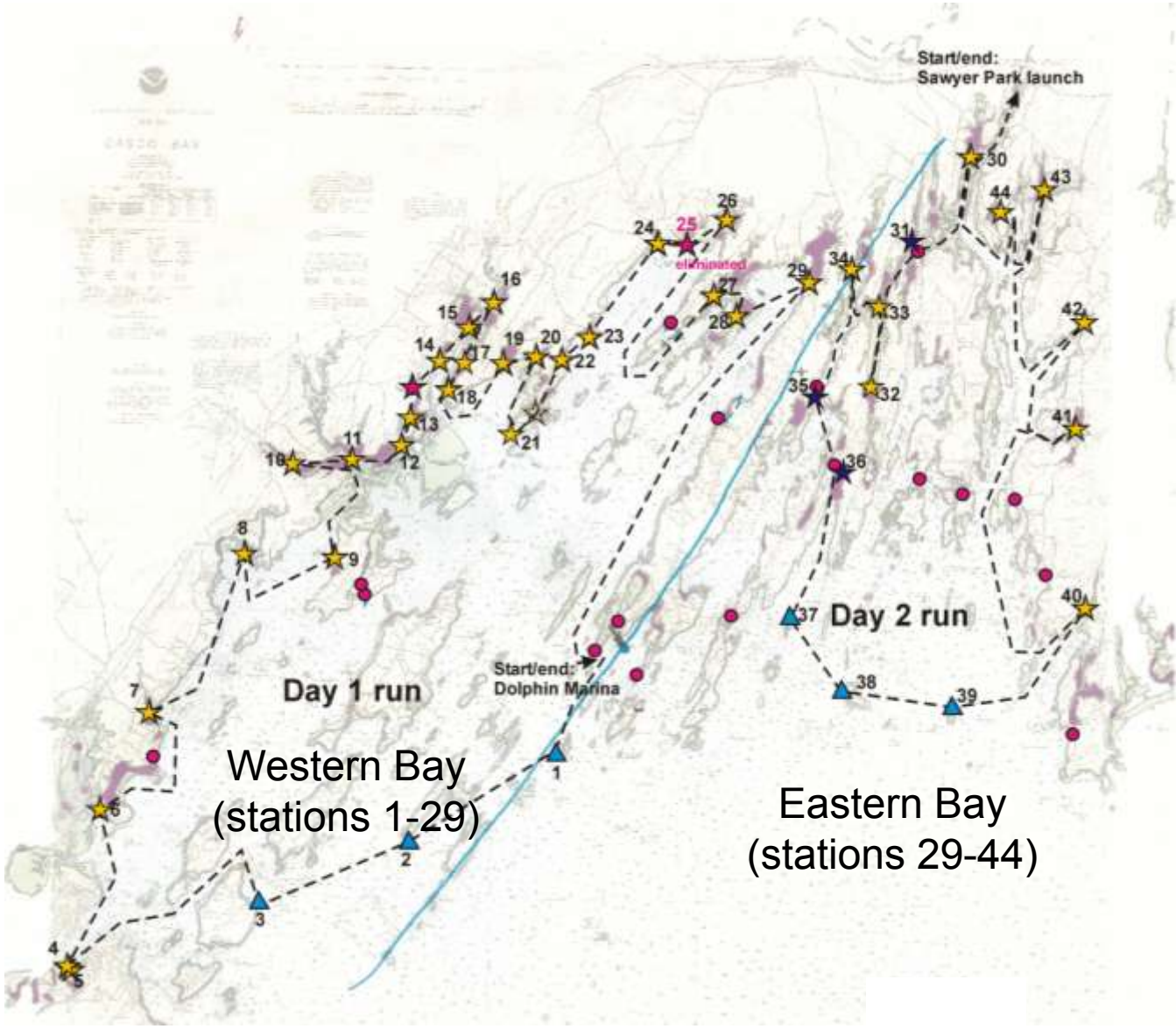
CBEP IPSP Monitoring Program

2005 PSP Closures

- **Record levels of toxicity in some locations**
- **First-time ever records of toxicity in some locations**
- **Large closure of federal (offshore) waters**
- **ME & MA – disaster declarations**
- **>$50M in losses for ME, NH and MA shellfish industry**

CBEP IPSP Monitoring Program

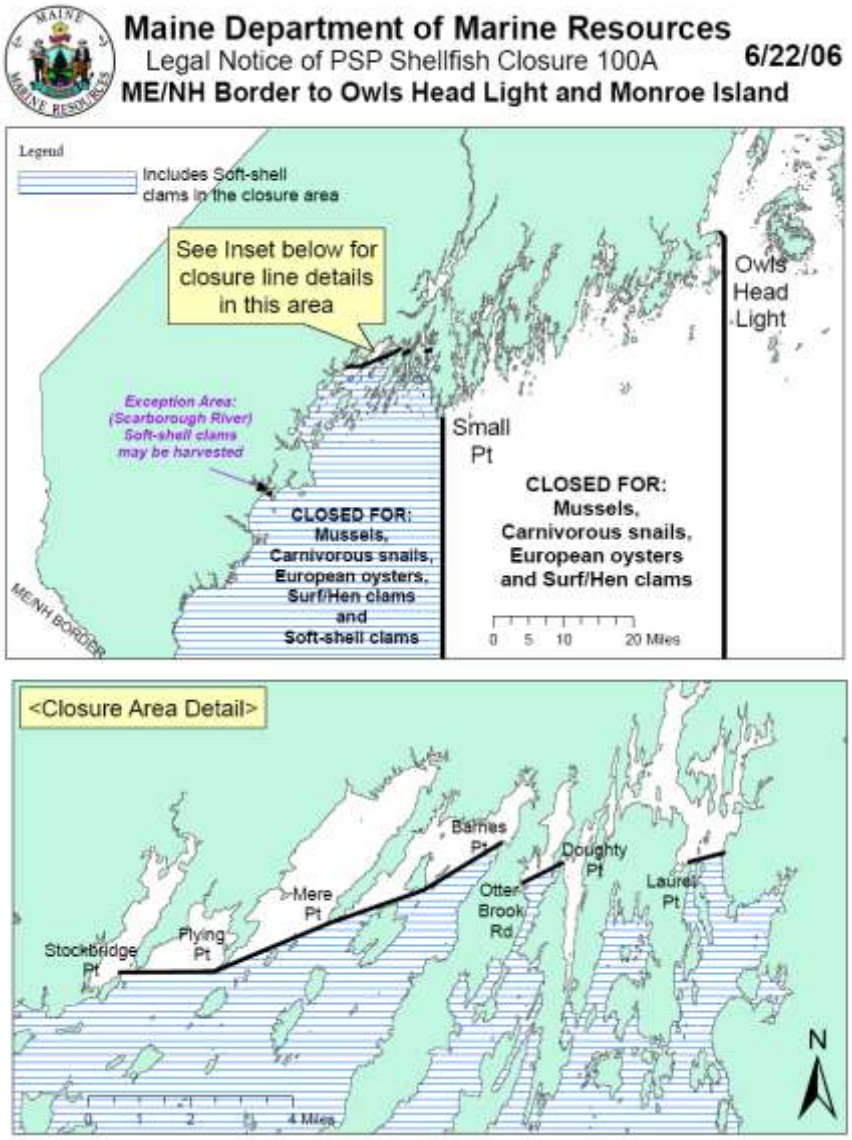
- Development
  - CBEP Casco Bay Clam Team
  - ME DMR
  - MER Assessment
- Parameters
  - *In situ*
  - Nutrients
  - *Alexandrium*
  - PSP toxicity
- Initiated in 2006

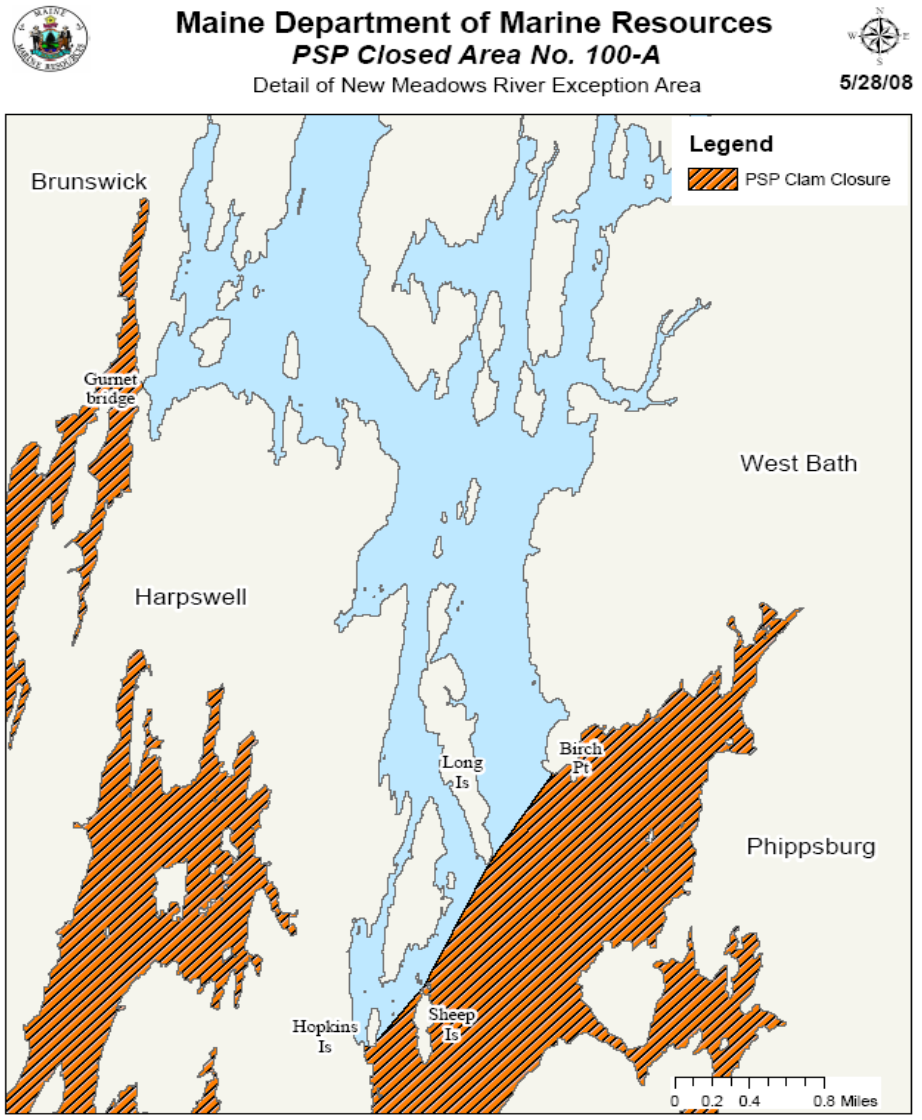


CBEP IPSP Program Goals

- Facilitate fine-scale decisions on closing and reopening shellfish growing/harvesting areas based on PSP toxicity
- Develop a better understanding of *Alexandrium* bloom dynamics in Casco Bay
  - Inshore vs. offshore origin and development of blooms
  - Role of nutrients in sustaining or enhancing blooms

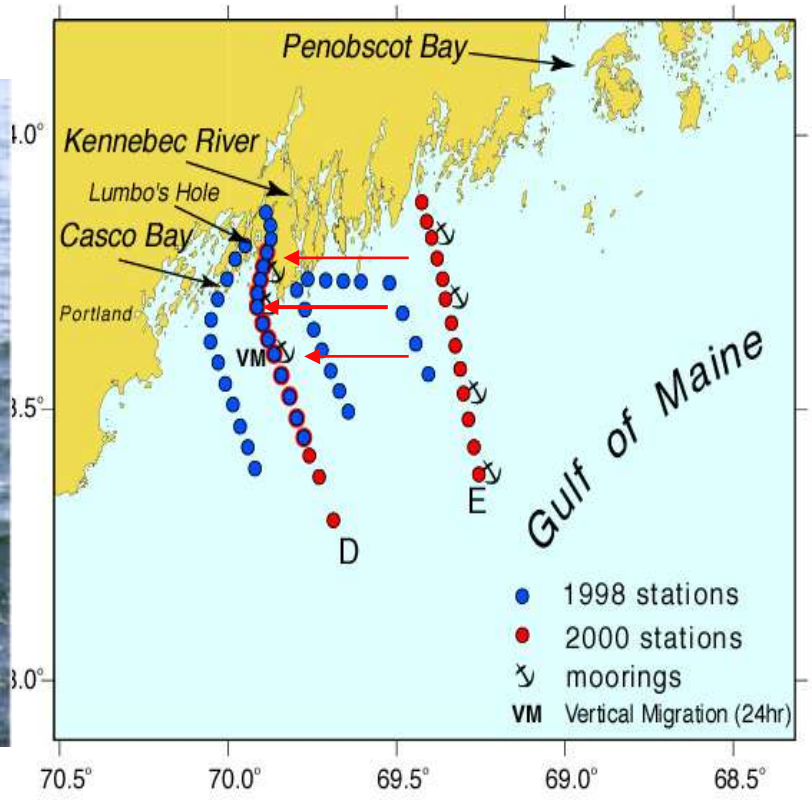
Successful on Goal 1 - Surgical Closures

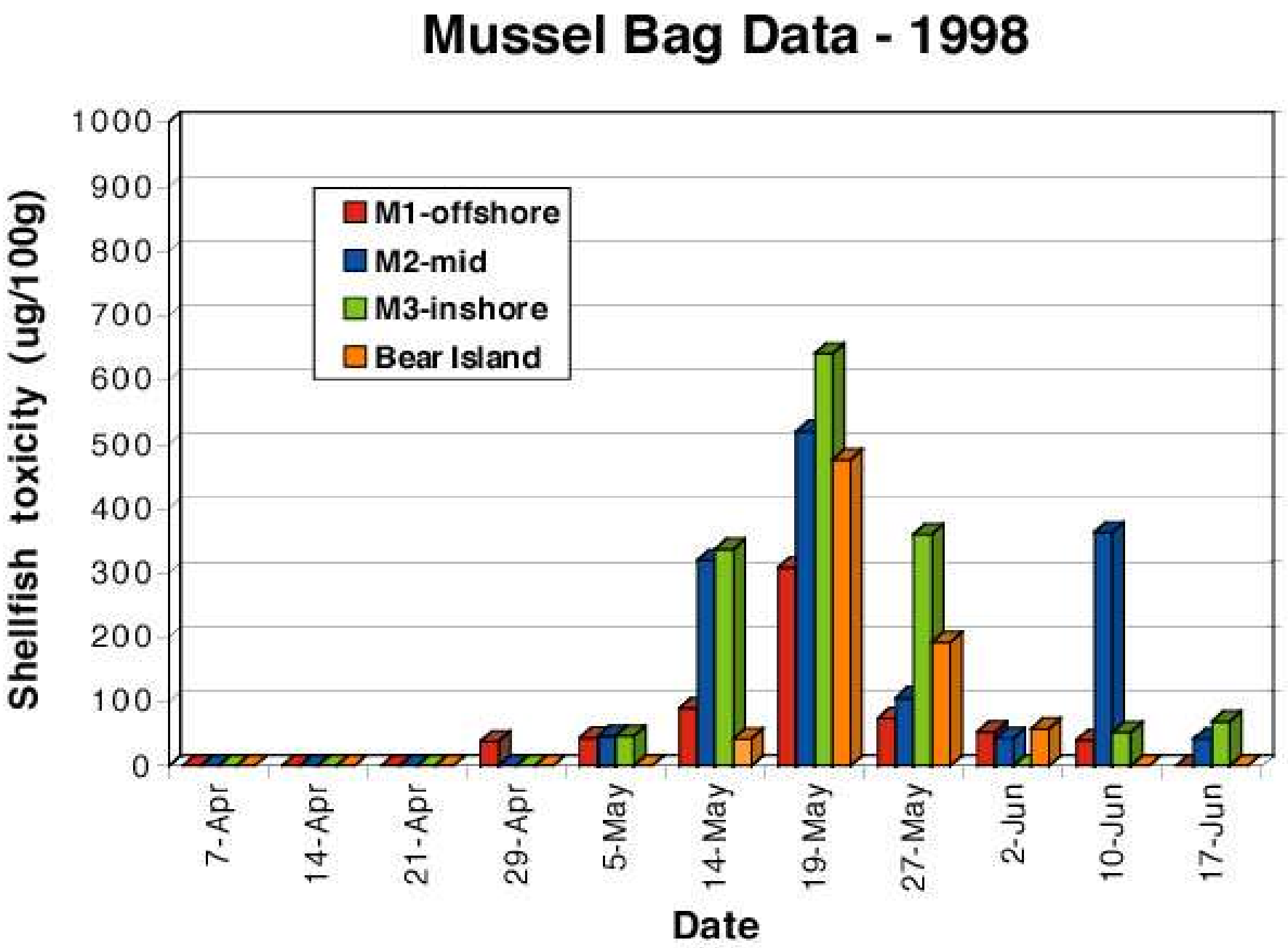




Goal 2a – Inshore vs. Offshore

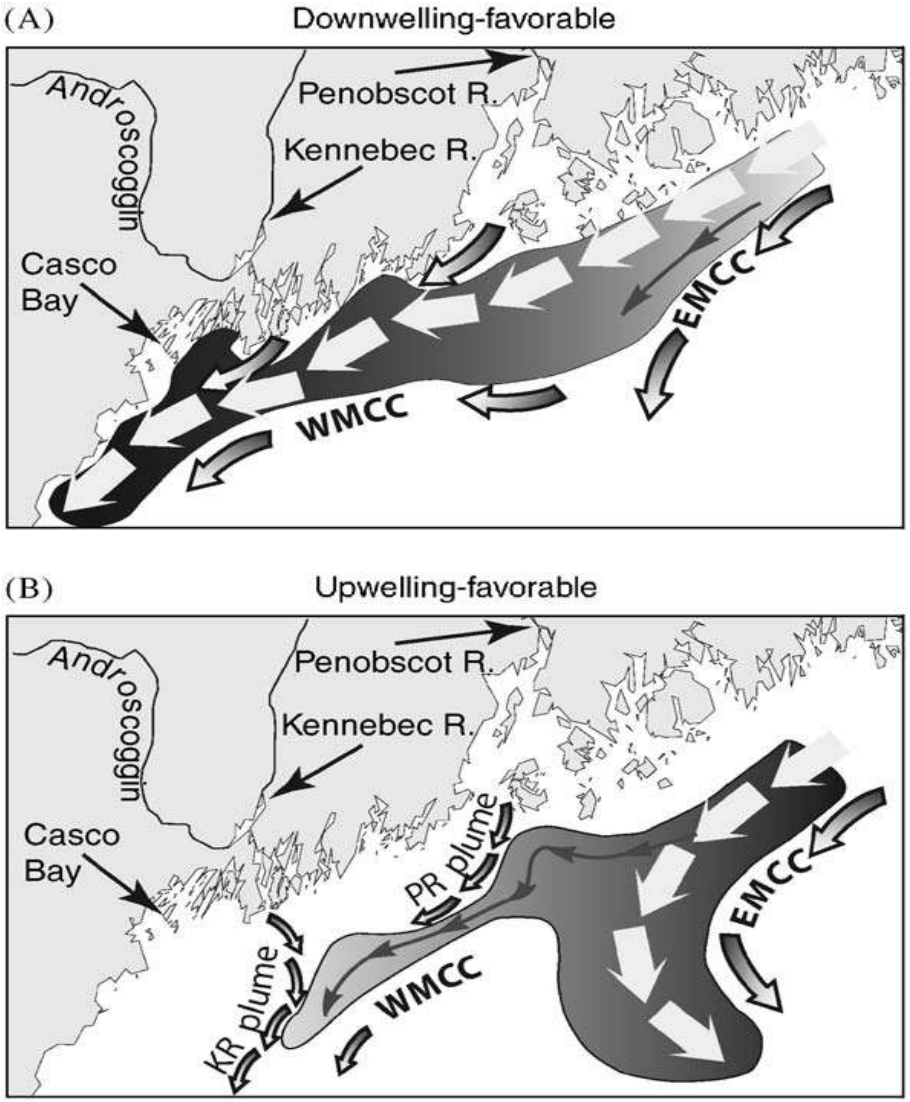
- 1998 and 2000 WHOI Studies
- Similar to IPSP with mussel bags deployed on moorings for offshore toxin detection
- Data show offshore -> onshore transport of *Alexandrium* populations




Mussel Bag Data - 1998
Shellfish toxicity (ug/100g)
1000
900
800
700
600
500
400
300
200
100
0
M1-offshore
M2-mid
M3-inshore
Bear Island
7-Apr
14-Apr
21-Apr
29-Apr
5-May
14-May
19-May
27-May
2-Jun
10-Jun
17-Jun
Date

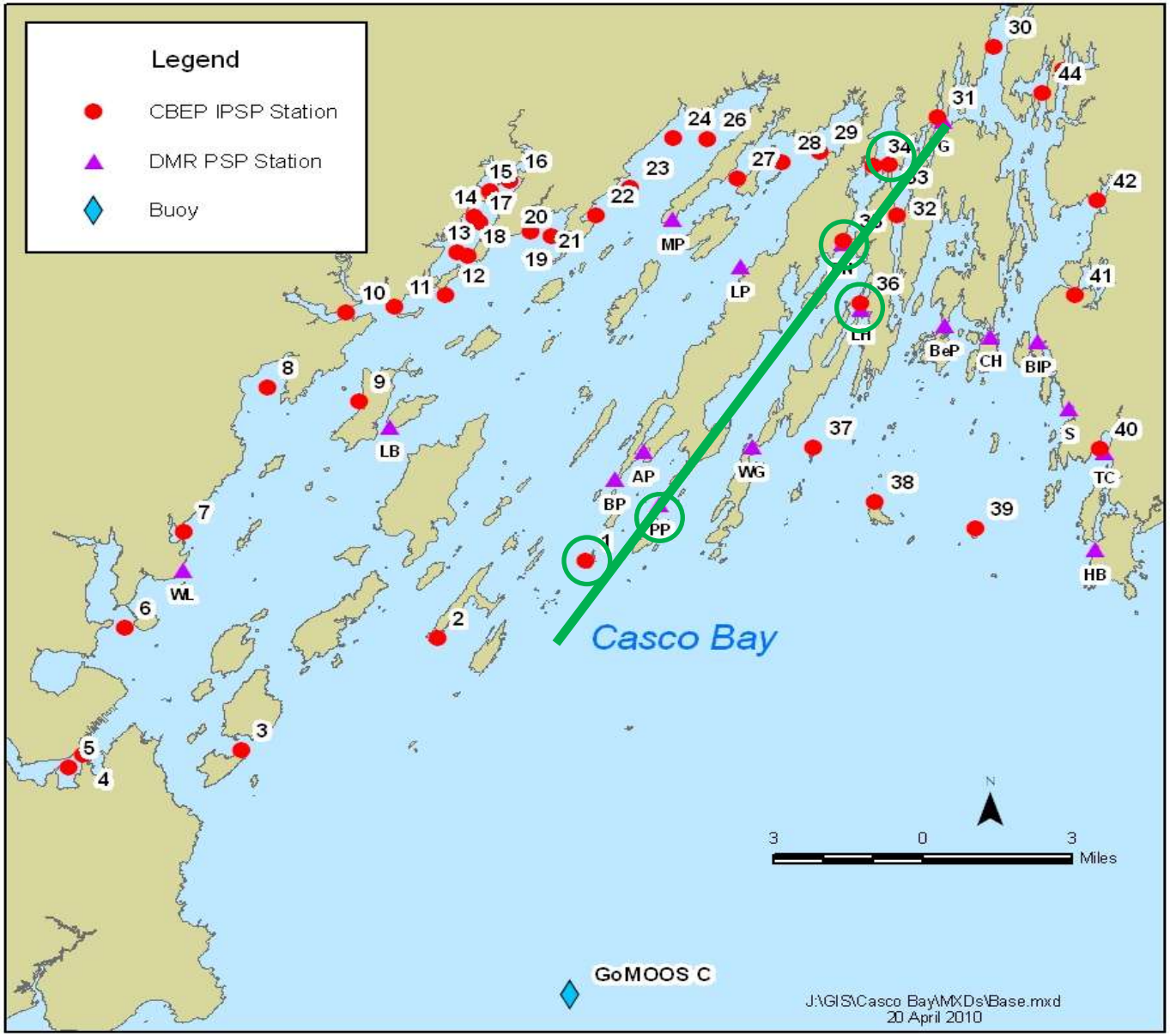
Onshore Physical Mechanism

- Downwelling-favorable winds (out of NE)
  - EMCC to WMCC
  - Drives nearshore coastal plume
  - Transports offshore waters (and *Alexandrium*) and Kennebec River plume into Casco Bay
- Upwelling-favorable
  - Pushes waters and cells offshore



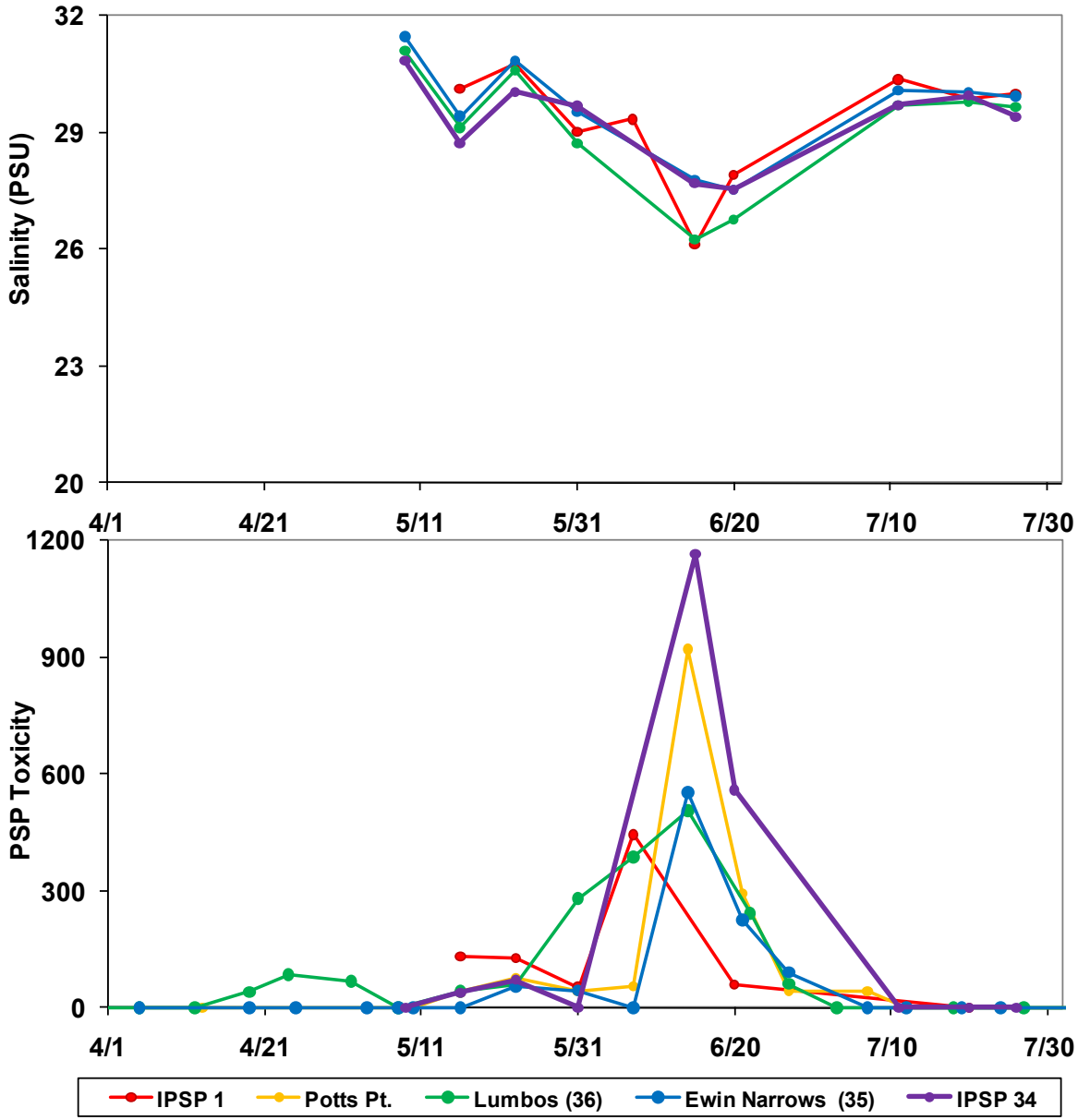
Source: Keafer et al. 2005

CBEP IPSP and DMR PSP Stations

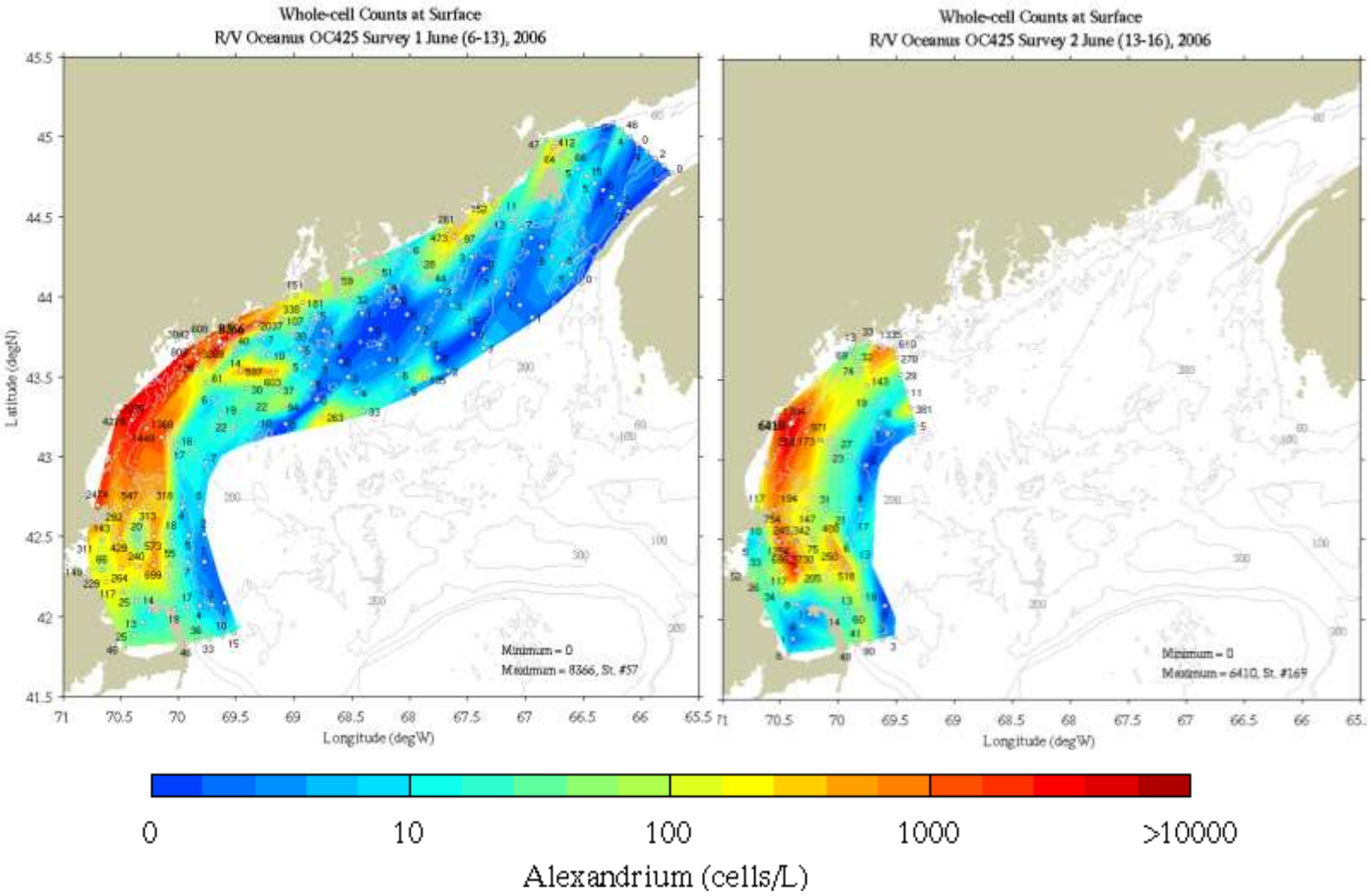


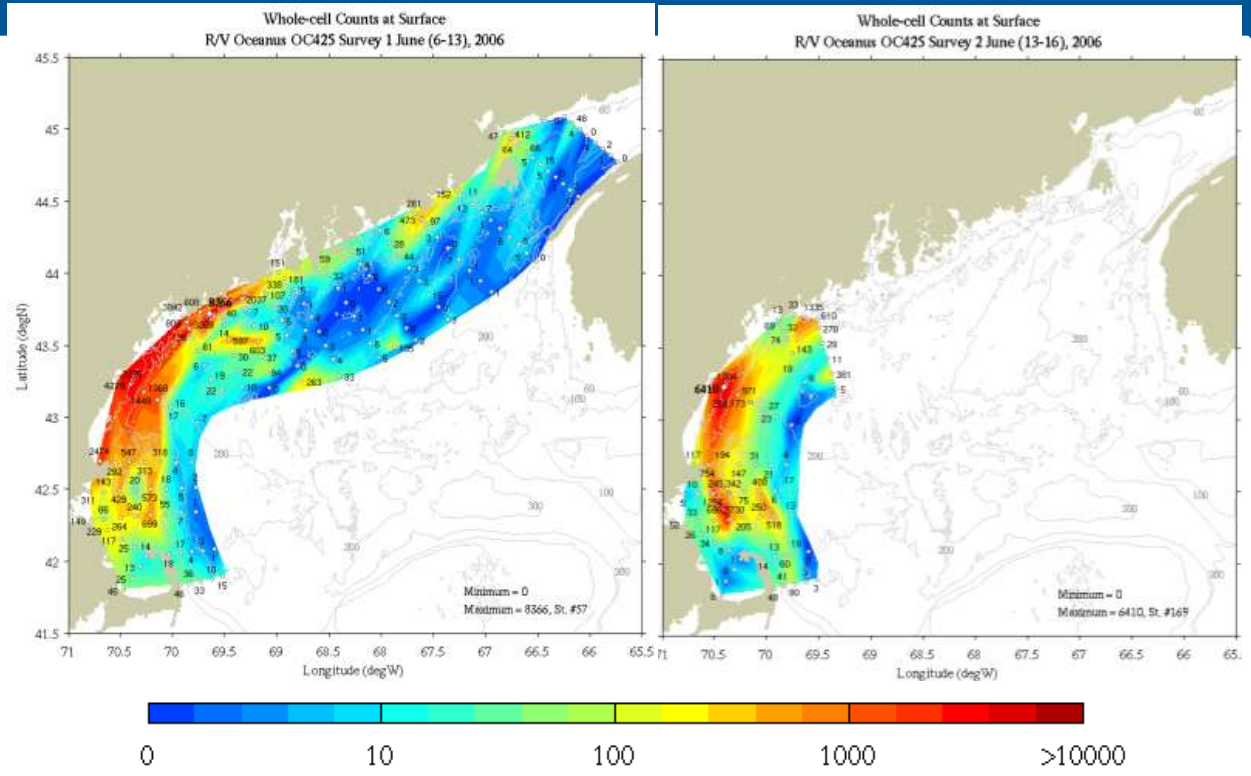
Harpswell Sound Data - 2006

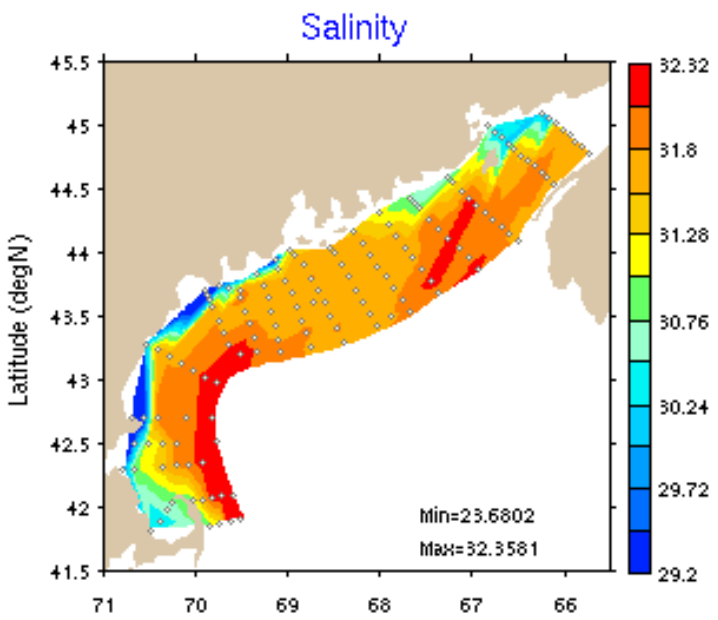
- Early toxicity at Lumbo's Hole
- Offshore toxicity in mid May
- Increasing offshore in early June before peaking in mid June
- Coincident with lower salinity water from Kennebec River plume ME DMR
- Suggests an early internal bloom and the subsequent intrusion of offshore bloom

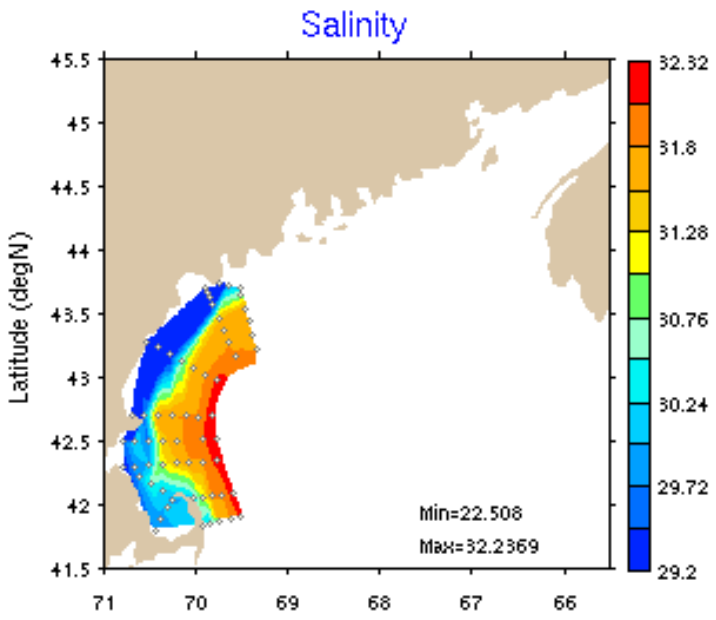


Offshore WHOI Counts 2006




Whole-cell Counts at Surface
R/V Oceanus OC425 Survey 1 June (6-13), 2006
Minimum = 0
Maximum = 8366, St. #57
Whole-cell Counts at Surface
R/V Oceanus OC425 Survey 2 June (13-16), 2006
Minimum = 0
Maximum = 6410, St. #169
Latitude (degN)
Longitude (degW)
0
10
100
1000
>10000


Salinity
Min=23.6802
Max=32.3581
32.32
31.8
31.28
30.76
30.24
29.72
29.2
Latitude (degN)

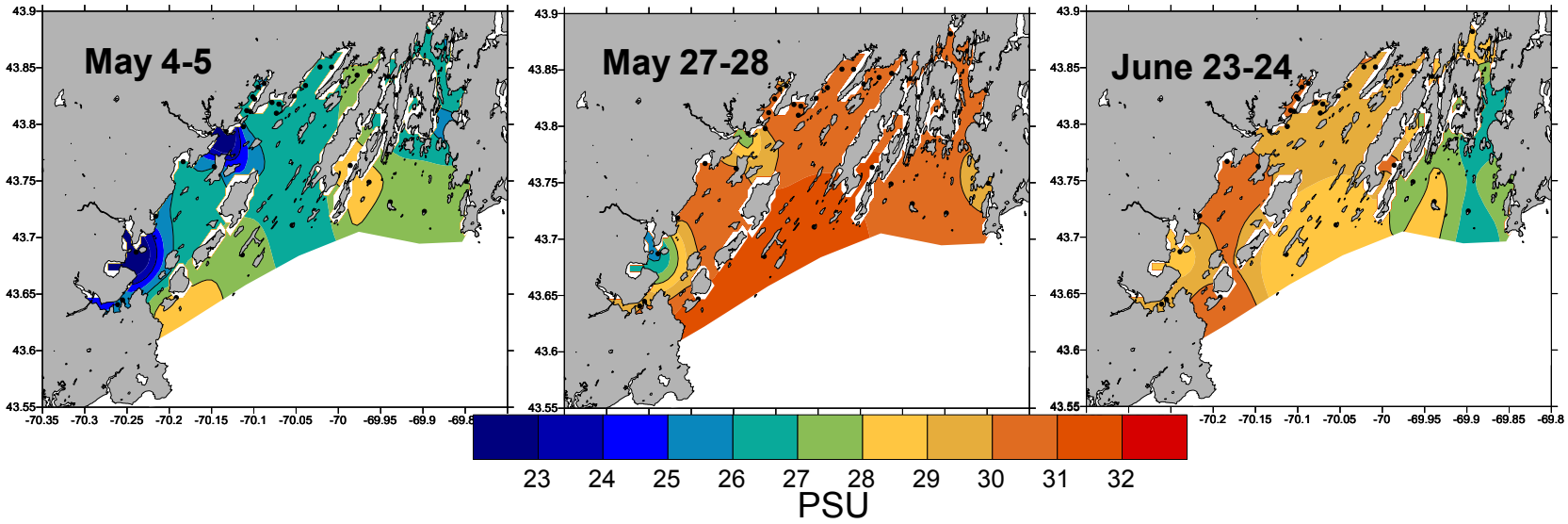

Salinity
Min=22.508
Max=32.2369
32.32
31.8
31.28
30.76
30.24
29.72
29.2
Latitude (degN)

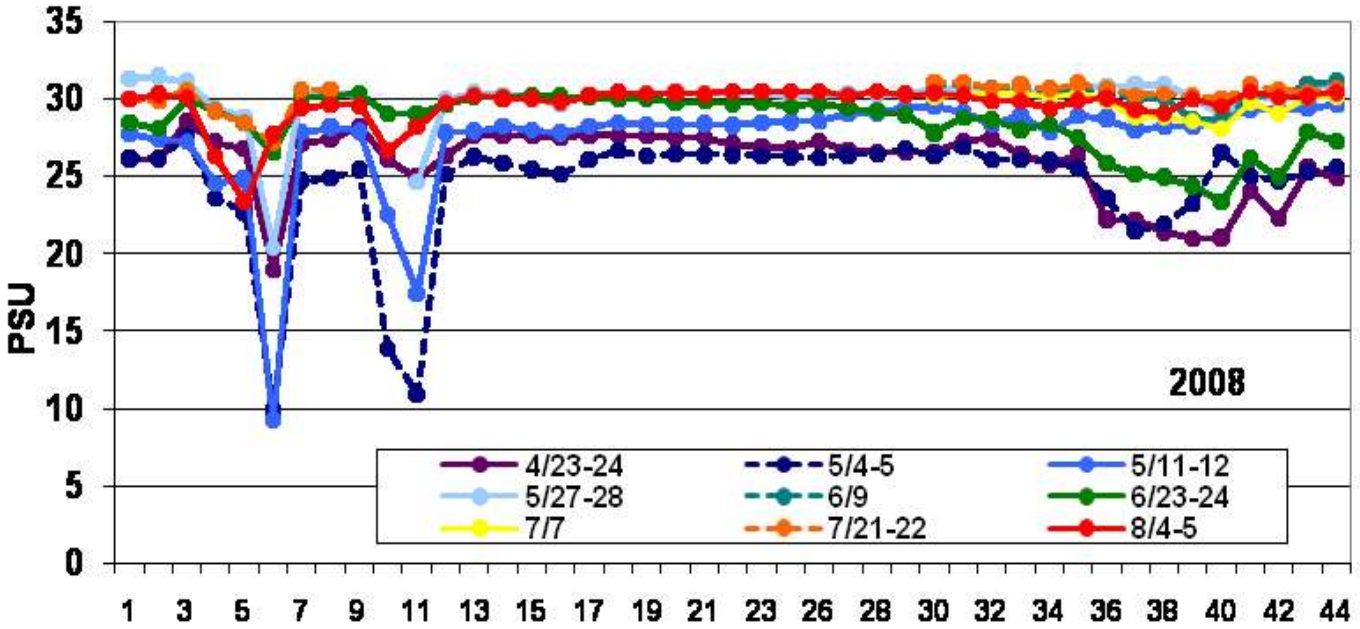
Goal 2a - Inshore vs. Offshore Blooms

- Earliest toxicity is consistently observed at inshore stations (Lumbo's Hole)
- However, data suggests that the peak bloom and toxicity in Casco Bay is associated with offshore blooms
- Meteorological conditions play an important roll in whether these offshore/Kennebec River plume waters impact the Casco Bay

Goal 2b – Nutrients and Red Tide

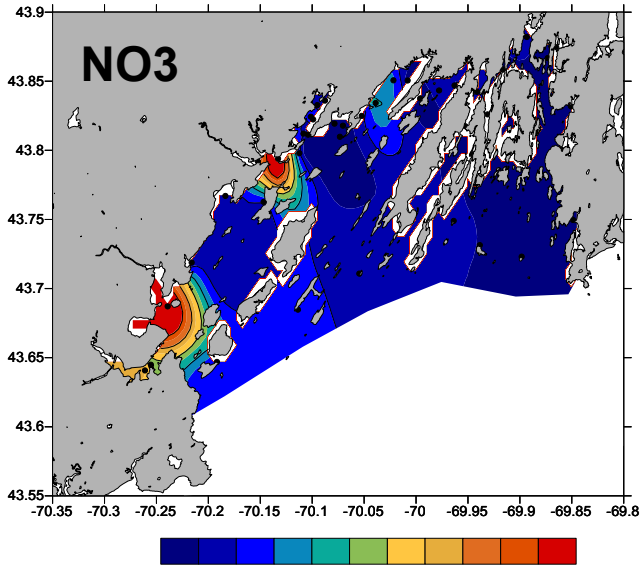
River influenced salinity distributions (2008)

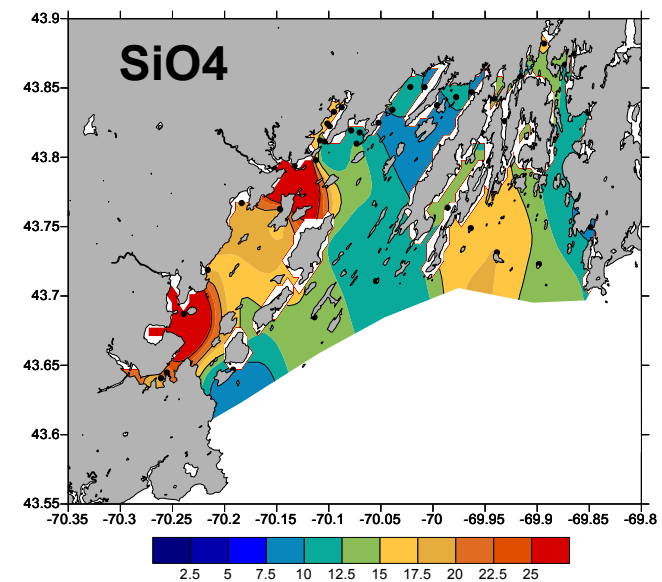


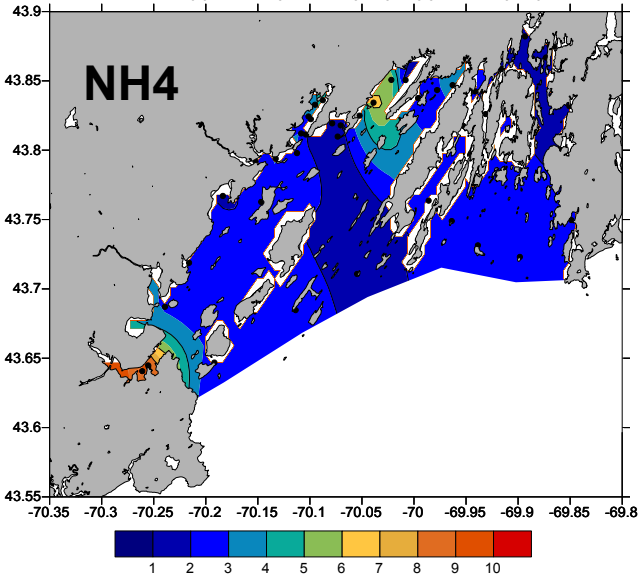


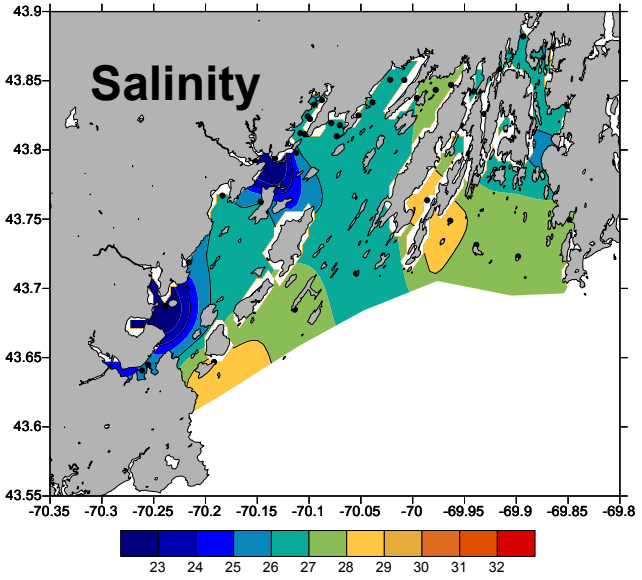
May 2008 Nutrients and Salinity

- Highest nutrient concentrations near rivers and Portland Harbor
- Elevated SiO_4 levels in lower salinity waters associated with Kennebec River plume

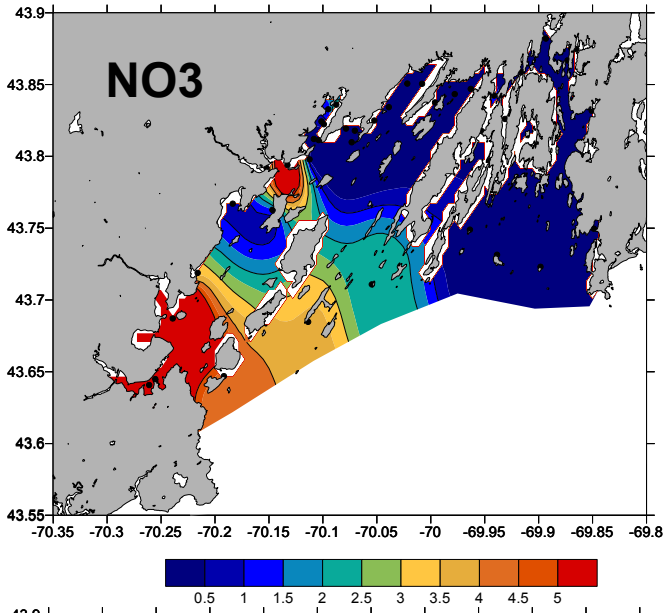


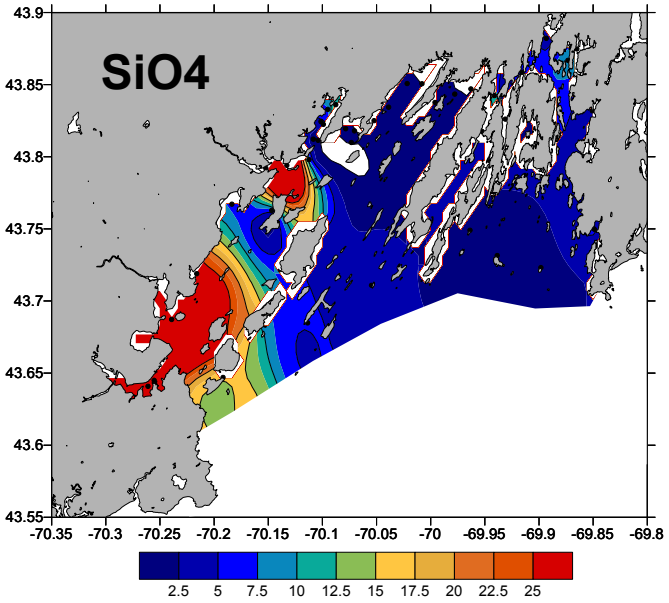


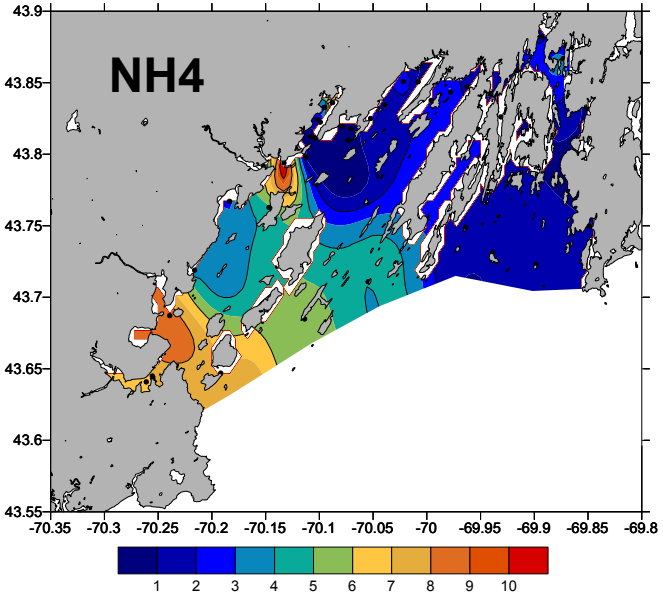


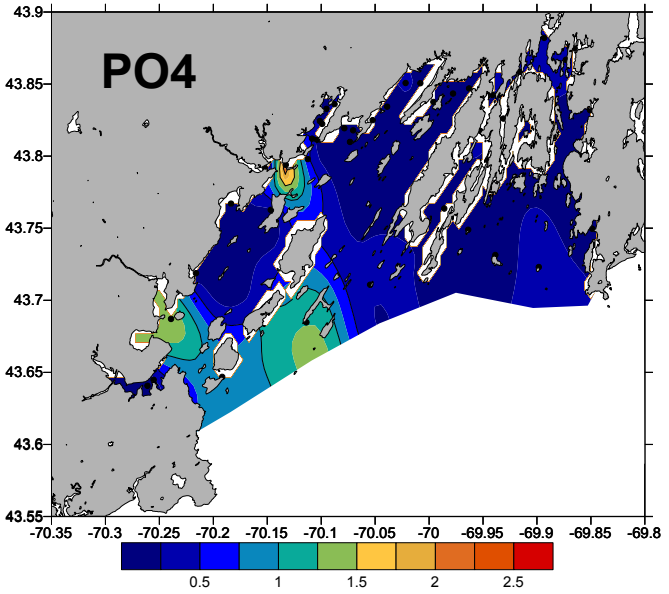


May 2006 Nutrients – High Harbor & Rivers

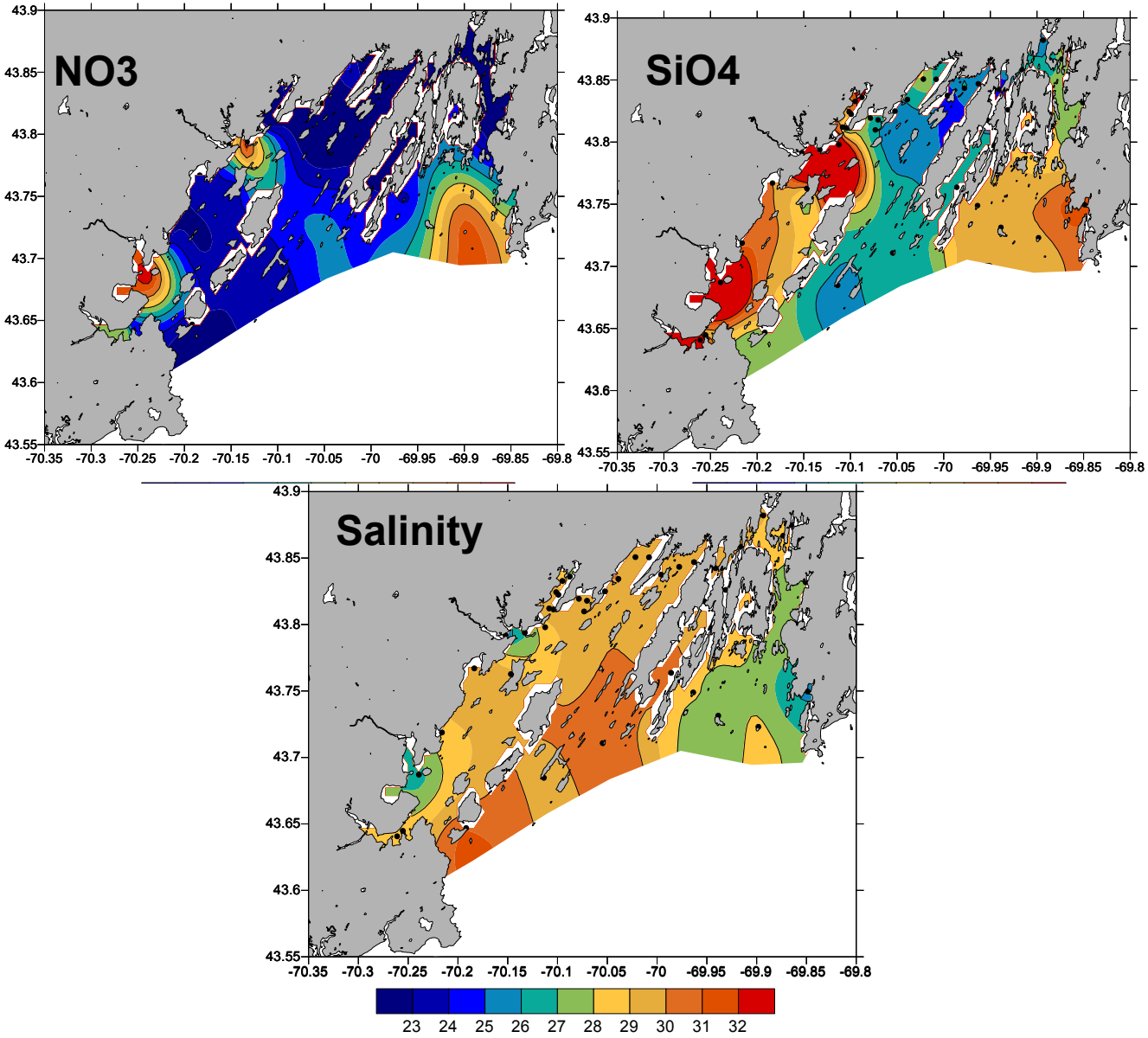








May 2007 – High Harbor, Rivers, & Kennebec River Plume

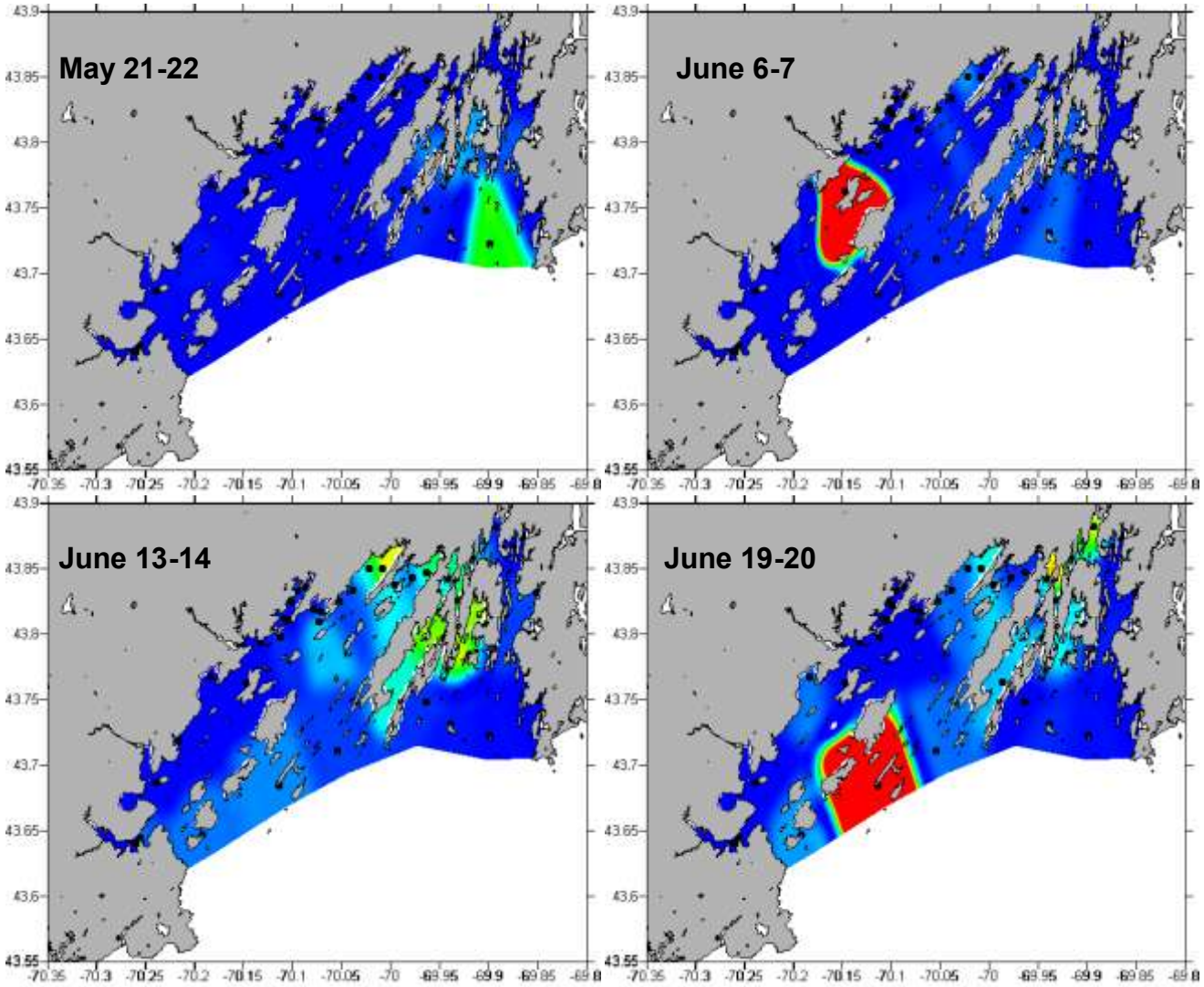


In situ and Nutrient Trends

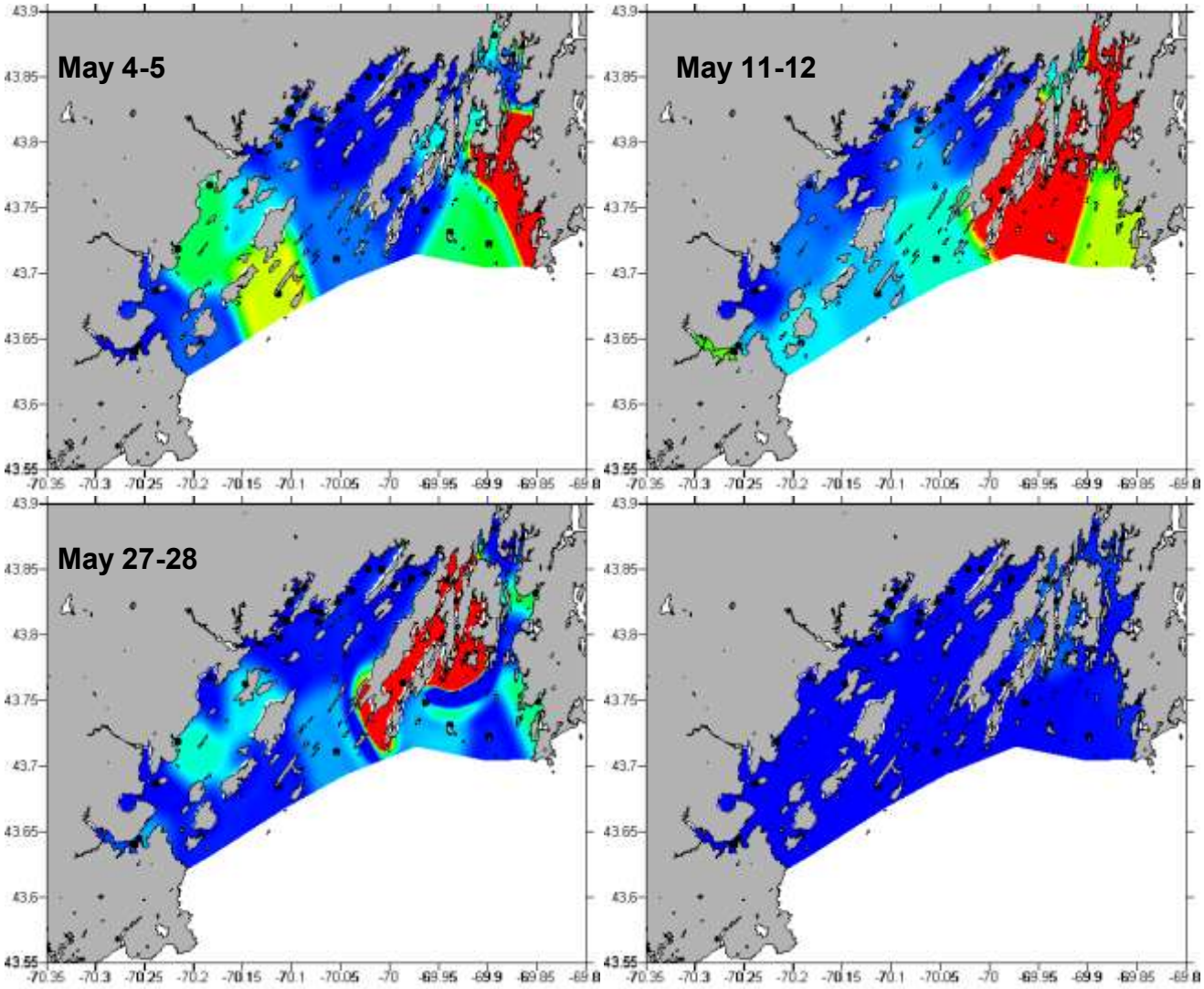
- Freshwater inputs
  - Presumpscot, Royal and Cousins Rivers
  - Portland Harbor
  - Kennebec River Plume

- Nutrient inputs/concentrations
  - Portland Harbor (highest NH_4 and PO_4)
  - Casco Bay Rivers (highest NO_3 and SiO_4)
  - Elevated NO_3 and SiO_4 associated with offshore waters and Kennebec River Plume

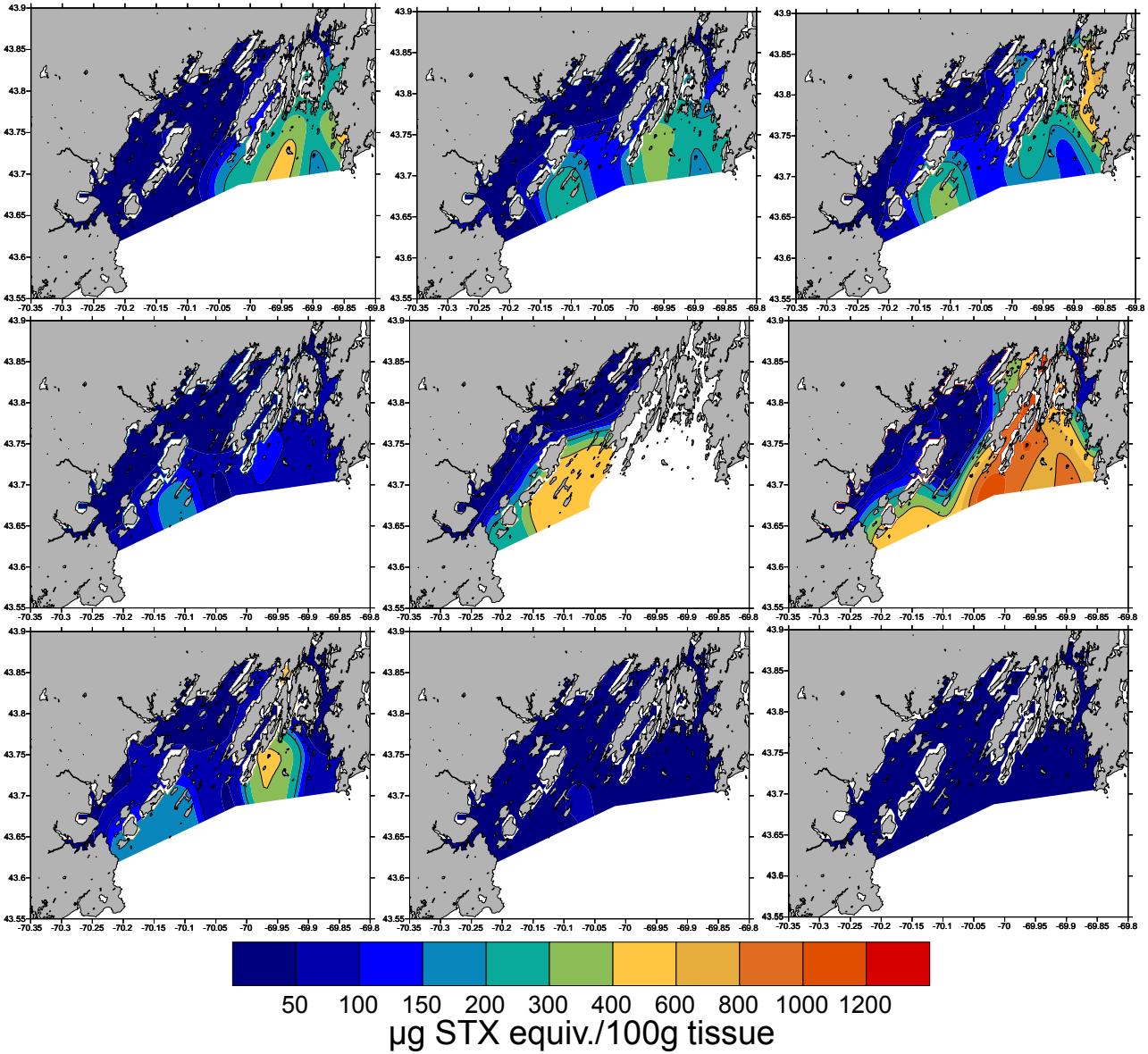
Alexandrium abundance - 2007



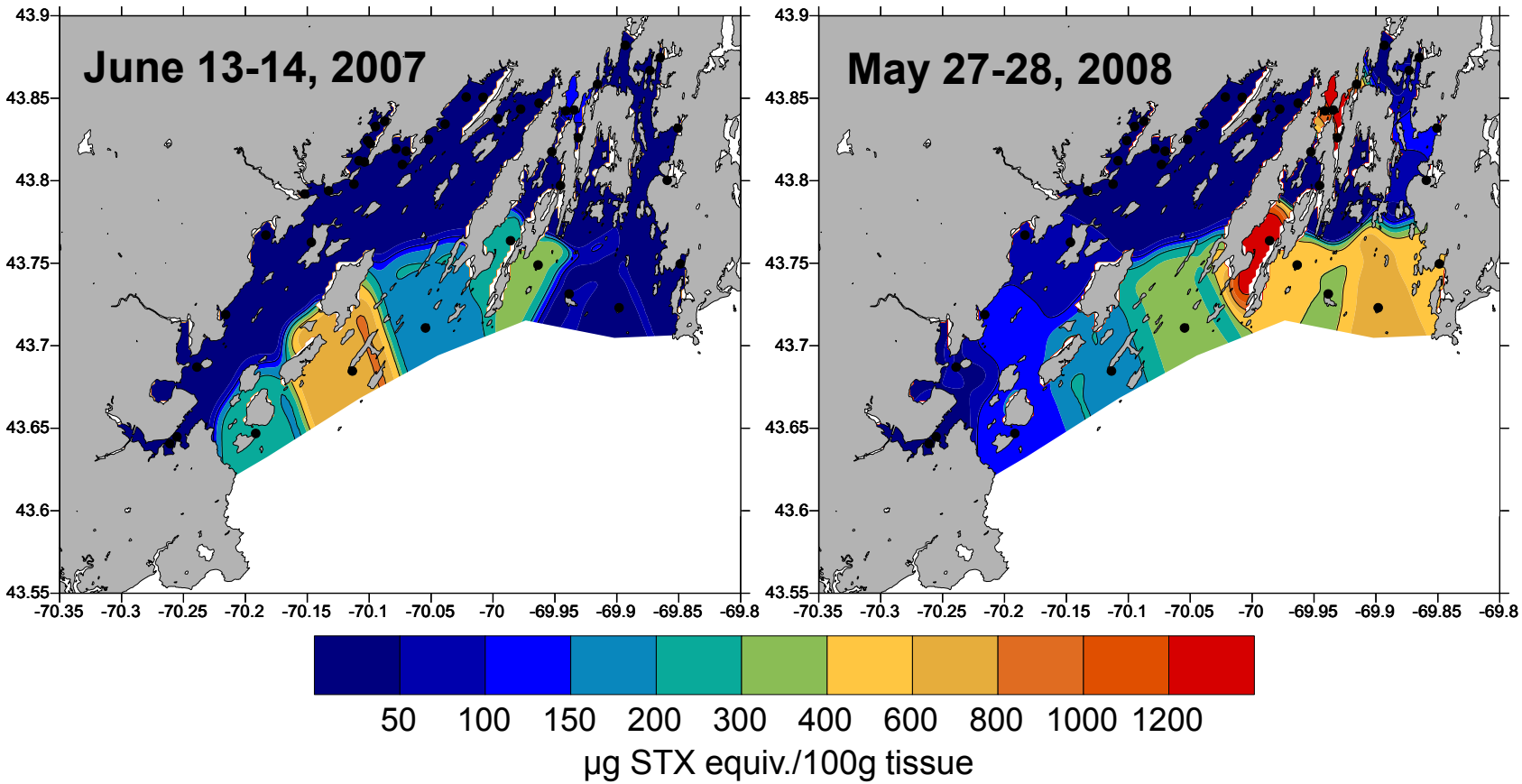
Alexandrium abundance - 2008



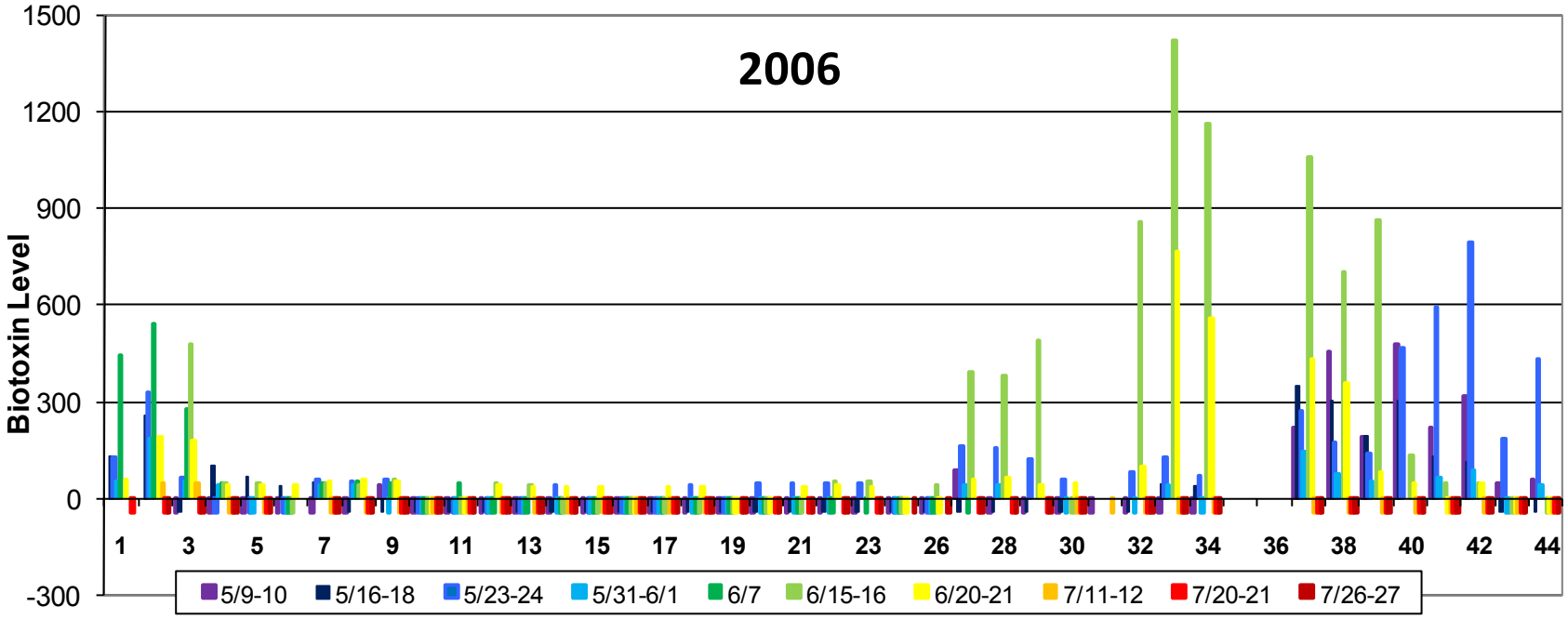
PSP Toxicity – May to July 2006



PSP Toxicity – Peak levels in 07-08



2006 PSP Toxicity



- Higher *Alexandrium* abundance and PSP toxicity in Eastern Casco Bay vs. Western Casco Bay
- No apparent association with higher nutrient levels in Portland Harbor and Casco Bay rivers
- No statistical correlations between nutrients and *Alexandrium* or PSP toxicity

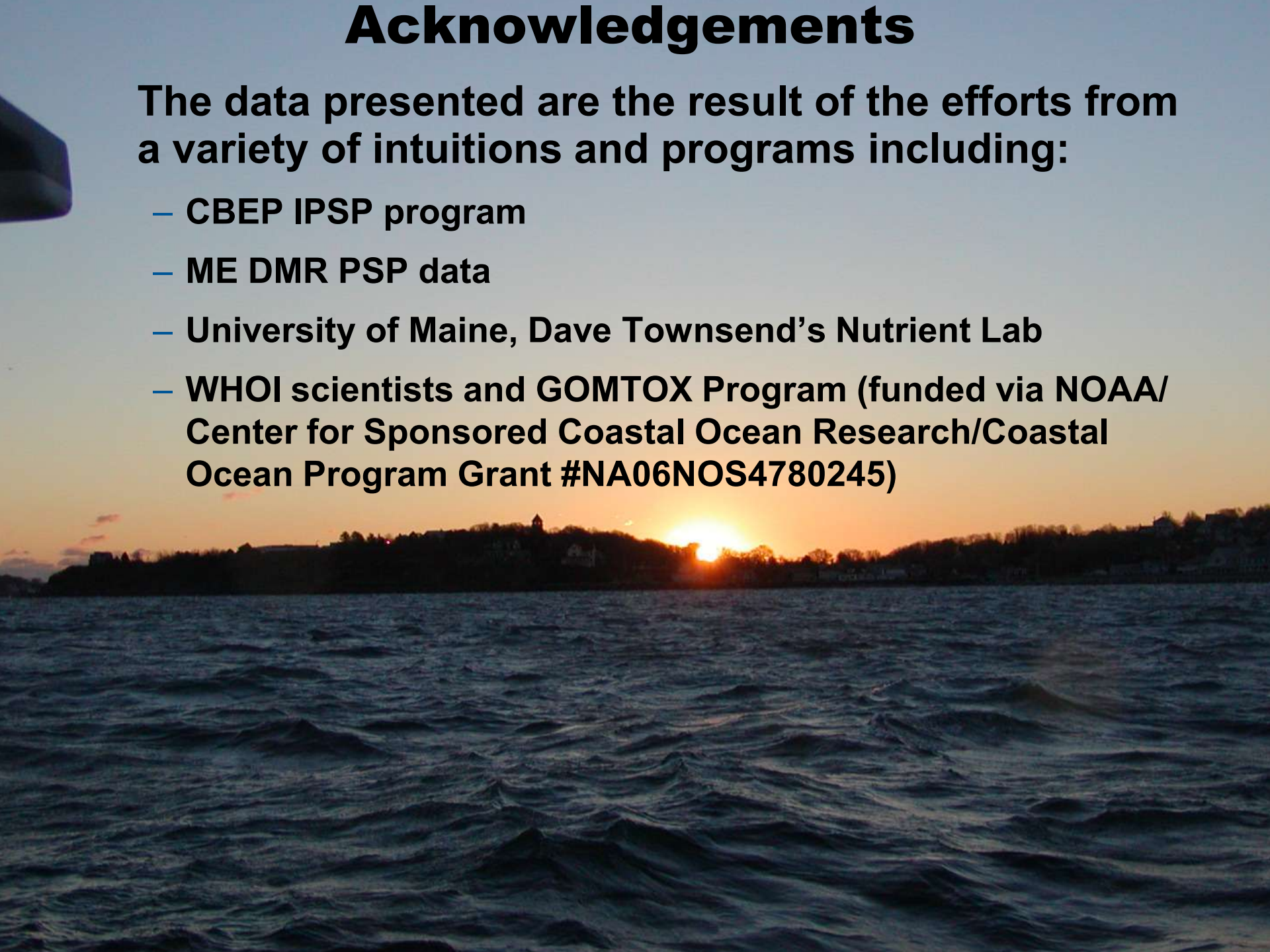
Summary of CBEP IPSP Results

- Clear Western vs. Eastern Casco Bay differences
  - Western Bay had significantly higher concentrations of all four dissolved inorganic nutrients
  - Eastern Bay significantly warmer, more saline, and higher Alexandrium abundance and PSP toxicity
- Earliest toxicity consistently observed at inshore stations - Lumbo's Hole
- Data suggests that the peak bloom and PSP toxicity in Casco Bay is associated with offshore blooms
- Kennebec River/Offshore Plume – strong influence on water quality and Alexandrium blooms in Eastern Casco Bay
- Meteorological conditions play an important roll in whether these offshore waters impact the bay
- No correlations between nutrient concentrations and *Alexandrium* abundance or PSP toxicity for the 2006-2008 Casco Bay IPSP data
- Report link on CBEP website

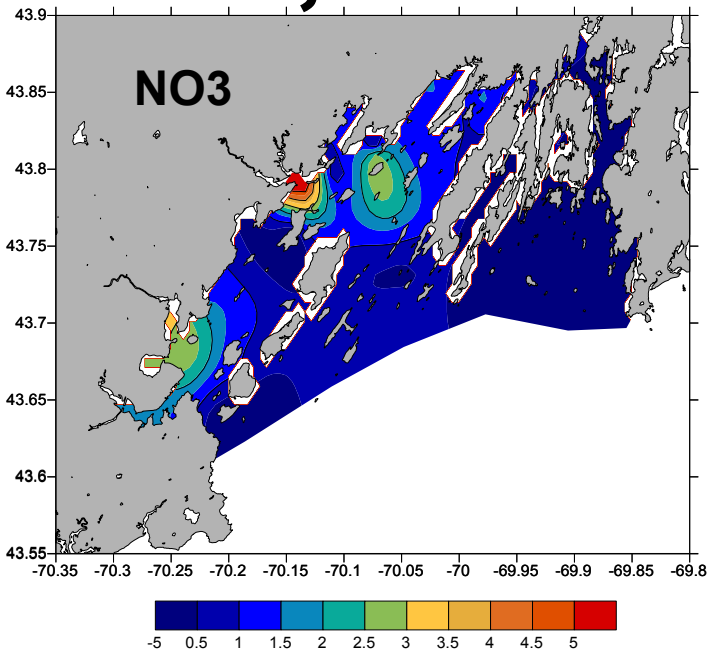
Acknowledgements

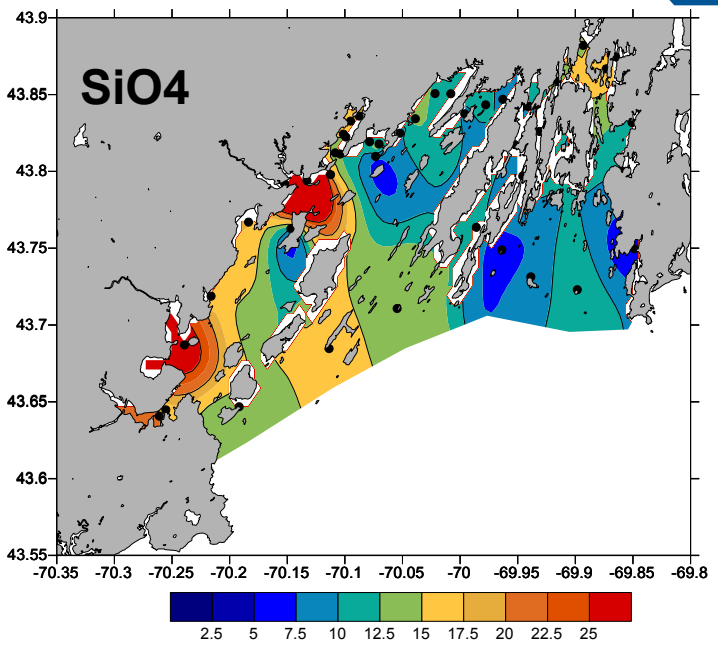
The data presented are the result of the efforts from a variety of intuitions and programs including:

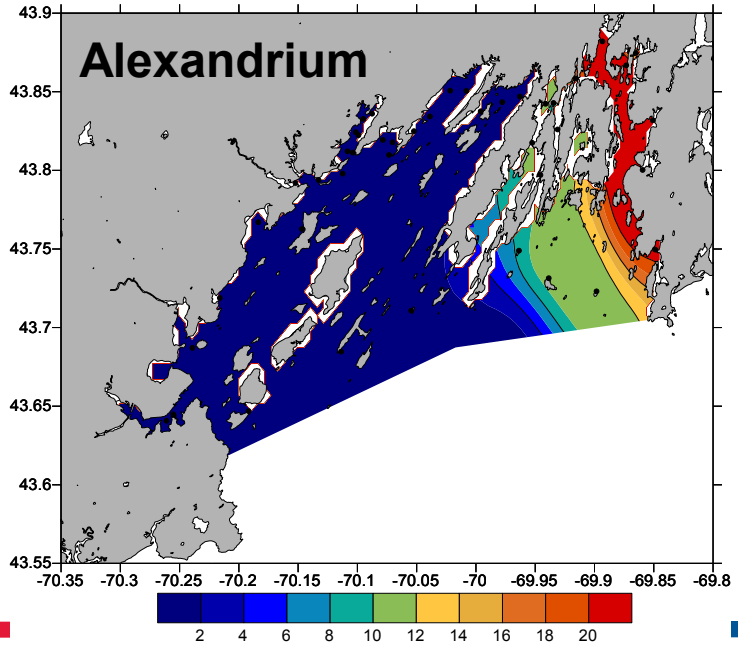
- CBEP IPSP program
- ME DMR PSP data
- University of Maine, Dave Townsend's Nutrient Lab
- WHOI scientists and GOMTOX Program (funded via NOAA/ Center for Sponsored Coastal Ocean Research/Coastal Ocean Program Grant #NA06NOS4780245)

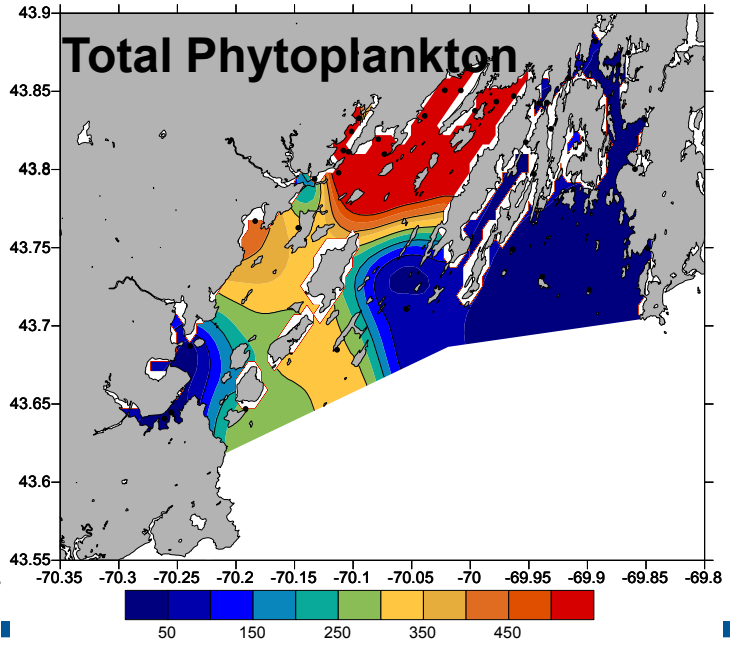


June 20-21, 2006

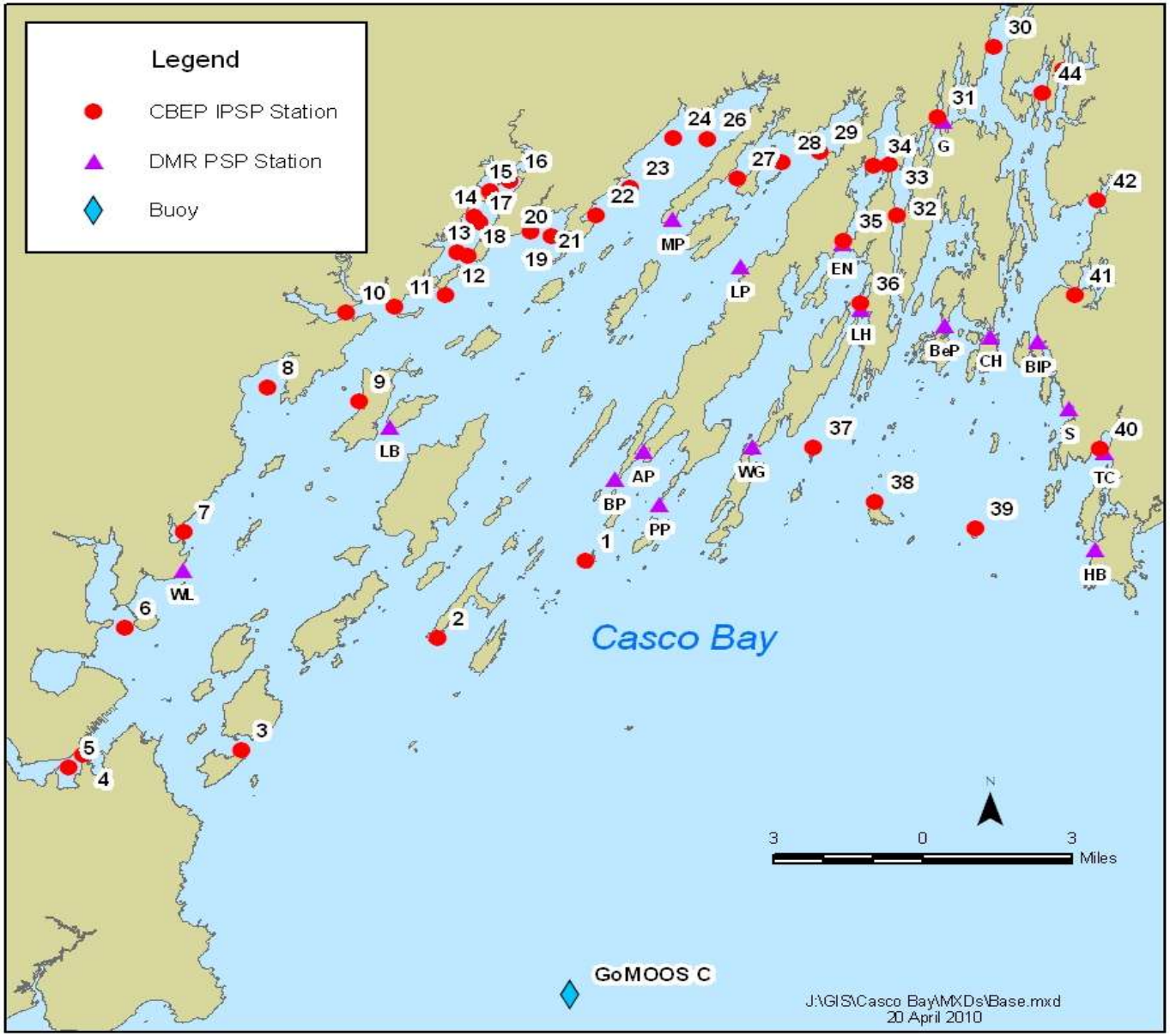








CBEP IPSP and DMR PSP Stations



- CBEP Data
  - *In situ*
  - Nutrients
  - *Alexandrium*
  - PSP toxicity
- ME DMR
  - PSP toxicity
- NERACOOS
  - C Buoy
- WHOI
  - ECOHAB
  - GOMTOX