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October 2010

Red Tides in Inshore and Offshore Casco Bay and Their Relationship to Local and Gulf of Maine Physical and Biological Conditions

Final Report

CASCO BAY ESTUARY PARTNERSHIP

Red Tides in Inshore and Offshore Casco Bay and Their Relationship to Local and Gulf of Maine Physical and Biological Conditions

Final Report

submitted to

Casco Bay Estuary Partnership
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October 2010

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TABLE OF CONTENTS

APPENDICES

FIGURES

TABLES

1.0 INTRODUCTION

Paralytic shellfish poisoning (PSP) is a recurrent and serious problem in marine coastal waters of the U.S. caused by blooms ("red tides") of several toxic dinoflagellate species in the genus *Alexandrium*. In the northeastern U.S., the causative organism is *Alexandrium fundyense* [1]. Potent neurotoxins called saxitoxins produced by this species are accumulated by filter-feeding shellfish and other grazers and are passed on to humans and animals at higher trophic levels, leading to illness, incapacitation, and even death. PSP is a relatively recent phenomenon within the northeastern U.S., but is now recurrent and widespread, affecting vast expanses of the Gulf of Maine (GOM) coastline (Anderson 1997).

Toxicity was historically restricted to the far eastern sections of Maine near the Canadian border, with the first documented PSP in 1958 (Hurst 1975; Shumway *et al.* 1988), but in 1972, a massive, visible red tide of *A. fundyense* stretched from southern Maine through New Hampshire and into Massachusetts, causing toxicity in southern areas for the first time (Mulligan 1975). Virtually every year since the 1972 outbreak, western Maine has experienced PSP outbreaks (Anderson 1997). This pattern was viewed as a direct result of *Alexandrium* resting cysts being retained in western Gulf of Maine waters once introduced there by the 1972 bloom (Anderson and Wall 1978).

As blooms of *A. fundyense* have become common in Casco Bay over the last several decades (Keafer *et al*. 2005a), large-area closures of shellfish harvesting have become annual events. A red tide event in 2005 was unusually intense and prolonged along the New England coast (Anderson *et al*. 2005a). Many studies have pointed to factors outside Casco Bay as drivers of the major 2005 bloom (e.g., Anderson *et al*. 2005a, Anderson *et al*. 2005b, Keafer *et al*. 2005a & b, Pettigrew and Xue 2006, Townsend 2006). In addition, recent studies have pointed to the importance of nutrient dynamics in the development and persistence of *A. fundyense* blooms (e.g., Anderson *et al*. 2008, Love *et al*. 2005). The complex dynamics of bloom development and transport in the Casco Bay region are not fully understood and continue to be the focus of a variety of research efforts.

Following the intense and well publicized 2005 bloom, model predictions suggested that 2006 would also experience a substantial *A. fundyense* bloom in the western Gulf of Maine. In a proactive effort, Maine Department of Marine Resources (DMR) and the CBEP Casco Bay Clam Team instituted the Intensive Paralytic Shellfish Poisoning (IPSP) monitoring program in Casco Bay in 2006 to:

- facilitate fine-scale decisions on closing and reopening shellfish growing/harvesting areas as a result of paralytic shellfish poisoning (PSP) toxicity during the bloom season, and
- develop a better understanding of *A. fundyense* bloom dynamics in Casco Bay.

To address these goals, a monitoring program was developed with a total of 43 stations sampled across Casco Bay on a series of weekly 2-day surveys from April to July in 2006-2008. Mussels were collected for PSP toxin analysis from a large number of sites over a short period of time providing DMR with a fine-scale "snapshot" of PSP across the bay. In addition to the mussel samples, *in situ* parameters were measured during CTD downcasts and coincident nutrient and phytoplankton samples were also collected. In 2007, based on recommendations from an analysis of the 2006 data (CBEP 2007), quantitative analyses of phytoplankton were added to the program. The data for *in situ* temperature and salinity, dissolved inorganic nutrients and *A. fundyense* abundance provide a comprehensive picture with which to understand the incidence and levels of PSP toxin measured.

[1] Both *A. tamarense* and *A. fundyense* occur in the Gulf of Maine. We consider these to be varieties of the same species (Anderson *et al*. 1994; Scholin *et al*. 1995). Neither antibody nor oligonucleotide probes can distinguish between them, and only detailed analysis of the thecal plates on individual cells can provide this resolution. This is not practical for large numbers of field samples. Accordingly, for the purpose of this study, the name *A. fundyense* or simply *Alexandrium* is used to refer to both forms.

The 2006-2008 (and continued efforts in 2009-2010) data have already proved their worth by allowing DMR to restrict closures to specific areas, leaving nearby waters open for harvesting. For instance, in 2009 DMR was able to keep upper reaches of many embayments in eastern Casco Bay open to clamming based on targeted, high-resolution sampling in these waters (D. Couture pers. comm. 7/18/2009). The closures within the bay were also of shorter duration than during previous PSP events. Furthermore, the sampling method employed is more protective of human health than the previously used methodology due to the increased frequency and spatial scale of the testing.

The objective of this report focuses on the secondary goal of the overall program – to develop a better understanding of *A. fundyense* bloom dynamics in Casco Bay – by examining bloom origin and development (outside Casco Bay, within Casco Bay or both) and correlations between water quality data, location, and bloom intensity. We analyzed the IPSP monitoring program 2006-2008 data to characterize the blooms (spatially and temporally), and examine correlations between water quality, toxicity and *A. fundyense* data. Using the IPSP data along with data from other studies, we have examined the role of local and regional physical and biological factors in the larger Gulf of Maine and their potential impact on the onset and temporal and spatial extent of red tide blooms in Casco Bay. We have also examined the role of nutrient availability in the spatial and temporal extent of Casco Bay blooms.

2.0 METHODS

2.1 Sampling Locations

A total of 43 IPSP stations were established within Casco Bay between the Fore River, Portland (at the western end of the bay) and Small Point in Phippsburg (at the eastern end; Figure 1). Sampling was conducted on a series of 2-day surveys with 28 stations sampled on Day 1 in western Casco Bay and 15 stations sampled on Day 2 in eastern Casco Bay, shown in Figure 1. Three of the stations sampled on Day 2 represented existing stations (red dots) routinely sampled by DMR – IPSP stations 31, 35, and 36 are collocated with DMR stations Gurnet, Ewin Narrows, and Lumbo's Hole, respectively. These stations were included to allow comparison of boat-based and land-based sampling results. All other CBEP IPSP stations represented new stations that intensified the spatial proximity of sampling; most stations represented specific, individual harvesting areas. Six of the stations were located "offshore" adjacent to islands (stations 1, 2, 3, 37, 38, and 39) to allow comparison of the chronology of inshore and offshore blooms.

During the initial occupation of the sampling locations each year, buoys were set for mussel deployments and *in situ* data profiles were collected along with nutrient and phytoplankton samples. No mussel samples for toxicity testing were collected during the initial setup. In 2006, the moorings were deployed April 11 & 12 and subsequently ten surveys were conducted between May 9 and July 27 for the collection of mussels and additional data and water samples. All stations were sampled on each survey except for two surveys (June 8 and July 11) that were shortened due to inclement weather. In 2007, the moorings were set April 21 & 23 and mussel bags deployed on May 3 & 4. During each of these initial surveys only *in situ* data were collected. Seven full surveys were conducted from May 10 to July 25 in 2007. In 2008, the moorings and mussels were deployed April 23 &24 and *in situ* data were collected during that survey. Eight additional surveys were conducted from May 4 to August 5, but survey activities were limited due to weather on June 9, July 7, and July 21. A summary of the sampling times, locations and data is provided in Appendix A.

2.2 Field Sampling and Laboratory Procedures

The field sampling and laboratory procedures used in 2006 were detailed in CBEP 2007. The same procedures were used in 2007 and 2008 for mussel collection, PSP toxicity testing, *in situ* data profiles, and nutrient sample collection and analysis. New procedures were instituted for the quantitative sampling and analysis of phytoplankton and *Alexandrium fundyense* in 2007 and are described below.

Two types of phytoplankton samples were collected for live counts and molecular probe analyses (e.g. Anderson *et al.* 2005c), respectively. For the live counts, 5-liter samples were sieved though a 20-µm mesh. The >20µm fraction retained on the sieve was backwashed and stored in filtered seawater (without preservative) for immediate counting of *A. fundyense* by DMR interns. These data have not been examined for this report, but were included in DMR's real time reporting. The fluorescent probe method described by Anderson *et al*. 2005 was used to confirm and enumerate the *Alexandrium fundyense* cells that were present. This method uses a molecular probe (NA-1) that has been developed for this species along with the appropriate optical filters on an epifluorescent microscope (Anderson *et al*. 2005c; Keafer *et al*. 2005a; Gribble *et al*. 2005). For the probe sample collection, a 2 liter sample was also sieved through a 20-µm mesh. The >20µm fraction was preserved with formalin until transfer to methanol could be completed, a step that must be done within 48hours. This process entailed centrifuging the samples and removing the formalin by aspiration leaving a pellet of material intact. The pellet was resuspended in 100% cold methanol for storage at -80°C until analysis.

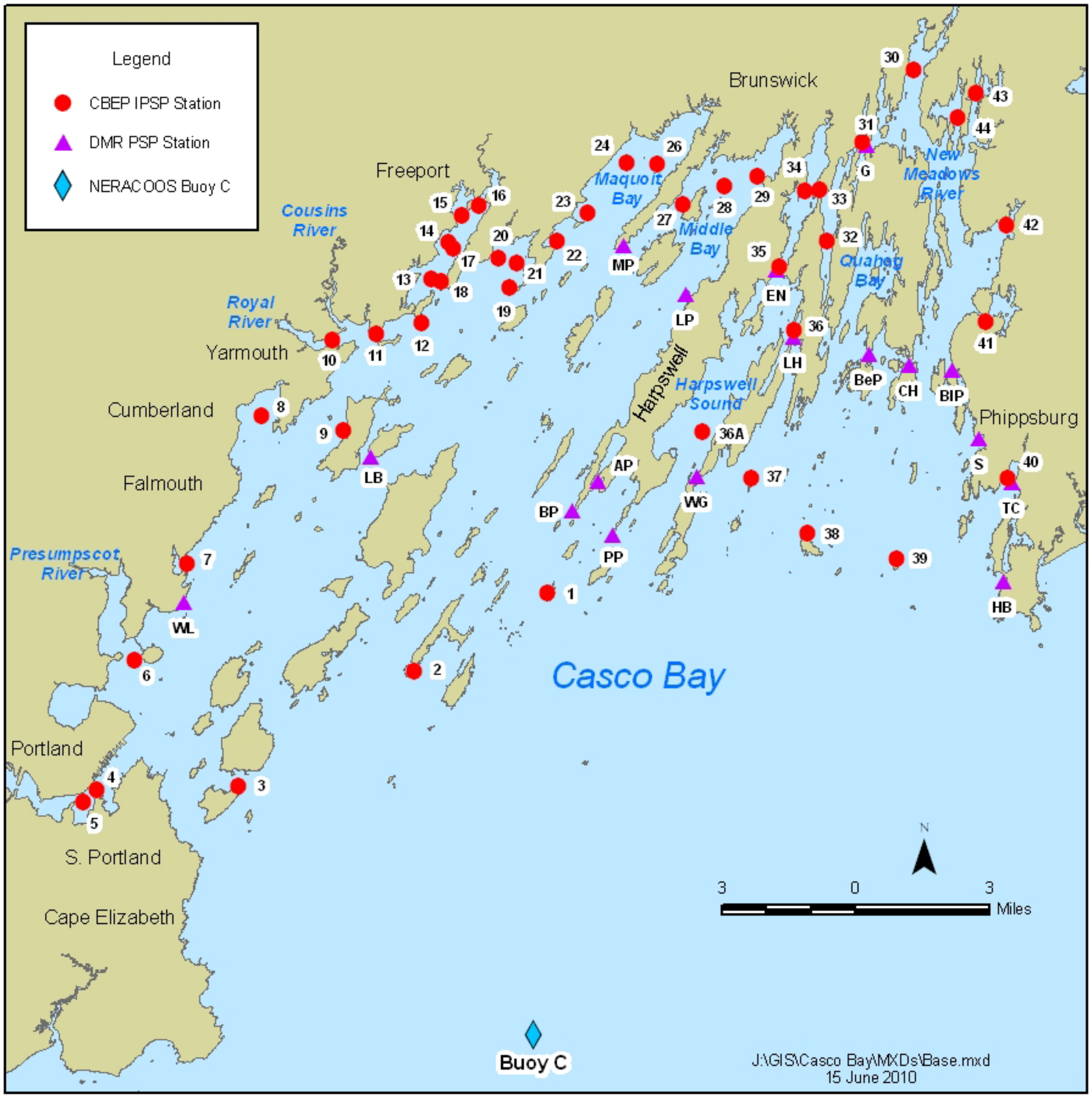

Figure 1. Intensified PSP Study and DMR PSP Station Locations in Casco Bay.

2.3 Data Management

Data were acquired from CBEP IPSP program and a variety of ancillary sources. The CBEP IPSP data included in situ profile measurements, nutrient concentrations, PSP toxicity levels, and *Alexandrium* abundance. These data were compiled and loaded into an MS Access database. The data were delivered by CBEP in excel workbooks and were loaded into the existing project database developed for the 2006 report (CBEP 2007). All data delivered by CBEP were fully quality assured and ready for data analysis. After loading, a quality assurance audit verified that all data received was accurately and completely uploaded into the database.

In addition to the CBEP IPSP program data, we also obtained local meteorological information (precipitation at Portland Jetport and wind direction/speed from the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) buoy C), river flow data from USGS, and DMR PSP toxicity data from their Casco Bay stations. Data from WHOI research cruises in 2006-2008 conducted in the western Gulf of Maine were also examined to provide a regional context for the Casco Bay blooms.

2.4 Data Analyses

Our data analyses consisted of a range of graphical and statistical approaches. Summary data tables were produced showing station depth, surface and station mean temperature and salinity, dissolved inorganic nitrogen concentrations, PSP toxicity, and *Alexandrium* counts as available for each sampling event and station (Appendix A). The summary results were all calculated within the MS Access database using appropriate queries. Subsequently, the data were examined graphically to assess temporal trends in the data (XY time series) and spatial patterns across the bay (scatter and contour plots) and statistically to evaluate correlations between various parameters and across/between locations.

2.4.1 Graphical Analyses

Horizontal contour plots were produced for each of the parameters for each survey using Surfer to show the spatial distributions across Casco Bay. For *in situ* temperature and salinity profile data, the contour plots were produced based on surface data as the majority of the stations were well mixed and the samples for the other parameters were all collected from the surface waters. The contour plots were produced using the "Minimum Curvature" method which provides a relatively smooth interpolation grid while attempting to honor the data as closely as possible. Essentially this method produces grids that smooth out sharp data peaks while combining the data spatially in a similar manner – it works well with the narrow embayments in eastern Casco Bay. Time series plots were produced in MS Excel to evaluate how parameters varied at individual stations across the bay or within specific embayments. In combination with the statistical evaluation, these graphical representations provided spatial and temporal context and allowed us to interpret the data across the bay and in context of the greater western Gulf of Maine.

An upwelling/downwelling index based on wind data from the NERACOOS C buoy was developed and compared to *in situ* data, nutrient concentrations, *Alexandrium* abundances or PSP toxicity (Fraga *et al*. 1988). Relaxation of upwelling or strong downwelling events may pull offshore waters into embayments of eastern Casco Bay. Precipitation and river flow data were also examined to see if there were any associations between rain/high flow events and trends in the Casco Bay data.

2.4.2 Statistical Analyses

Statistical analyses were performed on the data collected in 2007 and 2008 at the 43 stations in Casco Bay. As quantitative *Alexandrium* data were not available for 2006, it was not included in this suite of tests. This section summarizes the data, discusses summary statistics that were calculated, and presents the methods used to compare the results across sampling locations.

Data: Water quality data were collected at 43 sampling *stations* in Casco Bay (identified by station number). Casco Bay was divided into two *areas* (Eastern, Western) and 11 *groups* within these two areas:

- OW – Offshore west (1-3)
- PH – Portland Harbor (4-5)
- RV – Rivers – Presumpscot and Royal (6, 10-11)
- FS – Foresides (7-9)
- HR – Harraseeket River (12-18)
- MQ – Maquoit Bay (19-24, 26)
- MB – Middle Bay (27-29)
- HS – Harpswell Sound (32-36)
- NM – New Meadows River (30-31, 41-44)
- OE – Offshore east (37-39)
- TC – Tottman Cove (40)

Eleven parameters were examined for this set of analyses: station maximum depth, average temperature, average salinity, surface temperature, surface salinity, PSP toxicity, *Alexandrium* counts (cells/L), and concentrations (μM) of NO_3+NO_2, SiO_4, NH_4, and PO_4.

Summary Statistics: The summary statistics were calculated for each parameter for each area, station group or embayment, and station using SAS (Appendix B). The summary statistics included the number of observations, the minimum, the maximum, the median, the mean, and the standard deviation. In addition to these summary statistics, correlations were calculated between the 11 parameters to determine the degree to which the parameters were related. Parametric (Pearson) and nonparametric (Kendall) correlations were calculated using all stations and sampling events combined. The Pearson correlation represents the linear relationship of two parameters, while the Kendall correlation represents a measurement of the concordance of two parameters (i.e., the likelihood that the highest values of one parameter are associated with the highest values of the other parameter).

Comparison of Sampling Locations: Analysis-of-variance (ANOVA) methods in SAS were used to compare the mean values of each parameter between various sampling locations. The sampling locations are arranged so that a station is in a single location, and a group is in a single area. Because of the nature of the locations, the following "nested" model was used for the ANOVA:

$$R_{ijkl} = \mu + A_i + L_{j(i)} + S_{k(j)} + \varepsilon_{ijkl}$$

where R_{ijkl} = observed measurement for area i, location j, station k, and sampling event l;
μ = overall mean response;
A_i = difference from overall mean due to Area i (East, West);
$L_{j(i)}$ = difference due to Group j (nested within Area i);
$S_{k(j)}$ = difference due to Station k (nested in Group j); and
ε_{ijkl} = random error for area i, location j, station k, and event l.

A three-factor ANOVA was performed using this model for each of the 11 parameters to determine whether there were differences in the average value between the two areas, between the 11 groups, and between the 43 stations. Specifically, this analysis determined:

1. Whether the average readings were different between the two areas,
2. Whether the average readings of the groups varied *within area*, and
3. Whether the average readings of the station varied *within group*.

To determine which specific areas, groups, and stations differed, three separate Tukey multiple comparison analyses were performed. In the Tukey multiple comparisons, the mean values for each site (area, group, or station) are compared to all other sites with an overall significance level for *all* comparisons of 5%. In the first, the two areas were compared; in the second, the 11 groups were compared (without regard for area); in the third, the 43 stations were compared (without regard for group or area). While this Tukey analysis does not specifically align with the overall nested ANOVA model, the results do indicate how the areas, groups, and stations differed with regard to the 11 parameters.

3.0 DATA RESULTS

The data fall into a number of different categories based on the sampling methods used (*in situ* profiles, near-surface nutrient and *Alexandrium* samples, and mussel deployments). The *in situ* downcast profiles have not been examined on an individual basis in this report. Instead, surface (<1 m) and profile average *in situ* values were calculated from the downcast data. A table of these surface and average *in situ* salinity and temperature values and the associated nutrient concentrations, PSP toxicity, and *Alexandrium* abundances is presented in Appendix A.

3.1 DMR PSP Shellfish Closures

During all three years, there were PSP closure areas throughout Casco Bay for mussels, carnivorous snails, and European oysters (Figure 2), but eastern Casco Bay was always the first area to report toxicity. The first shellfish closure in Casco Bay in 2006 was reported in the Lumbo's Hole area of Harpswell Sound on April 25th, which was about two weeks earlier than the 2007 closure (Figure 2). Similarly in 2008, the first signs of toxicity were seen at Ewin Narrows to the north of Lumbo's Hole in Harpswell Sound in late April. Rapidly rising scores at other nearby stations led to a PSP closure on April 29, 2008 in the Sound and New Meadows River. This same pattern was evident in 2010, based on a late February prediction released by scientists at WHOI of an early and major *Alexandrium* bloom (http://www.whoi.edu/page.do?pid=7545&tid=282&cid=69586&ct=162) that led ME DMR to begin their shellfish sampling in early March. They recorded toxicity at the Lumbo's Hole station on March 23rd (pers. comm.. Darcie Couture). The Harpswell area is suspected of having a local, self-seeding population or seedbed of *Alexandrium* cells and is historically one of the first closures in western Maine (Bean *et al*. 2005).

One of the primary goals of the IPSP monitoring is to provide data for more "surgical" closures of shellfishing beds within Casco Bay. In 2006, the first soft-shell clam closure was put in place on May 11th closing much of Casco Bay to shellfishing (Figure 3), but due to the efforts of the intensified PSP monitoring program many of the upper bays from the Harraseeket River west to the New Meadows River remained open to harvesting. On June 14th, all of the western Maine waters from Cousins Island in Casco Bay to the NH border were closed, but the upper reaches in eastern Casco Bay remained open. By June 28th, PSP toxicity decreased below regulatory levels in western Casco Bay. DMR was able to open many areas of the bay to shellfish harvesting by late June (Figure 3). The soft-shell clam closure covering western Maine (NH border to Port Clyde including waters of Casco Bay in bottom right panel of Figure 3) was lifted on July 13th.

In 2007, PSP toxicity levels were lower and the only closure for soft-shell clam harvesting in Casco Bay was instituted on June 22nd and focused on the areas offshore of New Meadows River from about the middle of Bailey Island (Harpswell) across to Harbor Island (Phippsburg) and to the south. The IPSP data from within New Meadows River helped keep that productive shell fishing area open for harvest.

The 2008 red tide event was stronger in Casco Bay than in 2007 and the first closure for soft-shell clams was issued on May 20th for all of the area from Basin Point (Harpswell) to Small Point (Phippsburg) out to federal waters and included the upper reaches of Harpswell Sound and New Meadows River. However, on May 28th, the data collected at IPSP buoy stations in the New Meadows allowed ME DMR to create an exception area for the harvest of soft-shell clams in the upper New Meadows River (Figure 4). This exception area persisted for the remainder of the period during which the lower New Meadows and Harpswell Sound were closed to clamming (May 28 to June 24) and provided local shell fishermen nearly a month of harvesting that would not have been possible without the data from the ISPS monitoring buoys.

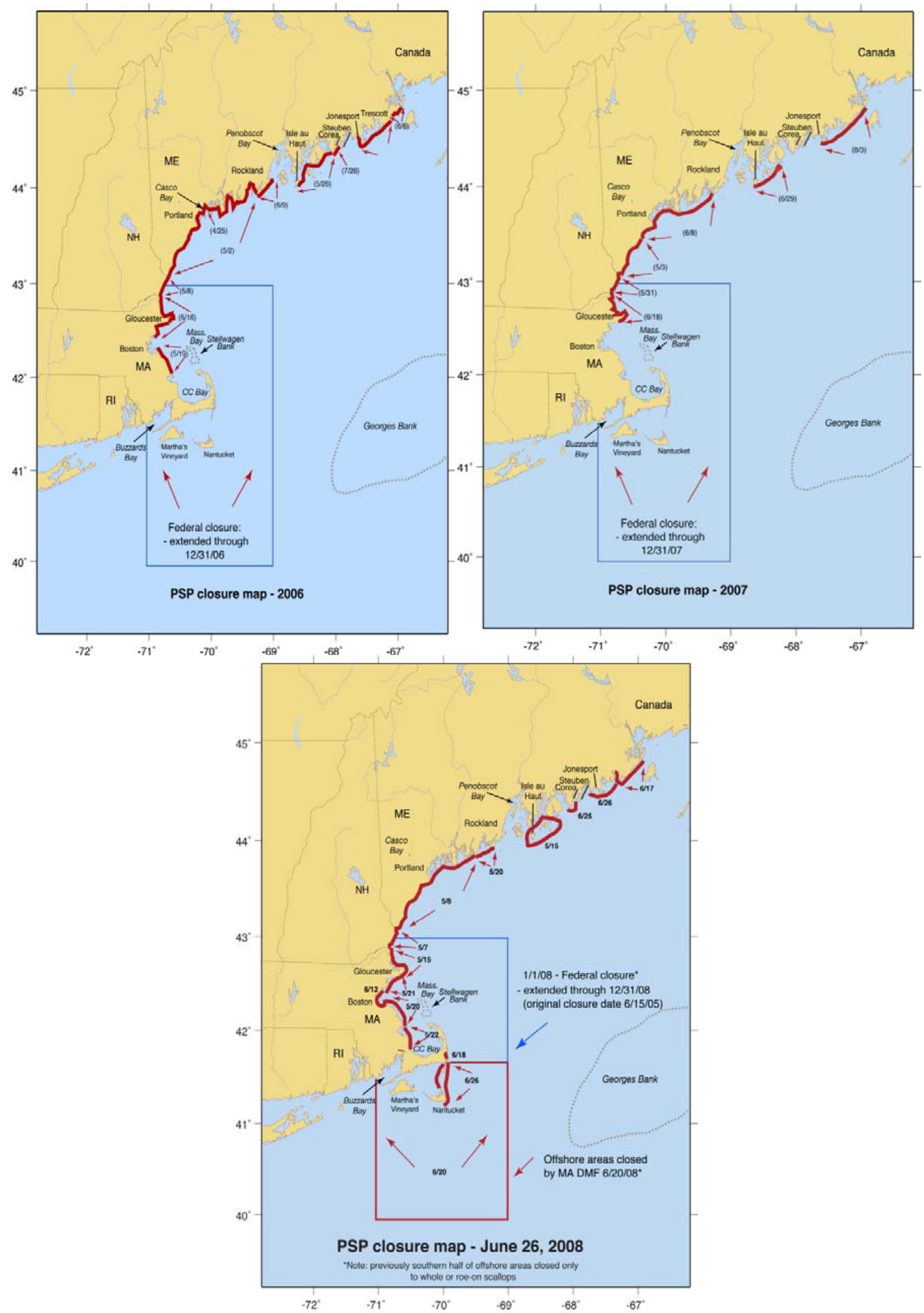

Figure 2. PSP shellfish closures (red lines) for western Gulf of Maine for 2005 through 2008. (produced by Judy Kleindinst from information provided by the Massachusetts Division of Marine Fisheries, the New Hampshire Department of Environmental Services, and the Maine Department of Marine Resources see http://www.whoi.edu/northeastpsp/ for additional information.)

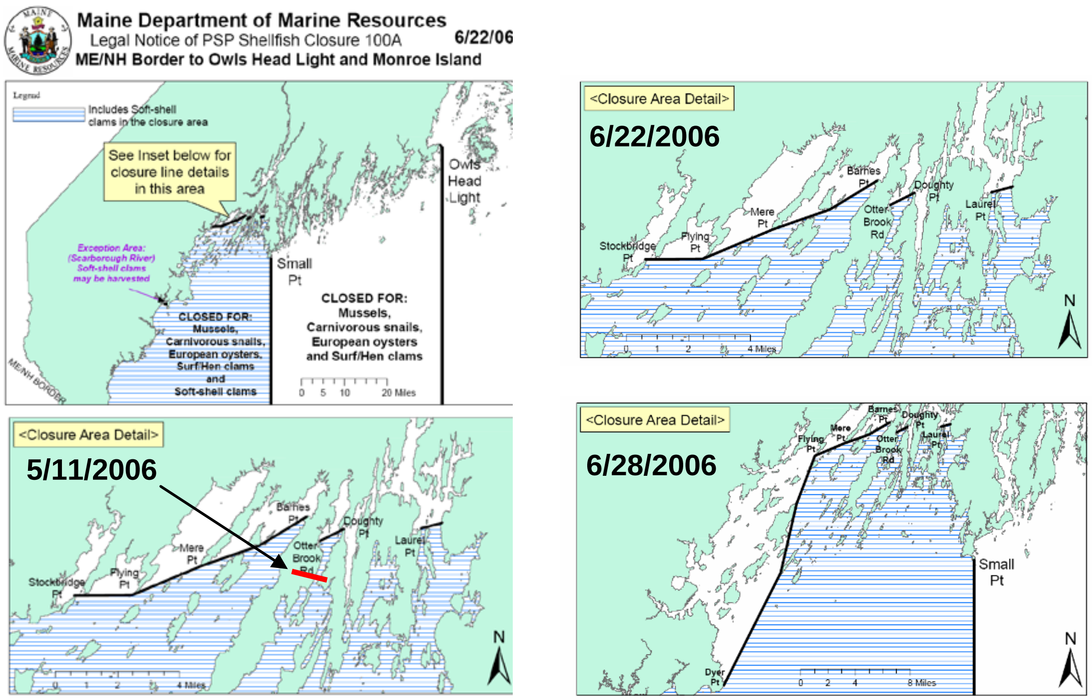

Figure 3. Maine DMR PSP shellfish closure maps for western Maine and Casco Bay from May 11th, June 22nd, and June 28th, 2006. The only change from May 11 to June 22 is the expansion of closures to the north in the Harpswell area above Ewing Narrows (red line represents May 11th closure boundary; figure from CBEP 2007).

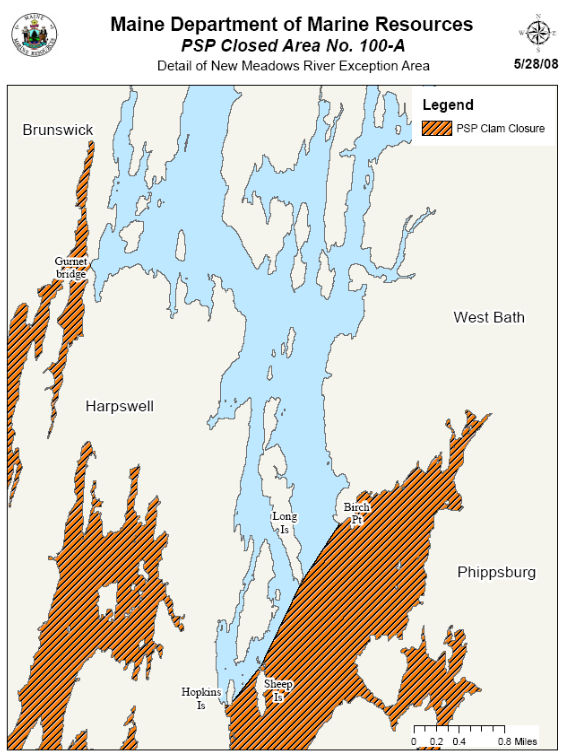

Figure 4. Maine DMR PSP shellfish closure exception map for upper New Meadows River in 2008

3.2 Meteorological Conditions

The years of 2006-2008 were marked by high precipitation and river flow. On an annual basis 2008 was the wettest, followed by 2006 and then 2007 (NOAA NWS Portland). Precipitation data from the Portland International Jetport shows major rain events occurring throughout the April-July period during each of the monitoring years (Figure 5). April-July 2006 led the way with seven major rainfall events with recorded levels of >1 inch while 2007 and 2008 each had four such events. High river flows were coincident with these rainfall events (Figure 6). 2006 was unique because river flow was relatively low in April with peak flows in the May and June period. In contrast, during both 2007 and 2008, river flow along the Androscoggin River (and the Kennebec) peaked in April during the freshet that resulted from the combination of storms and snowmelt, a more typical spring condition.

The storms that brought these rains also pushed offshore waters toward shore on occasion. Wind data from the NERACOOS buoy C shows the direction and strength of prevailing winds off Casco Bay from April to August 2006-2008 (Figure 7). In 2006, two features of interest are the northeasterly winds that occurred in early May and again in early June. These strong Nor'easters resulted in alongshore current flows that brought coastal Gulf of Maine waters into Casco Bay from the northeast. Northeast winds also dominated the coastal circulation in early April and mid May 2007 and mid May and early June in 2008.

To take a closer look at the impact of the winds on near coastal circulation, the approach used by Janzen *et al.* 2005 was applied to the NERACOOS buoy C wind data to examine the alongshore wind component. Due to the orientation of the coast near Casco Bay, the wind data were offset by 70° versus true north. The resulting along shore component is presented in Figure 8 where downwelling favorable winds are negative (towards the southwest) and upwelling favorable winds are positive. The most cohesive periods of downwelling favorable winds are highlighted in Figure 8. These are slightly offset from the periods described above for the Nor'easters. These data will be compared to representative water properties in later sections to help identify trends and potential source waters.

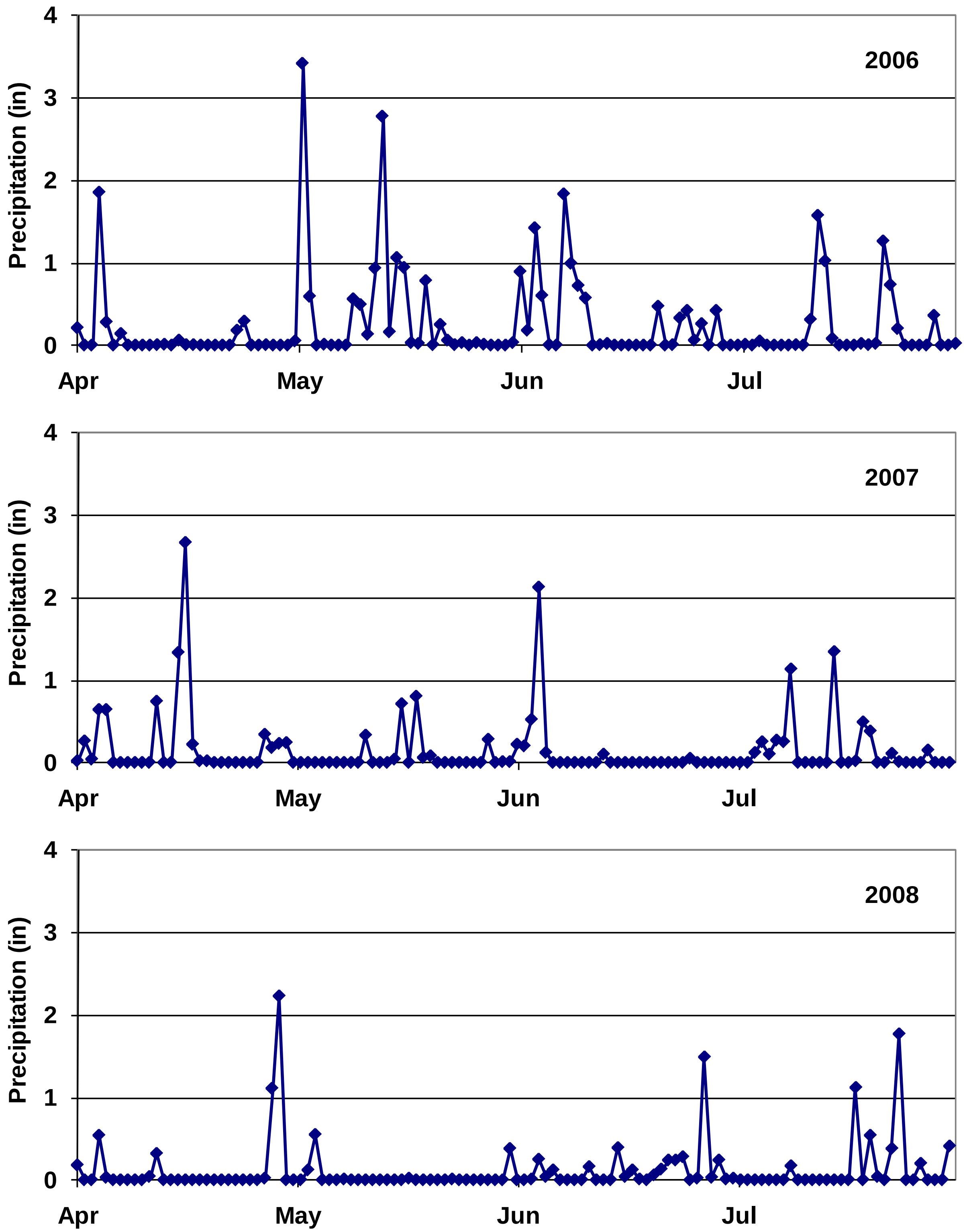

Figure 5. Precipitation (in) at Portland International Jetport (April-July 2006, 2007, & 2008)

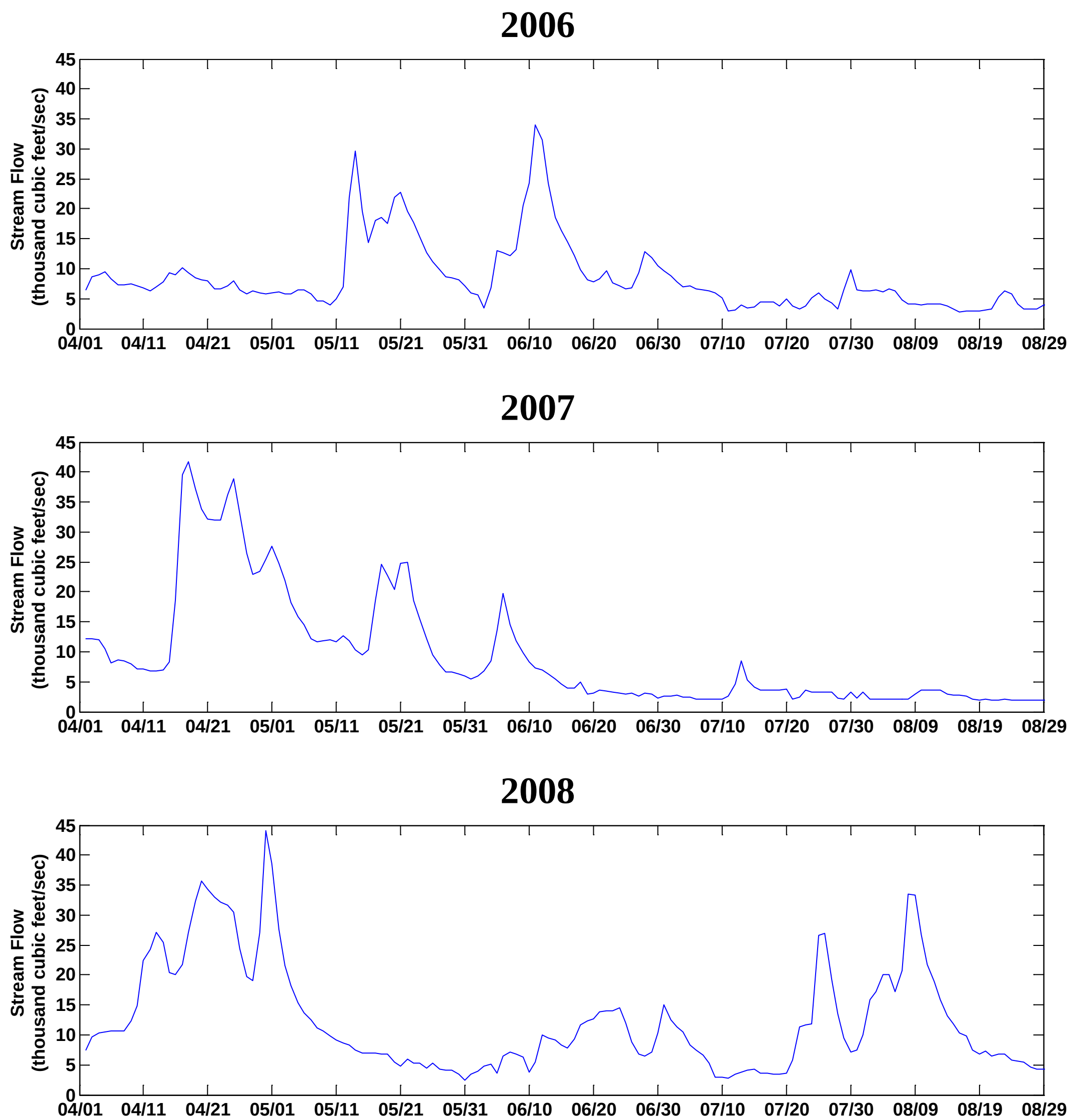

Figure 6. River flow (1,000 ft^3/sec) at USGS gauging station on the Androscoggin River (April-August 2006, 2007, & 2008)

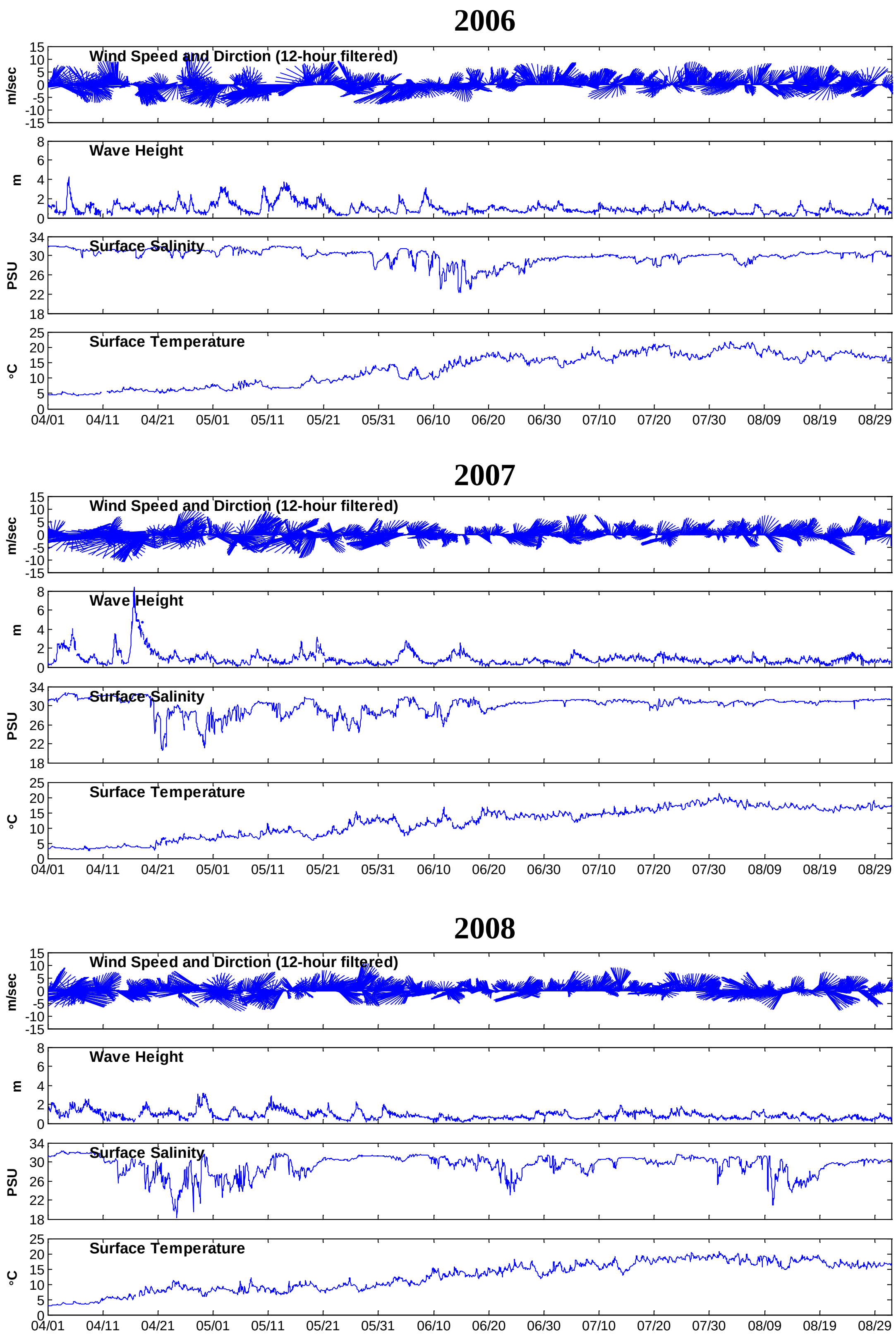

Figure 7. Wind, wave and surface data from NERACOOS buoy C in Casco Bay (April-August 2006, 2007, & 2008). Data from http://gyre.umeoce.maine.edu/gomoos.php.

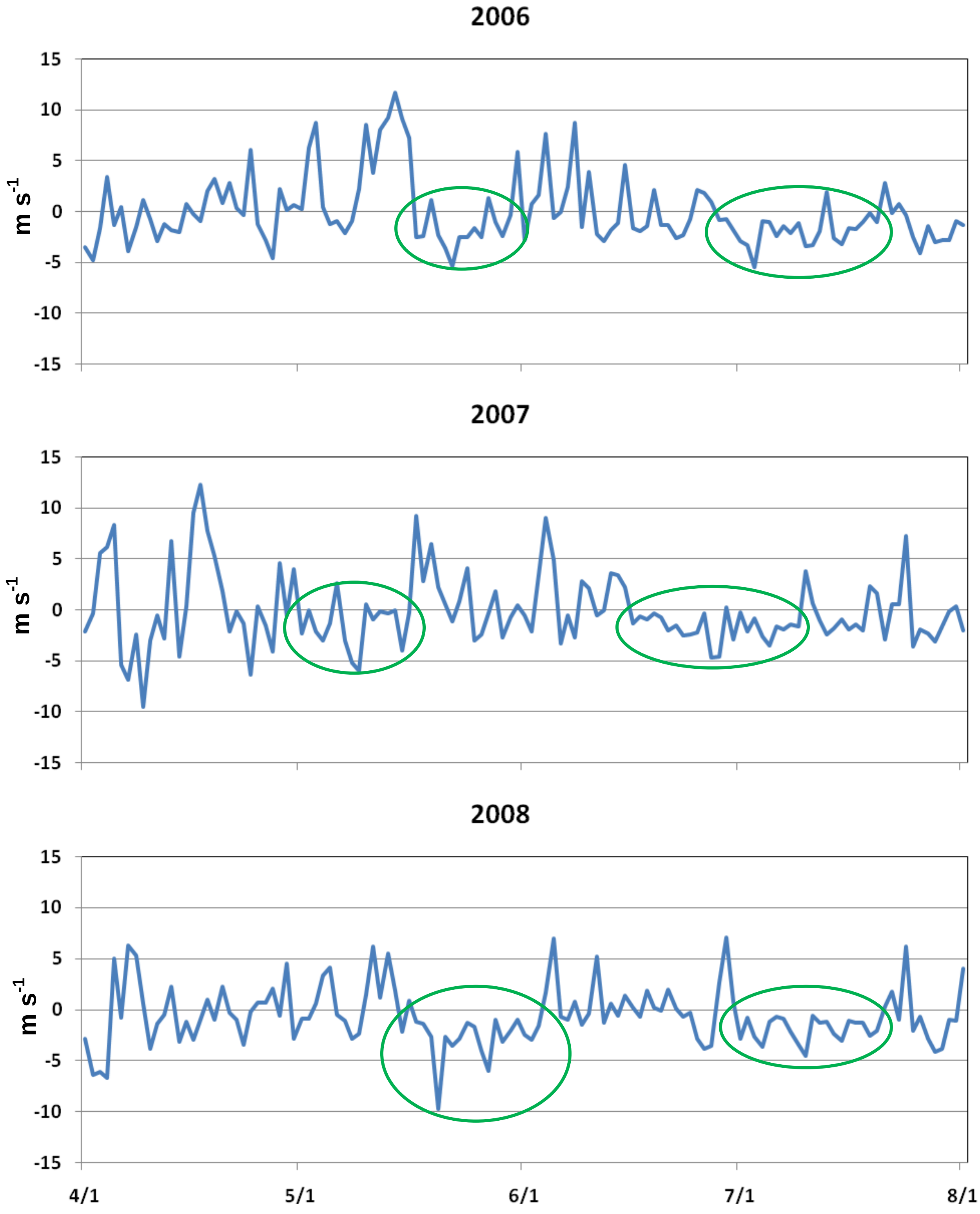

Figure 8. Time series of alongshore winds at NERACOOS Buoy C in Casco Bay (April-July 2006, 2007, & 2008). Positive values indicate upwelling-favorable conditions and negative values indicate downwelling-favorable conditions. Prolonged downwelling-favorable periods are highlighted, as these are implicated in the delivery of offshore *Alexandrium* into nearshore waters, including Casco Bay.

3.3 Temperature and Salinity

Surface water temperatures ranged from a minimum of ~5°C in April 2007 at the western offshore stations (1-3) to a maximum of >22°C in the upper reaches of the New Meadows River in late July 2006 (Appendix A). Time series plots of temperature suggest more temporal than spatial variability across the bay. Although there is a general pattern of increasing temperatures by date, in 2006 the May to July surveys appear to break out into three separate temperature regimes. Surface water temperatures were around 10±2°C during the first three May surveys, 15±2°C for the 5/31 to 6/16 surveys, and 20±2°C for the remaining surveys. The only exceptions are the offshore and Portland Harbor stations that remained cooler than the other areas during late June and July. These stations also tended to remain cooler than the stations to the east during 2007 and 2008. In 2007, surface water temperatures rose over time at a relatively consistent rate from survey to survey. There was a large increase in temperatures in 2008 from the end of May (27-28) to early June (9-10) that broke the data out into two periods. On the whole, there was little year to year variability as the trends in temperature were driven by the seasonal increase in temperatures from April through July.

In contrast, surface salinity values showed a number of clear temporal and spatial patterns based on station data (Figure 9). Lower salinity values were consistently observed in Portland Harbor (stations 4 and 5 are influenced by the Fore River and station 5 is in very close proximity to the South Portland Sewer District's Fore River outfall) and in association with the Presumpscot (station 6) and Royal (stations 10 & 11) Rivers. The lowest values at these stations (<15 PSU) were observed following major rain events during each of the study years. In 2006, salinity values at these stations were as low as 5 PSU (station 6) on the May 16-18 survey which was conducted after a five day period when ~6 inches of rain had fallen in the area (see Figure 5). In 2007, minimum salinity values were measured during the first survey April 21-24 that was conducted after more than 4 inches of rain had fallen in the area. Similarly minimum salinity values in 2008 were measured following large rain events in late April/early May. Other decreases in salinity observed at these stations were also associated with rain events. Four stations in eastern Casco Bay most exposed to offshore waters (stations 37-40) also exhibited much lower salinities than non-riverine stations. There was no apparent salinity signature at these stations during the mid May rain event in 2006, but after the early June rain and high river flow that followed lower salinities (2-3 PSU lower) were observed at these 4 stations during the surveys conducted June 15-16 and 20-21, 2006 (Figure 9). The April and mid May rain events in 2007 exhibited lower salinities over these four stations and others in Harpswell Sound and New Meadows River. Likewise in 2008, the high precipitation and flow observed in late April and early May resulted in relatively low salinity values at stations 36 (Lumbo's Hole), offshore and the New Meadows River stations. Particularly evident in 2008 is the trend towards higher salinities bay-wide as the season progressed from April and May to June and August. These trends in rainfall, river flow, and salinity in eastern Casco Bay are indicative of offshore influence via the Kennebec River plume.

Trends in these physical parameters were also examined via contours of the data (Appendix B). Temperature patterns showed typical inshore to offshore gradients of decreasing temperatures. The warmest temperatures were consistently observed in the upper reaches of the embayments from Maquoit Bay east to New Meadows River. Water temperatures decreased to the southern extent of the bay and offshore to the east. Salinity patterns across the bay were more complex and driven, as mentioned above, by a combination of the river inputs to Portland Harbor (Fore River), at stations near the mouths of the Presumpscot and Royal Rivers, and from the Kennebec River plume in eastern Casco Bay (Figure 10). The entire set of contours can be found in Appendix B. Figure 10 presents a number of representative spatial distributions of salinity across the bay over the three years. The influence of lower salinity offshore water in 2006 is apparent for June 15-16 and 20-21 surveys. The influence of the Kennebec River plume can also be seen in May 10-11, 2007 and June 23-24, 2008 (Figure 10). The freshwater signature in Portland Harbor and the 'river stations' in western Casco Bay was evident during nearly all of the surveys (Appendix B).

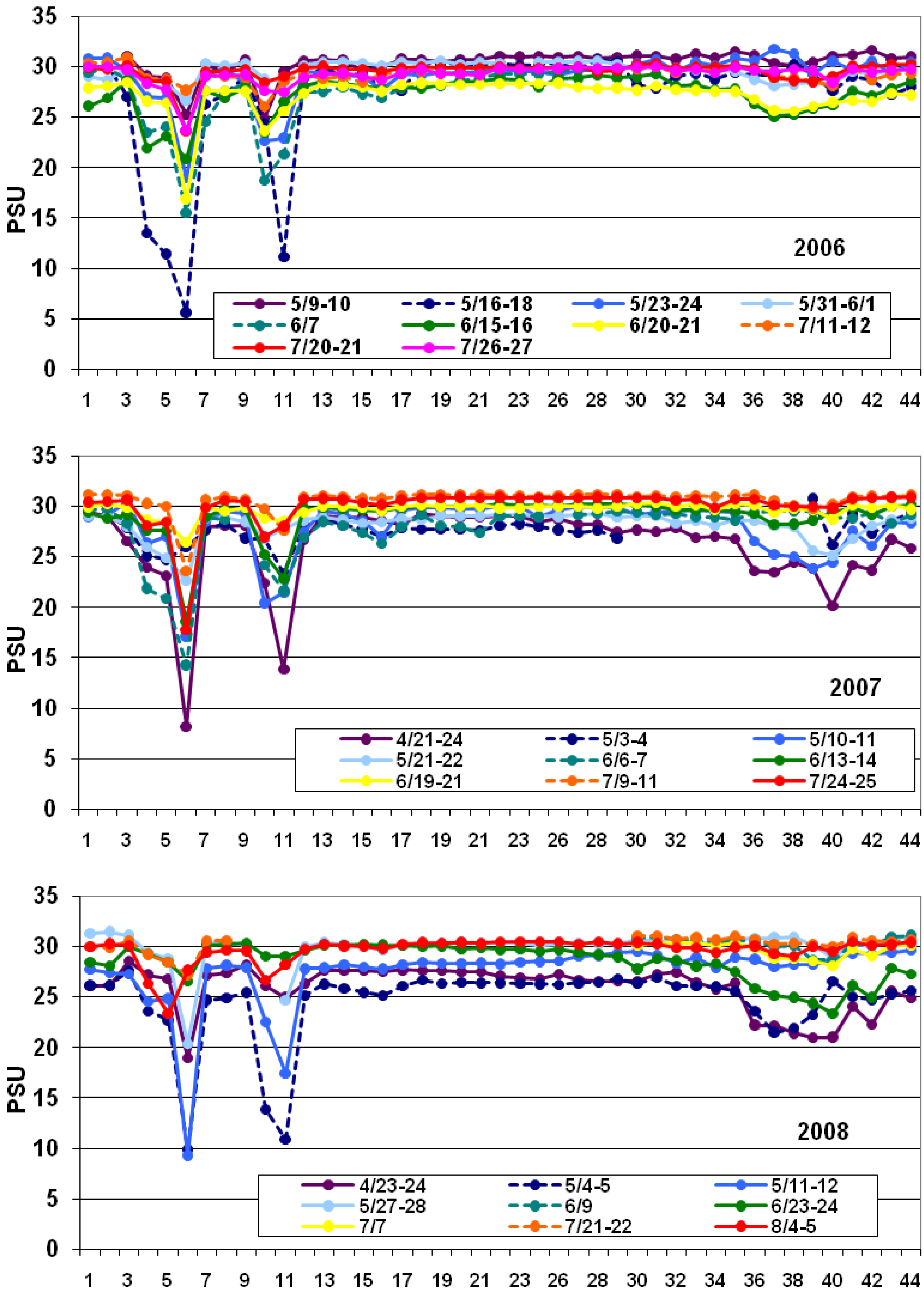

Figure 9. Surface (<1 m) salinity by station during the 2006, 2007, and 2008 surveys.

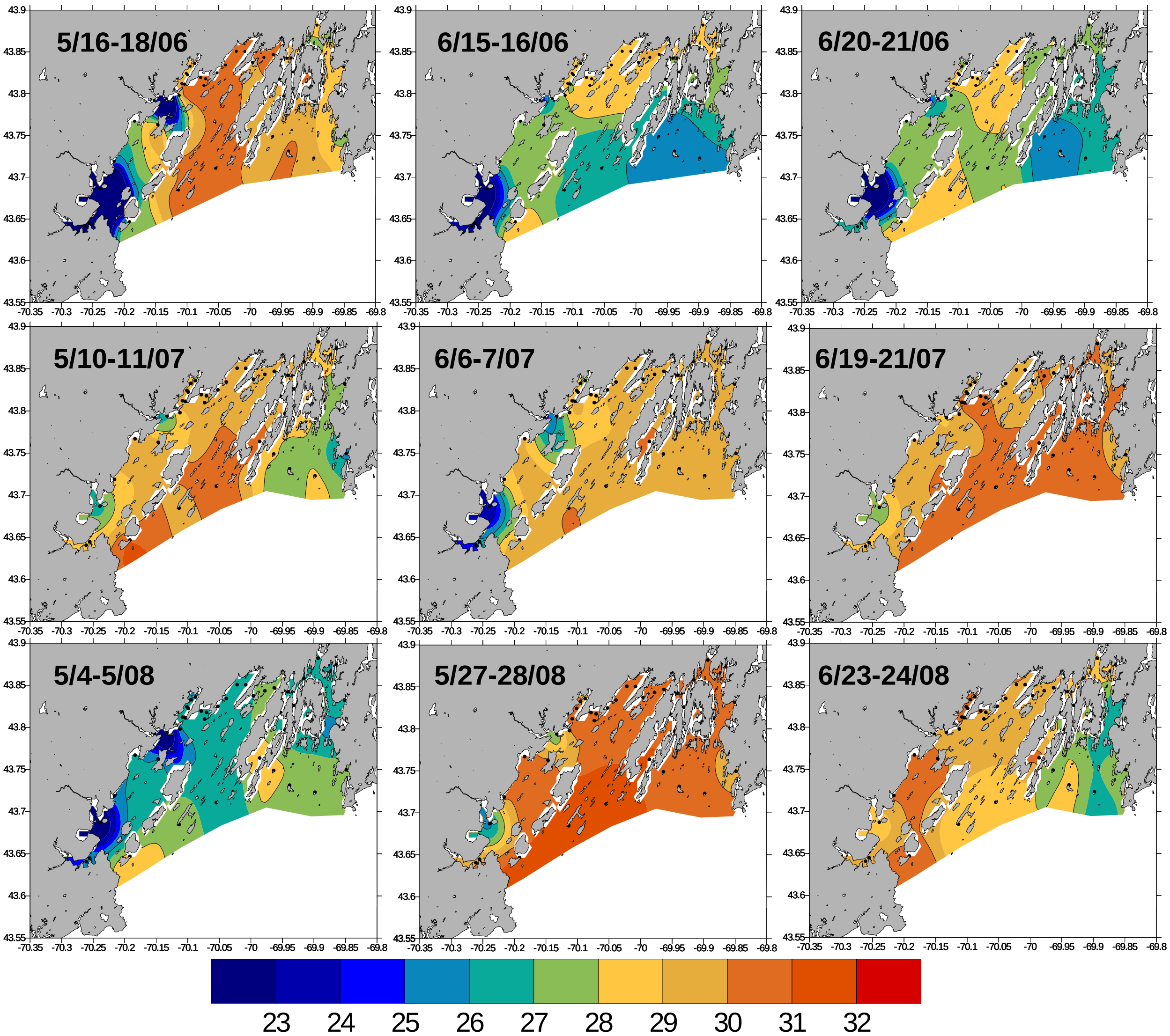

Figure 10. Contours of surface water salinity (PSU) during representative surveys in 2006, 2007, & 2008 (see Appendix B for complete set of survey contours).

3.4 Nutrients

As with salinity, there were some clear geographic and temporal trends in the nutrient data (Figures 11-14). The highest nutrient concentrations were typically associated with Portland Harbor and the river stations in western Casco Bay. The times series of nutrient concentrations for 2007 is representative of the other two years – showing higher concentrations across all stations earlier in the year (early to mid May) that generally decreased through July (Figure 11). The main exceptions were elevated nutrient concentrations at stations 6, 10, and 11 (river stations) that were associated with the early June and early July rain events. Elevated nitrate+nitrite (NO_3+NO_2; hereafter referred to as nitrate) and silicate (SiO_4) concentrations were also seen at stations 36-40 that showed a strong Kennebec River plume salinity signal. Ammonium (NH_4) and phosphate (PO_4) concentrations were consistently highest in Portland Harbor (stations 4 and 5) with elevated levels also associated with the western bay river stations (Figures 12-14).

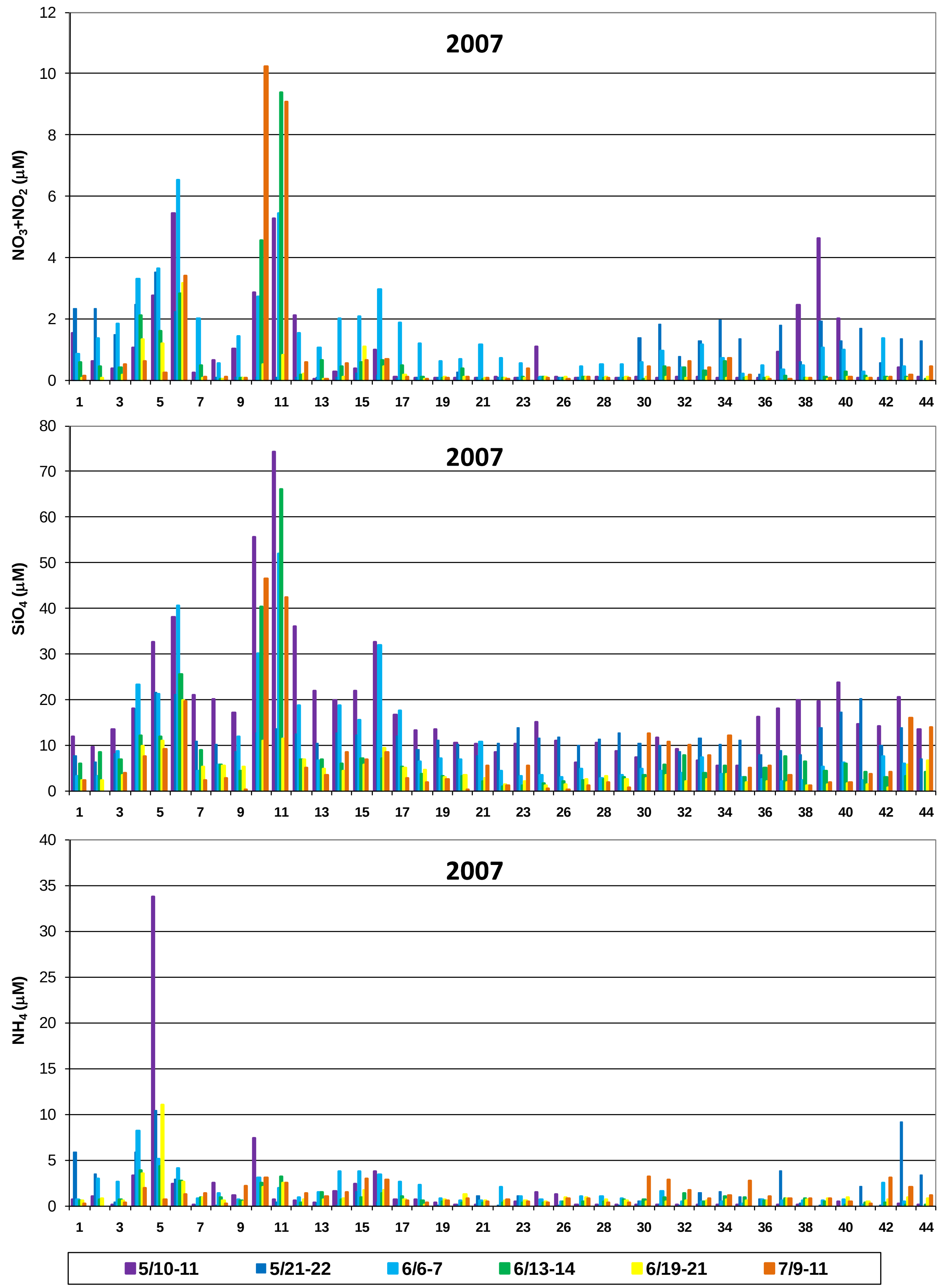

Figure 11. Surface nutrient concentrations by station during the 2007 surveys.

These spatial trends are more apparent in the surface water contour plots and a few of the common distributions are represented in Figures 12-14. During the May 16-18, 2006 survey, there was a strong harbor and riverine signal of elevated nutrient concentrations in western Casco Bay (Figure 12). This was coincident with high precipitation levels and low salinity waters at these stations (see Figures 5 and 10). Interestingly, although river flow was high prior to and during this survey (Figure 6) there was no salinity or nutrient signal indicative of the Kennebec River plume. A review of the winds during that time period suggests that they were strongly upwelling favorable (Figure 8), which would tend to drive the plume offshore of Casco Bay. The spatial distribution of nutrients and low salinity waters in mid May 2006 (Figures 12 and 10, respectively) is likely representative of high flow, high precipitation conditions under an upwelling dominated circulation regime.

Another scenario is represented by the distribution of nutrients in early May 2007 (Figure 13). During this survey, there was relatively little precipitation, but river flow was moderate and the wind regime was downwelling favorable (Figure 8). There were slightly fresher (2-3 PSU lower) surface waters in the harbor, western rivers and in eastern Casco Bay (Figure 10). The nutrient levels at these lower salinity stations were elevated – especially in regards to overall NO_3 and SiO_4 concentrations. There is a clear Kennebec River plume signal in both of these nutrients, while the more anthropogenic source nutrients (NH_4 and PO_4) remained high just near the sources in western Casco Bay.

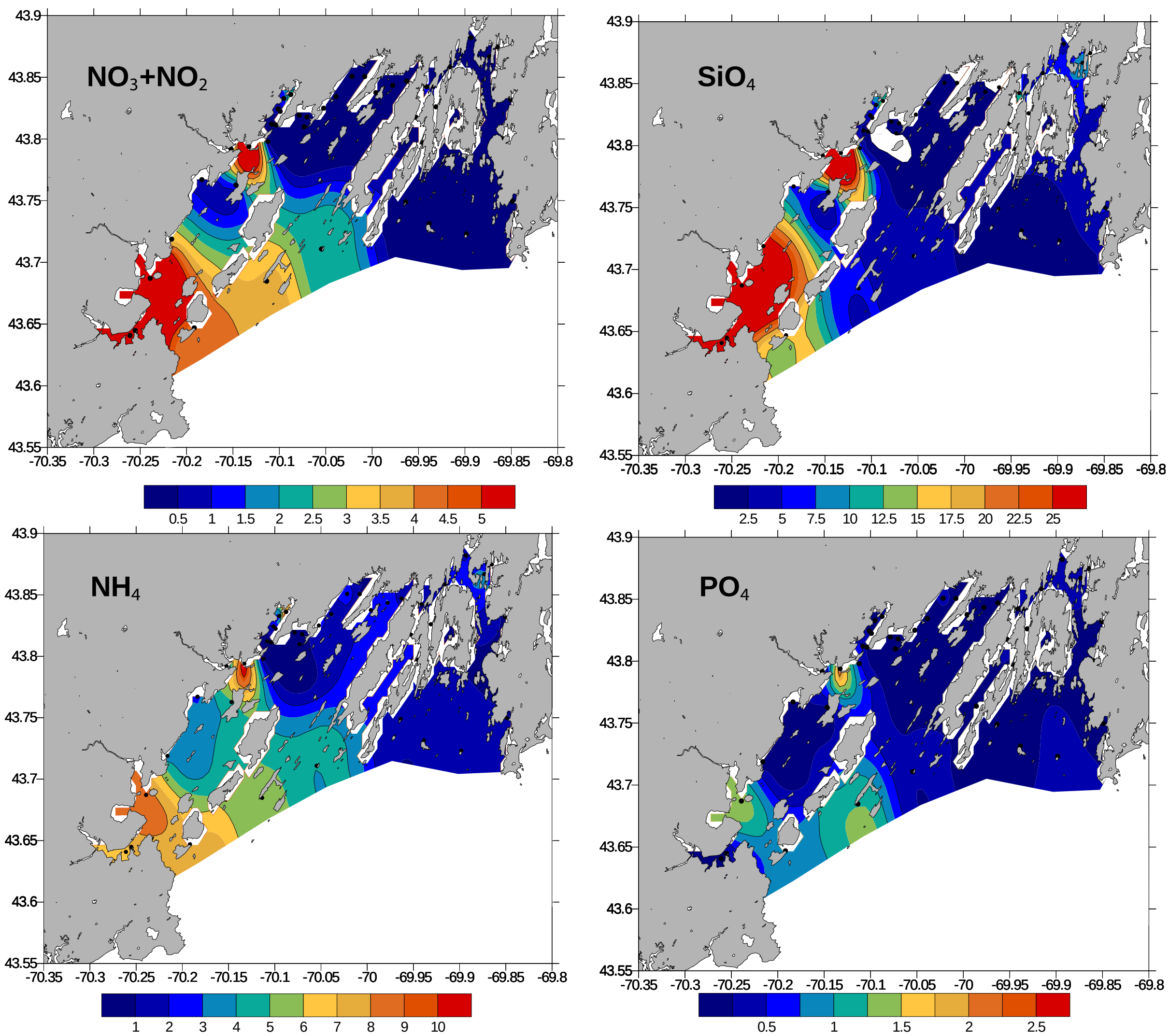

Figure 12. Surface nutrient concentrations (µM) during the May 16-18, 2006 survey.

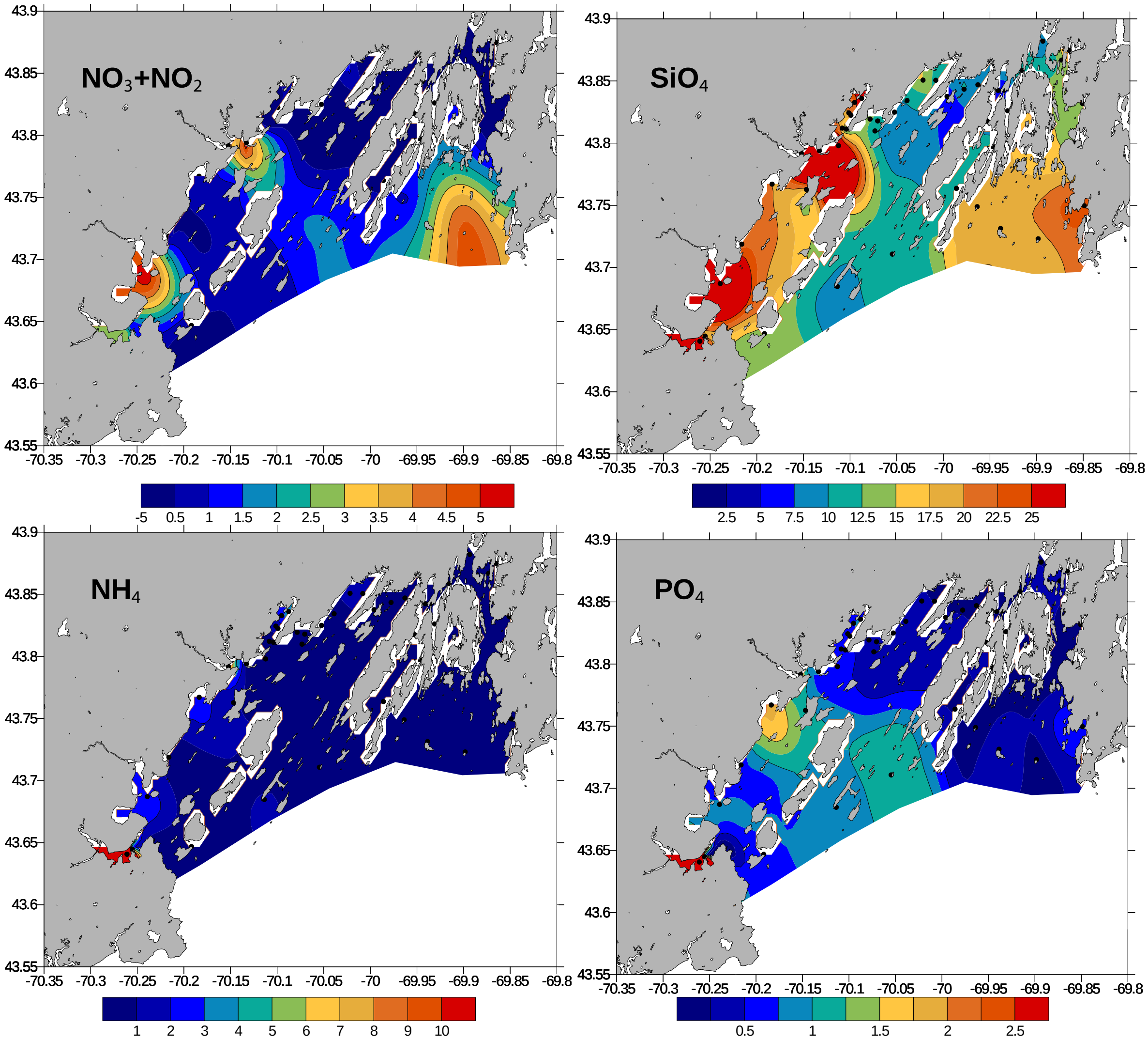

Figure 13. Surface nutrient concentrations (µM) during the May 10-11, 2007 survey.

A similar distribution of nutrients was observed in early May 2008 when lower salinity water was observed across the bay (Figure 14) due to high precipitation and flow at that time. Unlike the May 2007 survey when there was a Kennebec River salinity and nutrient signal (Figures 10 and 13), in 2008 higher SiO_4 concentrations were associated with higher salinity (offshore) water in eastern Casco Bay, while each of the nutrients continued to be elevated in Portland Harbor and the eastern rivers (Figure 14). The other dominant scenario was seen during periods of low precipitation and river flow – basically elevated salinity over most of the bay with slightly lower salinity levels near the fresh water sources in western Casco Bay (e.g. June 19-21, 2007 and May 27-28, 2008 in Figure 10). Under these conditions nutrient concentrations tended to be low across the bay with elevated levels in Portland Harbor and near the Presumpscot and Royal Rivers (Appendix B).

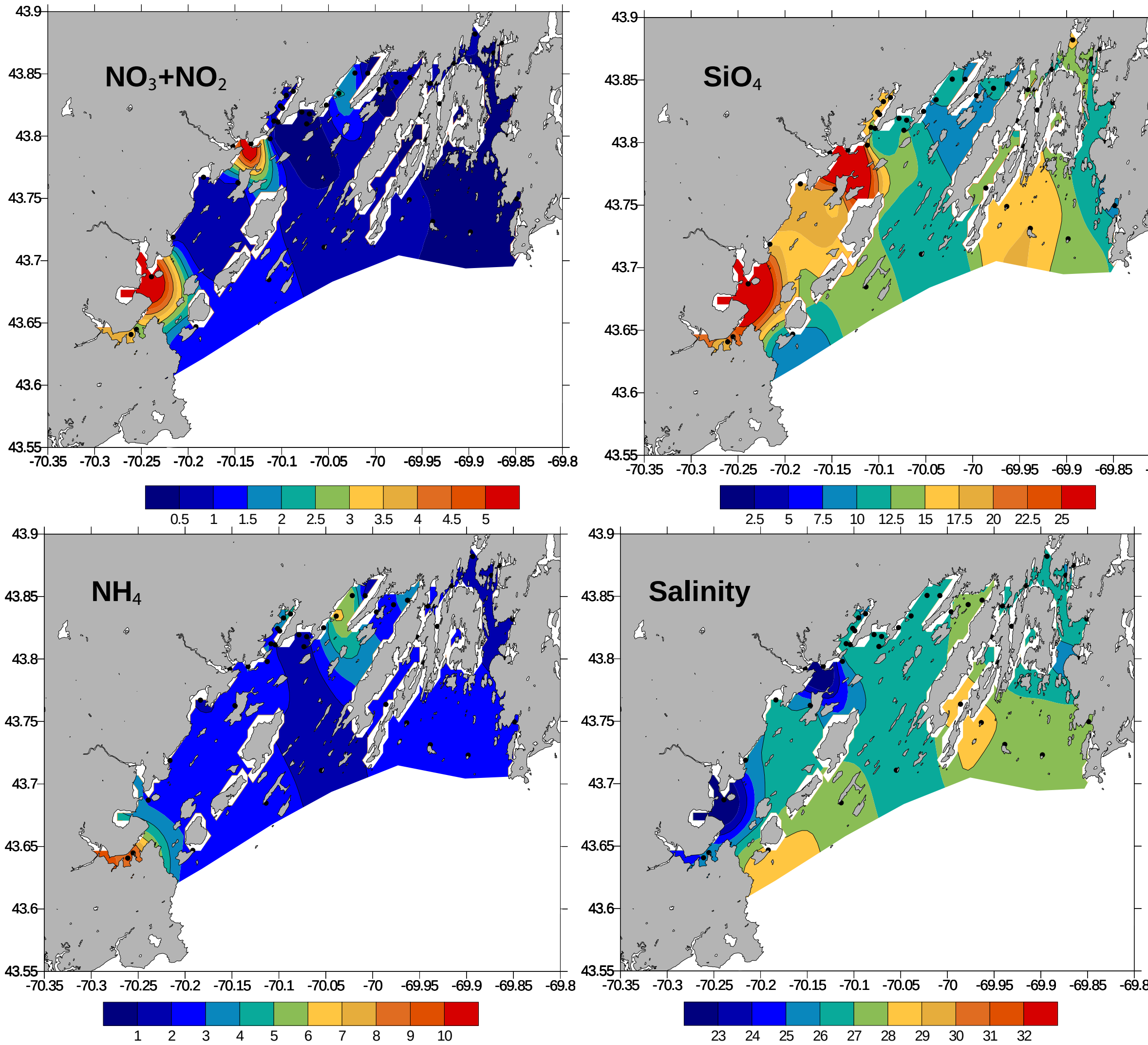

Figure 14. Surface nutrient concentrations (µM) during the May 4-5, 2008 survey.

3.5 *Alexandrium* Counts

In 2006, the *Alexandrium* abundance data were not quantitative. However, given that consistent methods were used, the data are internally comparable for that year and are presented as relative abundance on a station-to-station basis over the May to July 2006 surveys. In 2007 and 2008, ME DMR began using a molecular probe technique with a quantitative volume based sampling method where the data are presented in cells/L. In 2006, higher *Alexandrium* counts were observed in eastern Casco Bay with the highest relative counts observed in Harpswell Sound and New Meadows River (Figure 15). Interestingly, the relative abundance of total phytoplankton showed a different distribution with much higher levels in western Casco Bay with the highest relative abundances seen in Portland Harbor (CBEP 2007). The distribution of total phytoplankton counts fits with the conceptual model of higher nutrient load leading to an increase in phytoplankton biomass/abundance. The *Alexandrium* distributions, however, do not follow the pattern observed for total phytoplankton. The 2006 data and findings were presented in CBEP 2007. This report focuses on the *Alexandrium* abundances observed in 2007 and 2008.

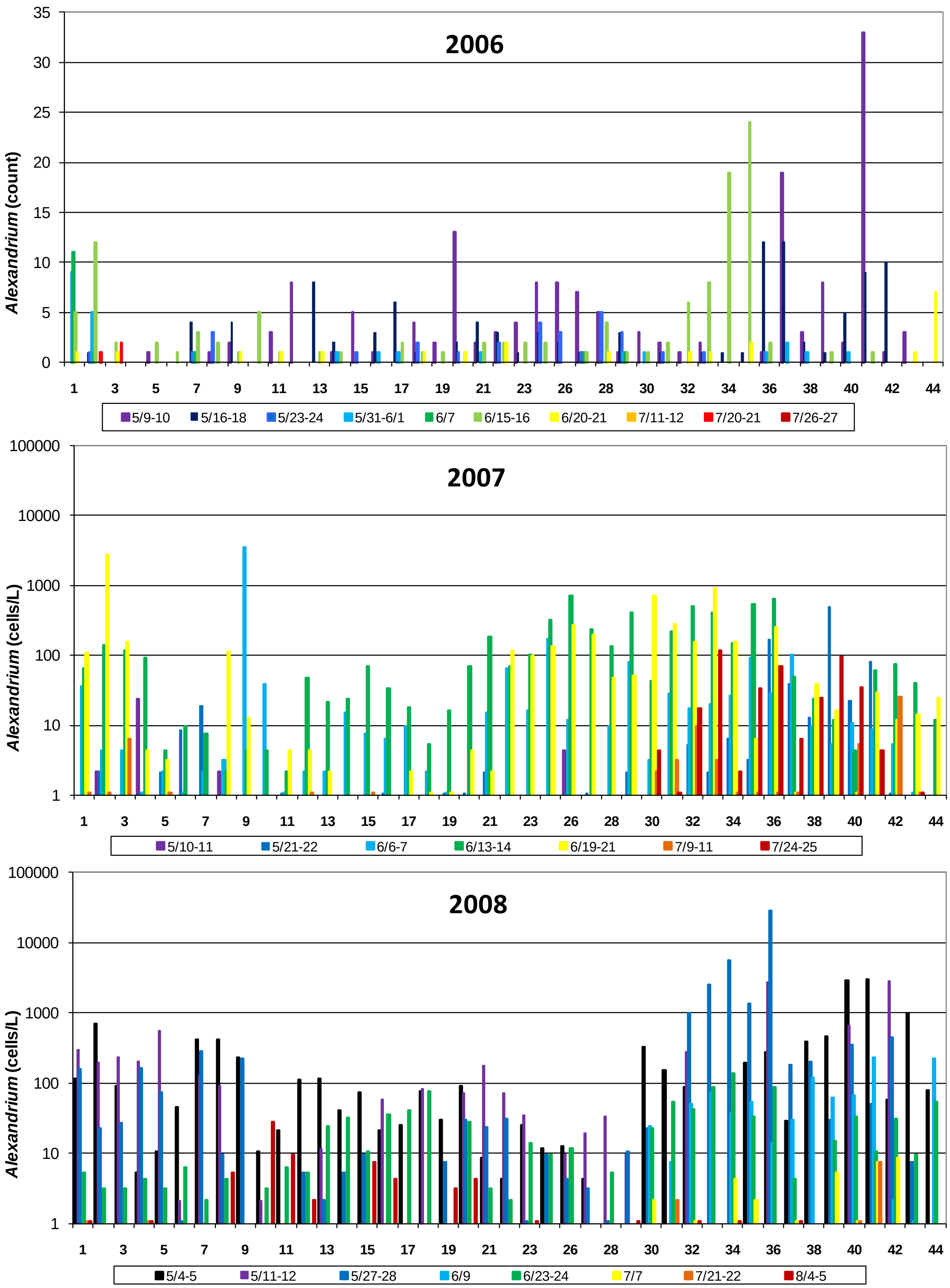

Figure 15. *Alexandrium* abundance by station for 2006, 2007, and 2008 surveys. Note the 2006 counts represent relative abundance rather than measurement of absolute cell abundance per unit volume. The 2007 and 2008 data are in cells/L and presented versus a logarithmic scale.

In 2007, *Alexandrium* were first seen sporadically during the May 10-11 survey. By May 21-22, elevated cell counts were observed at the offshore eastern Casco Bay stations (Figures 15 & 16) with a maximum of ~ 500 cells/L at station 39. This is consistent with "mussel bag" toxicity data reported by Keafer *et al* (2004) which showed that toxicity first appeared at stations outside Casco Bay, and then moved inshore with time. By early June, counts remained at moderate levels over most of the bay, but the annual maximum of >3,500 cells/L was measured at station 9 (in western Casco Bay). During the two mid June surveys, *Alexandrium* counts were generally <100 cells/L at the inshore western Casco Bay stations and higher (100-1,000 cells/L) at the offshore western stations (1, 2 and 3) and in the embayments from Maquoit Bay to Harpswell Sound and the upper New Meadow River stations. Levels at the three offshore eastern bay stations (37, 38 and 39) and the lower New Meadows River were similar to the western portions of the bay (10-100 cells/L; Figures 15-16). By July, the bloom was over in western Casco Bay, but elevated cell counts continued to be observed in Harpswell Sound and the stations offshore of and in the lower New Meadows River (37-42) through July 24-25.

The 2008 *Alexandrium* bloom reached higher abundances than seen in 2007 with a maximum of ~28,000 cells/L at the Lumbo's Hole station 36 during the May 27-28 survey (Figures 15 and 17). The 2008 bloom was well underway by the first survey that phytoplankton samples were collected on May 4-5. Abundances of 10-100 cells/L were observed over much of the bay with two areas of higher counts (100-500 cells/L) at offshore station 2 and to the north at the Foresides stations 7-9 and even higher levels at the eastern offshore stations (37, 38 and 39) and the lower New Meadow River (Figures 15 and 17). These peak *Alexandrium* abundances in eastern Casco Bay were associated with the intrusion/presence of higher salinity waters. Salinity levels were still <29 PSU so it is unclear if these were associated with the Kennebec River plume or other less-saline offshore waters in the Gulf of Maine coastal current system. By mid and late May, the bloom had reached peak abundances in Harpswell Sound and New Meadows River. Prevailing winds over the second half of May were downwelling favorable. There was no apparent Kennebec River plume detected though river flow and precipitation were low at this time so a salinity signature would not be expected. *Alexandrium* abundances decreased in June, though the bloom continued to be observed in the bay through early August.

To put the Casco Bay *Alexandrium* abundances into a broader context, we examined data from a series of six surveys (two per year) conducted in the western Gulf of Maine by Woods Hole Oceanographic Institution (WHOI) scientists. In 2006, the R/V Oceanus sampled off of Casco Bay on June 8-9 and June 13-14. During the first leg of the survey an area of high *Alexandrium* abundances (>1,000 cells/L) were observed from Cape Ann east to Port Clyde with a maximum of 8,366 cells/l at a station just west of Small Point in eastern Casco Bay (Figure 18). By June 13-14, on the return leg of this survey, *Alexandrium* abundances had decreased off of Casco Bay to <100 cells/L with higher abundances (>1,000 cells/L) observed to both the northeast and the southwest. Since there were no quantitative counts for Casco Bay for that year, it is difficult to directly compare these observations, but they were coincident with some elevated relative counts at the offshore stations 1 and 2 and Harpswell Sound stations (Figure 15). The high abundances seen during the 2006 WHOI surveys were found in near-shore coastal waters with lower salinity (<30PSU; Figure 18). This is consistent with the influence of lower salinity offshore waters seen in eastern Casco Bay during the mid June surveys (Figure 10). The WHOI data emphasize the magnitude of the regional bloom in 2006, which in combination with the salinity and qualitative counts in Casco Bay data suggests a direct input of offshore cells on at least the outer waters of the bay.

The 2007 WHOI surveys were conducted aboard the R/V Endeavor in May 17-25 and June 27- July 2. During both of these surveys *Alexandrium* abundances in the coastal and offshore waters near Casco Bay were low (<50 cells/L with the closest stations having <10 cells/L; Figure 19). The elevated cell abundances seen in mid to late June in Casco Bay (Figures 15 & 16) were not evident near or downstream of Casco Bay during the late June WHOI survey. An area of elevated abundances was observed off of Penobscot Bay in late June that may have been associated with the eastern Maine coastal current. It is unclear if this water mass stayed inshore or was diverted offshore in July 2007. If it stayed inshore it may have been a source of *Alexandrium* to sustain the mid to late July bloom in eastern Casco Bay (Figure 15).

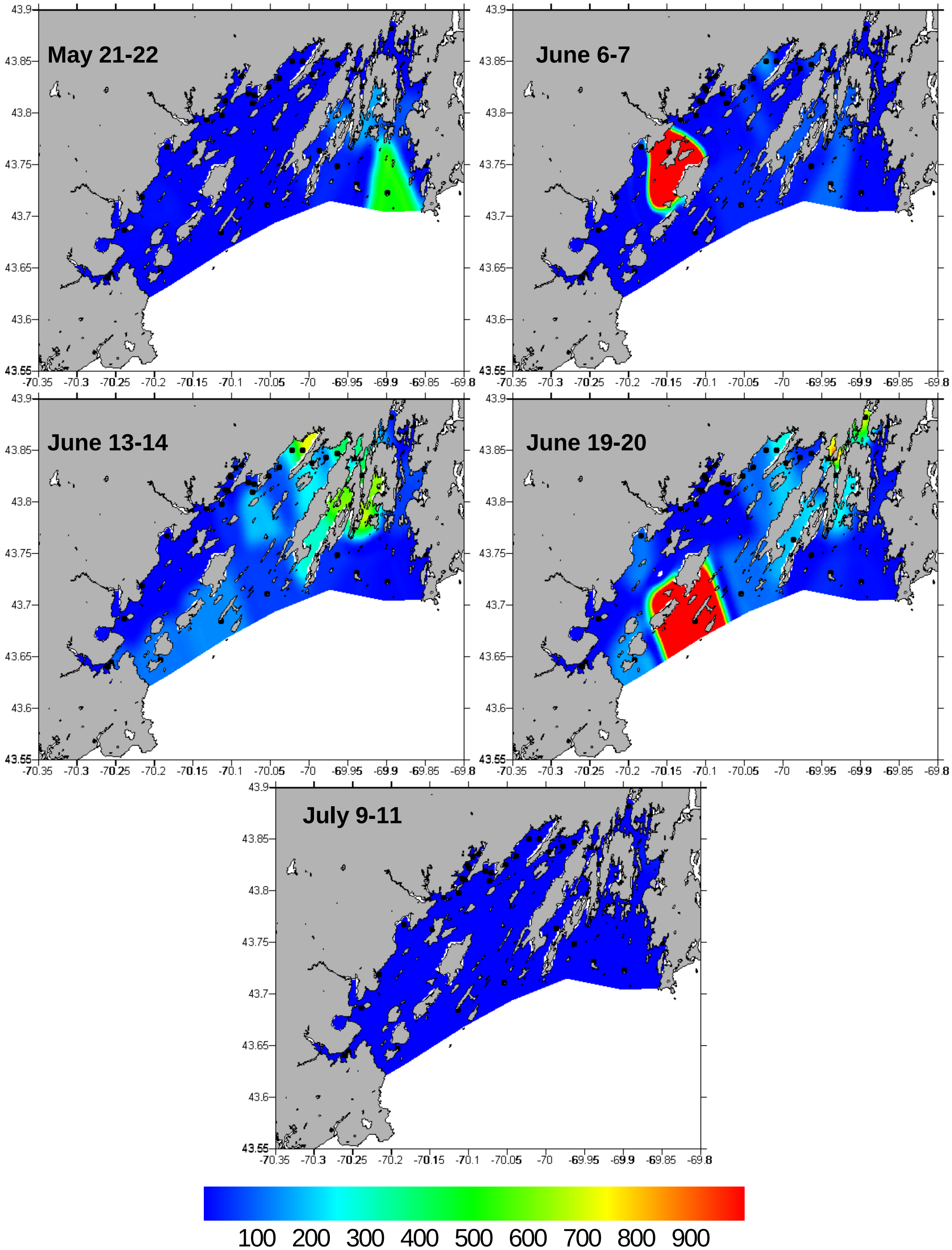

Figure 16. *Alexandrium* abundance (cells/L) during selected 2007 surveys.

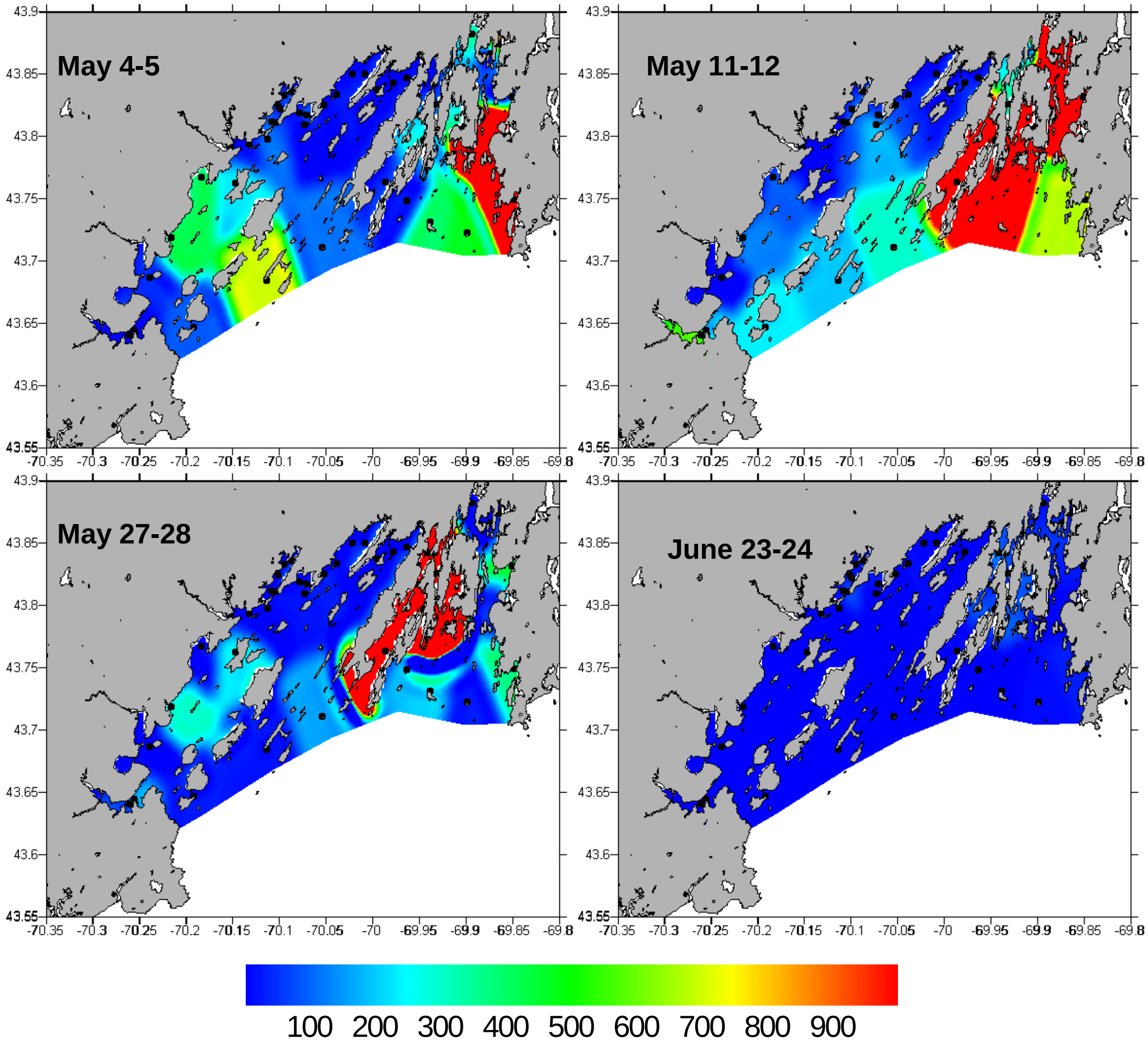

Figure 17. *Alexandrium* abundance (cells/L) during selected 2008 surveys.

In 2008, WHOI conducted two surveys in early and late May aboard the R/V Oceanus. On May 3, *Alexandrium* were present at low to moderate abundances (10-200 cells/L) along a transect off of Casco Bay (Figure 20). These levels were lower than those measured in Casco Bay during the same time period (Figure 17). By late May, *Alexandrium* abundance had reached levels of 1,000's cells/L from Casco Bay to Cape Ann reaching a maximum of 7,518 cells/L along a transect off of Portsmouth. These high levels of cells to the south of Casco Bay are consistent with the higher abundances seen in the bay in mid to late May. Although there were no major precipitation or runoff events during this period, winds were predominantly downwelling favorable from mid May to early June 2008 (Figure 8) and the surface water salinity observations aboard the R/V Oceanus suggest the western Maine Coastal current was relatively close to shore (Figure 20). There were no indications of a Kennebec River plume entering Casco Bay in mid to late May 2008, but salinity and SiO_4 concentrations were suggestive of an intrusion of offshore waters over most of the month.

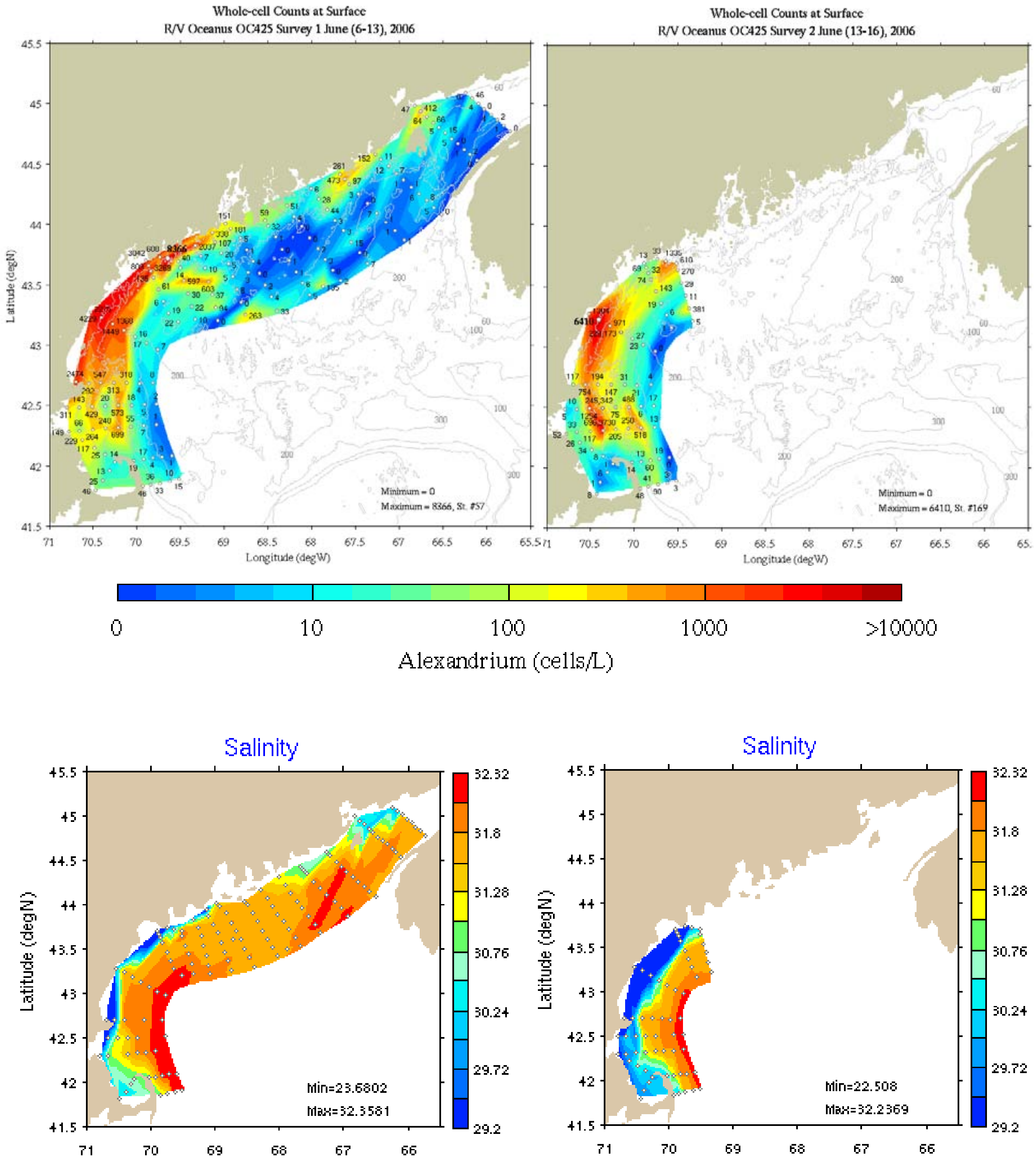

Figure 18. Surface water abundance of *Alexandrium* (cells/l) and salinity (PSU) aboard the *R/V Oceanus* on June 6-13 and June 13-16, 2006 (Anderson, McGillicuddy, Keafer, unpublished data)

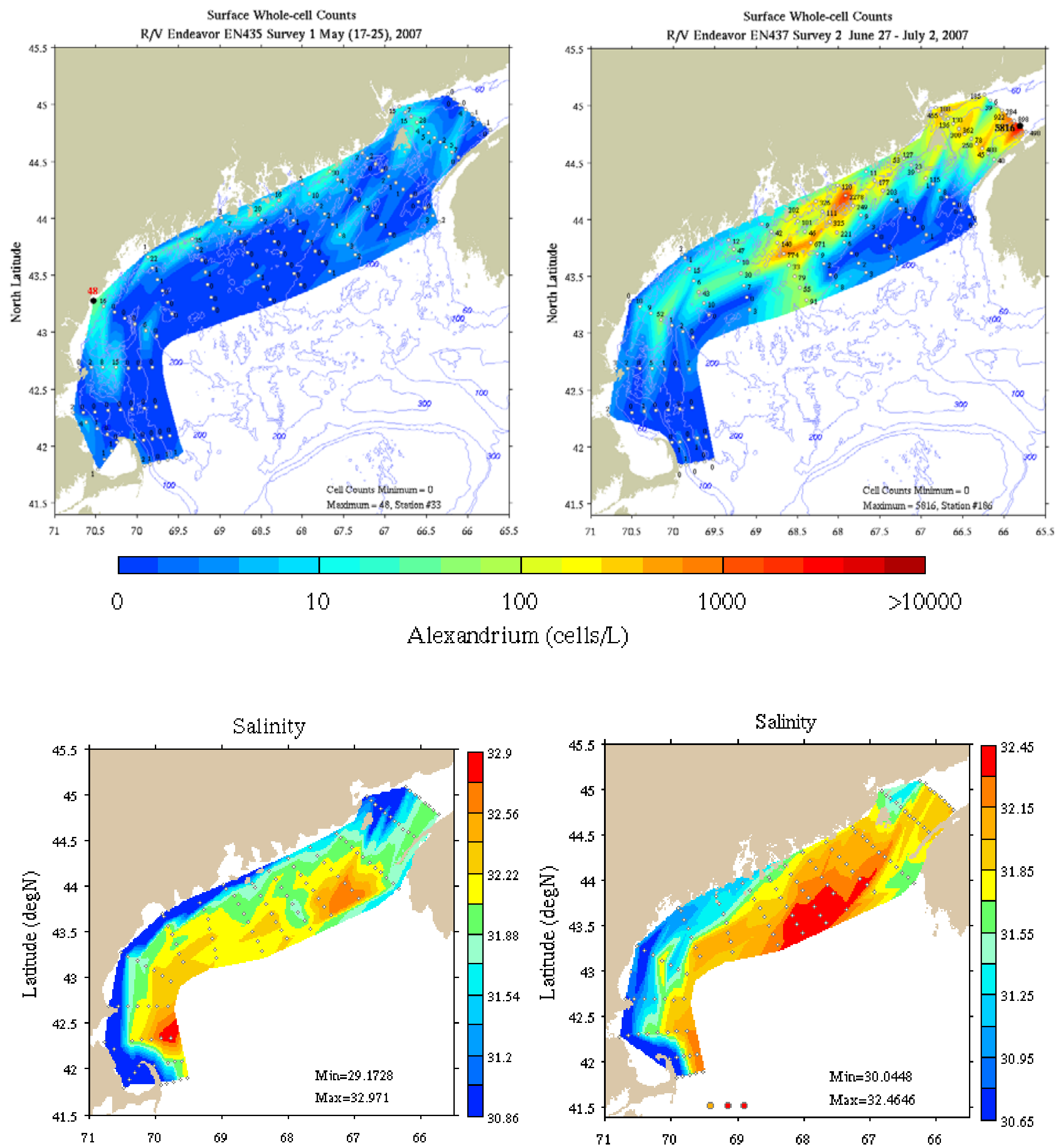

Figure 19. Surface water abundance of *Alexandrium* (cells/l) and salinity (PSU) aboard the *R/V Endeavor* on May 17-31 and June 21-July 2, 2007 (Anderson, McGillicuddy, Keafer, unpublished data)

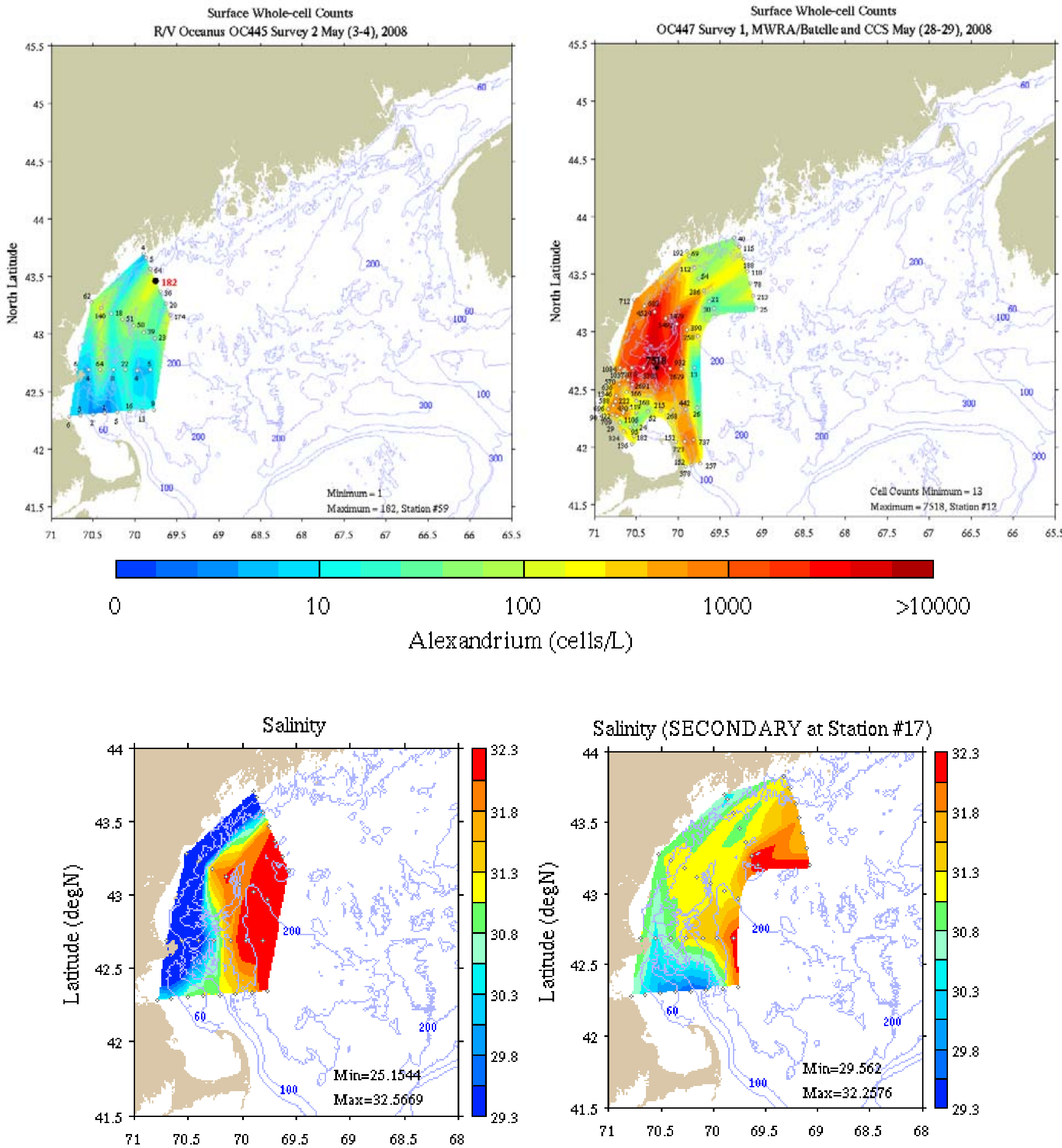

Figure 20. Surface water abundance of *Alexandrium* (cells/l) and salinity (PSU) aboard the *R/V Oceanus* on April 28-May 5 and May 27-June 4, 2008 (Anderson, McGillicuddy, Keafer, unpublished data)

3.6 PSP Toxicity

As with the other parameters, there were clear spatial and temporal patterns in the PSP shellfish toxicity data (Figure 21). Note that overall toxicity levels were highest in 2006 and 2008 with the lowest levels measured in 2007 – though there were shellfishing closures during each of these years in Casco Bay (see Section 3.1). A few general trends were observed during all three study years. Toxicity was highest at the western (1, 2, & 3) and eastern (37, 38, & 39) offshore stations, within upper Harpswell Sound (32, 33, & 34), and lower New Meadows River (40, 41, & 42).

In 2006, high toxicity levels were observed in eastern Casco Bay on May 9-10 – the first survey of the year that mussels were collected and analyzed (Figure 22). Toxicity continued in eastern Casco Bay and New Meadows River during the remaining May surveys and was also observed at the offshore stations in western Casco Bay. Toxicity peaked during the June 15-16 survey with levels >800 µg STX equiv./100g (µg saxotoxin equivalents per 100 g of shellfish tissue) at stations in Harpswell Sound and offshore stations in eastern Casco Bay. This survey occurred about a week after *Alexandrium* abundances >1,000 cells/L were observed off of Small Point by WHOI scientists (Figure 18). By late June, toxicity had decreased sharply and was well below 50 µg STX equiv./100g at all stations by July 11-12 (only detectable at stations 2 and 3 off of Cliff and Cushing Islands, respectively).

Toxicity levels in 2007 peaked during the mid June surveys with toxicity levels of >100 µg STX equiv./100g at the offshore stations in western and eastern Casco Bay (Figure 23). These levels were coincident with relatively high *Alexandrium* abundances (100 to >1,000 cells/L), higher salinity levels (30±1 PSU), and low nutrient concentrations. The pattern is suggestive of an offshore bloom, but there is no other data (i.e. Kennebec plume signal, offshore abundance data, etc.) to corroborate this explanation. It should be noted that downwelling favorable winds predominated from mid June to early July which would have brought coastal waters into the bay.

In 2008, toxicity levels were greater than 2007 levels and peaked earlier with maximum toxicity observed in late May. PSP toxicity levels of >300 µg STX equiv./100g were seen at offshore stations 1, 37, 38, and 39 as well as in Tottman Cove (40), which is also exposed to more offshore waters (Figure 23). Levels were even higher in upper Harpswell Sound (stations 32-34). The high toxicity levels were associated with similarly high *Alexandrium* abundances both in Harpswell Sound and waters offshore of Casco Bay. In the Sound, cell counts ranged from 1,000 cells/L to a maximum of 28,000 cells/L at station 36 in Lumbo's Hole while offshore levels during the WHOI survey were in the thousands of cells/L just to the south of Casco Bay.

It had been hypothesized that there might be a relationship between salinity and toxicity or *Alexandrium* abundance, but given the varied inputs of low salinity waters (internal river inputs, offshore riverine plume, and alongshore coastal currents that can be less saline than the open waters of the Gulf of Maine) and the combination of both higher and lower salinity water inputs into the bay from offshore, only a weak inverse correlation was observed for the 2006 data (CBEP 2006). A closer examination of the data for the Harpswell Sound and New Meadow River areas was undertaken given that these areas were both suspected as being potential inshore sources of *Alexandrium* and are most directly influenced by offshore circulation either via the Kennebec River plume or intrusions of offshore waters during downwelling favorable wind conditions. Initial data analyses looked at all stations along the general axis of the two embayments. In Harpswell Sound this ranged from station 1 northeast into the Sound including PSP data from DMR stations along the shoreline (Ash Point, Potts Point, Will's Gut, Lumbo's Hole, and Ewin Narrows the last two of which are collocated with IPSP stations 36 and 35, respectively). In the New Meadows River area, the initial analyses included a wider area offshore with stations 37, 38, 39, and 40 in Tottman Cove, an assortment of ME DMR PSP stations from Bethel Point to Head Beach, and the IPSP stations within New Meadows River 30 and 40-44. To more clearly illustrate possible relationships, a subset of these stations is shown in Figures 24-26, but the trends are representative of the entire set of data from these embayments.

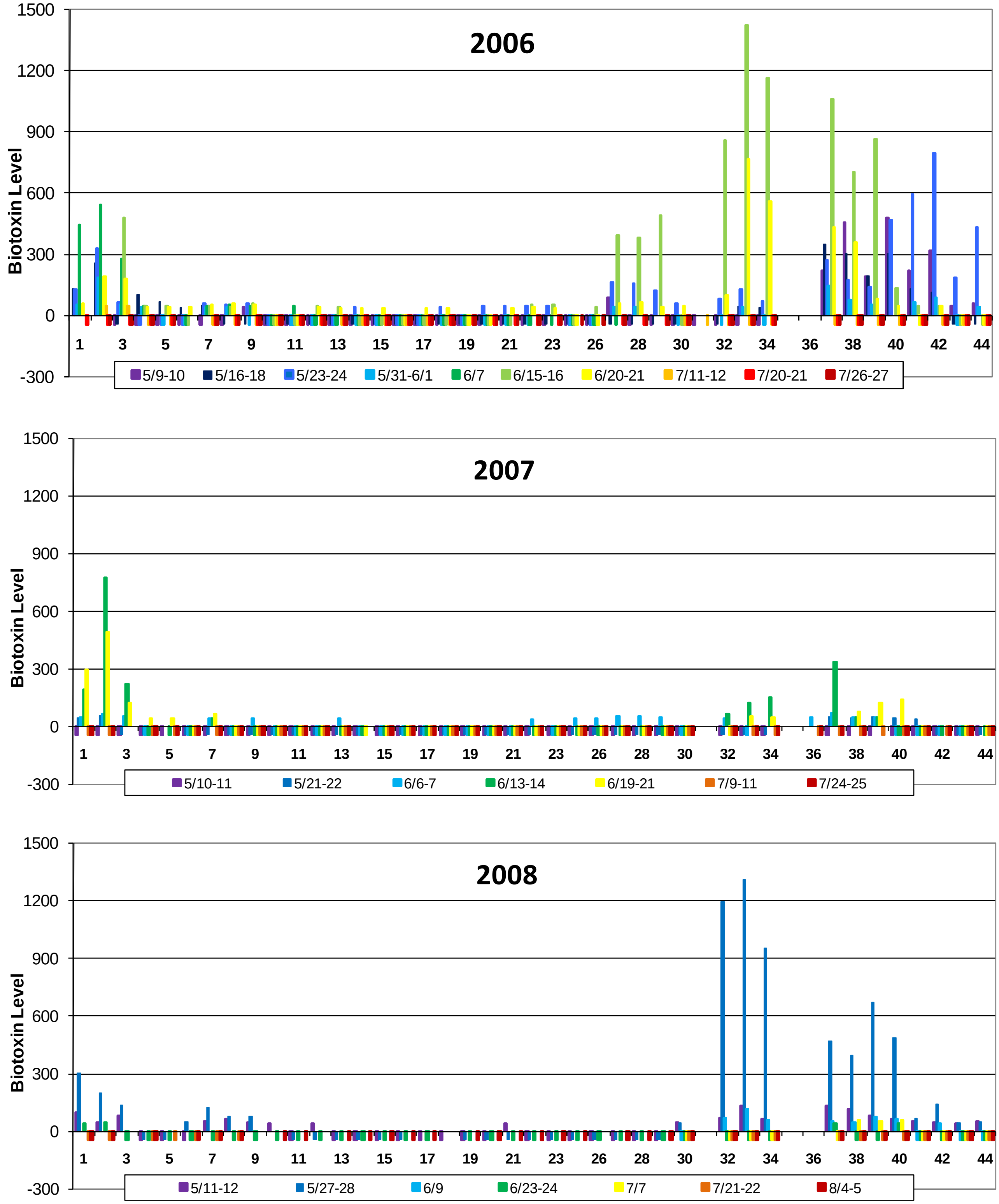

Figure 21. PSP toxicity levels (µg STX eq/100g tissue) by IPSP station during the 2006, 2007, and 2008 surveys.

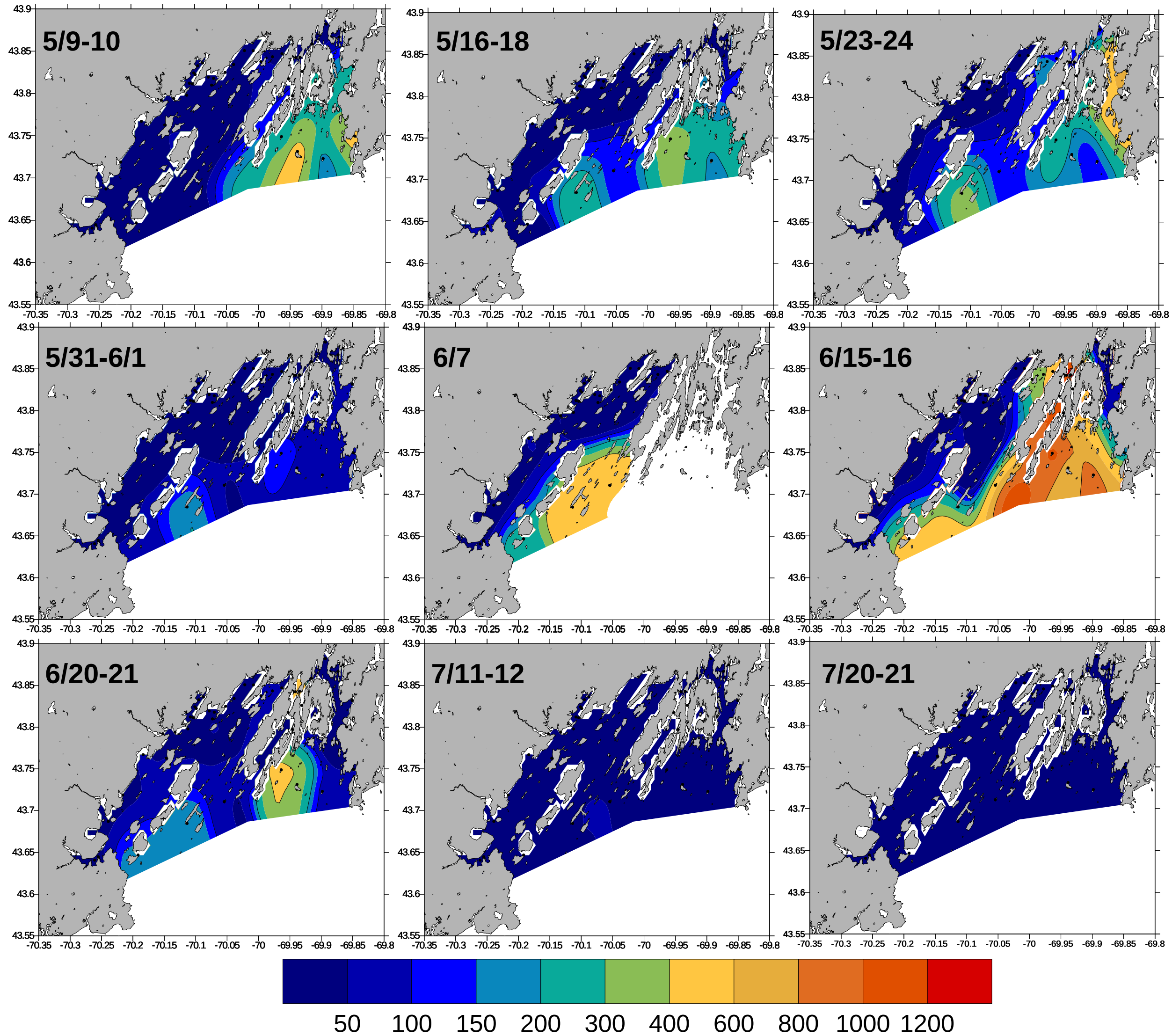

Figure 22. Contours of PSP toxicity levels (µg STX equiv./100g tissue) during the nine surveys from May 9-10 to July 20-21, 2006.

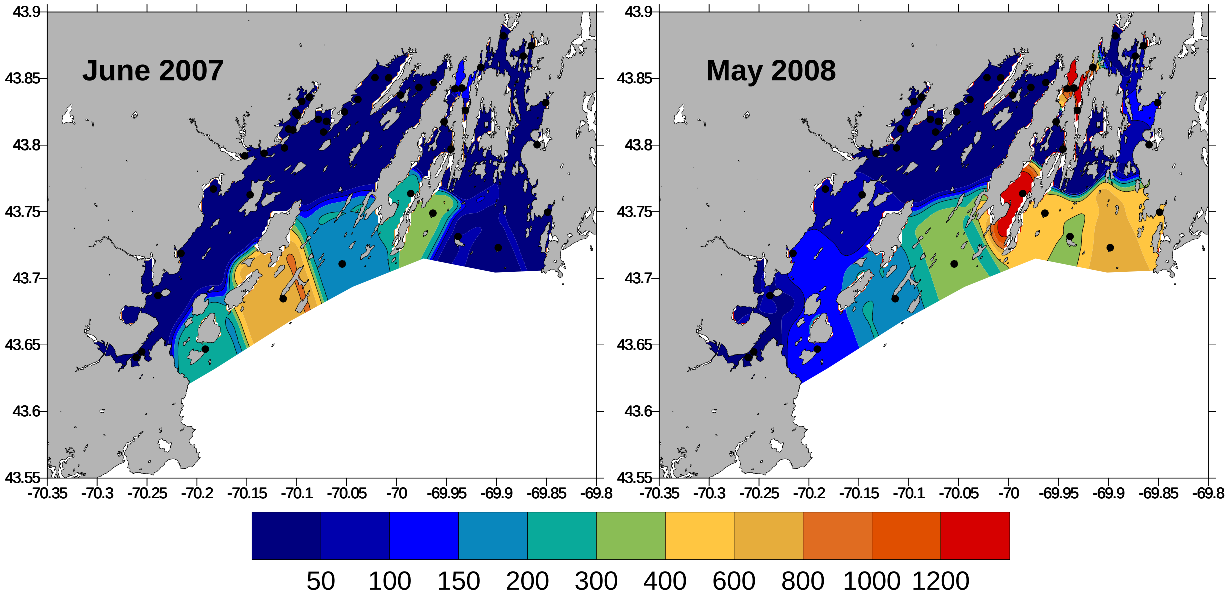

Figure 23. Contours of PSP toxicity levels (µg STX equiv./100g tissue) during June 13-14, 2007 and May 27-28, 2008 surveys when annual peak toxicity levels were observed.

During each of the years, there was an interesting trend in toxicity at Lumbo's Hole (36) – namely an early appearance of toxicity in April or early May prior to detection of toxicity elsewhere, followed by a later, second peak reaching the annual maximum for this station that was coincident with peak toxicity measured at other Casco Bay stations. Often, Lumbo's Hole is where ME DMR first detects PSP toxicity – not only for Casco Bay, but for all of Maine – this was the case for 2010 when toxicity was first reported at this station in late March. That knowledge is also one of the driving factors for trying to decipher the relative influence of inshore and offshore sources for *Alexandrium* blooms in the bay.

In 2006, low PSP toxicity was observed at Lumbo's Hole in late April. However, the peak of the toxicity in Harpswell Sound in June 15-16, 2006 was preceded by increasing toxicity at both the Lumbo's Hole station and IPSP station 1 offshore of the Sound (Figure 24). The peak levels were also coincident with salinity minima for the season at each of the stations. These results suggest that although a bloom may have initiated in Harpswell Sound in late April, the main peak in toxicity was likely associated with an intrusion of offshore waters associated with the Kennebec River plume. In New Meadows River, a slightly different pattern was observed with elevated PSP offshore and mid embayment (stations 39 and 42) in early May, levels peaking mid embayment (stations 42 and 44) and Cundy's Harbor in late May, but the highest toxicity was measured during the June 15-16 survey at the offshore station 39. This station also exhibited the Kennebec River plume signature with low salinity during that survey as seen at the Harpswell Sounds stations.

The most obvious difference from 2006 to 2007 is the relatively low PSP toxicity levels measured in Harpswell Sound and New Meadows River in 2007 (Figure 25) where peak toxicity reached a quarter of the level observed in 2006. Low salinity waters were observed during the first survey of the year in late April, but elevated toxicity was not measured until late May (Lumbo's Hole station 36). *Alexandrium* counts peaked in Harpswell Sound during the June 13-14 survey (~500 cells/L) at stations 35 and 36. This was coincident with elevated toxicity at Lumbo's Hole (station 36), but relatively low toxicity was observed further inland at the Ewin Narrows station 35. This disconnect between toxicity and cell counts is also evident at the offshore station 1 where very low *Alexandrium* abundance was measured in 2007, but there was a peak in toxicity on June 19th (Figure 25). In New Meadows River, the data are also difficult to decipher. There were two peaks with >500 cells/L in *Alexandrium* abundance in late May at offshore station 39 and in late June in the upper reaches of the embayment at station 30, neither of which resulted in high PSP toxicity. The highest toxicity level (121 µg STX equiv./100g tissue) was observed in late June at station 39, which was the only station to exhibit toxicity along the New Meadows River transect in 2007. Though no clear trends were evident, the 2007 data from these two embayments highlight the issues associated with snapshots versus integrated datasets – while the water samples and *Alexandrium* counts provide a snapshot of conditions in the water column, the buoy deployed mussels provide an integrated sampling of the toxicity and presence of *Alexandrium* over a longer period.

The 2008 sampling started during a period of high river flow with low salinity waters (• 26 PSU) observed throughout both embayments (Figure 26). Early toxicity was measured in Ewin Narrows and Lumbo's Hole in late April. In Harpswell Sound, toxicity levels increased over the course of May with peaks (• 300 µg STX equiv./100g tissue) at all stations in late May. High levels were observed both within the upper reaches and near the mouth of the Sound (stations 34 and Potts Pt., respectively). However, *Alexandrium* counts in the Sound reached a monitoring program maximum of 28,300 cells/L at the Lumbo's Hole station 36 in late May (there were no Pott's Point cell data). Given the nearly two weeks between *Alexandrium* abundance data (mid to late May), it is unclear how cell abundance may have varied prior to the late May survey. In New Meadows River, cell abundance peaked in mid May at station 42, but toxicity levels peaked at Cundy's Harbor on May 19th and at the offshore station 39 on May 27th. There was no apparent correlation between parameters in these embayments in 2008. The WHOI survey data from late May (Figure 20) suggests that there was an offshore source of elevated cell abundance that may have contributed to both the high toxicity and peaks in *Alexandrium* abundance that were seen from mid to late May.

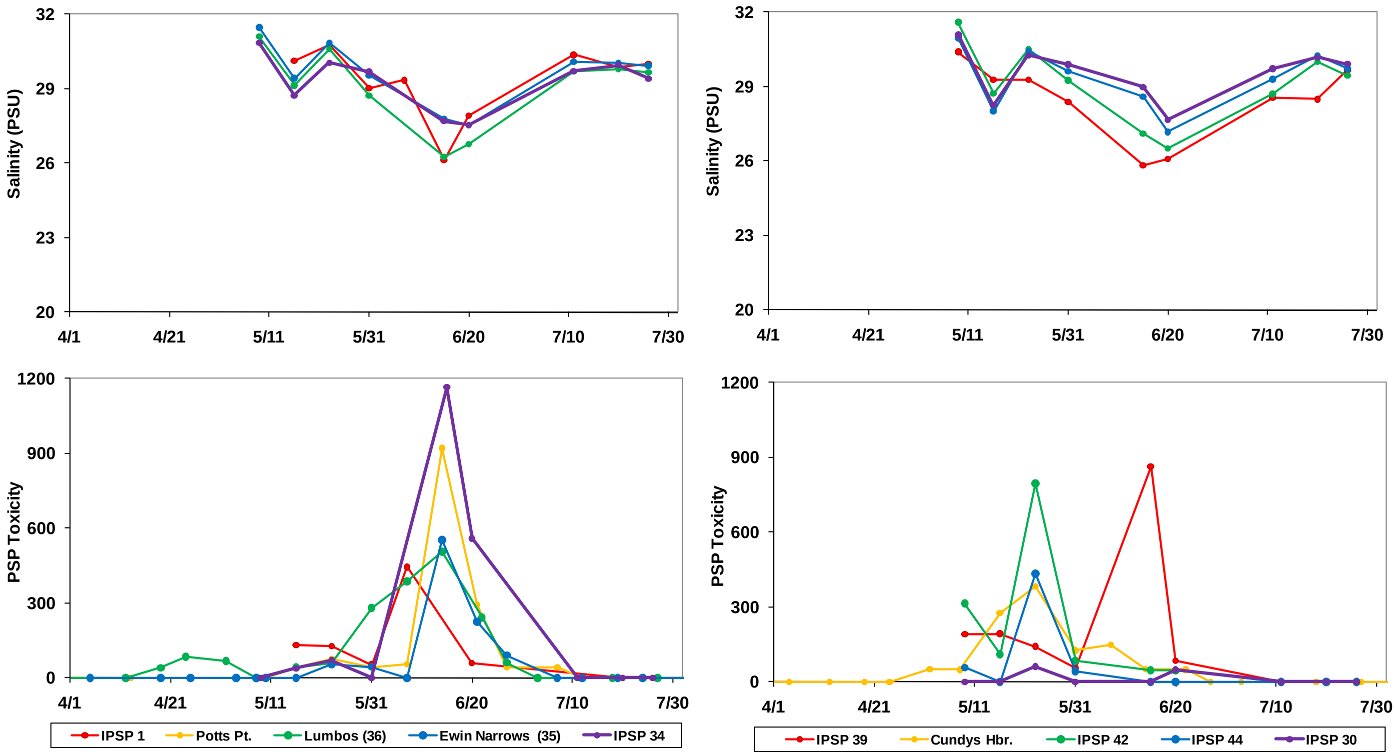

Figure 24. Time series of Salinity (PSU) and PSP toxicity (µg STX equiv./100g tissue) at representative stations in or near Harpswell Sound (left) and New Meadows River (right) in 2006.

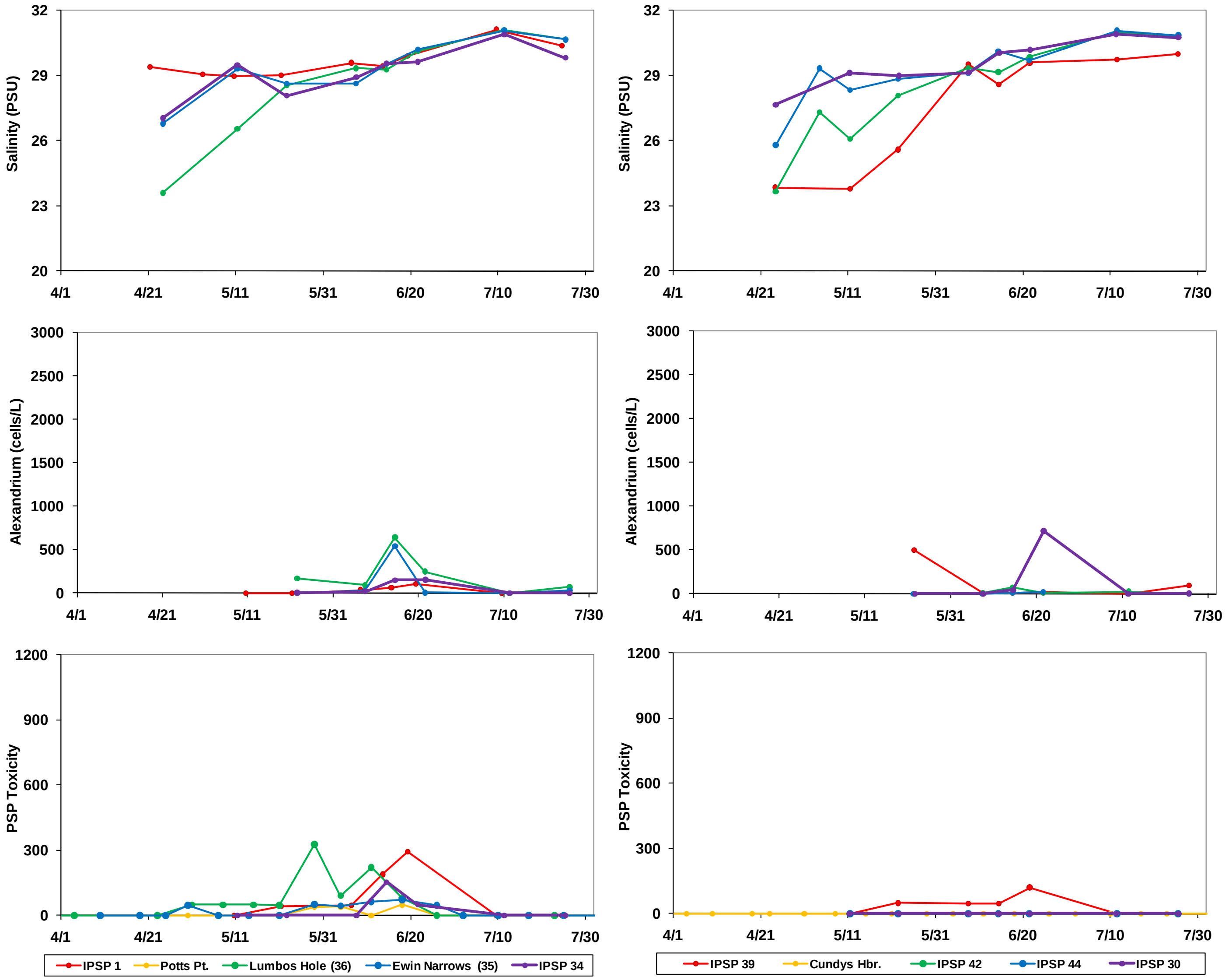

Figure 25. Time series of Salinity (PSU), *Alexandrium* abundance (cells/L), and PSP toxicity (µg STX equiv./100g tissue) at representative stations in or near Harpswell Sound (left) and New Meadows River (right) in 2007.

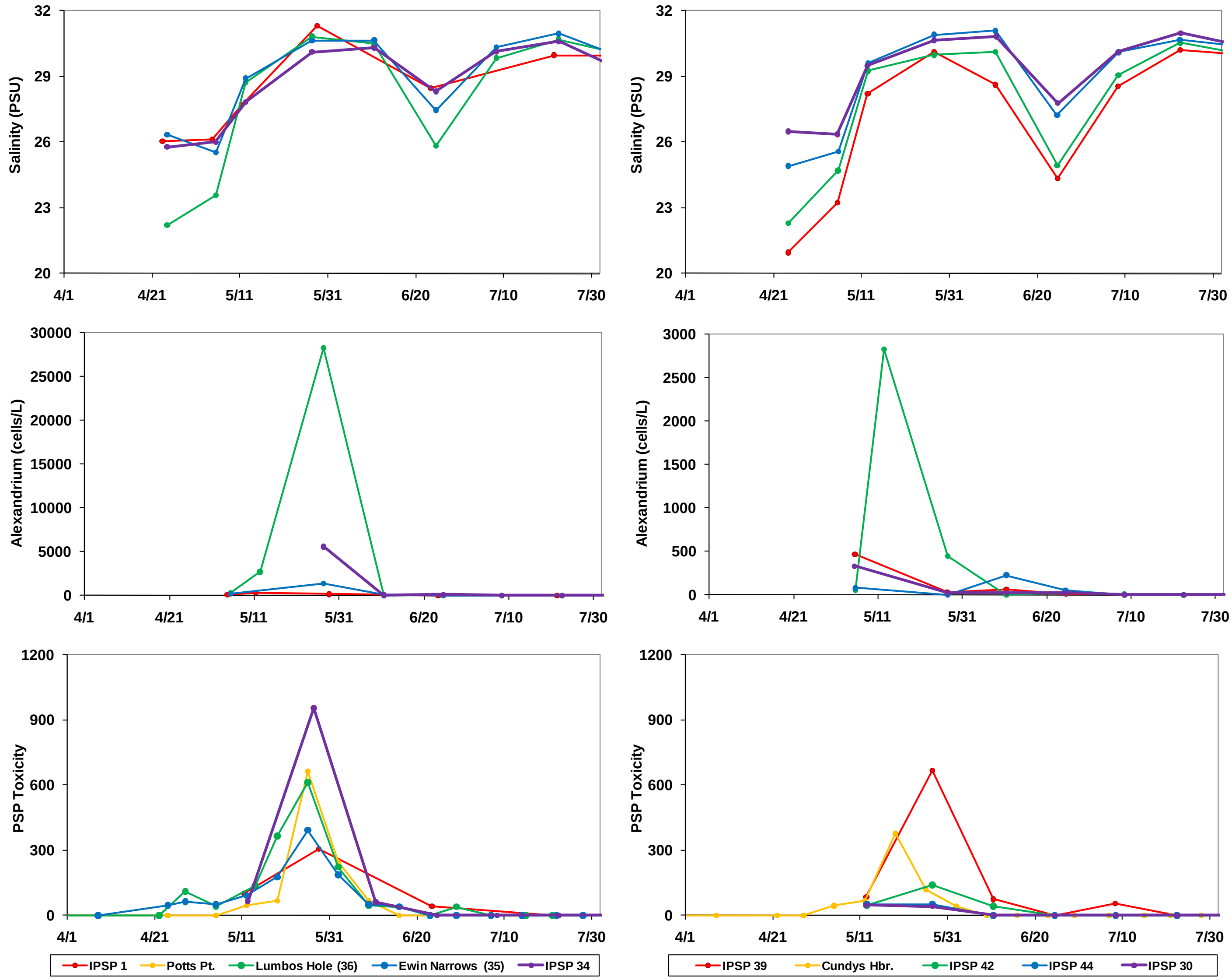

Figure 26. Time series of Salinity (PSU), *Alexandrium* abundance (cells/L), and PSP toxicity (µg STX equiv./100g tissue) at representative stations in or near Harpswell Sound (left) and New Meadows River (right) in 2008. Note higher scale for *Alexandrium* abundance in Harpswell Sound.

3.7 Statistical Results

In 2006, the apparently similar patterns observed in salinity, nutrients, and PSP toxicity led us to run a series of statistical tests. A statistical comparison of salinity and PSP toxicity data indicated that there was a significant inverse correlation between the two parameters (P=0.02), but the correlation coefficient is very low (-0.12) suggesting that it is a very weak relationship (CBEP 2007). A subsequent analysis conducted after removing the river influenced stations 4, 5, 6, 10 and 11 showed similar results. The non-river correlation was significant (P=0.0015) and suggested a slightly stronger relationship between the parameters (correlation coefficient of -0.18), but certainly was not a conclusive finding. Now that there are two years of results that include quantitative data on *Alexandrium* abundance, another round of statistical analyses was conducted for the 2007-2008 data as outlined in Section 2.4.2.

Summary statistics were calculated for each parameter for each area (western or eastern Casco Bay), embayment (station group;11 groupings), and station. The area and embayment means are presented in Table 1. The station means as well as the rest of the summary statistics for all locations are provided in Appendix B. There are a few general trends that are evident from the means that were also seen in the contour plots. Water temperatures are warmer in Eastern Casco Bay as most of the stations are within more sheltered embayments with limited circulation; the coolest waters are found offshore. The freshest waters are associated with the stations near the rivers in Western Casco Bay. Portland Harbor also has lower salinity waters as well as the offshore stations in Eastern Casco Bay and Tottman Cove that are most heavily influenced by the Kennebec River plume during the April-July time period. Nutrient concentrations tend to follow the salinity trends with the highest concentrations associated with the inputs (anthropogenic and riverine) in the vicinity of Portland Harbor and the river stations. **Most importantly for this project there is a clear difference between Western and Eastern Casco Bay with regards to both PSP toxicity and *Alexandrium* abundance with higher values for both at the eastern stations.** If not for a single high *Alexandrium* count of 3,560 cells/L at station 9 in early June 2007, all of the inshore locations in Western Casco Bay had low counts and low toxicity compared to Eastern Casco Bay and the offshore stations 1, 2 and 3.

Table 1. Overall mean values for 2007-2008 data by locations within Casco Bay. Station based values are provided in Appendix B along with the rest of the summary statistics for these locations.

Area	Location	Max Depth (m)	Surface Temp (°C)	Surface Salinity (PSU)	NO3+NO2 (µM)	NH4 (µM)	SiO4 (µM)	PO4 (µM)	PSP Toxicity (µg/100g)	*Alexandrium* (cells/L)
Western	FS	3.5	13.3	28.9	0.40	1.79	8.23	0.60	19	179
Western	HR	3.9	13.4	28.9	0.51	2.07	10.58	0.38	1	19
Western	MB	4.7	13.3	29.2	0.27	1.78	5.83	0.48	5	47
Western	MQ	4.1	13.5	29.2	0.24	1.54	5.94	0.36	2	46
Western	OW	7.3	10.9	29.2	0.79	2.26	6.29	0.64	104	149
Western	PH	8.5	12.6	26.4	2.90	7.86	15.36	3.33	4	53
Western	RV	4.3	13.9	22.5	3.91	3.27	30.85	0.53	3	7
Eastern	HS	9.6	14.3	29.0	0.41	1.93	7.11	0.32	123	778
Eastern	NM	6.1	14.5	29.0	0.33	1.76	7.96	0.40	10	134
Eastern	OE	8.6	13.3	27.6	0.53	1.64	5.98	0.29	79	64
Eastern	TC	3.2	13.6	27.1	0.47	2.30	7.37	0.18	68	296
Western	Mean	4.8	13.1	28.2	0.97	2.47	10.63	0.68	15	65
Eastern	Mean	7.7	14.2	28.6	0.41	1.84	7.23	0.34	65	369

The next step of the analysis was to examine the apparent trends seen in the graphical analyses and the summary statistics more closely using correlation and analysis-of-variance (ANOVA) statistical methods. The correlation results showed quite a few "significant" (P • 0.05) relationships (both positive and negative or inverse correlations). However, the statistical significance of the correlations is mainly due to the large number of samples rather than to strong correlations given the high number of data points for each comparison, and was therefore not surprising (Table 2). The more important factor to examine is the correlation coefficient (*r*) associated with each comparison. The higher the coefficient the more meaningful the correlation – a general rule-of-thumb suggests that a coefficient of <0.4 is not very important, 0.4 to 0.7 there is a moderate relationship, and >0.7 there is a strong correlation between parameters. Using these guidelines, a few moderate to strong correlations were identified during the parametric and nonparametric tests (Table 2). Temperature and salinity (both average and surface values) tended to be moderately correlated to each other, which is not surprising given that the freshet and other storm/precipitation/flow related events tend to occur earlier in the season when the waters are cooler and then decrease over time as the waters warm. The surface and average values for each of these parameters were strongly correlated with each other (Table 2).

Table 2. Pearson correlation results comparing all major parameters. The values listed are correlation coefficient (r; top), probability value (P; middle), and number of values (n; bottom).

	Max Depth (m)	Average Temp (°C)	Average Salinity (PSU)	Surface Temp (°C)	Surface Salinity (PSU)	PSP Toxicity (µg/100g)	NO3+ NO2 (µM)	SiO4 (µM)	NH4 (µM)	PO4 (µM)
Alex (cells/L)	0.1008 0.0276 478	-0.0846 0.0646 478	0.0374 0.4151 478	-0.0892 0.0514 478	0.0375 0.414 478	0.6649 <.0001 387	-0.0506 0.2786 461	-0.0517 0.2677 461	-0.0229 0.6245 461	-0.0244 0.6012 461
Max Depth (m)		-0.2089 <.0001 701	0.1415 0.0002 701	-0.0943 0.0125 701	-0.0165 0.6628 701	0.2124 <.0001 476	-0.0161 0.7104 533	-0.0907 0.0364 533	0.0084 0.8462 533	-0.0141 0.7458 533
Average Temp (°C)			0.4400 <.0001 701	0.9691 <.0001 701	0.4287 <.0001 701	-0.1748 0.0001 476	-0.0825 0.0569 533	-0.1446 0.0008 533	0.0734 0.0906 533	0.0060 0.891 533
Average Salinity (PSU)				0.4523 <.0001 701	0.8898 <.0001 701	0.0856 0.0619 476	-0.4724 <.0001 533	-0.6070 <.0001 533	-0.1462 0.0007 533	0.0324 0.456 533
Surface Temp (°C)					0.3771 <.0001 701	-0.1737 0.0001 476	-0.0666 0.1248 533	-0.1415 0.0011 533	0.0770 0.0759 533	0.0064 0.8835 533
Surface Salinity (PSU)						0.0742 0.1059 476	-0.5877 <.0001 533	-0.6797 <.0001 533	-0.1751 <.0001 533	0.0153 0.7248 533
PSP Toxicity (µg/100g)							-0.0868 0.0699 437	-0.1129 0.0183 437	-0.0092 0.8476 437	-0.0315 0.5111 437
NO3+ NO2 (µM)								0.7270 <.0001 534	0.3494 <.0001 534	0.3470 <.0001 534
SiO4 (µM)									0.2245 <.0001 534	0.0977 0.024 534
PO4 (µM)										0.6098 <.0001 534

There were moderate inverse correlations between salinity (surface and average) and the concentrations of both NO_3 and SiO_4 and these two nutrients were strongly correlated (r=0.72) with one another (Table 2). These results indicate the importance of riverine inputs of these nutrients to the system (low salinity=high concentrations) as well as the similar source for these two nutrients. Ammonium and phosphate were also correlated (r=0.61) with each other as is often the case as inputs of these nutrients are typically associated with anthropogenic sources. The only other correlation that was moderately significant (r=0.66) was between *Alexandrium* abundance and PSP toxicity (Table 2). This is to be expected as it is the basis for the conceptual model of how these red tide blooms impact the ecosystem. It is reassuring to have evidence that the conceptual model is correct.

The graphical analyses and summary statistics showed clear trends spatially from west to east across Casco Bay, between embayments, and from station to station. To get a better handle on what trends were meaningful, ANOVA analyses were used to compare mean values for each parameter between the various levels of sampling locations. Tukey multiple comparison analyses were performed on each set of area, embayment, and station comparisons to determine if there were significant differences between the means. The results of these comparisons are presented in Table 3 that shows only the significant differences between location means. If no significant differences were notes, for example for NO3, 'none' is listed in the table. When significant differences are noted they are shown as "x>a, b" meaning that the mean response for location x was greater than those for locations a or b. Note that the top line supersedes subsequent lines in each cell of Table 3.

All of the Eastern vs. Western Casco Bay comparisons were significant. Eastern Casco Bay was deeper, warmer, and more saline, had lower concentrations of all four nutrients, and had higher PSP toxicity and *Alexandrium* abundances (Table 3). On the embayment and station levels, the results are a bit more complicated, but highlight many of the trends that were discussed previously. Station depth was highly variable within embayments as shown in Appendix B by the range in values. Overall, Harpswell Sound and Offshore Eastern bay stations were deeper than the other embayments from Freeport to Harpswell and the river stations. Portland Harbor and the Offshore Western stations were also deeper than some of these shallower areas. On a station by station basis the results were quite variable and are not shown in Table 3. Surface temperatures at the Offshore Western stations were significantly cooler than those in some of the embayments (NM, HS, MQ, and HR) and at the river stations. Due to the overall variability in temperature associated with seasonal warming at each station, there were no significant differences between stations. In regards to surface salinity, the waters in the areas directly influenced by riverine inputs (PH and RV) and by the Kennebec River plume (OE and TC) had significantly lower salinity than those in some of the embayments (MQ, MB, HS and NM) and Offshore Western stations. On a station basis, the highest salinities were in the upper reaches of the New Meadows River/Harpswell Sound (stations 30 and 31) and the lowest at the three river stations (6, 10, and 11).

The trends in nutrients that have been discussed previously were also supported by these statistical analyses. The River stations had significantly higher concentrations of NO_3 and SiO_4 than all other areas and NH_4 and PO_4 concentrations were significantly higher in Portland Harbor compared to all other areas. Nitrate concentrations at the individual stations were quite variable and there were no significant differences across stations, whereas for SiO_4 the river stations (6, 10, and 11) were significantly higher than nearly all other stations. Portland Harbor station 5, which is in very close proximity to the South Portland Sewer District's Fore River outfall, had significantly higher NH_4 and PO_4 concentrations than all other stations.

Table 3. ANOVA results comparing parameters in Casco Bay by Area, Embayment and Station. Significant differences are displayed between each grouping based on Tukey multiple comparisons.

Parameter	Area Comparison	Embayment Comparison	Station Comparison
Depth	E > W	HS, OE > NM, MB, RV, MQ, HR, FS, TC PH > MB, RV, MQ, HR, FS, TC OW > RV, MQ, HR, FS, TC NM > MQ, HR, FS	Highly variable
Surface Temp	E > W	NM, HS, RV, MQ, HR > OW	None
Surface Salinity	E > W	MQ, MB, OW, HS, NM > OE, TC, PH, RV FS, HR > PH, RV	31, 30 > 5, 10, 11, 6 All (except 42, 37, 38, 39, 40, 4, 5) > 10, 11, 6 All (except 4, 5, 10) > 11, 6
NO3+NO2	W > E	RV > PH, OW, OE, HR, TC, HS, FS, NM, MB, MQ PH > OW, OE, HR, TC, HS, FS, NM, MB, MQ	None
SiO4	W > E	RV > PH, HR, FS, NM, TC, HS, OW, OE, MQ, MB PH > FS, NM, TC, HS, OW, OE, MQ, MB HR > OE, MQ, MB	11 > all except 10 10 > all except 6 6 > all except 5, 16, 4 5 > 24, 27, 20, 42, 38, 22
NH4	W > E	PH > RV, TC, OW, HR, HS, FS, MB, NM, OE, MQ RV > NM, OE, MQ	5 > all 4 > all except 6, 16, 10, 15, 2, 11, 32,43
PO4	W > E	PH > OW, FS, RV, MB, NM, HR, MQ, HS, OE, TC	5 > all
PSP Toxicity Score	E > W	HS > FS, NM, MB, PH, RV, MQ, HR OW > NM, RV, MQ, HR	None
Alex cells/L	E > W	None	None

Interestingly, although PSP toxicity and *Alexandrium* abundance were significantly higher in Eastern vs. Western Casco Bay, there were no differences between embayments for *Alexandrium* abundance or between stations for either parameter. This is likely due to the very wide range in values in these parameters (0 to thousands) within groups of stations and between stations. PSP toxicity was significantly higher in Harpswell Sound compared to all other areas except Offshore Western, Offshore Eastern, and Tottman Cove. Offshore Western toxicity was also significantly higher than toxicity at the River stations and within the NM, MQ, and HR embayments.

The residuals from the fitted nested ANOVA model were examined to determine whether ANOVA assumptions had been met (independent observations, normal distribution). The residual analysis found that an underlying normal distribution was usually a reasonable assumption; however, the analysis also found that different order relationships (e.g., squared measurements) might provide a better model fit.

One additional approach was taken to try to develop a model to predict *Alexandrium* abundances based on the other parameters examined. A stepwise regression analysis approach was used to choose only the important variable for this predication and the location variable was excluded. The results indicated that there were only two significant predictors of *Alexandrium* abundance – PSP toxicity and station depth, and these two parameters accounted for about 50% of the variability of *Alexandrium* abundance in the model.

4.0 DISCUSSION

4.1 Gulf of Maine Red Tides

Toxic red tides in the Gulf of Maine are a regional phenomenon for the most part, with the blooms of *Alexandrium fundyense* extending for hundreds of miles along the coast from the Bay of Fundy to Massachusetts and beyond (Anderson *et al*. 2005a). It is well established that these blooms originate from dormant cysts that accumulate in “seed beds” in the Bay of Fundy and along the mid-coast of Maine. Conceptual models of bloom formation in this region have been presented by Anderson *et al*. (2005b) and McGillicuddy *et al*. (2005). Cysts that germinate in the Bay of Fundy cause recurrent and self-seeding blooms in those waters, with some of the cells escaping around Grand Manan Island where they enter the Eastern Maine Coastal Current (EMCC) and travel to the south and west (Figure 27). As this water mass and its associated cells approach Penobscot Bay, much of the water veers offshore toward the central Gulf of Maine, but under certain conditions it can also continue in an alongshore direction where it joins with river outflow from the Kennebec and Androscoggin Rivers and other freshwater sources to form a buoyant plume called the Western Maine Coastal Current (WMCC). This water mass is also seeded by germination of cysts from the mid-coast Maine seedbed. These populations are then transported along the coast by the WMCC where they can affect Massachusetts Bay and waters to the south.

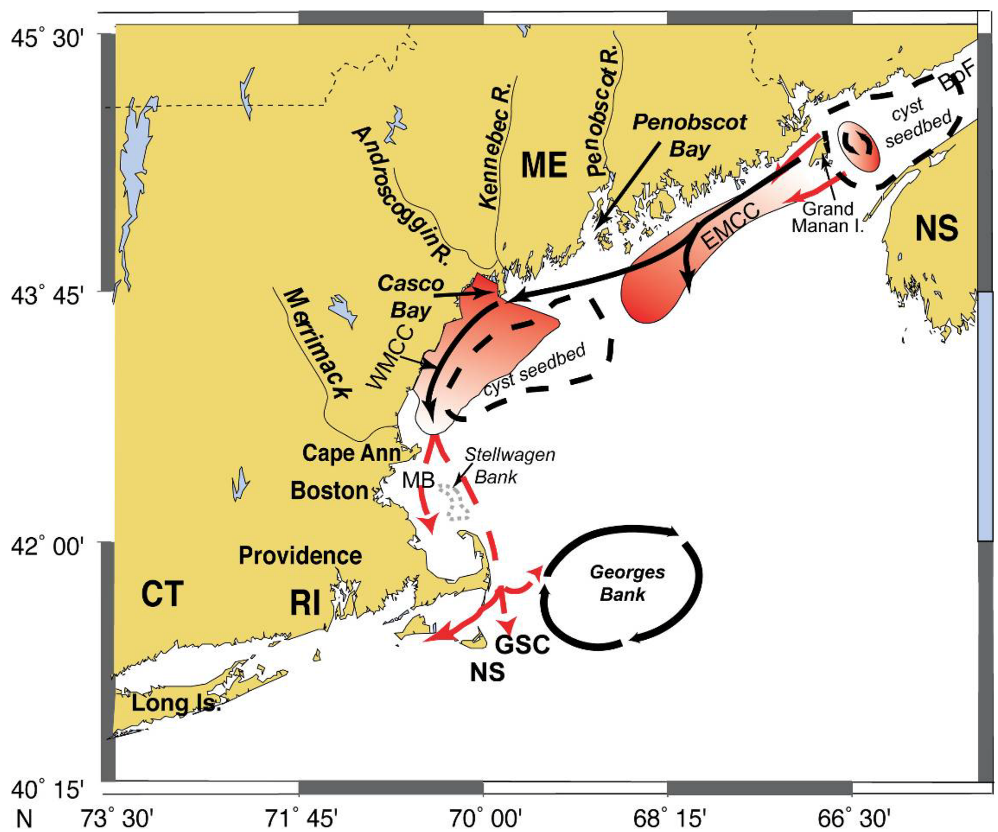

Figure 27. Conceptual model of *A. fundyense* bloom dynamics and PSP toxicity. Solid black lines denote the eastern and western segments of the Maine Coastal Current system (EMCC and WMCC, respectively);the arrows depict circulation around Georges Bank. Short, dashed black lines delimit the cyst seedbeds in the Bay of Fundy and mid-coast Maine. The red shaded areas represent portions of the EMCC and WMCC where *A. fundyense* blooms tend to occur with the highest color intensity denoting areas with higher cell concentrations. Dashed red arrows depict the transport pathways of EMCC and WMCC water masses and their associated *Alexandrium* cells. Modified from Anderson et al. (2005b).

The water mass that is most relevant in terms of toxicity within Casco Bay is the WMCC. It can carry cells past or into Casco Bay, and can deliver established populations from the Bay to downstream areas. This is not, however, the only source of cells to the bay, as there are also *A. fundyense* cysts within the bay that can cause localized germination and growth. In particular, small embayments and kettle holes such as Lumbo's Hole are known to be "point sources" of cells and toxicity within the Casco Bay system (Bean *et al*., 2005). This is evidenced by early season toxicity far up into the bay at these locations, often occurring several weeks before toxicity develops fully within the bay itself. Historically, Lumbo's Hole has been repeatedly the first site to become toxic along the coast of Maine.

The situation is less clear in some of the waters adjunct to Lumbo's Hole such as the New Meadows River and Cundy's Harbor. These are also sites for early season toxicity, but it is not known whether the cells that cause this toxicity have originated in New Meadows River or Cundy's Harbor, upstream, or offshore, with delivery by the WMCC. In the main body of Casco Bay, there is evidence that toxicity originates offshore. Keafer *et al*. (2004) deployed mussel bags in a transect line extending away from Casco Bay. These bags were collected on a weekly basis during the bloom season, and analyzed for PSP toxins. Results from 1998 demonstrate that toxicity was first detected during late April at the most offshore site, followed 1 week later by detection at two moorings within Casco Bay. Toxicity at the intertidal monitoring sites in Casco Bay and along the western Maine coast was not detected until two weeks after the offshore levels increased. The progression of toxicity from offshore to onshore was associated with downwelling-favorable wind conditions that transported the offshore *A. fundyense* population towards shore (Figure 28). A similar set of data collected along this transect in spring 2000 showed a similar trend of increasing cells and toxicity at the inshore and offshore moorings after a strong downwelling event (Keafer *et al*. 2005a). However, in 2000 toxicity was first observed about two weeks earlier at the Lumbo's Hole station in Harpswell Sound.

The conceptual model that we now have for toxicity within Casco Bay is therefore one with two sources of *A. fundyense* cells. The first source is the cyst population that resides within the bay, and in particular at the distal portions of the New Meadows River and other sounds (e.g., Lumbo's Hole). These populations germinate and cause localized toxicity, while also exporting cells with typical estuarine flow. These areas are "self-seeding", resulting in annually recurrent outbreaks at the same locations. Because these waters are shallow and warm quickly, the population development is faster than it is in the deeper and colder offshore waters, and therefore toxicity develops first within these areas.

The second source of toxicity is the WMCC and cells that have originated from the mid-coast Maine cyst seedbed, as well as some cells from the EMCC and the Bay of Fundy. Onshore and downwelling favorable winds, such as those from the east or northeast, bring the WMCC and its associated *Alexandrium* cells into Casco Bay, leading to rapid and significant increases in toxicity. In addition, an offshore source for early season blooms cannot be completely ruled out because low level populations of *Alexandrium* could be transported into Casco Bay from offshore before the abundances are sufficiently high to cause toxicity. Once trapped in an embayment, the population could grow more quickly in these warmer, more sheltered waters, mimicking in some ways the inoculum from cysts localized within that embayment or sound. Thus the same conceptual mechanism for inshore growth could be attributed to either self-seeding or inoculation from offshore populations.

Casco Bay is thus a highly dynamic environment with respect to *A. fundyense* bloom development, serving as a sink as well as a source of cells. It is also one of the few places in the Gulf of Maine where there are concerns about the influence of human activities, most notably pollution, in enhancing the red tide problem. Anderson *et al*. (2008) examined the relative importance of natural versus anthropogenic nutrients for the *Alexandrium* populations in the Gulf of Maine and concluded that for the large-scale regional blooms, natural sources of nutrients vastly exceeded those from rivers and land. However, this study also noted that in areas such as Casco Bay, there is the potential for local stimulation of *Alexandrium* (and other phytoplankton) by nutrient loading from the highly populated Portland region, leading to an enhancement of cell abundance and thus toxicity. Unfortunately, much of the research on *Alexandrium* in the Gulf of Maine has been at the regional level, with the large research vessels and broad coverage of the area from the Bay of Fundy to Massachusetts. Thus, the data from the CBEP study in Casco Bay are important for understanding whether concerns about human enhancement of the red tide problem are justified.

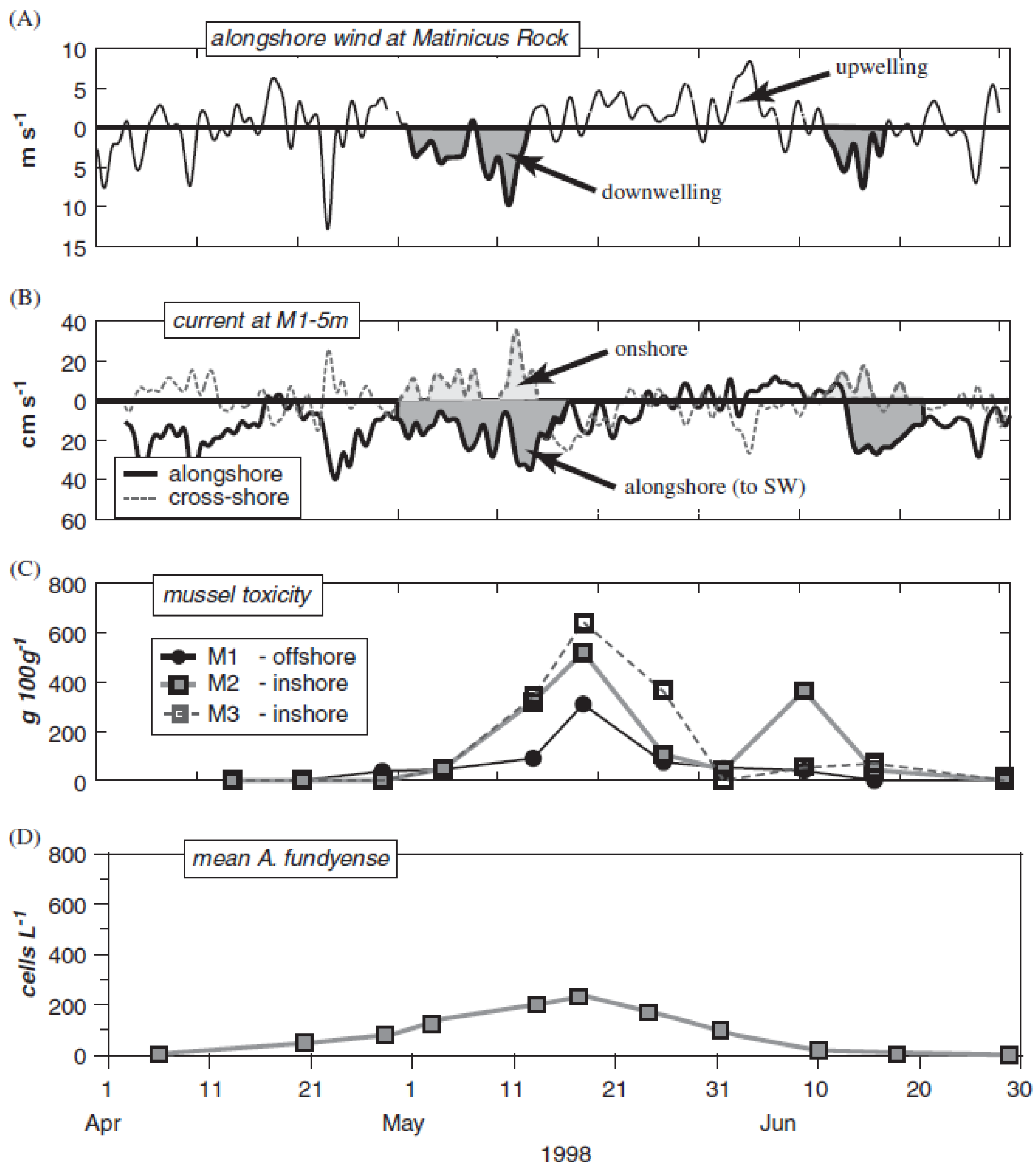

Figure 28. Time series of wind, currents, PSP toxicity, and *Alexandrium* abundance during a WHOI survey in 1998 (Figure 3 from Keafer *et al*. 2005a).

4.2 Coastal/Kennebec River Plume

Throughout this report, the importance of "offshore" populations of *A. fundyense* have been highlighted, as has the influence of the "Kennebec river plume". The association of the *A. fundyense* populations with low-salinity water near the coast and outside Casco Bay is complex, and needs to be clarified because of its importance to the bay.

We know that there are cells within low salinity waters that enter Casco Bay (Keafer et al. 2005a & b; this report). However, the source of the *A. fundyense* cells observed within that water and the source of the freshwater itself are not well understood. The rivers are unlikely contributors to these populations as there are no documented observations of *A. fundyense* cells, at least in the Kennebec River (Anderson and Keafer, 1992). Local germination of cysts within the western Maine coastal region would contribute to the cells in the low salinity nearshore waters, especially during upwelling when the plume is displaced over deep-water cyst reservoirs (McGillicuddy et al., 2003). However, given the clear evidence for alongshore transport from the eastern to the western Maine coastal regions (Keafer et al. 2005b), it is also likely that cells from the *A. fundyense* populations off the eastern coast of Maine would be transported to the vicinity of the Penobscot and Kennebec River plumes. Keafer et al. (2005b) present evidence of a transport pathway (termed the Gulf of Maine Coastal Plume or GOMCP) by which cells originating in the eastern Maine coastal region are transported to the south and underneath or along the outside edges of the western Maine river plumes, where some may enter those plumes through upward swimming behavior. These cells would then be introduced into embayments such as Casco Bay during downwelling favorable winds.

The source waters for the GOMCP are thought to be the major river systems in Maine and the Bay of Fundy, including the St. John. The *Alexandrium* populations in the GOMCP probably derive in part from a large *Alexandrium* cyst seedbed in the Bay of Fundy (Anderson et al., 2005c; McGillicuddy et al., 2005) which lies underneath freshwater flows from the St. John that enter the eastern Gulf of Maine during the spring (Brooks, 1994; Bisagni et al., 1996; Lynch et al., 1997).

The GOMCP should be distinguished from the WMCC, at least at its origin. The GOMCP is a continuum of the freshwater along the coast, while the WMCC is generally defined as the western branch of the EMCC. In those instances when the WMCC and its intermittent connection with its EMCC parent are evident, the *A. fundyense* populations are predominantly located in low-salinity water shoreward of the core of the WMCC (Keafer et al. 2005b). This is also apparent in other studies that show that *A. fundyense* populations were most abundant within the western river plumes or at their outer edge (Anderson et al., 2005a; Keafer et al., 2005b) and indicates that during transit westward, populations are maintained in a continuous nearshore feature within low-salinity waters as those waters are freshened from the western Gulf of Maine rivers. Thus the GOMCP can be viewed as a part of the Maine Coastal Current linking the major freshwater sources of the eastern and western Gulf of Maine. A conceptual diagram is shown in Figure 29, which distinguishes the short-term effects of the wind on the *A. fundyense* distributions within the GOMCP during persistent downwelling and persistent upwelling-favorable periods.

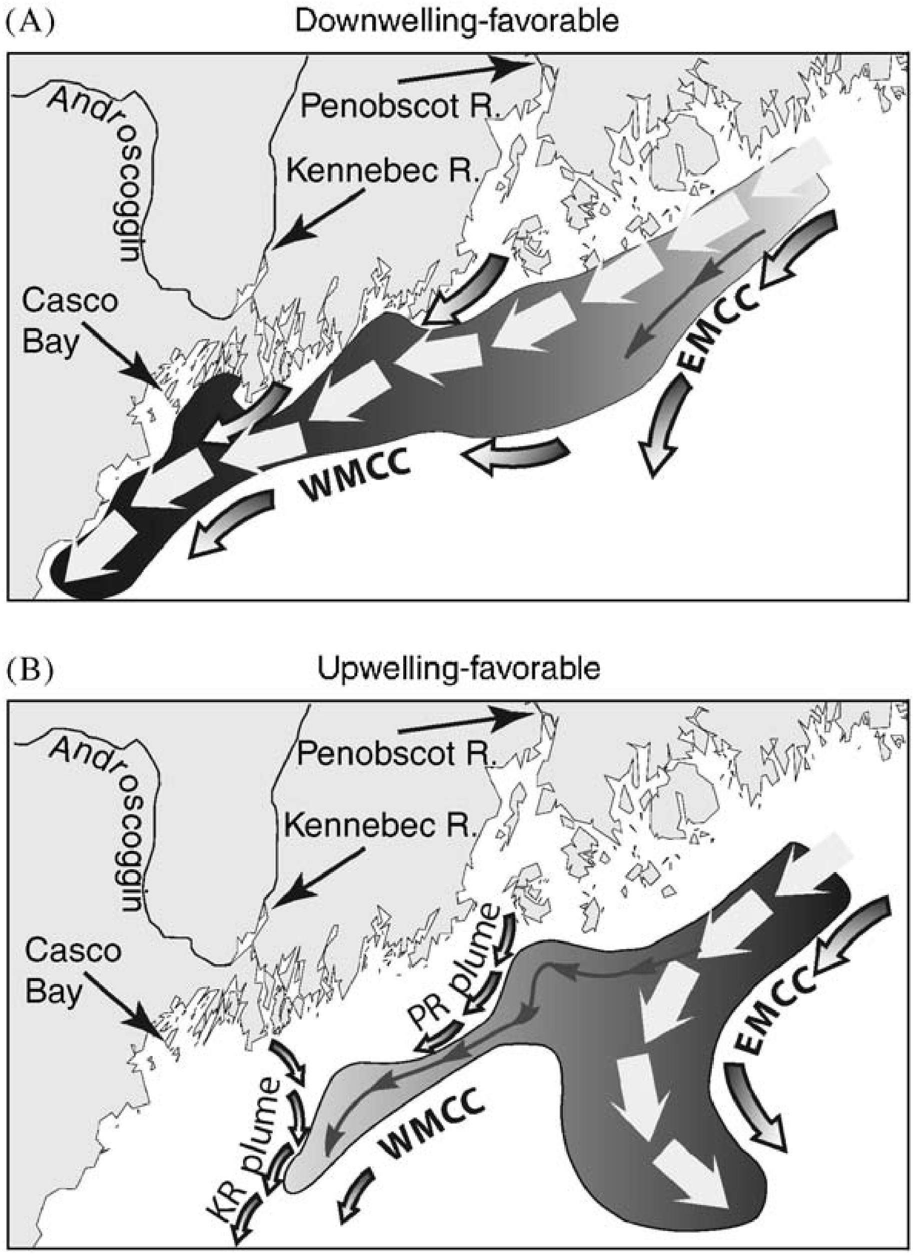

Figure 29. Conceptual diagram of the delivery of *A. fundyense* populations from eastern Maine to the western Maine coastline. The shaded gradient represents *A. fundyense* populations within low-salinity waters (<32) of the Gulf of Maine Coastal Plume. The large light arrows emphasize the dominant flow paths of the *A. fundyense* populations, while the small, dark arrows represent the pathway of the remainder of the total population transported along the coast. The outlined and shaded dark arrows represent the major coastal currents offshore or the Kennebec and Penobscot plume waters entering the western GOM. (A) Following periods of strong of persistent downwelling- favorable conditions, the eastern population is close to the coast and converges along an inside track to the western Maine coastline. (B) Following periods of strong or persistent upwelling-favorable conditions, the eastern population is further offshore and follows a more offshore track to the interior GOM. Eastern populations in the westward coastal flow can either merge with the freshwater inputs from the Penobscot and Kennebec River plumes (most common during downwelling) or be blocked and steered around those features (most common during upwelling). From Keafer et al. (2005b).

4.3 Casco Bay IPSP Study

The interannual variability in the magnitude and toxicity of red tide blooms of *Alexandrium* in Casco Bay seen by other researchers (e.g. Keafer *et al*. 2005a) was evident in the 2006-2008 CBEP IPSP data. The 2006 bloom exhibited the highest toxicity and the 2007 bloom, the weakest. During each of the years, toxicity was observed in Harpswell Sound (Lumbo's Hole or Ewin Narrows) about a week or two before it was measured further offshore. However, during both 2006 and 2008 there appeared to be a major influx of offshore waters that may have contributed to the peak cell abundances and toxicity measured during the bloom events. The primary objective of the CBEP IPSP Study and this report was to examine *Alexandrium* bloom dynamics in Casco Bay by understanding the relative influences of internal and external processes.

As noted above, Anderson *et al*. (2008) suggested that anthropogenic inputs of nutrients could exacerbate or spur on localized blooms leading to higher cell abundance and PSP toxicity. This may be the case at certain times or in other areas, but from the 2006-2008 IPSP data there was no indication of this for Casco Bay. There was no correlation between elevated nutrient concentrations (and by association nutrient loading) and the magnitude of the blooms or toxicity levels. Portland Harbor had significantly higher concentrations of nutrients than all other areas except the River stations (which had higher average concentrations of NO_3 and SiO_4). However, Portland Harbor and the River stations were among the areas that had the lowest PSP toxicity and *Alexandrium* abundance. **For the 2006-2008 data, there does not appear to be localized stimulation of the bloom within Casco Bay due to the excessive nutrient loading in the harbor and rivers.** Rather, there is a spatial pattern showing higher abundance and toxicity in Eastern Casco Bay and the offshore waters in Western Casco Bay (stations 1, 2 and 3).

Elevated concentrations of NO_3 and SiO_4 were observed in association with the Kennebec River plume during a number of surveys. The nutrient and salinity signal of the plume suggests that the plume is not only a source of external nutrients to Casco Bay, but may also play a role in transporting *Alexandrium* into the bay. In addition to the Coriolis effect pushing the buoyant river plume into Casco Bay, there were times when consistently downwelling-favorable winds out of the northeast likely brought the plume and offshore waters into the bay (as depicted in Figure 29). The timing and resolution of the sampling for wind and IPSP data are such (hourly vs. biweekly) that it is difficult to make conclusions on the cause and effect of these processes. However, the IPSP data do suggest that although there may be an early bloom initiated within the bay, peak toxicity and *Alexandrium* cell abundance is often coincident with conditions conducive for onshore flow and during periods when offshore *Alexandrium* blooms are present. This pattern of offshore delivery of cells to Casco Bay has been frequently observed during the ECOHAB-Gulf of Maine and GOMTOX programs and was documented by Keafer *et al.* (2005a & b) for Casco Bay as discussed above.

The CBEP IPSP dataset for the 2006-2008 *Alexandrium* blooms provided additional insight into bloom dynamics in Casco Bay. The IPSP dataset and DMR long term monitoring data consistently shows early toxicity in Harpswell Sound in the Lumbo's Hole/Ewin Narrows area. This area is suspected of having a local *Alexandrium* population. The 2006-2008 IPSP data as well as earlier research suggest a conceptual model of early inshore initiated blooms, but thereafter, large regional blooms dominate and serve as the source for *Alexandrium* resulting in peak abundance and PSP toxicity. However, the data do not provide any definitive indication as to the origin of the bloom nor the source of the early blooms observed in Harpswell Sound. It may be possible using sophisticated genetic methods to ascribe local or regional origins of *Alexandrium* cells/bloom. These methods or perhaps sediment sampling to assess the number of *Alexandrium* cysts in the local area would be appropriate approaches for determining if the Lumbo's Hole *Alexandrium* are a self-seeding population. Regardless, the trends in the data and the statistical analyses suggest that it is the offshore blooms that lead to the major PSP toxicity events in Casco Bay.

The value of the IPSP monitoring data cannot be overstated. Although the 2006-2008 findings were not definitive, additional data during different "bloom years" should continue to shed light on bloom dynamics in the bay. Finally, the PSP toxicity data from the buoy sites has allowed for surgical closures, leaving certain shellfishing areas open during each year, thereby allowing local clammers to continue earning a living during a period of consistent red tide bloom events.

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APPENDIX A

Data Tables

2007 and 2008 sampling information with surface and downcast average temperature (°C) and salinity (PSU), PSP toxicity (µg STX/100g), Alexandrium abundance (cells/L) and nutrient concentrations (µM)

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
21-Apr-07	1	8.91	4.74	29.39	4.43	29.86						
21-Apr-07	2	9.47	5.03	29.07	4.38	29.78						
21-Apr-07	3	9.74	5.19	26.53	4.39	29.13						
21-Apr-07	4	10.90	5.95	23.95	4.59	27.84						
21-Apr-07	5	10.43	6.20	23.07	4.85	26.84						
21-Apr-07	6	5.51	6.11	8.15	5.02	23.54						
21-Apr-07	7	2.39	6.58	27.99	6.46	27.97						
23-Apr-07	8	4.09	8.81	28.04	7.24	28.59						
23-Apr-07	9	2.35	8.41	28.07	8.26	28.10						
23-Apr-07	10	3.82	10.20	22.42	7.74	26.70						
23-Apr-07	11	3.64	10.53	13.83	8.29	22.55						
23-Apr-07	12	3.09	8.95	26.71	7.35	28.34						
23-Apr-07	13	5.94	8.03	29.02	7.94	29.03						
23-Apr-07	14	3.61	8.44	28.96	8.29	28.97						
23-Apr-07	15	3.08	8.33	28.95	8.20	28.96						
23-Apr-07	16	3.48	9.19	28.57	8.52	28.79						
23-Apr-07	17	1.92	9.71	28.25	9.50	28.34						
23-Apr-07	18	4.88	7.68	29.25	7.61	29.24						
23-Apr-07	19	2.29	9.73	29.08	9.75	29.10						
23-Apr-07	20	4.91	8.10	28.94	8.09	29.01						
23-Apr-07	21	2.63	7.98	28.93	7.97	28.93						
23-Apr-07	22	3.97	7.92	28.99	7.88	29.10						
23-Apr-07	23	3.88	8.27	28.98	8.07	29.08						
23-Apr-07	24	3.22	8.24	28.42	8.30	28.67						
23-Apr-07	26	4.75	8.67	28.73	8.64	28.95						
23-Apr-07	27	5.15	7.91	28.21	7.94	28.28						
23-Apr-07	28	5.90	8.27	28.19	8.21	28.52						
23-Apr-07	29	3.70	7.92	27.41	8.10	27.64						
24-Apr-07	30	3.69	10.41	27.67	10.43	27.70						
24-Apr-07	31	17.70	9.18	27.48	9.20	27.64						
24-Apr-07	32	5.93	9.43	27.89	9.48	28.12						
24-Apr-07	33	7.70	8.30	26.93	8.41	27.03						

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
24-Apr-07	34	4.41	8.52	27.04	8.71	27.22						
24-Apr-07	35	8.66	8.06	26.79	8.07	26.82						
24-Apr-07	36	9.10	9.96	23.60	7.62	27.05						
24-Apr-07	37	13.18	8.92	23.46	5.88	28.33						
24-Apr-07	38	9.15	7.86	24.46	5.83	28.21						
24-Apr-07	39	13.35	7.56	23.85	5.13	29.08						
24-Apr-07	40	4.12	9.25	20.14	6.46	26.13						
24-Apr-07	41	5.24	8.86	24.16	8.75	24.64						
24-Apr-07	42	4.61	11.16	23.65	10.00	24.04						
24-Apr-07	43	3.23	11.74	26.72	11.13	26.69						
24-Apr-07	44	4.23	10.63	25.81	10.69	26.00						
03-May-07	1	7.87	6.83	29.06	6.24	29.57						
03-May-07	2	10.09	6.30	29.22	5.86	29.61						
03-May-07	3	11.20	6.60	27.89	5.36	29.72						
03-May-07	4	3.10	7.84	25.06	7.83	25.06						
03-May-07	5	10.38	7.99	24.71	6.76	27.07						
03-May-07	6	7.97	7.05	26.00	6.23	27.81						
03-May-07	7	4.41	7.94	27.60	7.13	28.19						
03-May-07	8	4.45	7.51	28.34	6.99	28.65						
03-May-07	9	4.04	8.85	26.82	8.72	26.94						
03-May-07	10	5.34	8.98	26.82	8.36	27.50						
03-May-07	11	5.43	9.84	23.37	8.75	26.57						
03-May-07	12	4.24	9.23	28.00	7.97	28.66						
03-May-07	13	5.38	9.02	28.82	8.68	28.91						
03-May-07	14	3.66	9.54	28.18	8.89	28.38						
03-May-07	15	2.76	10.37	27.76	10.23	27.80						
03-May-07	16	2.06	10.98	26.99	10.50	27.32						
03-May-07	17	3.43	9.67	27.87	8.92	28.31						
03-May-07	18	4.91	9.87	27.69	8.97	28.22						
03-May-07	19	2.56	10.11	27.75	10.10	27.75						
03-May-07	20	5.28	10.11	27.74	8.92	28.34						
03-May-07	21	2.87	9.78	27.60	9.76	27.62						

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
03-May-07	22	4.87	8.93	28.10	8.11	28.61						
03-May-07	23	3.89	8.88	28.26	7.94	28.74						
03-May-07	24	3.57	9.43	27.92	9.29	27.95						
03-May-07	26	5.37	10.03	27.67	9.42	27.97						
03-May-07	27	4.45	9.77	27.38	9.03	27.87						
03-May-07	28	4.85	9.31	27.61	8.51	28.19						
03-May-07	29	3.76	10.14	26.84	9.54	27.29						
04-May-07	36A	28.59	7.02	29.70	4.97	31.02						
04-May-07	37	9.76	5.75	30.76	4.96	31.13						
04-May-07	40	3.76	6.92	26.20	6.35	28.32						
04-May-07	41	5.17	7.06	29.27	7.02	29.29						
04-May-07	42	6.06	8.19	27.31	7.11	28.89						
04-May-07	43	3.83	8.70	28.51	8.01	28.91						
04-May-07	44	6.17	7.65	29.34	6.41	30.02						
10-May-07	1	6.03	9.68	28.98	7.39	30.18	-42	0	1.55	11.97	0.73	1.12
10-May-07	2	10.23	9.62	29.20	8.44	29.90	-42	2	0.63	9.57	1.00	0.86
10-May-07	3	6.76	7.06	30.50	5.85	30.97	-42	0	0.38	13.50	0.03	0.74
10-May-07	4	5.33	11.39	26.35	9.55	28.20	-42	24	1.07	18.13	3.30	1.23
10-May-07	5	3.40	11.43	27.02	9.65	28.25	-42		2.75	32.51	33.80	19.76
10-May-07	6	6.11	11.48	17.11	8.80	26.55	-42		5.45	38.18	2.39	0.80
10-May-07	7	1.24	13.41	28.41	12.63	28.78	-42		0.24	20.96	0.07	0.70
10-May-07	8	3.82	15.30	29.55	12.26	29.83	-42	2	0.64	19.99	2.56	1.96
10-May-07	9	1.57	12.33	29.30	11.83	29.36	-42		1.02	17.17	1.15	1.10
10-May-07	10	2.70	14.89	20.43	12.89	25.10	-42		2.87	55.72	7.45	1.41
10-May-07	11	3.26	13.89	21.48	11.98	26.86	-42		5.26	74.39	0.67	0.51
10-May-07	12	2.12	13.27	27.45	12.67	28.53	-42		2.12	36.09	0.60	0.57
10-May-07	13	3.79	12.65	29.50	12.25	29.57	-42	0	0.06	22.01	0.31	0.65
10-May-07	14	2.90	13.26	29.23	12.80	29.35	-42		0.29	19.90	1.62	0.80
10-May-07	15	2.65	14.21	28.59	13.75	29.05	-42		0.40	21.87	2.45	0.73
10-May-07	16	1.00	14.77	26.97	14.77	26.97	-42	0	0.98	32.67	3.76	0.82
10-May-07	17	3.34	12.16	29.59	11.67	29.67	-42		0.10	16.63	0.67	0.40
10-May-07	18	4.36	10.21	29.89	10.10	29.87	-42		0.09	13.33	0.65	0.61

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
10-May-07	19	1.96	12.85	29.80	12.68	29.80	-42	0	0.09	13.51	0.35	0.53
10-May-07	20	4.87	12.45	29.78	10.26	29.89	-42		0.09	10.61	0.11	0.40
10-May-07	21	2.61	11.91	29.75	10.53	29.96	-42		0.09	10.30	0.03	0.40
10-May-07	22	4.14	11.42	29.96	10.31	29.91	-42		0.10	8.35	0.00	0.39
10-May-07	23	3.46	12.47	29.94	11.10	30.01	-42		0.09	10.33	0.51	0.26
10-May-07	24	3.27	12.87	28.90	12.05	29.60	-42		1.09	15.16	1.46	0.48
10-May-07	26	5.22	12.90	29.66	11.70	29.86	-42	4	0.10	11.04	1.29	0.16
10-May-07	27	5.13	11.97	29.91	11.00	29.83	-42		0.09	6.23	0.02	0.31
10-May-07	28	3.84	10.56	29.84	9.63	29.77	-42		0.10	10.49	0.03	0.24
10-May-07	29	3.98	11.25	29.85	11.05	29.83	-42	0	0.09	8.71	0.03	0.20
11-May-07	30	4.60	11.89	29.13	11.75	29.13	-42		0.10	7.21	0.06	0.23
11-May-07	31	14.47	12.25	29.42	11.76	29.40			0.09	11.60	0.11	0.23
11-May-07	32	5.90	12.51	29.48	12.31	29.49	-42		0.10	9.11	0.02	0.19
11-May-07	33	5.94	10.97	29.56	10.95	29.56	-42		0.10	6.71	0.03	0.18
11-May-07	34	3.99	12.02	29.49	11.55	29.51	-42		0.09	5.47	0.03	0.12
11-May-07	35	8.76	10.59	29.33	10.52	29.34			0.09	5.45	0.02	0.77
11-May-07	36	9.69	12.04	26.56	10.32	28.92			0.09	16.22	0.00	0.02
11-May-07	36A	29.22	9.84	28.66	6.64	30.58	44		0.10	10.72	0.00	0.13
11-May-07	37	9.04	10.66	25.21	8.78	28.11	-42		0.93	17.98	0.03	0.15
11-May-07	38	6.81	10.19	24.97	9.17	27.32	-42		2.47	19.85	0.03	0.35
11-May-07	39	7.70	9.81	23.80	7.85	28.12	-42		4.64	19.73	0.00	0.22
11-May-07	40	3.88	10.42	24.47	9.94	25.64	-42		2.03	23.75	0.44	0.75
11-May-07	41	4.83	10.56	27.52	10.17	28.09	-42		0.09	14.53	0.00	0.07
11-May-07	42	4.38	10.87	26.09	11.22	26.70	-42		0.09	14.17	0.00	0.02
11-May-07	43	3.00	14.42	28.40	14.15	28.57	-42		0.43	20.50	0.22	0.45
11-May-07	44	4.45	14.10	28.34	13.67	28.39	-42		0.10	13.41	0.02	0.33
21-May-07	1	7.35	7.79	29.03	7.24	29.39	43	0	2.33	7.59	5.83	4.40
21-May-07	2	8.71	7.52	29.05	7.20	29.33	59	2	2.35	6.35	3.50	3.33
21-May-07	3	9.53	8.31	28.02	7.52	29.01	-42	0	1.48	8.06	0.43	0.66
21-May-07	4	10.41	8.90	25.91	8.06	27.75	-42	1	2.48	17.98	5.82	1.13
21-May-07	5	9.59	9.61	24.84	8.45	26.79		2	3.54	21.67	10.45	2.05
21-May-07	6	5.64	9.82	22.60	9.29	25.25	-42	9	2.23	21.06	2.97	0.76

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
21-May-07	7	2.66	9.08	28.77	9.00	28.79	-42	19	0.09	10.82	0.02	0.38
21-May-07	8	4.58	9.31	28.93	9.06	29.00	-42	0	0.10	10.16	0.03	0.53
21-May-07	9	3.56	9.97	28.49	9.62	28.70	-42	0	0.10	8.64	0.02	0.24
21-May-07	10	4.70	10.97	26.84	10.10	27.73	-42	0	0.09	12.71	0.12	0.32
21-May-07	11	5.02	9.91	27.71	9.55	27.96	-42	1	0.09	13.48	0.38	0.31
21-May-07	12	4.08	10.47	28.62	9.96	28.60	-42	0	0.10	12.36	0.02	0.26
21-May-07	13	6.48	9.25	28.87	9.14	28.88	-42	0	0.10	10.29	0.32	0.31
21-May-07	14	6.28	9.81	28.62	9.31	28.78	-42		0.10	12.62	0.06	0.31
21-May-07	15	3.62	10.40	28.34	9.76	28.58	-42		0.24	12.32	1.57	0.41
21-May-07	16	2.72	10.30	28.46	10.00	28.55	-42	1	0.15	13.12	0.43	0.48
21-May-07	17	4.98	9.66	28.75	9.46	28.79	-42		0.05	11.90	0.02	0.33
21-May-07	18	7.05	10.10	28.68	9.15	28.90	-42		0.10	8.97	0.00	0.30
21-May-07	19	3.09	10.42	29.08	10.13	29.06	-42	1	0.09	11.09	0.02	0.32
21-May-07	20	5.87	10.00	28.99	9.57	29.00	-42	1	0.27	10.24	0.02	0.39
21-May-07	21	3.15	9.46	29.00	9.47	29.00	-42	2	0.10	7.69	1.05	0.27
21-May-07	22	4.26	9.42	29.18	9.21	29.19	-42	0	0.10	10.34	0.02	0.08
21-May-07	23	4.00	10.38	29.14	9.80	29.15	-42	0	0.09	13.92	1.10	0.68
21-May-07	24	3.68	10.21	29.04	10.01	29.05	-42	0	0.10	11.56	0.00	0.19
21-May-07	26	5.24	10.09	28.98	10.04	28.98	-42	1	0.09	11.86	0.03	0.29
21-May-07	27	5.12	10.69	29.17	10.11	29.18	-42	1	0.10	9.98	0.00	0.18
21-May-07	28	2.63	9.08	29.31	9.06	29.31	-42		0.09	11.26	0.02	0.09
21-May-07	29	3.73	11.04	28.89	10.11	29.10	-42	2	0.09	12.67	0.03	0.20
22-May-07	30	4.10	11.33	29.00	9.72	29.36	-42	0	1.40	10.50	0.58	0.34
22-May-07	31	17.58	9.83	29.02	9.77	29.04		0	1.84	9.97	0.20	0.54
22-May-07	32	4.78	10.86	28.28	10.67	28.31	-42	5	0.76	8.57	0.02	0.27
22-May-07	33	4.90	9.97	28.61	9.94	28.61	-42	2	1.30	11.54	1.40	7.18
22-May-07	34	5.60	11.63	28.08	10.16	28.55	-42	6	1.96	10.08	1.53	0.61
22-May-07	35	7.54	9.98	28.63	9.33	28.75		3	1.35	11.06	1.01	0.40
22-May-07	36	8.32	10.96	28.54	9.53	28.77		170	0.20	8.00	0.74	0.21
22-May-07	36A	19.18	9.73	28.33	7.60	29.51	75	32	1.55	8.37	3.41	1.45
22-May-07	37	3.84	10.41	28.05	9.50	28.35	49	40	1.79	8.73	3.79	3.23
22-May-07	38	7.18	9.45	27.97	8.09	28.97	44	13	0.62	7.78	0.29	0.54

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
22-May-07	39	10.57	11.02	25.60	8.49	28.45	49	498	1.93	13.76	0.02	0.88
22-May-07	40	2.40	9.89	25.14	9.33	25.94	47	23	1.28	17.20	0.00	0.22
22-May-07	41	1.26	9.58	26.79	9.22	27.45	41	83	1.68	20.27	2.12	0.40
22-May-07	42	3.23	9.86	28.09	8.47	29.07	-42	1	0.57	9.92	0.03	0.25
22-May-07	43	2.99	10.71	28.59	10.12	28.77	-42	0	1.35	13.73	9.16	3.97
22-May-07	44	4.07	9.85	28.84	9.76	28.96	-42	0	1.27	7.08	3.37	8.04
06-Jun-07	1	4.86	10.88	29.59	10.36	29.76	46	36	0.86	3.30	0.73	0.56
06-Jun-07	2	8.92	10.49	29.72	9.70	29.99	65	4	1.37	3.31	2.94	0.58
06-Jun-07	3	5.89	10.99	28.34	9.99	29.46	57	4	1.85	8.72	2.67	0.53
06-Jun-07	4	3.27	13.37	21.84	11.96	26.13	-42	1	3.32	23.17	8.20	1.20
06-Jun-07	5	2.44	14.05	20.81	12.68	24.35		2	3.66	21.32	5.15	0.44
06-Jun-07	6	2.96	15.27	14.26	12.95	23.03	-42	1	6.53	40.57	4.08	0.19
06-Jun-07	7	1.96	12.51	28.92	12.21	29.12	41	2	2.00	4.41	0.86	0.22
06-Jun-07	8	4.63	13.40	28.66	12.28	29.14	-42	3	0.55	5.78	1.43	0.07
06-Jun-07	9						40	3,559	1.45	11.87	0.71	0.02
06-Jun-07	10	0.28	14.12	24.19	14.12	24.19	-42	39	2.74	30.19	3.12	0.18
06-Jun-07	11	3.30	14.86	21.63	13.24	25.96	-42	1	5.46	52.09	1.96	0.02
06-Jun-07	12	3.31	14.17	26.85	12.08	28.64	-42	2	1.53	18.81	0.91	0.03
06-Jun-07	13	6.14	12.57	28.48	12.39	28.61	40	2	1.05	6.59	1.47	0.03
06-Jun-07	14	5.42	12.95	28.04	11.83	28.94	-42	15	2.02	18.80	3.78	0.26
06-Jun-07	15	4.41	13.75	27.36	12.63	28.30	-42	8	2.08	15.46	3.78	0.21
06-Jun-07	16	2.57	14.19	26.30	13.64	27.14	-42	6	2.96	31.90	3.41	0.00
06-Jun-07	17	4.96	13.31	27.96	12.24	28.73	-42	10	1.88	17.59	2.65	0.03
06-Jun-07	18	6.30	11.78	29.17	11.06	29.44	-42	2	1.19	6.52	2.34	0.06
06-Jun-07	19	2.93	14.40	28.08	14.19	28.14	-42	1	0.62	7.13	0.87	0.03
06-Jun-07	20	5.80	14.48	27.98	12.18	29.04	-42		0.68	6.78	0.55	0.03
06-Jun-07	21	3.46	14.71	27.35	12.62	28.65	-42	15	1.17	10.64	0.55	0.08
06-Jun-07	22	4.86	13.85	29.07	11.87	29.50	38	65	0.71	4.34	2.03	0.44
06-Jun-07	23	4.09	13.59	29.00	12.33	29.18	-42	16	0.54	3.33	1.06	0.49
06-Jun-07	24	3.88	14.10	28.97	13.23	29.08	40	173	0.10	3.37	0.65	0.39
06-Jun-07	26	5.64	13.53	29.11	12.84	29.17	42	12	0.09	2.93	0.43	0.46
06-Jun-07	27	5.28	15.23	29.29	12.72	29.35	56		0.45	4.74	1.05	0.67

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
06-Jun-07	28	2.73	12.28	29.47	11.79	29.48	57	10	0.51	2.75	1.06	0.54
06-Jun-07	29	3.69	13.39	29.43	13.05	29.43	48	79	0.52	3.56	0.79	0.65
07-Jun-07	30	4.04	13.77	29.14	11.79	29.67	-42	3	0.59	4.92	0.52	0.31
07-Jun-07	31	9.16	12.43	29.26	12.46	29.23		28	0.97	4.40	1.67	0.50
07-Jun-07	33	4.05	14.30	28.95	14.18	28.95	40	17	0.42	3.85	0.50	0.53
07-Jun-07	34	3.52	13.68	28.93	13.68	28.93	-42	20	1.17	7.29	0.43	0.47
07-Jun-07	35	2.72	14.12	28.63	13.76	28.79		27	0.72	3.57	0.47	0.38
07-Jun-07	36	7.03	12.74	29.34	12.18	29.43		91	0.23	2.90	0.30	0.33
07-Jun-07	36A	28.29	11.56	29.82	8.98	30.55	74		0.63	2.40	0.47	1.80
07-Jun-07	37	3.38	12.00	29.55	11.79	29.56	49	28	0.47	2.44	0.69	0.03
07-Jun-07	38	5.38	12.05	29.54	11.42	29.67	72	104	0.35	2.15	0.58	0.03
07-Jun-07	39	7.29	11.57	29.53	10.82	29.86	48	10	0.47	2.21	0.56	0.02
07-Jun-07	40	2.18	11.50	28.92	11.17	29.23	48	5	1.07	5.18	0.61	0.03
07-Jun-07	41	4.40	12.64	28.77	11.84	29.16	-42	11	0.99	6.09	0.67	0.02
07-Jun-07	42	3.82	11.86	29.35	10.71	29.85	-42	9	0.28	2.41	0.12	0.02
07-Jun-07	43	2.37	13.33	28.30	13.12	28.40	-42	5	1.36	7.59	2.48	1.15
07-Jun-07	44	4.55	12.64	29.13	12.35	29.18	-42	1	0.45	5.88	0.44	0.02
13-Jun-07	1	3.09	11.96	29.44	11.84	29.46	190	65	0.58	5.91	0.64	0.02
13-Jun-07	2	9.39	13.04	28.76	12.23	29.27	776	139	0.46	8.37	0.72	0.02
13-Jun-07	3	9.85	12.41	29.19	12.09	29.46	223	117	0.41	6.86	0.68	0.02
13-Jun-07	4	8.02	13.75	27.62	13.24	28.21	-42	91	2.10	12.19	3.94	0.36
13-Jun-07	5	11.09	14.57	27.63	13.50	28.20	-42	4	1.59	11.95	4.37	0.52
13-Jun-07	6	3.90	15.19	18.58	15.15	18.78	-42	10	2.84	25.58	2.74	0.03
13-Jun-07	7	1.65	14.71	28.91	14.66	29.05	40	8	0.47	8.95	0.92	0.03
13-Jun-07	8	4.80	14.59	29.76	14.45	29.75	-42	2	0.03	5.64	0.92	0.03
13-Jun-07	9	2.55	13.47	29.78	13.14	29.87	-42	4	0.09	4.25	0.57	0.03
13-Jun-07	10	5.09	15.31	25.21	14.55	28.22	-42	4	4.57	40.47	2.56	0.02
13-Jun-07	11	2.68	15.89	22.81	15.26	26.03	-42	2	9.37	66.05	3.20	0.03
13-Jun-07	12	1.97	14.57	29.78	14.49	29.82	-42	47	0.17	6.86	0.33	0.03
13-Jun-07	13	6.04	14.40	29.88	14.28	29.90	-42	21	0.64	6.76	1.48	0.25
13-Jun-07	14	2.55	14.63	29.77	14.44	29.83	-42	24	0.44	5.93	0.69	0.02
13-Jun-07	15	4.53	14.90	29.58	14.57	29.74	-42	70	0.60	7.13	0.94	0.24

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
13-Jun-07	16	2.74	15.21	29.48	14.92	29.64	-42	34	0.67	7.16	1.44	0.02
13-Jun-07	17	5.18	14.42	29.87	14.12	29.95	-42	18	0.48	5.19	1.09	0.22
13-Jun-07	18	4.99	14.25	29.94	13.77	30.00	-42	5	0.12	3.66	0.63	0.01
13-Jun-07	19	3.08	15.48	29.97	15.22	29.97	-42	16	0.09	3.24	0.52	0.00
13-Jun-07	20	6.14	13.78	30.01	13.54	30.04	-42	71	0.40	3.21	0.34	0.14
13-Jun-07	21	3.77	13.93	30.03	13.70	30.02	-42	184	0.06	1.99	0.36	0.06
13-Jun-07	22	4.69	13.32	30.15	13.13	30.15	-42	70	0.09	1.02	0.42	0.02
13-Jun-07	23	4.25	14.43	30.07	13.99	30.07	-42	102	0.10	1.13	0.42	0.02
13-Jun-07	24	4.10	14.47	30.07	14.36	30.08	-42	324	0.10	1.67	0.36	0.02
13-Jun-07	26	6.02	14.12	30.02	13.89	30.06	-42	718	0.09	2.08	0.53	0.23
13-Jun-07	27	5.95	14.37	30.16	13.77	30.16	-42	239	0.10	2.36	0.49	0.11
13-Jun-07	28	3.58	14.04	30.16	13.68	30.14	-42	137	0.09	2.59	0.45	0.03
13-Jun-07	29	4.20	13.68	30.15	13.32	30.14	-42	403	0.09	3.09	0.70	0.08
14-Jun-07	30	4.24	14.01	30.05	13.73	30.09	-42	43	0.05	3.50	0.73	0.03
14-Jun-07	31	10.47	14.38	29.95	13.83	30.05		221	0.46	5.63	0.88	0.09
14-Jun-07	32	5.76	15.80	29.67	14.74	29.69	65	512	0.42	7.86	1.43	0.08
14-Jun-07	33	4.04	13.61	29.65	13.61	29.64	123	413	0.31	3.80	0.45	0.02
14-Jun-07	34	4.42	14.62	29.57	14.05	29.60	154	152	0.61	5.56	1.08	0.02
14-Jun-07	35	8.83	13.23	29.54	13.19	29.57		541	0.09	3.05	0.94	0.03
14-Jun-07	36	9.23	14.08	29.28	13.24	29.42		643	0.07	4.99	0.59	0.14
14-Jun-07	36A	24.95	12.80	28.65	11.00	30.12	213	298	0.09	5.57	0.56	0.02
14-Jun-07	37	5.35	13.91	28.19	13.27	28.48	336	49	0.16	7.50	0.86	0.52
14-Jun-07	38	8.82	13.17	28.24	12.09	28.91	50	24	0.09	6.47	0.79	0.01
14-Jun-07	39	8.41	13.21	28.59	11.68	29.35	48	12	0.10	4.26	0.48	0.02
14-Jun-07	40	3.48	11.82	29.40	10.61	30.01	-42	4	0.29	5.89	0.13	0.02
14-Jun-07	41	3.33	11.87	29.89	11.82	29.92	-42	61	0.14	4.02	0.32	0.13
14-Jun-07	42	6.53	13.25	29.16	12.76	29.42	-42	76	0.10	2.90	0.31	0.02
14-Jun-07	43	2.61	13.05	29.97	12.88	29.99	-42	40	0.10	3.18	0.19	0.02
14-Jun-07	44	5.90	12.88	30.14	12.51	30.22	-42	12	0.03	4.04	0.03	0.02
19-Jun-07	1	3.21	13.23	29.92	12.66	30.04	294	108	0.09	2.27	0.58	0.02
19-Jun-07	2	7.52	14.15	30.18	12.58	30.37	495	2,724	0.09	2.35	0.81	0.05
19-Jun-07	3	4.49	13.13	29.86	12.43	30.04	124	153	0.18	3.39	0.58	0.03

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
19-Jun-07	4	4.03	16.14	28.67	14.70	28.89	41	4	1.34	9.91	3.53	0.58
19-Jun-07	5	10.58	14.83	28.43	13.77	28.99	42	3	1.19	10.89	11.02	2.89
19-Jun-07	6	2.40	15.13	26.40	14.72	27.20	-42	0	3.16	19.85	2.68	0.30
19-Jun-07	7	1.49	16.03	29.88	15.56	29.92	65		0.09	5.25	0.89	0.02
19-Jun-07	8	4.13	15.76	29.52	14.45	29.73	-42	114	0.01	5.59	0.58	0.07
19-Jun-07	9	2.24	14.66	29.83	14.02	29.93	-42	13	0.09	5.38	0.52	0.03
19-Jun-07	10	2.10	16.89	28.84	16.74	28.90	-42	0	0.52	10.97	2.04	0.17
19-Jun-07	11	3.73	17.10	28.57	16.84	28.65	-42	4	0.83	11.37	2.47	0.15
19-Jun-07	12	3.04	17.64	29.40	15.38	29.80	-42	4	0.21	6.77	0.68	0.07
19-Jun-07	13	2.97	15.04	30.01	15.11	30.01	-42	2	0.06	4.78	0.71	0.03
19-Jun-07	14	2.87	15.39	29.99	15.37	29.99	-42	0	0.10	4.35	0.86	0.04
19-Jun-07	15	2.01	15.85	29.86	15.80	29.87	-42	0	1.09	5.68	1.73	0.28
19-Jun-07	16	2.32	17.37	29.57	16.85	29.71	-42	0	0.46	9.35	1.78	0.21
19-Jun-07	17	4.73	15.27	30.00	15.19	30.01	-42	2	0.17	5.04	0.73	0.15
19-Jun-07	18	6.79	14.20	30.09	13.77	30.14	-42	1	0.05	4.65	0.17	0.09
19-Jun-07	19	2.84	17.35	30.00	17.33	30.00	-42	1	0.10	3.06	0.73	0.03
19-Jun-07	20	2.72	16.19	30.02	16.00	30.02	-42	4	0.10	3.47	1.26	0.03
19-Jun-07	21	3.58	15.47	30.04	15.37	30.04	-42	2	0.09	2.77	0.63	0.04
19-Jun-07	22	4.27	17.65	29.81	14.73	29.89	-42	118	0.09	1.34	0.62	0.02
19-Jun-07	23	4.30	19.40	29.79	15.97	29.98	-42	100	0.09	2.11	0.54	0.03
19-Jun-07	24	3.57	16.42	29.96	16.35	29.95	-42	136	0.10	1.15	0.47	0.03
19-Jun-07	26	5.59	16.44	29.98	15.81	29.93	-42	274	0.10	1.45	0.90	0.03
19-Jun-07	27	5.81	16.62	29.96	15.07	29.93	-42	199	0.10	2.44	0.93	0.03
19-Jun-07	28	6.03	16.62	29.81	13.85	30.05	-42	47	0.10	3.26	0.65	0.02
19-Jun-07	29	3.87	15.95	29.98	15.49	29.93	-42	51	0.10	2.49	0.62	0.26
21-Jun-07	30	4.70	16.73	30.20	14.25	30.39	-42	718	0.10	2.81	0.44	0.38
21-Jun-07	31	8.46	15.13	30.34	15.02	30.33		276	0.11	3.55	0.50	0.39
21-Jun-07	32	5.73	18.06	29.94	17.32	29.88	-42	155	0.09	2.17	0.58	0.25
21-Jun-07	33	4.54	15.63	30.16	15.53	30.16	52	900	0.10	2.48	0.63	0.38
21-Jun-07	34	3.90	16.93	29.63	15.73	30.03	51	154	0.09	3.78	0.65	0.65
21-Jun-07	35	8.33	15.47	30.21	14.14	30.38		6	0.10	1.80	0.59	0.02
21-Jun-07	36	3.12	15.79	30.13	14.03	30.17		249	0.10	2.09	0.62	0.03

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
21-Jun-07	36A	28.60	15.56	30.22	10.52	31.15	136	193	0.10	1.06	0.53	0.10
21-Jun-07	37	3.85	15.75	29.38	12.75	29.99		1	0.00	1.90	0.86	0.53
21-Jun-07	38	9.15	16.02	29.71	11.37	30.57	78	39	0.09	1.15	0.73	0.03
21-Jun-07	39	11.26	16.88	29.60	11.23	30.72	121	16	0.06	1.39	0.78	0.40
21-Jun-07	40	1.62	17.39	28.74	16.26	29.09	139	1	0.10	1.61	0.88	0.05
21-Jun-07	41	1.52	15.39	30.10	15.36	30.06	-42	29	0.09	1.45	0.53	0.02
21-Jun-07	42	3.08	17.30	29.86	15.39	30.11		12	0.09	0.61	0.76	0.02
21-Jun-07	43	2.40	16.81	30.05	16.35	30.06	-42	14	0.09	5.69	0.94	0.28
21-Jun-07	44	4.29	17.03	29.69	15.87	29.78	-42	25	0.10	6.61	0.81	0.00
09-Jul-07	1	4.03	12.80	31.12	11.70	31.24	-42	1	0.14	2.36	0.21	0.60
09-Jul-07	2	8.13	13.61	31.11	12.37	31.23	-42	1				
09-Jul-07	3	10.25	13.04	31.04	11.90	31.19		6	0.52	3.92	0.35	0.60
09-Jul-07	4	9.46	14.24	30.29	13.56	30.49	-42	0	0.61	7.64	1.94	1.17
09-Jul-07	5	9.62	14.86	29.94	13.71	30.41	-42	1	0.24	9.24	0.74	1.23
09-Jul-07	6	5.07	15.82	23.58	15.16	25.13	-42	0	3.41	19.52	1.33	0.78
09-Jul-07	7	2.31	15.26	30.62	14.62	30.90	-42	0	0.10	2.41	1.36	0.26
09-Jul-07	8	3.73	15.40	30.89	15.31	30.90	-42	0	0.10	2.73	0.20	0.13
09-Jul-07	9	2.28	15.13	30.70	14.47	30.99	-42	0	0.09	0.28	2.17	0.08
09-Jul-07	10	4.67	15.50	29.70	15.04	30.46	-42	0	10.24	46.60	3.14	0.63
09-Jul-07	11	3.12	16.50	27.60	15.59	29.66	-42	0	9.08	42.45	2.49	0.35
09-Jul-07	12	2.36	14.99	30.87	14.84	30.96	-42	1	0.60	5.07	1.44	0.71
09-Jul-07	13	5.60	15.54	31.05	15.22	31.08	-42	0	0.03	3.49	1.06	0.29
09-Jul-07	14	2.14	15.76	30.94	15.48	30.99		0	0.55	8.57	1.55	0.30
09-Jul-07	15	3.40	16.33	30.75	15.88	30.90	-42	1	0.66	6.90	2.99	0.58
09-Jul-07	16	2.22	16.39	30.74	16.14	30.85	-42	0	0.69	8.52	2.87	0.76
09-Jul-07	17	3.40	15.53	31.05	15.23	31.09	-42	0	0.12	2.80	0.57	0.28
09-Jul-07	18	5.94	15.10	31.11	14.62	31.14	-42	0	0.02	1.86	0.39	0.20
09-Jul-07	19	2.65	16.09	31.10	16.02	31.10	-42	0	0.09	2.56	0.56	0.15
09-Jul-07	20	2.57	15.45	31.10	15.08	31.09	-42	0	0.10	0.02	0.83	0.02
09-Jul-07	21	3.33	15.32	31.10	14.86	31.12	-42	0	0.08	5.59	0.46	0.12
09-Jul-07	22	4.17	15.38	31.09	14.56	31.11	-42	0	0.02	1.24	0.75	0.48
09-Jul-07	23	4.09	15.91	31.03	15.37	31.05	-42	0	0.38	5.50	0.52	0.62

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
09-Jul-07	24	3.90	16.37	30.95	15.91	31.01	-42	0	0.09	0.59	0.40	0.22
09-Jul-07	26	5.70	15.62	31.06	15.41	31.08	-42	0	0.06	0.36	0.84	0.34
09-Jul-07	27	5.82	15.43	31.12	14.70	31.16	-42	0	0.10	1.06	0.83	0.13
09-Jul-07	28	5.19	15.13	31.14	14.20	31.18	-42	0	0.09	1.85	0.40	0.03
09-Jul-07	29	4.17	15.39	31.12	15.05	31.16	-42	0	0.09	0.80	0.41	0.22
11-Jul-07	30	4.72	16.91	30.91	15.98	31.02	-42	2	0.44	12.48	3.16	0.58
11-Jul-07	31	19.89	16.18	31.01	16.08	31.05		3	0.41	10.79	2.90	0.51
11-Jul-07	32	6.01	16.68	30.93	16.56	30.95	-42	10	0.63	10.03	1.72	0.37
11-Jul-07	33	4.59	15.72	31.05	15.53	31.08	-42	3	0.41	7.72	0.80	0.30
11-Jul-07	34	4.42	16.18	30.90	15.59	31.03	-42	1	0.73	12.10	1.12	0.25
11-Jul-07	35	8.53	14.86	31.08	14.75	31.09		1	0.18	4.94	2.79	0.29
11-Jul-07	36	8.87	17.08	31.11	16.06	31.10	-42	1	0.06	5.50	1.10	0.24
11-Jul-07	36A	28.94	14.66	30.56	12.27	31.15		0	0.10	3.75	0.57	0.02
11-Jul-07	37	4.34	15.47	30.49	15.29	30.67	-42	1	0.03	3.48	0.78	0.12
11-Jul-07	38	9.14	13.77	30.06	13.42	30.44	-42	0	0.09	1.20	0.83	0.16
11-Jul-07	39	9.23	13.72	29.74	13.86	30.39	-42	0	0.09	1.79	0.78	0.15
11-Jul-07	40	3.31	15.70	30.13	15.56	30.15	-42	5	0.10	1.81	0.44	0.20
11-Jul-07	41	3.86	14.52	30.89	14.27	30.95	-42	0	0.09	3.68	0.25	0.05
11-Jul-07	42	4.16	15.95	31.01	15.53	31.00	-42	26	0.10	4.03	3.04	0.76
11-Jul-07	43	2.41	18.03	30.95	17.99	30.94	-42	1	0.17	16.08	2.07	0.15
11-Jul-07	44	4.51	16.87	31.08	16.73	31.06	-42		0.46	13.94	1.11	0.67
24-Jul-07	1	4.12	16.64	30.37	16.01	30.41	-42					
24-Jul-07	2	8.55	17.29	30.47	16.30	30.59	-42					
24-Jul-07	3	9.93	16.24	30.61	14.48	30.90						
24-Jul-07	4	11.04	18.56	28.06	15.09	29.80	-42					
24-Jul-07	5	11.45	17.82	28.40	15.83	29.29	-42					
24-Jul-07	6	5.77	19.68	17.74	16.64	26.41	-42					
24-Jul-07	7	1.84	18.77	29.86	17.81	30.35	-42					
24-Jul-07	8	4.92	19.13	30.55	18.30	30.63	-42					
24-Jul-07	9	2.21	18.28	30.48	17.92	30.52	-42					
24-Jul-07	10	4.15	19.25	26.97	18.61	28.78	-42					
24-Jul-07	11	1.93	19.23	28.03	18.87	28.96	-42					

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
24-Jul-07	12	3.42	18.90	30.70	18.48	30.73	-42					
24-Jul-07	13	5.64	18.38	30.73	18.14	30.76	-42					
24-Jul-07	14	0.69	18.61	30.63	18.61	30.63						
24-Jul-07	15	3.66	18.88	30.32	18.53	30.53	-42					
24-Jul-07	16	1.88	19.12	30.15	18.89	30.30	-42					
24-Jul-07	17	3.26	18.44	30.61	18.03	30.73	-42					
24-Jul-07	18	5.56	17.94	30.79	17.54	30.84	-42					
24-Jul-07	19	2.49	19.20	30.76	19.15	30.77	-42					
24-Jul-07	20	5.24	17.85	30.85	17.40	30.87	-42					
24-Jul-07	21	3.14	18.10	30.82	17.96	30.83	-42					
24-Jul-07	22	3.97	17.95	30.84	17.74	30.86	-42					
24-Jul-07	23	3.80	18.51	30.76	17.55	30.83	-42					
24-Jul-07	24	3.47	18.28	30.79	18.04	30.81	-42					
24-Jul-07	26	5.34	18.13	30.79	17.26	30.86	-42					
24-Jul-07	27	5.28	17.83	30.82	16.57	30.94	-42					
24-Jul-07	28	4.76	17.15	30.85	15.97	30.90	-42					
24-Jul-07	29	3.77	17.12	30.85	16.45	30.87	-42					
25-Jul-07	30	2.43	20.98	30.76	19.88	30.77	-42	4				
25-Jul-07	31	25.04	18.23	30.82	17.48	30.84		1				
25-Jul-07	32	4.70	19.32	30.54	19.02	30.54	-42	17				
25-Jul-07	33	3.70	18.49	30.69	18.32	30.68	-42	119				
25-Jul-07	34	3.46	20.23	29.82	18.87	30.43	-42	2				
25-Jul-07	35	7.77	18.17	30.66	17.74	30.71		34				
25-Jul-07	36	6.03	19.85	30.69	18.27	30.71	-42	71				
25-Jul-07	36A	29.23	17.70	30.22	13.37	31.01		10				
25-Jul-07	37	4.41	16.96	30.12	16.56	30.12	-42	6				
25-Jul-07	38	8.21	17.20	29.99	16.04	30.19	-42	25				
25-Jul-07	39	10.13	17.64	29.99	15.04	30.57		94				
25-Jul-07	40	3.13	18.43	29.80	18.34	29.88	-42	35				
25-Jul-07	41	1.92	18.98	30.72	17.96	30.88	-42	4				
25-Jul-07	42	3.73	20.06	30.80	19.07	30.84	-42	0				
25-Jul-07	43	2.81	20.97	30.86	20.73	30.82	-42	1				

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
25-Jul-07	44	4.24	20.66	30.87	19.79	30.82	-42	0				
23-Apr-08	1	2.50	8.07	26.03	8.00	26.25						
23-Apr-08	2	7.53	8.52	26.11	7.44	27.55						
23-Apr-08	3	10.59	7.83	28.53	6.62	29.44						
23-Apr-08	4	10.92	9.19	27.18	7.84	28.40						
23-Apr-08	5	10.58	9.09	26.80	7.97	28.16						
23-Apr-08	6	6.72	10.67	18.94	9.31	25.62						
23-Apr-08	7	4.90	11.64	27.13	10.23	27.95						
23-Apr-08	8	5.27	11.34	27.39	10.63	27.97						
23-Apr-08	9	3.75	10.24	28.15	9.69	28.20						
23-Apr-08	10	2.12	11.27	26.04	11.11	26.29						
23-Apr-08	11	4.64	11.62	24.92	10.90	25.92						
23-Apr-08	12	3.87	11.62	26.34	10.33	27.21						
23-Apr-08	13	5.71	10.62	27.66	10.53	27.66						
23-Apr-08	14	5.55	10.59	27.66	10.55	27.67						
23-Apr-08	15	2.86	11.22	27.60	11.12	27.60						
23-Apr-08	16	2.26	11.99	27.49	11.87	27.53						
23-Apr-08	17	5.42	10.72	27.67	10.58	27.67						
23-Apr-08	18	7.16	11.06	27.62	10.16	27.83						
23-Apr-08	19	3.10	11.53	27.63	11.41	27.64						
23-Apr-08	20	6.39	10.80	27.50	10.36	27.57						
23-Apr-08	21	3.67	10.96	27.49	10.40	27.50						
23-Apr-08	22	5.00	10.71	27.06	10.19	27.35						
23-Apr-08	23	4.54	11.66	26.84	10.59	27.08						
23-Apr-08	24	3.83	10.88	26.78	11.08	27.10						
23-Apr-08	26	5.57	11.37	27.24	11.26	27.41						
23-Apr-08	27	5.55	12.21	26.66	10.83	26.74						
23-Apr-08	28	6.61	11.94	26.52	10.45	26.78						
23-Apr-08	29	3.94	11.30	26.53	11.07	26.53						
24-Apr-08	30	4.34	12.45	26.49	11.83	27.31						
24-Apr-08	31	14.76	11.85	27.21	11.65	27.28						
24-Apr-08	32	3.93	13.48	27.44	13.46	27.46						

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
24-Apr-08	33	4.55	12.27	26.44	12.24	26.46						
24-Apr-08	34	2.39	12.81	25.78	12.60	26.00						
24-Apr-08	35	6.40	11.11	26.34	10.83	26.39						
24-Apr-08	36	7.29	11.93	22.21	9.17	26.90						
24-Apr-08	36A	28.10	10.71	25.13	6.09	29.75						
24-Apr-08	37	20.07	11.20	22.10	6.62	28.67						
24-Apr-08	38	11.01	10.43	21.39	6.80	28.07						
24-Apr-08	39	11.36	10.49	20.96	7.40	27.17						
24-Apr-08	40	3.38	11.06	21.03	8.67	25.14						
24-Apr-08	41	4.21	10.94	24.03	10.84	24.30						
24-Apr-08	42	4.00	11.24	22.28	11.44	22.60						
24-Apr-08	43	2.41	13.76	25.52	13.42	25.53						
24-Apr-08	44	4.13	12.87	24.91	10.79	26.57						
04-May-08	1	3.38	7.64	26.11	7.64	26.23		116	0.83	10.45	1.69	0.33
04-May-08	2	9.01	7.77	26.13	7.31	27.80		700	1.12	14.51	2.45	0.37
04-May-08	3	9.99	7.45	27.60	7.20	28.38		91	1.18	9.12	2.66	0.25
04-May-08	4	11.59	8.07	23.54	7.70	25.73		5	2.71	21.93	9.11	0.46
04-May-08	5	12.43	8.24	22.69	7.86	25.02		11	3.59	19.39	9.03	0.99
04-May-08	6	5.75	7.43	9.88	7.55	21.35		46	6.31	36.95	2.77	0.03
04-May-08	7	3.39	9.14	24.69	8.81	26.17		419	0.52	16.12	2.95	0.06
04-May-08	8	6.44	9.73	24.87	9.47	26.24		413	0.73	18.91	1.87	0.03
04-May-08	9	3.66	9.47	25.42	9.50	25.97		234	0.96	19.25	2.15	0.06
04-May-08	10	2.68	9.28	13.89	9.21	20.25		11	4.07	38.53	2.33	0.03
04-May-08	11	4.50	9.42	10.89	9.27	19.62		21	7.27	67.36	3.02	0.03
04-May-08	12	3.73	8.92	25.14	9.00	25.71		114	0.90	16.11	2.60	0.03
04-May-08	13	4.33	9.01	26.25	8.92	26.54		118	1.29	16.15	3.08	0.03
04-May-08	14	4.72	9.15	25.79	9.06	26.33		41	1.69	19.62	3.15	0.61
04-May-08	15	4.85	9.28	25.42	9.15	26.15		75	0.92	15.97	3.83	0.03
04-May-08	16	3.35	9.41	25.11	9.29	25.69		21	0.96	14.72	4.50	0.03
04-May-08	17	4.56	9.30	26.03	9.03	26.57		26	0.79	18.49	2.37	0.03
04-May-08	18	5.21	8.93	26.65	8.83	26.82		77	0.17	10.56	2.11	0.03
04-May-08	19	3.55	9.36	26.27	9.36	26.29		30	0.09	10.51	1.67	0.03

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
04-May-08	20	5.45	9.23	26.42	9.23	26.56		90	0.09	11.47	1.90	0.03
04-May-08	21	4.17	9.27	26.37	9.25	26.44		9	0.08	12.84	1.61	0.03
04-May-08	22	4.88	9.91	26.38	9.68	26.75		4	0.89	8.31	3.49	0.03
04-May-08	23	4.56	10.02	26.29	9.89	26.52		26	2.14	10.35	6.43	0.35
04-May-08	24	4.17	10.14	26.25	10.15	26.25		12	1.66	12.33	5.86	0.22
04-May-08	26	5.88	10.19	26.15	9.84	26.78		13	0.09	9.07	0.68	0.03
04-May-08	27	5.94	9.94	26.38	9.60	27.02		4	0.10	8.25	1.95	0.04
04-May-08	28	4.57	10.03	26.43	9.54	27.17		0	0.92	12.38	2.84	0.31
04-May-08	29	3.85	9.92	26.81	9.83	26.97		0	1.07	9.22	4.16	0.00
05-May-08	30	5.23	9.32	26.36	8.68	26.70		333	0.90	16.44	1.56	0.03
05-May-08	31	17.16	8.57	26.89	8.22	27.11		151	0.21	8.64	2.29	0.04
05-May-08	32	6.01	9.18	26.10	8.80	26.09		89	0.49	9.36	1.97	0.04
05-May-08	33	7.87	8.52	26.10	8.34	26.09		0	0.95	17.47	2.44	0.03
05-May-08	34	4.75	8.83	26.00	8.47	26.05			0.54	12.67	2.22	0.04
05-May-08	35	9.21	8.80	25.54	7.91	26.49		196	0.41	10.08	2.07	0.03
05-May-08	36	9.98	9.88	23.58	8.29	26.03		275	0.13	14.84	2.36	0.04
05-May-08	36A	25.82	9.33	24.09	6.06	29.71		41	0.63	13.30	2.69	0.03
05-May-08	37	19.93	9.21	21.50	6.50	28.74		29	0.54	16.39	2.58	0.04
05-May-08	38	11.48	8.86	21.95	7.18	27.22		396	0.49	17.55	2.56	0.04
05-May-08	39	13.08	10.92	23.23	7.55	27.89		467	0.05	14.18	2.79	0.04
05-May-08	40	4.32	9.73	26.50	8.27	27.49		2,938	0.19	9.45	2.31	0.04
05-May-08	41	4.02	9.96	24.99	8.92	25.58		2,964	0.09	11.22	1.87	0.04
05-May-08	42	4.64	11.00	24.71	8.66	27.15		58	0.09	12.36	1.55	0.03
05-May-08	43	3.42	11.27	25.28	10.69	25.57		979	0.09	12.43	1.41	0.04
05-May-08	44	4.22	11.59	25.57	10.68	25.99		80	0.09	12.27	1.43	0.04
11-May-08	1	9.81	8.41	27.70	7.59	28.74	101	300	1.42	11.32	4.41	0.03
11-May-08	2	9.36	8.69	27.39	8.06	28.37	48	199	2.02	14.43	9.44	0.19
11-May-08	3	9.45	8.62	27.24	8.22	28.01	81	238	1.04	11.54	3.27	0.03
11-May-08	4	7.65	9.82	24.52	8.95	26.53	-42	207	1.71	12.78	9.36	0.26
11-May-08	5	8.44	11.39	24.83	9.47	26.03	-42	555	1.57	13.71	8.24	0.66
11-May-08	6	5.61	11.14	9.28	10.13	17.77	-42	2	4.54	25.02	2.89	0.06
11-May-08	7	4.75	10.16	27.87	9.70	28.09	51	130	0.05	8.54	2.36	0.03

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
11-May-08	8	4.23	10.21	28.12	8.64	28.93	66	92	0.27	10.56	2.09	0.03
11-May-08	9	2.64	10.07	27.90	9.37	28.26	50		0.07	8.24	2.41	0.03
11-May-08	10	2.33	13.05	22.48	12.36	24.15	42	2	3.06	34.29	2.93	0.03
11-May-08	11	3.17	14.29	17.43	12.47	22.52	-42		5.09	47.89	3.02	0.03
11-May-08	12	2.61	12.21	27.79	11.97	27.78	43		0.74	13.20	4.06	0.03
11-May-08	13	3.97	10.93	27.89	10.54	28.02	-42	12	0.02	8.51	1.54	0.03
11-May-08	14	3.74	10.37	28.18	10.36	28.18	-42		0.07	5.06	1.86	0.04
11-May-08	15	3.82	10.90	27.93	10.76	27.96	-42		0.09	8.13	1.65	0.04
11-May-08	16	2.56	11.59	27.77	11.30	27.88	-42	60	0.09	8.66	1.97	0.03
11-May-08	17	4.50	10.27	28.23	10.24	28.24	-42		0.10	8.53	1.90	0.03
11-May-08	18	5.00	9.70	28.47	9.61	28.50	-42	85	0.09	5.35	1.97	0.03
11-May-08	19	2.95	11.27	28.28	11.22	28.29	-42		0.09	4.49	1.49	0.03
11-May-08	20	3.82	10.37	28.33	10.23	28.34	-42	74	0.01	3.46	1.38	0.03
11-May-08	21	3.59	10.19	28.37	10.14	28.37	41	179	0.09	3.90	2.42	0.04
11-May-08	22	4.55	11.46	28.27	10.03	28.69	-42	74	0.09	2.08	1.85	0.03
11-May-08	23	4.55	10.57	28.40	10.01	28.56	-42	35	0.09	2.43	1.90	0.03
11-May-08	24	3.89	10.37	28.49	10.30	28.54	-42		0.09	2.65	1.94	0.04
11-May-08	26	6.07	10.40	28.58	9.63	28.82	-42	10	0.09	2.03	1.72	0.03
11-May-08	27	5.71	9.74	29.03	8.95	29.17	-42	19	0.09	4.61	1.67	0.04
11-May-08	28	6.84	9.91	29.08	8.30	29.44	-42	34	0.09	6.56	1.55	0.03
11-May-08	29	4.32	8.86	29.37	8.83	29.38	-42	10	0.09	5.67	1.59	0.03
12-May-08	30	5.25	9.43	29.50	8.87	29.76	47		0.09	5.48	2.75	0.03
12-May-08	31	25.71	9.70	29.18	9.16	29.57			0.09	8.74	2.79	0.03
12-May-08	32	5.58	10.50	28.34	10.52	28.40	71	276	0.23	9.80	2.54	0.03
12-May-08	33	5.12	9.68	28.87	9.68	28.87	133		0.06	8.85	2.51	0.03
12-May-08	34	3.87	10.52	27.84	10.07	28.44	66		0.74	14.37	1.82	0.03
12-May-08	35	8.44	9.47	28.91	9.44	28.93			0.11	6.92	2.22	0.03
12-May-08	36	10.17	9.87	28.73	9.52	28.92		2,726	0.09	7.86	2.21	0.26
12-May-08	36A	28.06	9.23	28.50	7.64	29.74	154	1,219	0.09	6.14	1.56	0.03
12-May-08	37	8.39	9.70	28.01	8.89	28.58	132		0.09	8.77	1.97	0.03
12-May-08	38	6.93	9.10	28.20	8.97	28.25	115		0.09	7.56	1.53	0.03
12-May-08	39	8.54	8.92	28.20	8.52	28.60	84		0.09	6.42	1.65	0.03

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
12-May-08	40	3.07	9.42	28.60	9.29	28.70	67	673	0.32	6.84	2.20	0.03
12-May-08	41	5.55	8.64	29.33	8.57	29.47	54		0.34	10.11	1.40	0.03
12-May-08	42	4.37	9.09	29.26	9.19	29.49	48	2,832	0.09	3.49	0.60	0.03
12-May-08	43	3.20	10.62	29.43	10.32	29.46	44		0.22	9.63	1.90	0.03
12-May-08	44	3.95	10.58	29.62	10.41	29.68	53		0.09	9.12	2.28	0.23
28-May-08	1	5.28	9.51	31.31	8.82	31.37	305	161	0.19	8.42	1.67	0.60
28-May-08	2	5.38	8.96	31.45	8.30	31.50	198	23	0.28	2.16	2.32	1.10
28-May-08	3	10.47	8.97	31.09	8.17	31.27	139	27	0.45	1.52	2.63	0.36
28-May-08	4	4.77	11.71	29.35	10.51	29.92	-42	164	1.60	3.95	7.26	1.12
28-May-08	5	9.75	12.06	28.81	10.47	29.95	-42	74	1.41	6.67	6.78	1.29
28-May-08	6	5.75	13.15	20.41	11.24	25.76	50	1	4.88	22.65	5.92	0.97
28-May-08	7	2.16	10.99	30.37	10.93	30.37	126	288	0.24	1.97	3.78	1.85
28-May-08	8	4.43	12.57	30.40	11.20	30.45	77	10	0.09	1.14	2.17	0.55
28-May-08	9	2.67	12.15	30.13	12.04	30.18	82	228	0.09	1.48	1.36	0.26
28-May-08	11	3.18	14.49	24.67	13.98	26.92	-42	0	6.96	24.95	2.91	0.39
28-May-08	12	1.79	12.50	29.98	12.49	29.98	-42	5	0.07	2.73	2.04	0.55
28-May-08	13	3.83	12.51	30.38	12.43	30.37	-42	2	0.09	1.60	2.47	0.37
28-May-08	14	2.90	13.09	30.21	13.08	30.21	-42	5	0.01	2.71	3.58	1.20
28-May-08	15	3.32	13.47	30.06	13.46	30.07	-42	10	0.15	4.68	3.20	1.86
28-May-08	16	1.56	14.71	29.58	14.51	29.69	-42	0	0.09	8.75	2.52	0.74
28-May-08	19	2.11	13.95	30.34	13.66	30.33	-42	8	0.09	1.70	2.81	0.65
28-May-08	20	2.78	12.60	30.38	12.09	30.51	-42	30	0.07	1.82	4.44	0.35
28-May-08	21	2.75	12.20	30.34	12.18	30.34	-42	24	0.22	3.24	12.44	4.27
28-May-08	22	3.83	12.45	30.32	12.19	30.35	-42	31	0.09	2.28	2.81	1.07
28-May-08	23	3.74	13.08	30.30	12.71	30.34	-42	1	0.07	2.09	4.13	1.69
28-May-08	24	3.17	14.44	30.14	14.04	30.14	-42	10	0.04	1.68	3.42	0.84
28-May-08	26	5.18	13.25	30.24	13.25	30.24	-42	4	0.01	1.55	4.35	1.76
28-May-08	27	5.14	13.63	30.32	12.81	30.31	-42	3	0.03	3.59	5.69	2.05
28-May-08	28	2.64	13.01	30.29	12.97	30.28	-42	1	0.29	2.09	7.19	2.31
28-May-08	29	3.89	14.49	30.23	14.20	30.24	-42	11	1.17	2.12	10.10	3.93
27-May-08	30	2.46	13.96	30.65	13.77	30.63	42	23	0.09	1.17	2.04	0.36
27-May-08	31	21.52	12.80	30.54	12.32	30.74			0.09	4.48	2.46	0.23

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
27-May-08	32	3.96	13.48	30.37	13.25	30.38	1194	1,010	0.09	5.87	2.30	0.56
27-May-08	33	3.31	12.76	30.53	12.76	30.52	1312	2,567	0.09	5.44	2.99	0.87
27-May-08	34	4.33	13.72	30.12	13.57	30.16	955	5,584	0.07	6.78	2.40	0.74
27-May-08	35	6.74	12.27	30.63	12.18	30.64		1,350	0.09	4.74	3.60	0.20
27-May-08	36	8.00	12.59	30.83	12.12	30.81		28,317	0.09	2.94	1.97	0.35
27-May-08	36A	28.21	10.43	31.01	9.54	31.12	1322	9,951	0.04	2.64	1.88	0.29
27-May-08	37	8.60	10.54	30.85	10.24	30.85	469	184	0.09	1.05	1.77	0.17
27-May-08	38	4.77	10.25	30.90	10.15	30.88	396	206	0.09	1.18	2.38	1.54
27-May-08	39	8.93	10.28	30.14	9.65	30.53	669	30	0.09	2.72	3.18	0.40
27-May-08	40	2.96	13.18	28.94	11.83	29.48	490	357	0.00	2.69	3.13	0.08
27-May-08	41	4.97	11.38	30.25	11.17	30.24	68	50	0.09	1.62	3.37	0.44
27-May-08	42	4.03	12.43	29.98	12.34	29.99	141	445	0.09	0.89	2.22	0.14
27-May-08	43	3.27	15.34	30.76	15.23	30.73	46	8	0.09	3.87	2.49	0.10
27-May-08	44	3.16	14.39	30.91	14.27	30.88	51	0	0.09	4.76	2.26	0.85
9-Jun-08	1						58	24	0.05	2.85	2.36	0.34
9-Jun-08	2						113	68	1.16	3.71	5.04	0.75
9-Jun-08	3						46	40	0.50	3.39	3.04	1.14
9-Jun-08	4						-42	4	1.73	7.43	2.44	2.52
9-Jun-08	5						-42	4	1.48	10.38	9.00	4.50
9-Jun-08	6						-42	8	2.71	16.60	8.81	0.88
9-Jun-08	7						41	228	0.06	3.77	6.19	0.26
9-Jun-08	8						41	494	0.09	6.20	2.24	0.61
9-Jun-08	9						-42	279	0.09	4.28	3.16	0.37
9-Jun-08	10						-42	14	2.12	11.68	8.87	2.28
9-Jun-08	11						-42	1	1.05	11.20	4.44	0.67
9-Jun-08	12						-42	0	0.19	7.45	3.43	0.57
9-Jun-08	13						-42	11	0.07	4.96	2.38	0.61
9-Jun-08	14						-42	5	0.09	5.21	2.61	0.27
9-Jun-08	15						-42	8	0.00	7.35	5.13	0.44
9-Jun-08	16						-42	9	1.84	6.70	10.80	1.49
9-Jun-08	18							21	0.11	4.10	2.98	0.30
9-Jun-08	19						-42	2	0.11	6.89	2.70	0.10

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
9-Jun-08	20						-42	74	0.09	5.36	1.86	0.39
9-Jun-08	21						-42	46	0.09	4.68	2.57	0.35
9-Jun-08	22						-42	4	0.09	4.31	1.86	0.36
9-Jun-08	23						-42	29	0.05	5.58	2.44	0.72
9-Jun-08	24						-42	43	0.09	4.20	3.12	0.26
9-Jun-08	26						-42	23	0.09	4.22	3.16	2.21
9-Jun-08	27						-42	63	0.09	4.75	2.85	0.46
9-Jun-08	28						-42	43	0.04	2.03	2.58	0.03
9-Jun-08	29						-42	13	0.02	1.50	3.02	0.03
10-Jun-08	30	4.44	19.13	30.83	17.52	30.84	-42	25	0.05	7.23	3.00	0.03
10-Jun-08	31	19.78	17.23	30.87	17.15	30.87		8	0.34	8.79	3.52	0.74
10-Jun-08	32	4.28	18.47	30.67	17.45	30.71	72	50	0.05	5.96	3.85	0.03
10-Jun-08	33	4.71	17.45	30.54	16.90	30.60	117	74	0.14	4.56	3.92	0.10
10-Jun-08	34	5.48	18.59	30.31	17.06	30.56	61	36	0.42	8.71	3.85	0.02
10-Jun-08	35	6.78	16.09	30.66	15.18	30.70		54	0.04	2.55	3.53	0.03
10-Jun-08	36	7.72	15.98	30.49	15.05	30.56		14	0.09	1.96	2.47	0.03
10-Jun-08	36A	27.66	14.08	30.64	10.97	30.96	182		0.09	1.69	2.40	0.03
10-Jun-08	37	8.16	15.96	30.03	13.35	30.25	51	30	0.06	0.62	2.74	0.03
10-Jun-08	38	5.37	14.03	30.07	13.36	30.18	50	120	0.09	0.61	2.61	0.03
10-Jun-08	39	6.99	14.95	28.62	13.82	29.73	75	62	0.09	1.28	2.64	0.03
10-Jun-08	40	3.21	16.51	28.62	13.07	29.86	64	68	0.14	2.62	3.75	0.03
10-Jun-08	41	4.62	15.89	30.15	14.52	30.39	-42	235	0.09	3.76	2.57	0.03
10-Jun-08	42	4.29	17.53	30.13	15.20	30.34	42	2	0.12	2.96	2.25	0.03
10-Jun-08	43	3.93	18.51	30.94	18.11	30.92	-42	1	0.09	10.14	3.64	0.37
10-Jun-08	44	3.23	18.95	31.09	18.38	31.04	-42	227	0.09	11.75	1.63	0.27
23-Jun-08	1	4.19	15.06	28.47	14.38	28.72	43	5	0.13	1.70	1.04	0.44
23-Jun-08	2	4.45	15.60	28.04	14.89	28.54	46	3	0.09	0.96	2.39	0.48
23-Jun-08	3	4.57	14.39	29.94	12.78	30.50	-42	3	0.55	2.32	2.90	1.03
23-Jun-08	4	5.90	16.51	29.28	15.63	29.72	-42	4	2.22	9.61	4.27	2.24
23-Jun-08	5	2.50	17.21	28.46	16.27	29.34	-42	3	5.85	15.31	10.20	15.72
23-Jun-08	6	5.32	17.48	26.51	16.35	28.48	-42	6	0.98	11.42	5.31	1.69
23-Jun-08	7	3.06	17.44	30.15	16.87	30.15	-42	2	1.55	4.90	7.05	5.24

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23-Jun-08	8	5.50	18.55	30.15	17.71	30.32	-42	4	0.28	3.20	2.22	2.20
23-Jun-08	9	3.25	17.85	30.27	17.35	30.30	-42	0	0.16	2.06	2.15	1.68
23-Jun-08	10	2.30	18.67	29.02	18.13	29.40	-42	3	1.59	11.35	5.69	0.98
23-Jun-08	11	3.24	18.58	29.04	18.44	29.16	-42	6	1.55	10.79	7.05	1.19
23-Jun-08	12	4.11	16.74	29.59	16.72	29.68	-42	5	0.05	2.08	1.30	0.86
23-Jun-08	13	5.25	18.02	30.14	17.91	30.13	-42	25	0.14	3.60	2.18	0.66
23-Jun-08	14	3.78	17.72	30.09	17.73	30.11	-42	32	0.23	3.56	3.42	0.61
23-Jun-08	15	4.14	18.41	30.21	18.18	30.18	-42	11	0.63	5.66	7.31	1.83
23-Jun-08	16	2.92	19.52	30.14	19.00	30.20	-42	35	0.58	9.61	8.86	1.16
23-Jun-08	17	4.79	17.84	30.09	17.77	30.10	-42	42	0.35	3.66	2.89	1.30
23-Jun-08	18	3.22	17.23	29.99	17.20	29.99		76	0.43	3.34	3.35	1.32
23-Jun-08	19	3.00	18.27	30.04	18.43	30.15	-42		0.11	1.74	0.72	0.78
23-Jun-08	20	3.82	17.45	29.72	17.40	29.80	-42	28	0.02	0.97	1.83	0.34
23-Jun-08	21	3.74	18.06	29.86	17.61	29.81	-42	3	0.10	4.85	2.15	1.01
23-Jun-08	22	4.58	17.75	29.69	17.32	29.79	-42	2	0.14	1.77	1.79	0.68
23-Jun-08	23	4.26	19.76	29.71	18.41	29.63	-42	14	0.11	3.98	1.67	0.04
23-Jun-08	24	3.57	18.43	29.50	19.05	29.97	-42	10	0.22	2.40	1.55	0.35
23-Jun-08	26	5.55	18.57	29.68	18.73	29.95	-42	12	0.45	4.20	2.57	0.50
23-Jun-08	27	5.78	18.94	29.39	18.53	29.39	-42		0.33	3.13	2.23	0.45
23-Jun-08	28	4.19	18.45	29.20	18.05	29.19	-42	5	0.40	3.57	1.81	0.65
23-Jun-08	29	3.73	18.44	28.98	18.34	29.09	-42		0.02	1.93	3.25	0.17
24-Jun-08	30	4.01	19.15	27.78	18.58	28.22	-42	23	0.17	4.82	1.47	0.51
24-Jun-08	31	8.14	18.65	28.76	18.49	28.87		54	0.20	7.01	2.40	0.14
24-Jun-08	32	5.77	19.84	28.61	19.29	28.96	-42	43	0.65	9.20	3.61	0.03
24-Jun-08	33	7.21	17.50	28.02	17.50	28.02	-42	89	0.53	4.79	4.34	0.50
24-Jun-08	34	3.72	19.39	28.32	18.67	28.30	-42	138	0.74	7.73	2.95	0.11
24-Jun-08	35	8.16	17.48	27.47	16.66	27.85		33	0.62	5.36	3.23	0.00
24-Jun-08	36	3.30	18.43	25.83	17.31	27.19		89	0.52	5.72	1.84	0.03
24-Jun-08	36A	29.75	18.33	25.89	10.51	30.60	49	1	0.09	1.81	1.90	0.03
24-Jun-08	37	4.19	18.48	25.14	16.05	27.43	43	4	0.28	3.37	1.82	0.03
24-Jun-08	38	7.76	17.71	24.92	13.98	28.45	-42	0	0.19	1.84	3.02	0.21
24-Jun-08	39	3.67	18.01	24.35	15.73	26.76	-42	15	0.24	7.49	2.25	0.03

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
24-Jun-08	40	2.44	18.83	23.38	14.60	27.75	42	33	0.24	7.97	2.27	0.03
24-Jun-08	41	2.34	18.13	26.14	18.08	26.17	-42	11	0.19	4.14	2.12	0.51
24-Jun-08	42	4.46	19.69	24.92	18.14	25.67	-42	31	0.52	6.07	0.16	0.51
24-Jun-08	43	3.27	20.43	27.87	19.77	28.03	-42	10	0.52	6.52	0.75	1.07
24-Jun-08	44	4.26	19.34	27.23	16.71	28.54	-42	54	0.17	7.40	3.22	1.03
7-Jul-08	1						43	0	0.01	2.43	0.63	0.03
7-Jul-08	2						45	1	0.31	2.87	2.10	0.41
7-Jul-08	3							0				
7-Jul-08	5							0				
7-Jul-08	6							0				
7-Jul-08	7						-42	5	0.60	3.00	4.36	0.55
7-Jul-08	8						-42	26	0.46	5.67	2.51	0.13
7-Jul-08	9							1	0.03	2.68	1.38	0.03
7-Jul-08	10						-42	1	0.67	9.74	2.17	0.03
7-Jul-08	11						-42	6	2.59	26.61	11.22	0.40
7-Jul-08	12						-42	3	0.09	5.94	2.19	0.11
7-Jul-08	13						-42	5	0.08	5.48	2.13	0.00
7-Jul-08	14						-42	1	0.12	5.52	2.53	0.03
7-Jul-08	15						-42	2	0.34	7.47	1.82	0.09
7-Jul-08	16						-42	11	0.16	8.35	2.73	0.30
7-Jul-08	17						-42	0	0.08	5.81	2.19	0.80
7-Jul-08	19						-42	14	1.52	7.94	8.40	0.92
7-Jul-08	20						-42	4	0.15	6.08	2.13	0.46
7-Jul-08	21						-42	0	0.09	4.00	1.29	0.03
7-Jul-08	22						-42	2	0.09	6.13	1.50	0.05
7-Jul-08	23						-42	1	0.03	10.34	0.69	0.12
7-Jul-08	24						-42	8	0.09	8.18	2.09	0.00
7-Jul-08	26						-42	3	0.02	6.70	0.34	0.03
7-Jul-08	27						-42	10	0.09	6.77	0.39	0.03
7-Jul-08	28						-42	0	0.10	7.32	1.01	0.10
7-Jul-08	29						-42	0	0.08	5.62	2.55	0.08
08-Jul-08	30	2.97	21.62	30.13	19.70	30.33	-42	2	0.26	13.04	0.95	0.32

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
08-Jul-08	31	22.81	19.60	30.38	19.23	30.37		0	0.24	10.62	1.36	0.19
08-Jul-08	32	3.14	19.82	30.29	19.74	30.28	-42	1	1.73	8.89	8.73	0.87
08-Jul-08	33	3.86	18.67	30.34	18.65	30.34	-42	0	0.13	6.13	1.14	0.03
08-Jul-08	34	4.05	19.14	30.13	19.07	30.20	-42	4	0.41	9.25	2.35	0.03
08-Jul-08	35	7.13	18.38	30.34	18.37	30.34		2	0.27	6.16	4.14	0.03
08-Jul-08	36	8.05	18.88	29.85	17.52	30.19		0	0.10	2.85	1.55	0.03
08-Jul-08	36A	27.40	17.00	29.50	14.14	30.64	45	2	0.09	0.82	0.98	0.04
08-Jul-08	37	13.63	18.34	28.84	13.57	30.37	-42	1	0.44	5.27	1.56	0.03
08-Jul-08	38	6.46	17.87	28.81	15.18	29.76	59	0	0.16	1.55	1.35	0.03
08-Jul-08	39	10.39	18.79	28.55	13.70	30.40	54	5	2.80	3.87	1.33	0.66
08-Jul-08	40	3.60	19.14	28.05	15.91	29.28	61	1	0.02	3.11	11.03	0.03
08-Jul-08	41	4.68	18.81	29.78	17.06	30.05	-42	8	0.09	4.71	1.18	0.03
08-Jul-08	42	3.73	21.04	29.07	19.61	29.36	-42	9	0.10	3.72	1.74	0.03
08-Jul-08	43	4.14	21.97	30.08	20.64	30.08	-42	0	0.18	12.06	3.86	0.38
08-Jul-08	44	3.38	20.65	30.11	19.30	30.22	-42	0	0.09	11.04	1.16	0.03
21-Jul-08	1	4.36	15.41	29.98	14.39	30.14	-42	1	0.65	2.92	3.12	0.76
21-Jul-08	2	5.32	16.51	29.82	15.88	30.25	-42	0	0.49	3.02	5.75	0.66
21-Jul-08	3	6.38	14.83	30.55	13.16	31.03		0	0.70	4.12	2.97	0.38
21-Jul-08	4	9.40	16.44	29.19	15.46	29.82	-42	1	4.07	13.65	2.64	6.89
21-Jul-08	5	12.21	16.30	28.47	15.20	29.81	-42	0	11.64	15.15	10.82	16.34
21-Jul-08	6	8.08	18.17	27.17	16.96	28.99	-42	0	1.32	7.37	6.51	3.19
21-Jul-08	7	3.05	19.23	30.55	19.14	30.54	-42	0	0.07	4.81	4.99	0.68
21-Jul-08	8	2.56	19.07	30.57	18.69	30.59	-42	0	0.88	10.77	4.92	2.30
21-Jul-08	9							0	0.72	11.58	3.22	0.29
21-Jul-08	10						-42	0	3.47	19.77	3.17	5.87
21-Jul-08	11						-42	2	1.44	17.54	10.77	1.18
21-Jul-08	12							0	0.49	14.35	4.51	0.46
21-Jul-08	13						-42	18	0.75	8.45	7.61	1.03
21-Jul-08	14						-42	0	0.41	11.01	2.00	0.62
21-Jul-08	15						-42	15	0.55	16.34	7.06	0.26
21-Jul-08	16						-42	2	1.04	20.69	6.62	0.83
21-Jul-08	17						-42	2	0.36	14.40	5.38	0.60

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
21-Jul-08	18							3	0.05	9.35	3.06	0.80
21-Jul-08	19						-42	0	0.09	10.42	2.62	0.21
21-Jul-08	20						-42	1	0.09	10.51	1.88	1.12
21-Jul-08	21						-42	0	0.78	6.87	9.35	1.62
21-Jul-08	22						-42	0	0.45	13.08	1.48	0.35
21-Jul-08	23						-42	0	0.45	10.04	4.27	0.77
21-Jul-08	24						-42	0	0.21	10.27	1.50	0.07
21-Jul-08	26						-42	4	0.92	17.27	5.34	0.86
21-Jul-08	27						-42	1	0.15	10.16	1.48	0.04
21-Jul-08	28						-42	1	0.24	7.49	1.82	0.11
21-Jul-08	29						-42	1	0.22	10.20	2.12	0.24
22-Jul-08	30	4.19	19.64	30.99	17.95	31.05	-42	0	0.15	3.80	1.88	0.15
22-Jul-08	31	25.34	17.56	31.03	17.31	31.06		2	0.41	5.76	1.35	0.22
22-Jul-08	32	4.69	19.73	30.69	19.29	30.71	-42	0	0.94	11.76	2.38	0.32
22-Jul-08	33	6.00	17.75	30.87	17.66	30.86	-42	0	0.60	9.12	2.70	0.29
22-Jul-08	34	7.24	19.46	30.61	18.05	30.79	-42	0	0.82	12.14	2.71	0.23
22-Jul-08	35	9.06	16.79	30.96	16.02	31.03		0	0.40	7.81	2.77	0.20
22-Jul-08	36	9.69	18.10	30.70	17.45	30.75		0	0.03	6.76	1.73	0.15
22-Jul-08	36A	26.95	18.01	30.51	12.23	31.47	-42	1	0.09	2.73	1.24	0.03
22-Jul-08	37	4.72	20.35	30.21	18.37	30.41	-42	0	0.08	3.15	2.56	0.04
22-Jul-08	38	7.74	18.92	30.34	15.96	30.76	-42	0	0.01	1.06	2.85	0.03
22-Jul-08	39	12.37	17.62	30.22	14.65	30.91	-42	0	0.52	6.66	2.07	0.03
22-Jul-08	40	2.50	16.87	29.97	15.31	30.50	-42	1	0.65	9.54	1.59	0.03
22-Jul-08	41	2.79	16.80	30.86	16.34	30.91	-42	8	0.26	4.41	1.21	0.03
22-Jul-08	42	5.16	18.61	30.53	16.95	30.69	-42	0	0.09	2.33	1.71	0.03
22-Jul-08	43	4.20	19.63	30.41	19.01	30.51	-42	0	0.15	3.85	0.19	0.48
22-Jul-08	44	3.64	18.99	30.68	18.31	30.59	-42	0	0.55	7.54	0.81	0.53
04-Aug-08	1	4.13	15.94	29.97	15.40	30.08	-42	1	0.37	4.44	1.95	0.43
04-Aug-08	2	6.50	15.90	30.26	15.79	30.28	-42	0	0.39	4.32	2.75	0.02
04-Aug-08	3	10.88	16.63	30.08	15.47	30.56			0.56	4.95	3.43	0.93
04-Aug-08	4	9.37	18.19	26.28	16.84	29.01	-42	1	4.47	18.54	8.76	0.57
04-Aug-08	5	10.99	18.53	23.32	17.12	27.83			4.85	21.34	9.98	0.89

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex (cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
04-Aug-08	6	8.54	17.66	27.66	17.23	28.92	-42		2.03	11.84	4.56	0.55
04-Aug-08	7	3.72	19.28	29.43	18.85	29.69	-42	0	0.64	8.51	1.72	0.03
04-Aug-08	8	4.49	19.47	29.62	18.59	30.00	-42	5	0.06	7.06	1.89	0.03
04-Aug-08	9	5.54	19.30	29.57	18.16	30.11		0	0.07	10.11	1.76	0.06
04-Aug-08	10	3.68	19.90	26.66	19.16	28.77	-42	28				
04-Aug-08	11	5.68	19.22	28.17	18.84	29.03	-42	10	0.78	15.61	3.81	0.80
04-Aug-08	12	3.06	19.73	29.74	19.15	29.92		2	0.09	11.09	1.05	0.07
04-Aug-08	13	6.12	19.56	30.24	18.47	30.31	-42	0	0.14	10.79	2.55	0.36
04-Aug-08	14	5.54	20.10	30.05	19.37	30.23	-42	0	0.26	10.34	2.38	0.08
04-Aug-08	15	2.95	20.72	30.02	20.02	30.16	-42	8	0.40	14.94	5.24	0.32
04-Aug-08	16	3.38	20.90	29.78	20.48	29.91	-42	4	0.33	15.63	4.83	0.94
04-Aug-08	17	5.66	19.80	30.19	19.08	30.31	-42	0	0.43	16.07	1.85	0.47
04-Aug-08	18	5.88	18.88	30.37	18.46	30.37		0	0.21	13.02	2.81	0.30
04-Aug-08	19	3.37	20.14	30.33	19.77	30.37	-42	3	0.21	13.11	1.81	0.38
04-Aug-08	20	6.29	20.03	30.37	19.08	30.45	-42	4	0.11	7.22	1.23	0.16
04-Aug-08	21	3.98	20.05	30.28	19.35	30.39	-42	0	0.09	9.25	1.45	0.26
04-Aug-08	22	5.08	20.02	30.48	18.87	30.59	-42	0	0.26	14.88	1.56	0.59
04-Aug-08	23	4.87	20.99	30.43	19.46	30.62	-42	1	0.35	15.46	1.78	0.68
04-Aug-08	24	3.71	20.92	30.46	20.59	30.48	-42	0	0.38	12.84	2.35	0.66
04-Aug-08	26	5.51	20.84	30.41	20.15	30.51		0	0.67	14.40	2.78	0.46
04-Aug-08	27	5.54	20.57	30.21	19.74	30.32	-42	0	0.46	13.01	2.19	0.46
04-Aug-08	28	6.17	19.11	30.43	18.72	30.47	-42	0	0.38	13.18	1.57	0.45
04-Aug-08	29	3.53	19.85	30.27	19.61	30.31	-42	1	0.57	12.63	2.40	0.89
05-Aug-08	30	3.61	18.73	30.38	18.23	30.42	-42	0	0.56	15.15	5.13	0.48
05-Aug-08	31	20.78	18.80	30.25	18.73	30.27		0	0.81	14.35	5.80	0.47
05-Aug-08	32	3.46	20.32	29.86	20.18	29.85	-42	1	0.94	14.96	5.21	0.30
05-Aug-08	33	5.15	19.54	29.87	19.44	29.87	-42	0	1.10	11.56	5.42	0.24
05-Aug-08	34	4.64	19.74	29.36	19.46	29.58	-42	1	1.21	14.34	4.04	0.23
05-Aug-08	35	6.66	18.94	29.90	18.49	29.96		0	0.67	7.53	2.37	0.09
05-Aug-08	36	7.24	18.06	30.04	17.10	30.23		0	0.37	9.63	2.90	0.57
05-Aug-08	36A	26.59	17.29	30.16	13.94	30.93	-42		0.43	7.86	1.19	0.26
05-Aug-08	37	11.02	17.54	29.28	15.52	30.07	-42	1	0.60	5.66	4.32	0.52

Sampling Date	Station	Bottom Depth (m)	Surface Temp (ºC)	Surface Salinity (PSU)	Average Temp (ºC)	Average Salinity (PSU)	Toxicity (µg STX/100g)	*Alex* *(cells/L)*	NO_3+NO_2 (µM)	SiO_4 (µM)	NH_4 (µM)	PO_4 (µM)
05-Aug-08	38	4.32	17.68	29.02	17.51	29.13	-42	0	0.19	3.29	1.08	0.15
05-Aug-08	39	7.74	17.00	30.00	16.31	30.21	-42	0	0.38	5.72	3.44	0.43
05-Aug-08	40	3.77	18.24	29.46	15.88	30.63	-42	0	0.20	5.51	3.45	0.97
05-Aug-08	41	3.55	17.14	30.42	17.02	30.41	-42	0	0.42	8.25	3.89	0.43
05-Aug-08	42	4.29	18.01	30.06	15.12	30.87	-42	0	0.04	8.31	1.08	0.32
05-Aug-08	43	3.24	19.04	30.15	18.96	30.17	-42	0	0.46	18.38	6.23	0.21
05-Aug-08	44	3.82	17.98	30.40	17.93	30.36	-42	0	0.45	14.99	4.58	0.57

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APPENDIX B

Summary Statistics

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Table B - 1. Summary statistics for maximum depth (m) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	16	2.5	9.8	4.3	5.2	2.2
Western	OW	2	16	4.5	10.2	8.6	8.0	1.8
Western	OW	3	16	4.5	11.2	9.8	8.7	2.3
Western	PH	4	16	3.1	11.6	8.7	7.8	3.0
Western	PH	5	16	2.4	12.4	10.4	9.1	3.3
Western	ER	6	16	2.4	8.5	5.7	5.7	1.7
Western	FS	7	16	1.2	4.9	2.5	2.8	1.2
Western	FS	8	16	2.6	6.4	4.5	4.5	0.9
Western	FS	9	14	1.6	5.5	2.7	3.0	1.0
Western	ER	10	14	0.3	5.3	3.2	3.3	1.4
Western	ER	11	15	1.9	5.7	3.3	3.8	1.1
Western	HR	12	15	1.8	4.2	3.1	3.1	0.8
Western	HR	13	15	3.0	6.5	5.6	5.1	1.1
Western	HR	14	15	0.7	6.3	3.7	3.8	1.5
Western	HR	15	15	2.0	4.8	3.4	3.5	0.8
Western	HR	16	15	1.0	3.5	2.6	2.5	0.7
Western	HR	17	14	1.9	5.7	4.6	4.3	1.1
Western	HR	18	14	3.2	7.2	5.4	5.5	1.1
Western	MQ	19	15	2.0	3.5	2.9	2.8	0.5
Western	MQ	20	15	2.6	6.4	5.2	4.8	1.3
Western	MQ	21	15	2.6	4.2	3.5	3.4	0.5
Western	MQ	22	15	3.8	5.1	4.6	4.5	0.4
Western	MQ	23	15	3.5	4.9	4.1	4.2	0.4
Western	MQ	24	15	3.2	4.2	3.7	3.7	0.3
Western	MQ	26	15	4.7	6.1	5.5	5.5	0.3
Western	MB	27	15	4.4	5.9	5.5	5.4	0.4
Western	MB	28	15	2.6	6.8	4.8	4.7	1.4
Western	MB	29	15	3.5	4.3	3.9	3.9	0.2
Eastern	NM	30	17	2.4	5.3	4.2	4.1	0.8
Eastern	NM	31	17	8.1	25.7	17.7	17.6	5.9
Eastern	HS	32	16	3.1	6.0	5.2	5.0	1.0
Eastern	HS	33	17	3.3	7.9	4.7	5.1	1.4
Eastern	HS	34	17	2.4	7.2	4.3	4.4	1.1
Eastern	HS	35	17	2.7	9.2	8.2	7.6	1.6
Eastern	HS	36	17	3.1	10.2	8.1	7.8	2.1
Eastern	HS	36A	17	19.2	29.8	28.1	27.4	2.5
Eastern	OE	37	18	3.4	20.1	8.3	8.7	5.2
Eastern	OE	38	17	4.3	11.5	7.7	7.6	2.0
Eastern	OE	39	17	3.7	13.3	9.2	9.5	2.5
Eastern	TC	40	18	1.6	4.3	3.3	3.2	0.7
Eastern	NM	41	18	1.3	5.6	4.1	3.8	1.3
Eastern	NM	42	18	3.1	6.5	4.3	4.4	0.9
Eastern	NM	43	18	2.4	4.2	3.2	3.2	0.6
Eastern	NM	44	18	3.2	6.2	4.2	4.2	0.8

Table B - 2. Summary statistics for maximum depth (m) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	45	0.3	8.5	4.1	4.3	1.8
Western	FS	46	1.2	6.4	3.6	3.5	1.3
Western	HR	103	0.7	7.2	3.7	3.9	1.4
Western	MB	45	2.6	6.8	4.6	4.7	1.1
Western	MQ	105	2.0	6.4	4.0	4.1	1.0
Western	OW	48	2.5	11.2	7.7	7.3	2.6
Western	PH	32	2.4	12.4	9.6	8.5	3.2
Eastern	HS	101	2.4	29.8	6.4	9.6	8.3
Eastern	NM	106	1.3	25.7	4.2	6.1	5.6
Eastern	OE	52	3.4	20.1	8.4	8.6	3.6
Eastern	TC	18	1.6	4.3	3.3	3.2	0.7
Western		424	0.3	12.4	4.2	4.8	2.3
Eastern		277	1.3	29.8	4.8	7.7	6.6

Table B - 3. Summary statistics for average temperature (°C) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	16	4.43	16.01	9.59	10.26	3.58
Western	OW	2	16	4.38	16.30	9.07	10.42	3.88
Western	OW	3	16	4.39	15.47	9.10	9.73	3.49
Western	PH	4	16	4.59	16.84	11.23	11.34	3.69
Western	PH	5	16	4.85	17.12	11.57	11.47	3.76
Western	ER	6	16	5.02	17.23	12.09	12.04	4.09
Western	FS	7	16	6.46	19.14	12.42	12.79	4.13
Western	FS	8	16	6.99	18.69	12.27	12.83	4.08
Western	FS	9	14	8.26	18.16	11.93	12.44	3.50
Western	ER	10	14	7.74	19.16	13.50	13.44	3.83
Western	ER	11	15	8.29	18.87	13.24	13.48	3.72
Western	HR	12	15	7.35	19.15	12.49	12.86	3.63
Western	HR	13	15	7.94	18.47	12.39	12.80	3.58
Western	HR	14	15	8.29	19.37	12.80	13.01	3.69
Western	HR	15	15	8.20	20.02	13.46	13.47	3.66
Western	HR	16	15	8.52	20.48	14.51	14.05	3.76
Western	HR	17	14	8.92	19.08	11.95	12.93	3.61
Western	HR	18	14	7.61	18.46	10.61	12.20	3.64
Western	MQ	19	15	9.36	19.77	13.66	13.90	3.60
Western	MQ	20	15	8.09	19.08	12.09	12.63	3.56
Western	MQ	21	15	7.97	19.35	12.18	12.74	3.57
Western	MQ	22	15	7.88	18.87	11.87	12.39	3.55
Western	MQ	23	15	7.94	19.46	12.33	12.88	3.74
Western	MQ	24	15	8.30	20.59	13.23	13.52	3.81
Western	MQ	26	15	8.64	20.15	12.84	13.19	3.61
Western	MB	27	15	7.94	19.74	12.72	12.76	3.61
Western	MB	28	15	8.21	18.72	11.79	12.19	3.51
Western	MB	29	15	8.10	19.61	13.05	12.94	3.54
Eastern	NM	30	17	8.68	19.88	13.77	14.27	3.85
Eastern	NM	31	17	8.22	19.23	13.83	13.99	3.72
Eastern	HS	32	16	8.80	20.18	15.65	15.13	3.97
Eastern	HS	33	17	8.34	19.44	14.18	14.10	3.72
Eastern	HS	34	17	8.47	19.46	14.05	14.43	3.76
Eastern	HS	35	17	7.91	18.49	13.76	13.33	3.53
Eastern	HS	36	17	7.62	18.27	13.24	13.22	3.67
Eastern	HS	36A	18	4.96	18.37	12.27	11.55	4.05
Eastern	OE	37	17	4.97	14.14	10.51	9.79	2.91
Eastern	OE	38	17	5.83	17.51	11.42	11.56	3.55
Eastern	OE	39	17	5.13	16.31	11.23	11.26	3.41
Eastern	TC	40	18	6.35	18.34	11.50	12.05	3.67
Eastern	NM	41	18	7.02	18.08	11.83	12.72	3.64
Eastern	NM	42	18	7.11	19.61	12.55	13.16	3.85
Eastern	NM	43	18	8.01	20.73	14.69	15.04	4.05
Eastern	NM	44	18	6.41	19.79	13.97	14.14	3.90

Table B - 4. Summary statistics for average temperature (°C) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	45	5.02	19.16	12.95	12.96	3.86
Western	FS	46	6.46	19.14	12.24	12.69	3.85
Western	HR	103	7.35	20.48	12.49	13.05	3.59
Western	MB	45	7.94	19.74	12.72	12.63	3.48
Western	MQ	105	7.88	20.59	12.19	13.04	3.57
Western	OW	48	4.38	16.30	9.26	10.13	3.59
Western	PH	32	4.59	17.12	11.23	11.41	3.67
Eastern	HS	101	4.97	20.18	13.37	13.32	3.91
Eastern	NM	106	6.41	20.73	13.75	13.88	3.83
Eastern	OE	52	4.96	18.37	11.55	11.46	3.62
Eastern	TC	18	6.35	18.34	11.50	12.05	3.67
Western		424	4.38	20.59	12.22	12.50	3.73
Eastern		277	4.96	20.73	13.19	13.10	3.90

Table B - 5. Summary statistics for surface temperature (°C) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	16	4.74	16.64	10.28	10.91	3.64
Western	OW	2	16	5.03	17.29	10.06	11.19	3.95
Western	OW	3	16	5.19	16.63	9.98	10.73	3.68
Western	PH	4	16	5.95	18.56	12.54	12.50	3.97
Western	PH	5	16	6.20	18.53	13.06	12.76	3.82
Western	ER	6	16	6.11	19.68	14.14	13.20	4.24
Western	FS	7	16	6.58	19.28	12.96	13.26	4.15
Western	FS	8	16	7.51	19.47	13.99	13.76	4.02
Western	FS	9	14	8.41	19.30	12.24	12.87	3.68
Western	ER	10	14	8.98	19.90	14.51	14.16	3.68
Western	ER	11	15	9.42	19.23	14.49	14.36	3.45
Western	HR	12	15	8.92	19.73	13.27	13.59	3.53
Western	HR	13	15	8.03	19.56	12.57	13.04	3.69
Western	HR	14	15	8.44	20.10	13.09	13.29	3.68
Western	HR	15	15	8.33	20.72	13.75	13.80	3.74
Western	HR	16	15	9.19	20.90	14.71	14.38	3.77
Western	HR	17	14	9.30	19.80	12.74	13.29	3.64
Western	HR	18	14	7.68	18.88	11.42	12.64	3.61
Western	MQ	19	15	9.36	20.14	13.95	14.01	3.62
Western	MQ	20	15	8.10	20.03	12.60	13.26	3.57
Western	MQ	21	15	7.98	20.05	12.20	13.16	3.70
Western	MQ	22	15	7.92	20.02	12.45	13.21	3.77
Western	MQ	23	15	8.27	20.99	13.08	13.86	4.17
Western	MQ	24	15	8.24	20.92	14.10	13.70	3.82
Western	MQ	26	15	8.67	20.84	13.25	13.61	3.65
Western	MB	27	15	7.91	20.57	13.63	13.66	3.77
Western	MB	28	15	8.27	19.11	12.28	12.99	3.59
Western	MB	29	15	7.92	19.85	13.39	13.25	3.59
Eastern	NM	30	17	9.32	21.62	14.01	15.26	4.13
Eastern	NM	31	17	8.57	19.60	14.38	14.26	3.73
Eastern	HS	32	16	9.18	20.32	16.24	15.47	4.09
Eastern	HS	33	17	8.30	19.54	14.30	14.18	3.77
Eastern	HS	34	17	8.52	20.23	14.62	15.06	3.98
Eastern	HS	35	17	8.06	18.94	14.12	13.75	3.62
Eastern	HS	36	17	9.87	19.85	14.08	14.48	3.49
Eastern	HS	36A	17	7.02	18.33	12.80	13.13	3.69
Eastern	OE	37	18	5.75	20.35	12.95	13.40	4.10
Eastern	OE	38	17	7.86	18.92	13.17	13.21	3.75
Eastern	OE	39	17	7.56	18.79	13.21	13.44	3.66
Eastern	TC	40	18	6.92	19.14	12.50	13.57	4.02
Eastern	NM	41	18	7.06	18.98	12.26	13.17	3.83
Eastern	NM	42	18	8.19	21.04	12.84	14.29	4.19
Eastern	NM	43	18	8.70	21.97	14.88	15.46	4.08
Eastern	NM	44	18	7.65	20.66	14.25	14.87	4.04

Table B - 6. Summary statistics for surface temperature (°C) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	45	6.11	19.90	14.49	13.89	3.77
Western	FS	46	6.58	19.47	12.98	13.31	3.89
Western	HR	103	7.68	20.90	13.26	13.44	3.59
Western	MB	45	7.91	20.57	13.01	13.30	3.58
Western	MQ	105	7.92	20.99	13.08	13.54	3.67
Western	OW	48	4.74	17.29	10.09	10.94	3.68
Western	PH	32	5.95	18.56	12.72	12.63	3.83
Eastern	HS	101	7.02	20.32	14.12	14.34	3.76
Eastern	NM	106	7.06	21.97	14.05	14.55	3.98
Eastern	OE	52	5.75	20.35	13.19	13.35	3.77
Eastern	TC	18	6.92	19.14	12.50	13.57	4.02
Western		424	4.74	20.99	13.04	13.14	3.76
Eastern		277	5.75	21.97	13.91	14.18	3.87

Table B - 7. Summary statistics for average salinity (PSU) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	16	26.23	31.37	29.81	29.46	1.45
Western	OW	2	16	27.55	31.50	29.84	29.65	1.13
Western	OW	3	16	28.01	31.27	29.88	29.94	1.02
Western	PH	4	16	25.06	30.49	28.30	28.22	1.64
Western	PH	5	16	24.35	30.41	28.18	27.90	1.77
Western	ER	6	16	17.77	28.99	25.69	25.04	3.38
Western	FS	7	16	26.17	30.90	29.09	29.13	1.26
Western	FS	8	16	26.24	30.90	29.74	29.42	1.20
Western	FS	9	14	25.97	30.99	29.62	29.10	1.46
Western	ER	10	14	20.25	30.46	27.61	26.89	2.71
Western	ER	11	15	19.62	29.66	26.86	26.42	2.88
Western	HR	12	15	25.71	30.96	28.66	28.96	1.39
Western	HR	13	15	26.54	31.08	29.57	29.32	1.25
Western	HR	14	15	26.33	30.99	29.35	29.24	1.25
Western	HR	15	15	26.15	30.90	29.05	29.06	1.32
Western	HR	16	15	25.69	30.85	28.79	28.68	1.52
Western	HR	17	14	26.57	31.09	29.23	29.18	1.29
Western	HR	18	14	26.82	31.14	29.66	29.38	1.21
Western	MQ	19	15	26.29	31.10	29.80	29.25	1.37
Western	MQ	20	15	26.56	31.09	29.80	29.37	1.27
Western	MQ	21	15	26.44	31.12	29.81	29.27	1.35
Western	MQ	22	15	26.75	31.11	29.79	29.45	1.23
Western	MQ	23	15	26.52	31.05	29.63	29.39	1.29
Western	MQ	24	15	26.25	31.01	29.60	29.25	1.36
Western	MQ	26	15	26.78	31.08	29.86	29.37	1.25
Western	MB	27	15	26.74	31.16	29.39	29.31	1.32
Western	MB	28	15	26.78	31.18	29.48	29.39	1.27
Western	MB	29	15	26.53	31.16	29.43	29.19	1.44
Eastern	NM	30	17	26.70	31.05	30.09	29.61	1.36
Eastern	NM	31	17	27.11	31.06	30.05	29.63	1.29
Eastern	HS	32	16	26.09	30.95	29.77	29.36	1.37
Eastern	HS	33	17	26.09	31.08	29.64	29.25	1.56
Eastern	HS	34	17	26.00	31.03	29.58	29.14	1.55
Eastern	HS	35	17	26.39	31.09	29.57	29.28	1.58
Eastern	HS	36	17	26.03	31.10	29.43	29.24	1.58
Eastern	HS	36A	17	29.51	31.47	30.64	30.59	0.61
Eastern	OE	37	18	27.43	31.13	29.77	29.45	1.11
Eastern	OE	38	17	27.22	30.88	29.13	29.23	1.18
Eastern	OE	39	17	26.76	30.91	29.73	29.34	1.30
Eastern	TC	40	18	25.14	30.63	29.16	28.51	1.77
Eastern	NM	41	18	24.30	30.95	29.70	28.78	2.21
Eastern	NM	42	18	22.60	31.00	29.45	28.67	2.46
Eastern	NM	43	18	25.53	30.94	29.72	29.12	1.74
Eastern	NM	44	18	25.99	31.06	29.90	29.35	1.66

Table B - 8. Summary statistics for average salinity (PSU) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	45	17.77	30.46	26.57	26.08	3.06
Western	FS	46	25.97	30.99	29.53	29.22	1.28
Western	HR	103	25.69	31.14	29.35	29.11	1.30
Western	MB	45	26.53	31.18	29.44	29.30	1.32
Western	MQ	105	26.25	31.12	29.80	29.34	1.27
Western	OW	48	26.23	31.50	29.82	29.68	1.21
Western	PH	32	24.35	30.49	28.20	28.06	1.69
Eastern	HS	101	26.00	31.47	29.87	29.48	1.47
Eastern	NM	106	22.60	31.06	29.81	29.19	1.84
Eastern	OE	52	26.76	31.13	29.62	29.34	1.18
Eastern	TC	18	25.14	30.63	29.16	28.51	1.77
Western		424	17.77	31.50	29.19	28.86	1.89
Eastern		277	22.60	31.47	29.74	29.28	1.61

Table B - 9. Summary statistics for surface salinity (PSU) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	16	26.03	31.31	29.42	29.15	1.50
Western	OW	2	16	26.11	31.45	29.21	29.12	1.57
Western	OW	3	16	26.53	31.09	29.52	29.19	1.46
Western	PH	4	16	21.84	30.29	26.76	26.69	2.44
Western	PH	5	16	20.81	29.94	26.91	26.14	2.70
Western	ER	6	16	8.15	27.66	19.68	19.64	6.61
Western	FS	7	16	24.69	30.62	28.92	28.82	1.55
Western	FS	8	16	24.87	30.89	29.53	29.08	1.53
Western	FS	9	14	25.42	30.70	29.44	28.92	1.53
Western	ER	10	14	13.89	29.70	26.35	24.96	4.16
Western	ER	11	15	10.89	29.04	24.67	23.34	5.57
Western	HR	12	15	25.14	30.87	28.62	28.46	1.72
Western	HR	13	15	26.25	31.05	29.50	29.26	1.31
Western	HR	14	15	25.79	30.94	29.23	29.09	1.37
Western	HR	15	15	25.42	30.75	28.95	28.85	1.46
Western	HR	16	15	25.11	30.74	28.57	28.47	1.64
Western	HR	17	14	26.03	31.05	29.17	29.01	1.41
Western	HR	18	14	26.65	31.11	29.57	29.26	1.30
Western	MQ	19	15	26.27	31.10	29.80	29.24	1.37
Western	MQ	20	15	26.42	31.10	29.72	29.21	1.37
Western	MQ	21	15	26.37	31.10	29.75	29.16	1.43
Western	MQ	22	15	26.38	31.09	29.69	29.29	1.36
Western	MQ	23	15	26.29	31.03	29.71	29.26	1.36
Western	MQ	24	15	26.25	30.95	29.04	29.11	1.39
Western	MQ	26	15	26.15	31.06	29.66	29.22	1.37
Western	MB	27	15	26.38	31.12	29.39	29.20	1.45
Western	MB	28	15	26.43	31.14	29.47	29.22	1.45
Western	MB	29	15	26.53	31.12	29.43	29.11	1.52
Eastern	NM	30	17	26.36	30.99	30.05	29.41	1.51
Eastern	NM	31	17	26.89	31.03	29.95	29.55	1.34
Eastern	HS	32	16	26.10	30.93	29.77	29.32	1.39
Eastern	HS	33	17	26.10	31.05	29.65	29.24	1.57
Eastern	HS	34	17	25.78	30.90	29.49	28.94	1.54
Eastern	HS	35	17	25.54	31.08	29.54	29.16	1.71
Eastern	HS	36	17	22.21	31.11	29.34	28.32	2.87
Eastern	HS	36A	17	24.09	31.01	29.70	28.92	2.04
Eastern	OE	37	18	21.50	30.85	29.06	27.84	3.02
Eastern	OE	38	17	21.39	30.90	28.81	27.68	2.99
Eastern	OE	39	17	20.96	30.22	28.59	27.35	3.02
Eastern	TC	40	18	20.14	30.13	28.61	27.08	3.08
Eastern	NM	41	18	24.03	30.89	29.55	28.56	2.35
Eastern	NM	42	18	22.28	31.01	29.21	28.13	2.67
Eastern	NM	43	18	25.28	30.95	29.70	29.04	1.79
Eastern	NM	44	18	24.91	31.09	29.66	29.10	1.97

Table B - 10. Summary statistics for surface salinity (PSU) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	45	8.15	29.70	24.19	22.53	5.92
Western	FS	46	24.69	30.89	29.37	28.94	1.51
Western	HR	103	25.11	31.11	29.23	28.91	1.46
Western	MB	45	26.38	31.14	29.43	29.18	1.44
Western	MQ	105	26.15	31.10	29.68	29.21	1.34
Western	OW	48	26.03	31.45	29.31	29.16	1.48
Western	PH	32	20.81	30.29	26.91	26.42	2.54
Eastern	HS	101	22.21	31.11	29.57	28.98	1.91
Eastern	NM	106	22.28	31.09	29.56	28.96	2.01
Eastern	OE	52	20.96	30.90	28.72	27.63	2.96
Eastern	TC	18	20.14	30.13	28.61	27.08	3.08
Western		424	8.15	31.45	29.00	28.18	3.17
Eastern		277	20.14	31.11	29.38	28.59	2.34

Table B - 11. Summary statistics for PSP toxicity (µg STX/100g) for each station (2007-2008). Note – to run the statistical analyses the "-44" below detection limit values were set equal to zero.

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	12	0	305	43	85.2	114.6
Western	OW	2	12	0	776	47	140.6	245.2
Western	OW	3	8	0	223	69	78.0	80.7
Western	PH	4	12	0	41	0	3.4	11.8
Western	PH	5	9	0	42	0	4.7	14.0
Western	ER	6	12	0	50	0	4.2	14.4
Western	FS	7	12	0	126	0	26.9	39.6
Western	FS	8	12	0	77	0	11.9	27.9
Western	FS	9	10	0	82	0	17.2	29.6
Western	ER	10	10	0	42	0	4.2	13.3
Western	ER	11	11	0	0	0	0.0	0.0
Western	HR	12	10	0	43	0	4.3	13.6
Western	HR	13	11	0	40	0	3.6	12.1
Western	HR	14	9	0	0	0	0.0	0.0
Western	HR	15	11	0	0	0	0.0	0.0
Western	HR	16	11	0	0	0	0.0	0.0
Western	HR	17	10	0	0	0	0.0	0.0
Western	HR	18	8	0	0	0	0.0	0.0
Western	MQ	19	11	0	0	0	0.0	0.0
Western	MQ	20	11	0	0	0	0.0	0.0
Western	MQ	21	11	0	41	0	3.7	12.4
Western	MQ	22	11	0	38	0	3.5	11.5
Western	MQ	23	11	0	0	0	0.0	0.0
Western	MQ	24	11	0	40	0	3.6	12.1
Western	MQ	26	10	0	42	0	4.2	13.3
Western	MB	27	11	0	56	0	5.1	16.9
Western	MB	28	11	0	57	0	5.2	17.2
Western	MB	29	11	0	48	0	4.4	14.5
Eastern	NM	30	14	0	47	0	6.4	16.2
Eastern	NM	31	0					
Eastern	HS	32	13	0	1194	0	107.8	327.7
Eastern	HS	33	14	0	1312	0	126.9	344.9
Eastern	HS	34	14	0	955	0	91.9	252.4
Eastern	HS	35	0					
Eastern	HS	36	2	0	0	0	0.0	0.0
Eastern	HS	36A	12	0	1322	74.5	191.2	362.7
Eastern	OE	37	14	0	396	47	61.7	103.2
Eastern	OE	38	13	0	669	48	88.3	178.8
Eastern	OE	39	14	0	490	44.5	68.4	127.8
Eastern	TC	40	14	0	68	0	11.6	23.7
Eastern	NM	41	13	0	141	0	17.8	40.7
Eastern	NM	42	14	0	46	0	6.4	16.3
Eastern	NM	43	14	0	53	0	7.4	18.9
Eastern	NM	44	12	0	305	43	85.2	114.6

Table B - 12. Summary statistics for PSP toxicity (µg STX/100g) for each location and area (2007-2008). Note – to run the statistical analyses the "-44" below detection limit values were set equal to zero.

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	33	0	50	0	2.8	11.2
Western	FS	34	0	126	0	18.8	32.6
Western	HR	70	0	43	0	1.2	7.0
Western	MB	33	0	57	0	4.9	15.7
Western	MQ	76	0	42	0	2.1	9.1
Western	OW	32	0	776	46	104.2	168.2
Western	PH	21	0	42	0	4.0	12.5
Eastern	HS	55	0	1322	0	122.9	310.7
Eastern	NM	69	0	141	0	9.8	24.2
Eastern	OE	40	0	669	48	78.5	142.3
Eastern	TC	14	0	490	44.5	68.4	127.8
Western		299	0	776	0	15.2	64.2
Eastern		178	0	1322	0	64.8	193.9

Table B - 13. Summary statistics for *Alexandrium* abundance (cells/L) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	12	0	300.0	20.9	66.3	92.4
Western	OW	2	12	0	2723.6	3.8	316.4	784.2
Western	OW	3	11	0	237.9	6.4	58.1	81.0
Western	PH	4	12	0	206.8	4.3	42.0	72.2
Western	PH	5	10	0	555.0	3.2	65.6	173.4
Western	ER	6	10	0	46.1	1.6	7.5	14.0
Western	FS	7	10	0	418.9	4.8	86.8	149.3
Western	FS	8	12	0	412.5	3.8	53.8	119.5
Western	FS	9	9	0	3559.4	4.3	448.7	1170.7
Western	ER	10	9	0	38.6	3.2	9.6	14.0
Western	ER	11	9	0	21.4	2.1	5.1	6.9
Western	HR	12	9	0	113.6	4.3	20.1	38.0
Western	HR	13	11	0	117.9	2.1	16.6	34.8
Western	HR	14	8	0	40.7	10.2	14.6	16.0
Western	HR	15	8	0	75.0	8.6	22.6	30.9
Western	HR	16	11	0	60.0	4.3	14.8	20.3
Western	HR	17	7	0	41.8	9.6	13.9	15.7
Western	HR	18	8	0	84.6	3.7	30.8	40.3
Western	MQ	19	9	0	30.0	1.1	6.7	10.2
Western	MQ	20	9	0	90.0	27.9	33.6	35.6
Western	MQ	21	10	0	184.3	5.9	41.8	74.1
Western	MQ	22	10	0	117.9	17.7	36.4	42.4
Western	MQ	23	10	0	101.8	15.0	29.5	39.4
Western	MQ	24	9	0	323.6	9.6	73.7	114.2
Western	MQ	26	11	0	717.9	9.6	95.3	221.7
Western	MB	27	8	0	238.9	3.8	58.3	100.0
Western	MB	28	9	0	137.1	5.4	26.1	45.0
Western	MB	29	10	0	402.9	5.9	55.7	124.9
Eastern	NM	30	13	0	717.9	4.3	90.4	208.9
Eastern	NM	31	12	0	276.4	5.4	62.0	98.0
Eastern	HS	32	13	0	1009.8	42.9	166.9	293.4
Eastern	HS	33	13	0	2567.0	17.1	321.8	721.8
Eastern	HS	34	12	0	5584.0	13.4	508.4	1599.6
Eastern	HS	35	13	0	1349.7	26.8	172.9	384.1
Eastern	HS	36	14	0	28316.8	90.0	2331.8	7512.8
Eastern	HS	36A	11	0	9950.6	32.1	1067.9	2967.9
Eastern	OE	37	13	0	184.3	6.4	28.8	49.8
Eastern	OE	38	13	0	396.4	23.6	71.2	116.0
Eastern	OE	39	13	0	498.2	15.0	93.0	175.2
Eastern	TC	40	14	0	2937.5	13.9	296.0	784.0
Eastern	NM	41	13	0	2964.0	10.7	266.3	813.0
Eastern	NM	42	14	0	2831.7	10.2	249.9	752.1
Eastern	NM	43	13	0	979.2	1.1	81.4	270.0
Eastern	NM	44	12	0	227.1	0.5	33.2	66.4

Table B - 14. Summary statistics for *Alexandrium* abundance (cells/L) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	28	0	46.1	2.1	7.4	11.9
Western	FS	31	0	3559.4	4.3	179.1	639.0
Western	HR	62	0	117.9	5.4	18.8	28.9
Western	MB	27	0	402.9	4.3	46.6	94.5
Western	MQ	68	0	717.9	9.1	46.3	105.0
Western	OW	35	0	2723.6	5.4	149.5	467.6
Western	PH	22	0	555.0	3.8	52.7	125.6
Eastern	HS	76	0	28316.8	32.7	777.6	3477.5
Eastern	NM	77	0	2964.0	7.5	134.3	479.8
Eastern	OE	39	0	498.2	15.0	64.4	124.3
Eastern	TC	14	0	2937.5	13.9	296.0	784.0
Western		273	0	3559.4	4.3	64.9	284.1
Eastern		206	0	28316.8	11.8	369.4	2156.8

Table B - 15. Summary statistics for nitrate+nitrite (μM) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	12	0.09	2.33	0.62	0.76	0.69
Western	OW	2	11	0.09	2.35	0.49	0.84	0.77
Western	OW	3	12	0.18	1.85	0.56	0.78	0.50
Western	PH	4	12	0.61	4.47	2.16	2.31	1.18
Western	PH	5	12	0.24	11.64	3.15	3.49	3.04
Western	ER	6	12	0.98	6.53	3.29	3.64	1.88
Western	FS	7	12	0.05	2.00	0.24	0.51	0.63
Western	FS	8	12	0.01	0.88	0.18	0.31	0.31
Western	FS	9	11	0.07	1.45	0.09	0.38	0.50
Western	ER	10	9	0.09	10.24	2.87	3.31	3.00
Western	ER	11	11	0.09	9.37	5.26	4.70	3.39
Western	HR	12	11	0.05	2.12	0.21	0.60	0.69
Western	HR	13	11	0.02	1.29	0.10	0.33	0.45
Western	HR	14	11	0.01	2.02	0.26	0.52	0.68
Western	HR	15	11	0.09	2.08	0.60	0.66	0.56
Western	HR	16	11	0.09	2.96	0.58	0.72	0.81
Western	HR	17	10	0.05	1.88	0.26	0.45	0.55
Western	HR	18	10	0.02	1.19	0.11	0.25	0.35
Western	MQ	19	11	0.09	0.62	0.09	0.15	0.16
Western	MQ	20	11	0.01	0.68	0.10	0.18	0.20
Western	MQ	21	11	0.06	1.17	0.09	0.20	0.33
Western	MQ	22	11	0.02	0.89	0.10	0.23	0.29
Western	MQ	23	11	0.07	2.14	0.10	0.37	0.61
Western	MQ	24	11	0.04	1.66	0.10	0.36	0.53
Western	MQ	26	11	0.01	0.67	0.09	0.17	0.20
Western	MB	27	11	0.03	0.46	0.10	0.18	0.16
Western	MB	28	11	0.09	0.92	0.10	0.28	0.26
Western	MB	29	11	0.02	1.17	0.09	0.35	0.42
Eastern	NM	30	14	0.05	1.40	0.16	0.35	0.40
Eastern	NM	31	14	0.09	1.84	0.29	0.45	0.48
Eastern	HS	32	13	0.05	1.73	0.49	0.55	0.48
Eastern	HS	33	14	0.06	1.30	0.36	0.45	0.41
Eastern	HS	34	14	0.07	1.96	0.67	0.69	0.51
Eastern	HS	35	14	0.04	1.35	0.23	0.37	0.37
Eastern	HS	36	14	0.03	0.52	0.10	0.16	0.14
Eastern	HS	36A	14	0.04	1.55	0.09	0.29	0.42
Eastern	OE	37	14	0.00	1.79	0.22	0.40	0.49
Eastern	OE	38	14	0.01	2.47	0.13	0.36	0.63
Eastern	OE	39	14	0.05	4.64	0.17	0.82	1.37
Eastern	TC	40	14	0.00	2.03	0.22	0.47	0.59
Eastern	NM	41	14	0.09	1.68	0.12	0.33	0.46
Eastern	NM	42	14	0.04	0.57	0.10	0.17	0.17
Eastern	NM	43	14	0.09	1.36	0.18	0.38	0.44
Eastern	NM	44	14	0.03	1.27	0.10	0.29	0.34

Table B - 16. Summary statistics for nitrate+nitrite (µM) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	32	0.09	10.24	3.29	3.91	2.77
Western	FS	35	0.01	2.00	0.10	0.40	0.49
Western	HR	75	0.01	2.96	0.24	0.51	0.60
Western	MB	33	0.02	1.17	0.10	0.27	0.30
Western	MQ	77	0.01	2.14	0.09	0.24	0.36
Western	OW	35	0.09	2.35	0.56	0.79	0.64
Western	PH	24	0.24	11.64	2.35	2.90	2.34
Eastern	HS	83	0.03	1.96	0.23	0.41	0.43
Eastern	NM	84	0.03	1.84	0.15	0.33	0.39
Eastern	OE	42	0.00	4.64	0.16	0.53	0.92
Eastern	TC	14	0.00	2.03	0.22	0.47	0.59
Western		311	0.01	11.64	0.28	0.97	1.68
Eastern		223	0.00	4.64	0.17	0.41	0.55

Table B - 17. Summary statistics for silicate (µM) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	12	1.70	11.97	5.18	6.05	3.78
Western	OW	2	11	0.96	14.51	4.32	6.30	4.83
Western	OW	3	12	1.52	13.50	5.91	6.50	3.76
Western	PH	4	12	3.95	23.17	13.22	14.12	5.90
Western	PH	5	12	6.67	32.51	15.23	16.60	7.07
Western	ER	6	12	7.37	40.57	21.86	23.33	10.75
Western	FS	7	12	1.97	20.96	6.88	8.14	5.65
Western	FS	8	12	1.14	19.99	6.42	8.46	5.99
Western	FS	9	11	0.28	19.25	8.24	8.07	6.24
Western	ER	10	9	10.97	55.72	34.29	31.20	16.33
Western	ER	11	11	10.79	74.39	42.45	38.77	24.51
Western	HR	12	11	2.08	36.09	11.09	11.92	9.65
Western	HR	13	11	1.60	22.01	6.76	8.60	6.05
Western	HR	14	11	2.71	19.90	8.57	10.13	6.67
Western	HR	15	11	4.68	21.87	8.13	10.79	5.62
Western	HR	16	11	7.16	32.67	9.61	14.55	9.18
Western	HR	17	10	2.80	18.49	10.22	10.59	6.26
Western	HR	18	10	1.86	13.33	5.94	7.13	4.11
Western	MQ	19	11	1.70	13.51	4.49	6.56	4.67
Western	MQ	20	11	0.02	11.47	3.47	5.39	4.08
Western	MQ	21	11	1.99	12.84	5.59	6.64	3.68
Western	MQ	22	11	1.02	14.88	2.28	5.09	4.67
Western	MQ	23	11	1.13	15.46	3.98	6.42	5.16
Western	MQ	24	11	0.59	15.16	2.65	5.95	5.68
Western	MQ	26	11	0.36	14.40	2.93	5.54	5.04
Western	MB	27	11	1.06	13.01	4.61	5.40	3.66
Western	MB	28	11	1.85	13.18	3.57	6.36	4.55
Western	MB	29	11	0.80	12.67	3.56	5.72	4.37
Eastern	NM	30	14	1.17	16.44	6.35	7.75	4.90
Eastern	NM	31	14	3.55	14.35	8.69	8.17	3.16
Eastern	HS	32	13	2.17	14.96	9.11	8.73	3.05
Eastern	HS	33	14	2.48	17.47	6.42	7.43	4.03
Eastern	HS	34	14	3.78	14.37	8.98	9.31	3.41
Eastern	HS	35	14	1.80	11.06	5.41	5.79	2.71
Eastern	HS	36	14	1.96	16.22	5.61	6.59	4.48
Eastern	HS	36A	14	0.82	13.30	3.24	4.92	3.88
Eastern	OE	37	14	0.62	17.98	4.38	6.17	5.36
Eastern	OE	38	14	0.61	19.85	2.00	5.23	6.23
Eastern	OE	39	14	1.28	19.73	4.99	6.53	5.61
Eastern	TC	40	14	1.61	23.75	5.70	7.37	6.27
Eastern	NM	41	14	1.45	20.27	4.56	7.02	5.36
Eastern	NM	42	14	0.61	14.17	3.61	5.30	4.27
Eastern	NM	43	14	3.18	20.50	9.89	10.26	5.54
Eastern	NM	44	14	4.04	14.99	8.33	9.27	3.59

Table B - 18. Summary statistics for silicate (μM) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	32	7.37	74.39	25.30	30.85	18.65
Western	FS	35	0.28	20.96	7.06	8.23	5.78
Western	HR	75	1.60	36.09	8.66	10.58	7.13
Western	MB	33	0.80	13.18	3.59	5.83	4.10
Western	MQ	77	0.02	15.46	3.90	5.94	4.60
Western	OW	35	0.96	14.51	4.95	6.29	4.01
Western	PH	24	3.95	32.51	14.43	15.36	6.49
Eastern	HS	83	0.82	17.47	6.76	7.11	3.87
Eastern	NM	84	0.61	20.50	7.15	7.96	4.69
Eastern	OE	42	0.61	19.85	3.68	5.98	5.63
Eastern	TC	14	1.61	23.75	5.70	7.37	6.27
Western		311	0.02	74.39	8.42	10.63	10.82
Eastern		223	0.61	23.75	6.16	7.23	4.74

Table B - 19. Summary statistics for ammonium (μM) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	12	0.21	5.83	1.36	1.88	1.73
Western	OW	2	11	0.72	9.44	2.45	3.10	2.54
Western	OW	3	12	0.03	3.43	2.65	1.88	1.33
Western	PH	4	12	1.94	9.36	5.05	5.68	2.73
Western	PH	5	12	0.74	33.80	9.51	10.05	8.11
Western	ER	6	12	1.33	6.51	2.93	3.68	1.59
Western	FS	7	12	0.02	7.05	1.54	2.25	2.13
Western	FS	8	12	0.03	4.92	1.88	1.74	1.31
Western	FS	9	11	0.02	2.41	1.36	1.36	0.82
Western	ER	10	9	0.12	7.45	2.93	3.26	2.13
Western	ER	11	11	0.38	7.05	2.91	2.82	1.75
Western	HR	12	11	0.02	4.06	1.05	1.37	1.16
Western	HR	13	11	0.31	3.08	1.48	1.56	0.93
Western	HR	14	11	0.06	3.78	1.86	2.09	1.27
Western	HR	15	11	0.94	7.31	2.99	3.15	1.86
Western	HR	16	11	0.43	8.86	2.87	3.31	2.27
Western	HR	17	10	0.02	2.89	1.47	1.47	0.99
Western	HR	18	10	0.00	3.35	1.31	1.44	1.21
Western	MQ	19	11	0.02	2.81	0.73	1.05	0.81
Western	MQ	20	11	0.02	4.44	1.23	1.26	1.23
Western	MQ	21	11	0.03	12.44	1.05	2.10	3.51
Western	MQ	22	11	0.00	3.49	1.56	1.39	1.14
Western	MQ	23	11	0.42	6.43	1.10	1.82	1.86
Western	MQ	24	11	0.00	5.86	1.46	1.68	1.73
Western	MQ	26	11	0.03	4.35	0.90	1.47	1.29
Western	MB	27	11	0.00	5.69	1.05	1.55	1.59
Western	MB	28	11	0.02	7.19	1.06	1.60	2.04
Western	MB	29	11	0.03	10.10	0.79	2.19	2.95
Eastern	NM	30	14	0.06	5.13	1.52	1.73	1.40
Eastern	NM	31	14	0.11	5.80	1.98	2.02	1.52
Eastern	HS	32	13	0.02	8.73	2.30	2.64	2.36
Eastern	HS	33	14	0.03	5.42	1.92	2.09	1.66
Eastern	HS	34	14	0.03	4.04	2.02	1.94	1.22
Eastern	HS	35	14	0.02	4.14	2.30	2.13	1.32
Eastern	HS	36	14	0.00	2.90	1.64	1.46	0.90
Eastern	HS	36A	14	0.00	3.41	1.22	1.38	0.98
Eastern	OE	37	14	0.03	4.32	1.80	1.88	1.23
Eastern	OE	38	14	0.03	3.02	1.22	1.47	1.02
Eastern	OE	39	14	0.00	3.44	1.49	1.57	1.17
Eastern	TC	40	14	0.00	11.03	1.90	2.30	2.81
Eastern	NM	41	14	0.00	3.89	1.31	1.54	1.19
Eastern	NM	42	14	0.00	3.04	0.92	1.11	0.98
Eastern	NM	43	14	0.19	9.16	1.99	2.54	2.55
Eastern	NM	44	14	0.02	4.58	1.30	1.65	1.34

Table B - 20. Summary statistics for ammonium (µM) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	32	0.12	7.45	2.92	3.27	1.79
Western	FS	35	0.02	7.05	1.72	1.79	1.53
Western	HR	75	0.00	8.86	1.85	2.07	1.61
Western	MB	33	0.00	10.10	1.05	1.78	2.21
Western	MQ	77	0.00	12.44	1.06	1.54	1.81
Western	OW	35	0.03	9.44	2.32	2.26	1.94
Western	PH	24	0.74	33.80	7.73	7.86	6.33
Eastern	HS	83	0.00	8.73	1.84	1.93	1.49
Eastern	NM	84	0.00	9.16	1.45	1.76	1.59
Eastern	OE	42	0.00	4.32	1.55	1.64	1.13
Eastern	TC	14	0.00	11.03	1.90	2.30	2.81
Western		311	0.00	33.80	1.81	2.47	2.93
Eastern		223	0.00	11.03	1.59	1.84	1.58

Table B - 21. Summary statistics for phosphate (μM) for each station (2007-2008).

Area	Location	Station	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	OW	1	12	0.02	4.40	0.50	0.78	1.19
Western	OW	2	11	0.02	3.33	0.48	0.70	0.94
Western	OW	3	12	0.02	1.03	0.46	0.46	0.35
Western	PH	4	12	0.26	6.89	1.13	1.43	1.80
Western	PH	5	12	0.44	19.76	1.26	5.23	7.35
Western	ER	6	12	0.03	3.19	0.66	0.78	0.90
Western	FS	7	12	0.02	5.24	0.24	0.79	1.49
Western	FS	8	12	0.03	2.30	0.10	0.66	0.92
Western	FS	9	11	0.02	1.68	0.06	0.33	0.55
Western	ER	10	9	0.02	1.41	0.18	0.42	0.49
Western	ER	11	11	0.02	1.19	0.31	0.35	0.37
Western	HR	12	11	0.03	0.86	0.07	0.29	0.32
Western	HR	13	11	0.03	0.66	0.29	0.27	0.23
Western	HR	14	11	0.02	1.20	0.30	0.39	0.38
Western	HR	15	11	0.03	1.86	0.32	0.59	0.65
Western	HR	16	11	0.00	1.16	0.48	0.47	0.43
Western	HR	17	10	0.03	1.30	0.25	0.32	0.38
Western	HR	18	10	0.01	1.32	0.15	0.30	0.40
Western	MQ	19	11	0.00	0.78	0.15	0.27	0.28
Western	MQ	20	11	0.02	0.40	0.14	0.17	0.16
Western	MQ	21	11	0.03	4.27	0.12	0.60	1.25
Western	MQ	22	11	0.02	1.07	0.39	0.35	0.35
Western	MQ	23	11	0.02	1.69	0.35	0.44	0.49
Western	MQ	24	11	0.02	0.84	0.22	0.31	0.27
Western	MQ	26	11	0.03	1.76	0.29	0.39	0.49
Western	MB	27	11	0.03	2.05	0.18	0.41	0.58
Western	MB	28	11	0.02	2.31	0.24	0.43	0.66
Western	MB	29	11	0.00	3.93	0.20	0.60	1.14
Eastern	NM	30	14	0.03	0.58	0.32	0.27	0.19
Eastern	NM	31	14	0.03	0.74	0.23	0.31	0.22
Eastern	HS	32	13	0.03	0.87	0.25	0.26	0.25
Eastern	HS	33	14	0.02	7.18	0.27	0.76	1.86
Eastern	HS	34	14	0.02	0.74	0.18	0.25	0.26
Eastern	HS	35	14	0.00	0.77	0.06	0.18	0.22
Eastern	HS	36	14	0.02	0.57	0.15	0.17	0.16
Eastern	HS	36A	14	0.02	1.80	0.04	0.30	0.57
Eastern	OE	37	14	0.03	3.23	0.08	0.39	0.84
Eastern	OE	38	14	0.01	1.54	0.03	0.23	0.41
Eastern	OE	39	14	0.02	0.88	0.09	0.24	0.28
Eastern	TC	40	14	0.02	0.97	0.04	0.18	0.30
Eastern	NM	41	14	0.02	0.51	0.04	0.16	0.19
Eastern	NM	42	14	0.02	0.76	0.03	0.16	0.23
Eastern	NM	43	14	0.02	3.97	0.33	0.62	1.03
Eastern	NM	44	14	0.00	8.04	0.30	0.90	2.08

Table B - 22. Summary statistics for phosphate (µM) for each location and area (2007-2008).

Area	Location	Number of Samples	Minimum	Maximum	Median	Mean	Std Dev
Western	ER	32	0.02	3.19	0.32	0.53	0.66
Western	FS	35	0.02	5.24	0.08	0.60	1.06
Western	HR	75	0.00	1.86	0.28	0.38	0.42
Western	MB	33	0.00	3.93	0.20	0.48	0.81
Western	MQ	77	0.00	4.27	0.23	0.36	0.57
Western	OW	35	0.02	4.40	0.48	0.64	0.88
Western	PH	24	0.26	19.76	1.15	3.33	5.58
Eastern	HS	83	0.00	7.18	0.14	0.32	0.82
Eastern	NM	84	0.00	8.04	0.23	0.40	0.97
Eastern	OE	42	0.01	3.23	0.04	0.29	0.55
Eastern	TC	14	0.02	0.97	0.04	0.18	0.30
Western		311	0.00	19.76	0.30	0.68	1.83
Eastern		223	0.00	8.04	0.14	0.34	0.82

APPENDIX C

Horizontal Contour Plots

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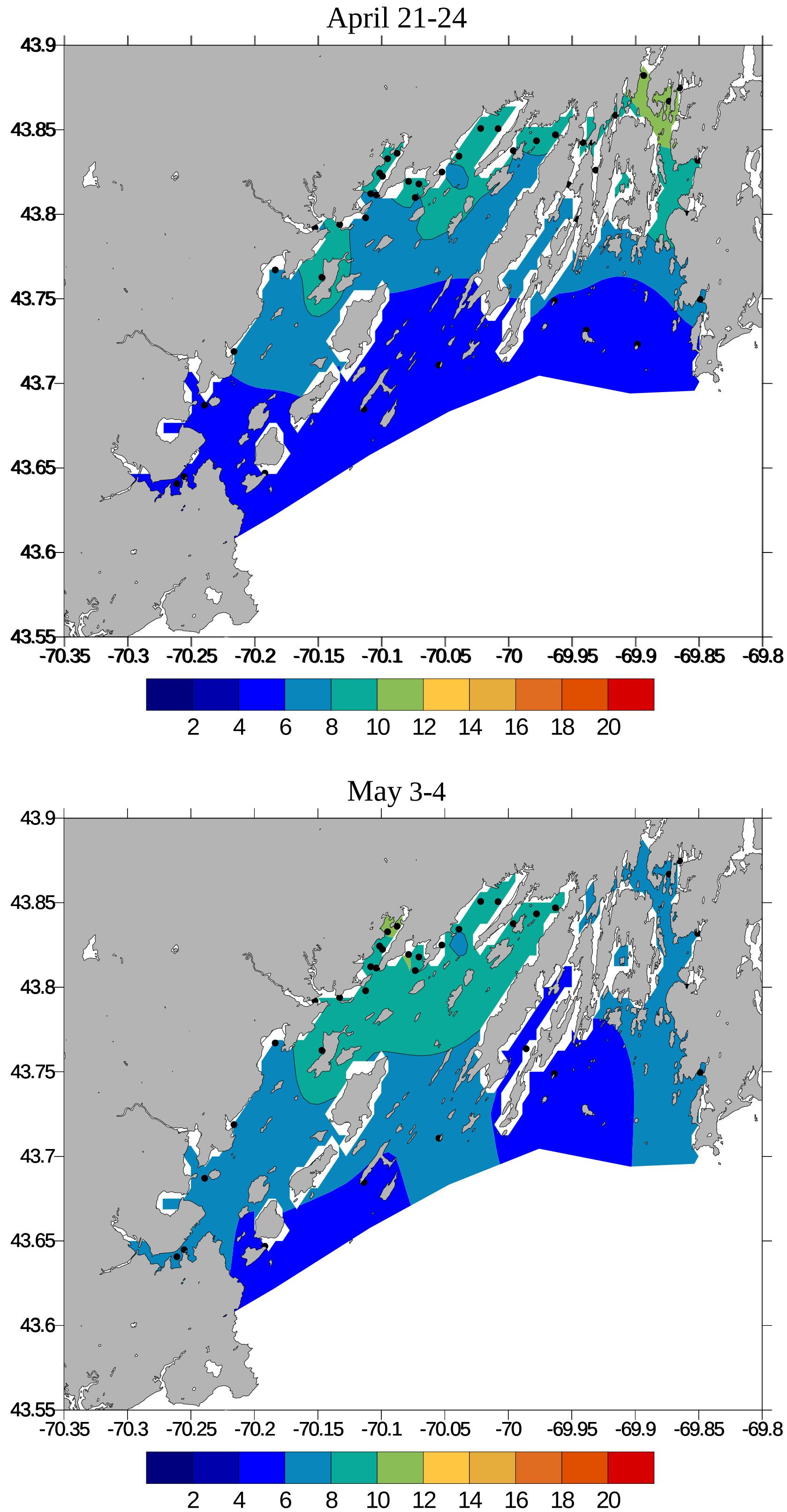


Figure 1. Surface water temperature (°C) on the April 21-24 and May 3-4, 2007 surveys. Station locations sampled denoted by black dots.

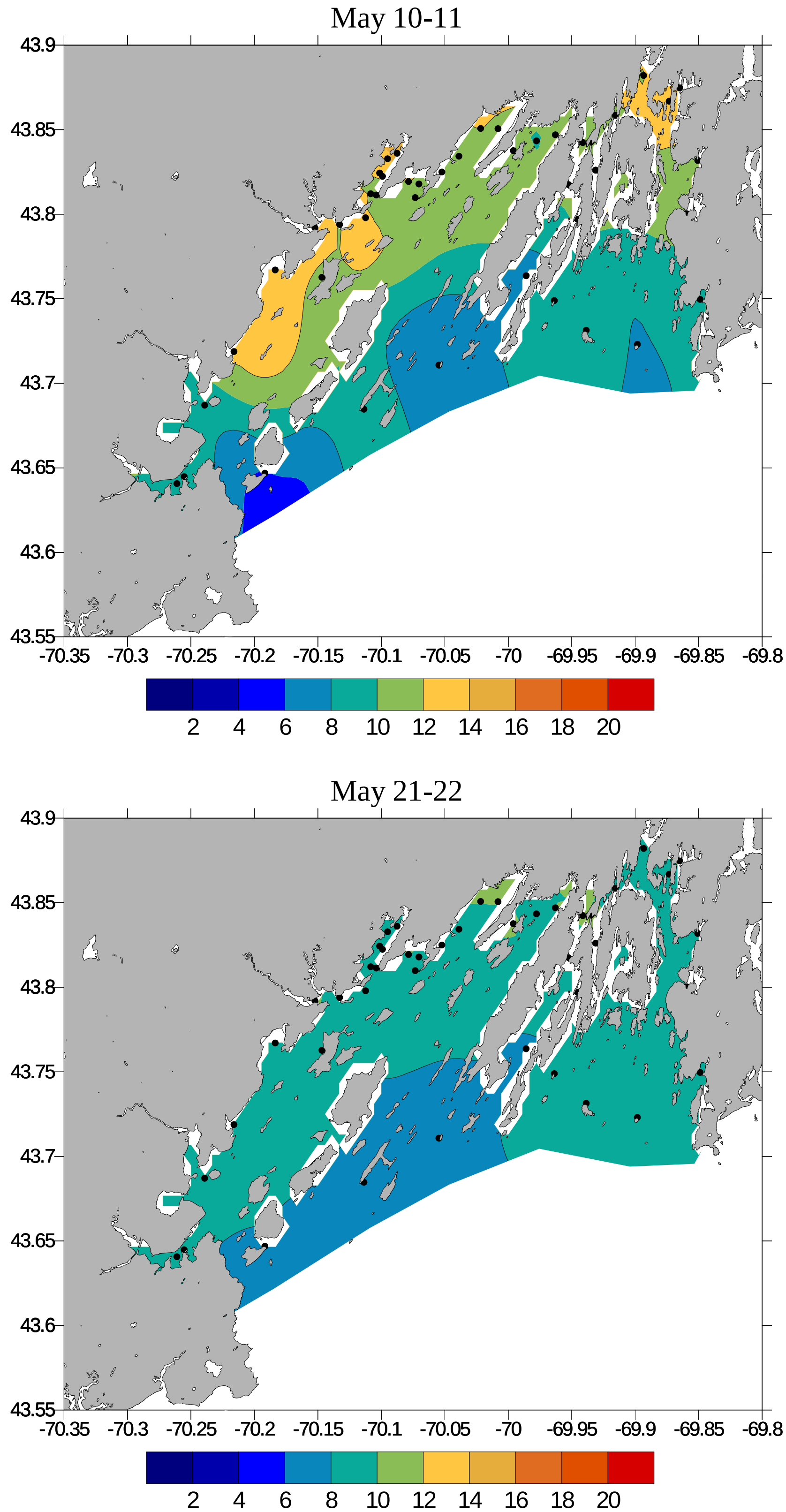
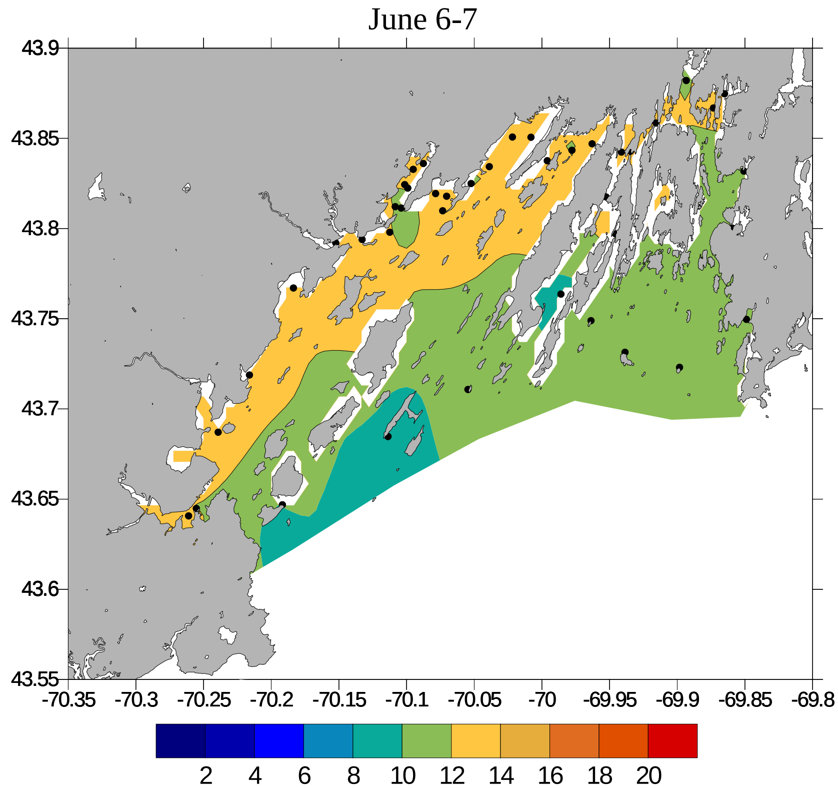


Figure 2. Surface water temperature (°C) on the May 10-11 and May 21-22, 2007 surveys. Station locations sampled denoted by black dots.



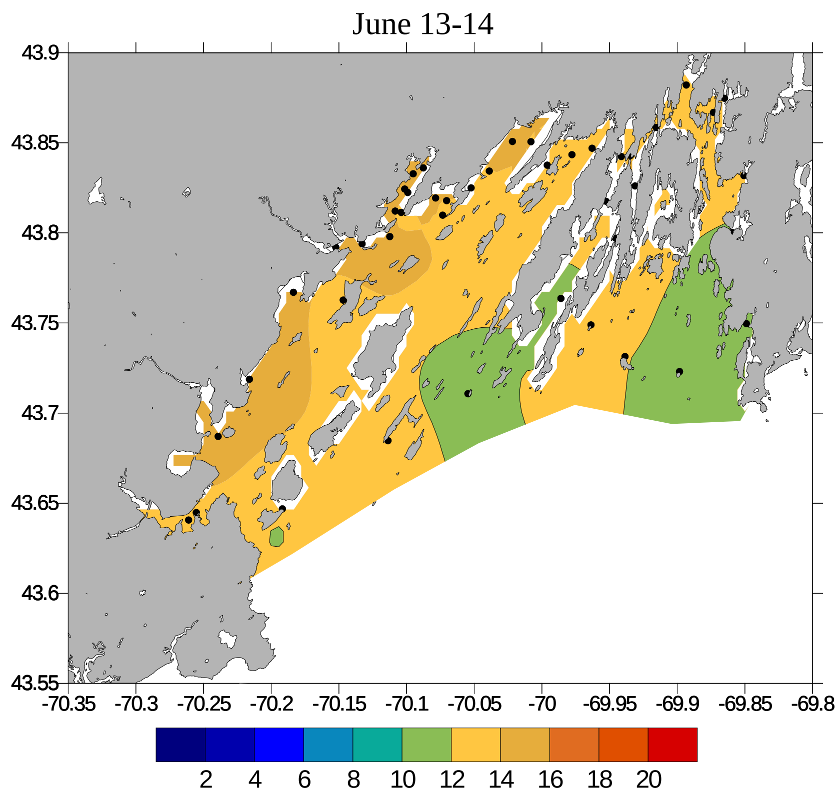
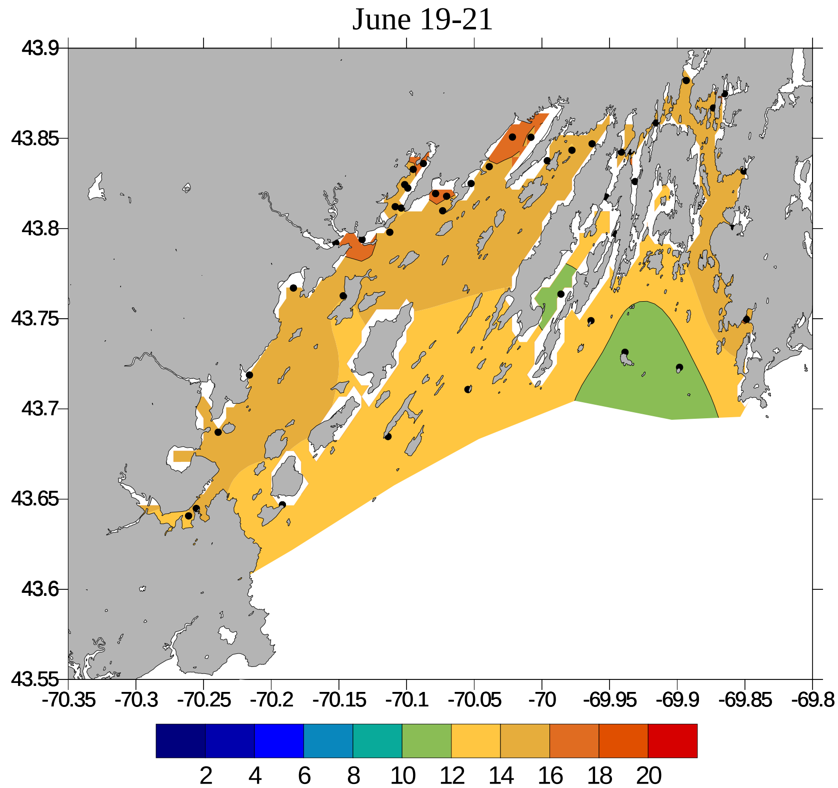


Figure 3. Surface water temperature (°C) on the June 6-7 and June 13-14, 2007 surveys. Station locations sampled denoted by black dots.



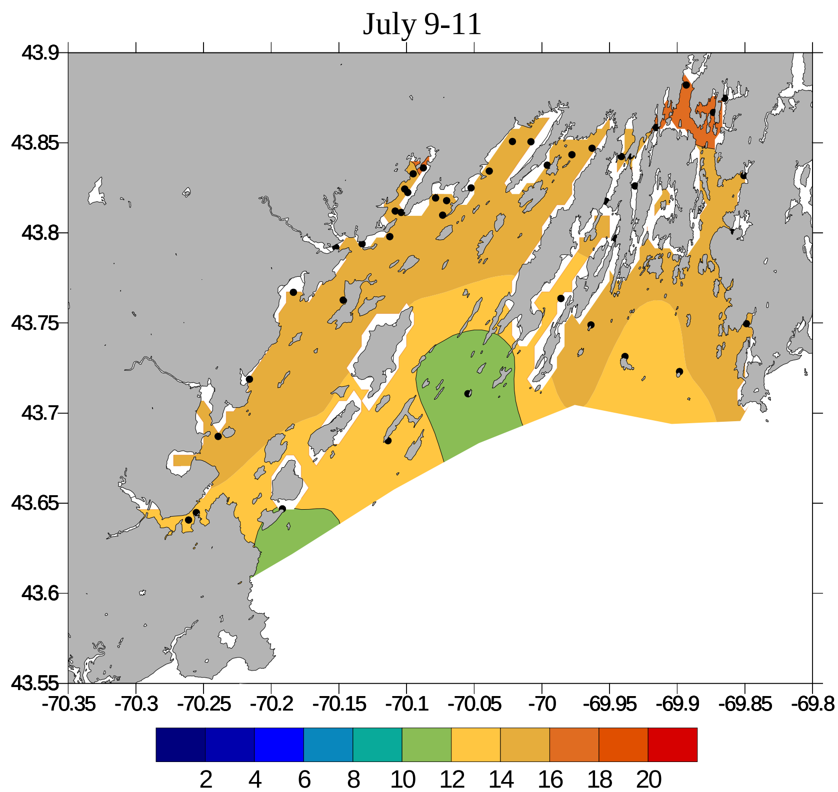
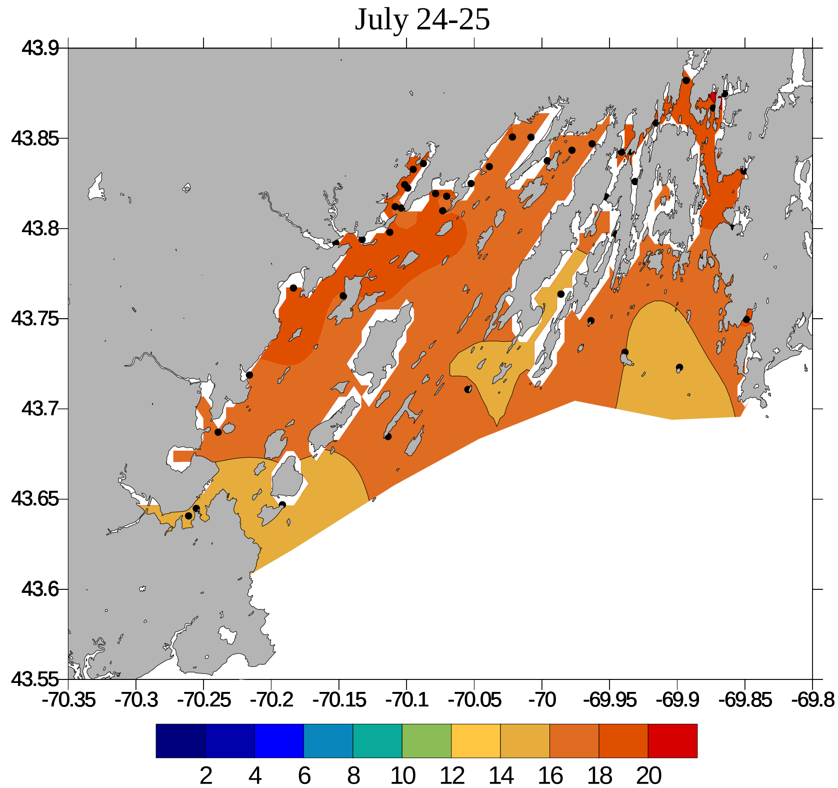


Figure 4. Surface water temperature (°C) on the June 19-21 and July 9-11, 2007 surveys. Station locations sampled denoted by black dots.



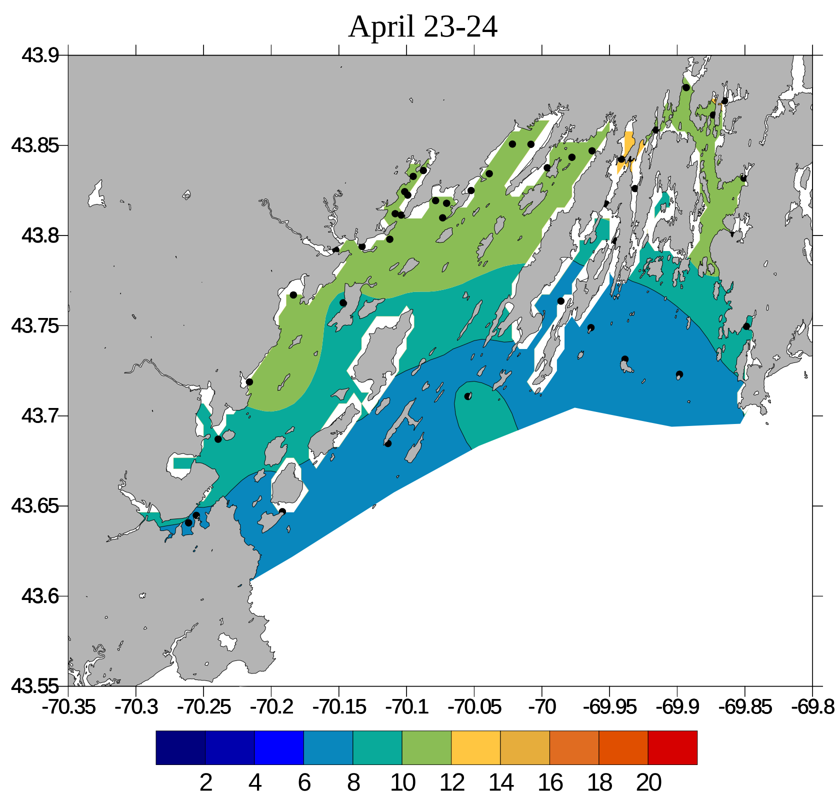
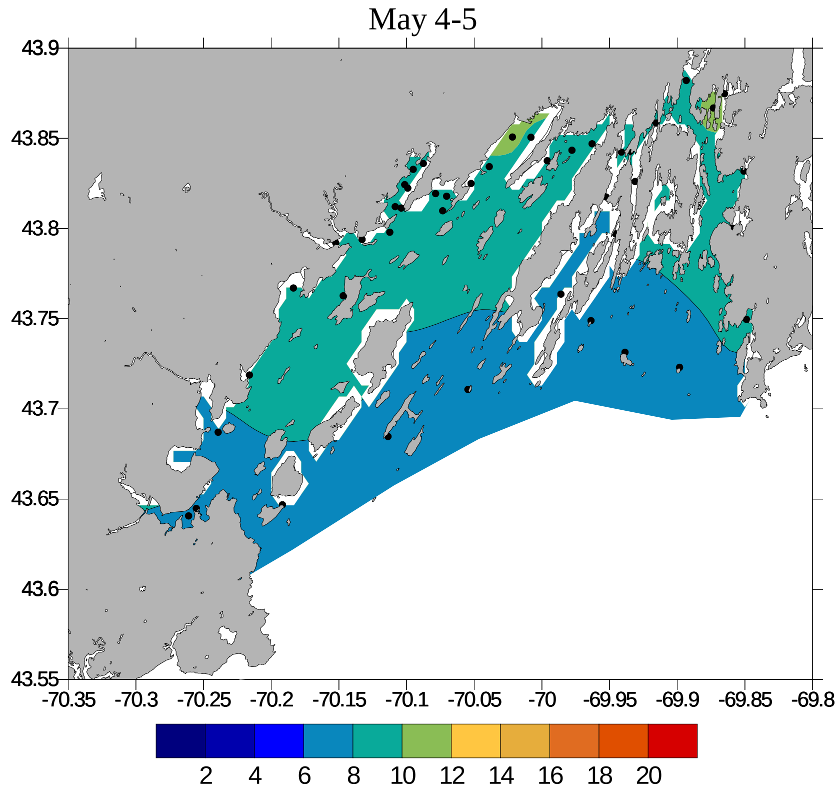


Figure 5. Surface water temperature (°C) on the July 24-25, 2007 and April 23-24, 2008 surveys. Station locations sampled denoted by black dots.



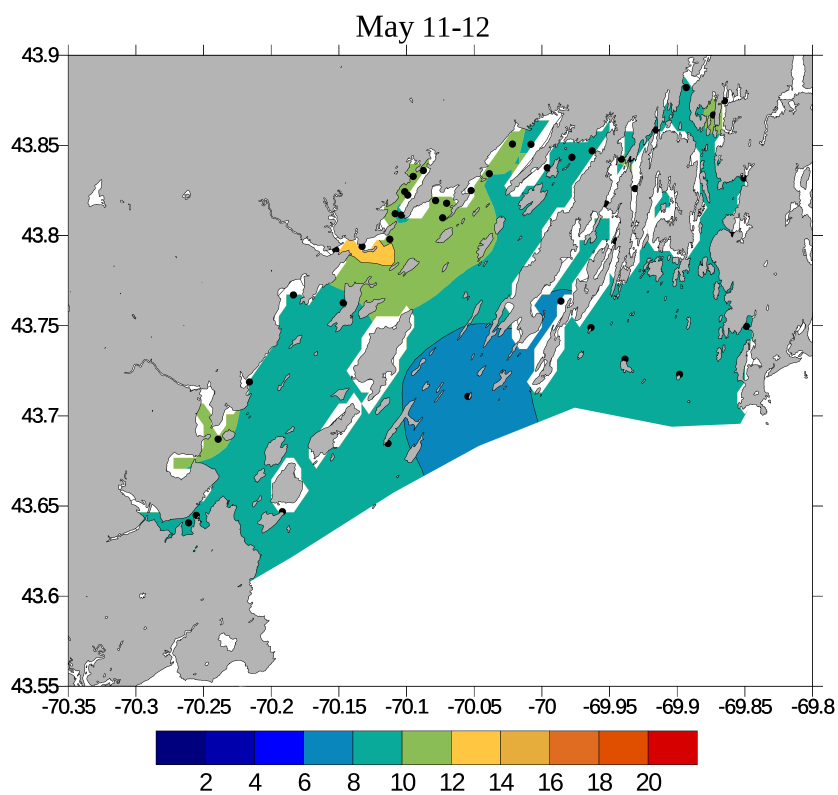


Figure 6. Surface water temperature (°C) on the May 4-5 and May 11-12, 2008 surveys. Station locations sampled denoted by black dots.

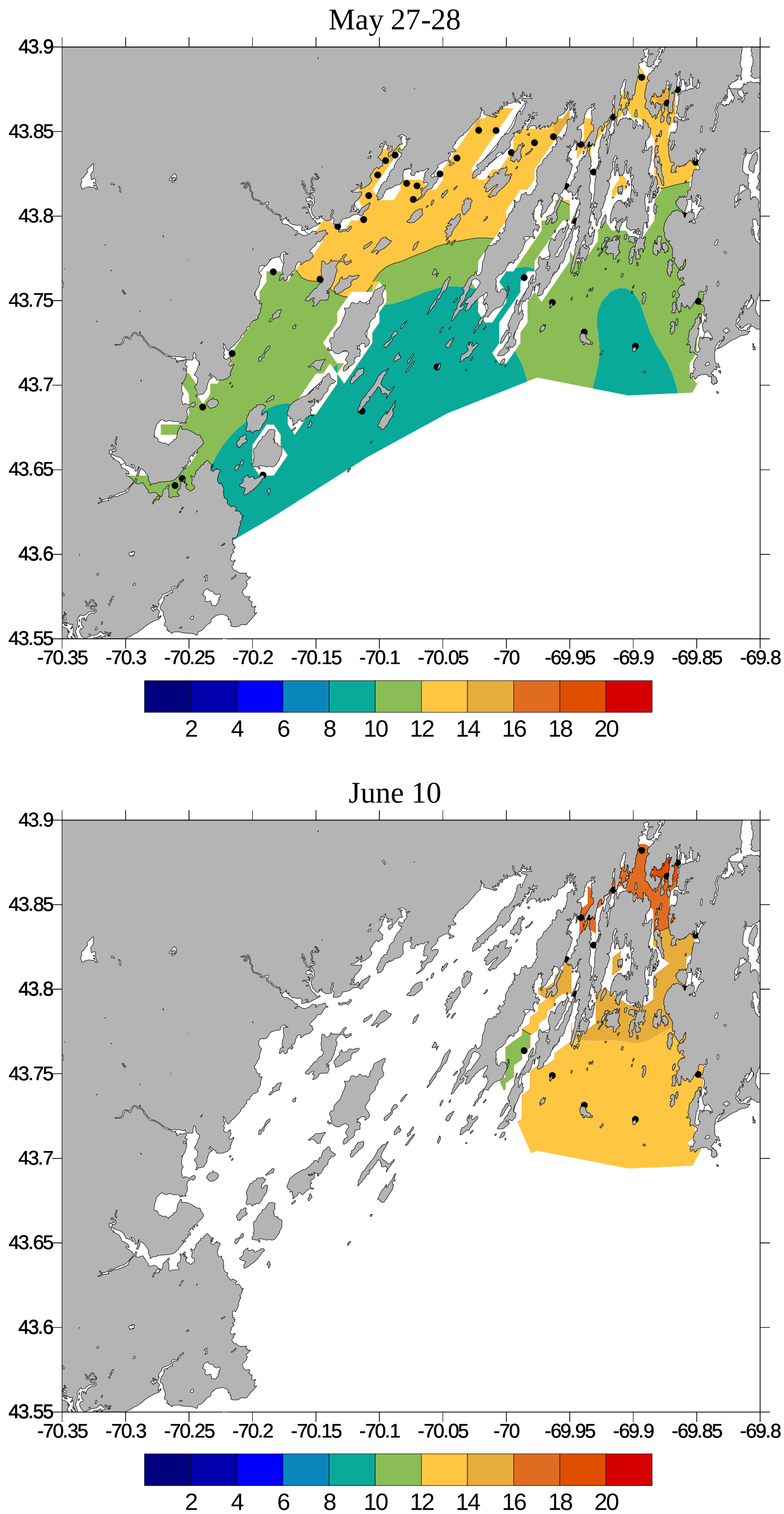


Figure 7. Surface water temperature (°C) on the May 27-28 and June 10, 2008 surveys. Station locations sampled denoted by black dots.

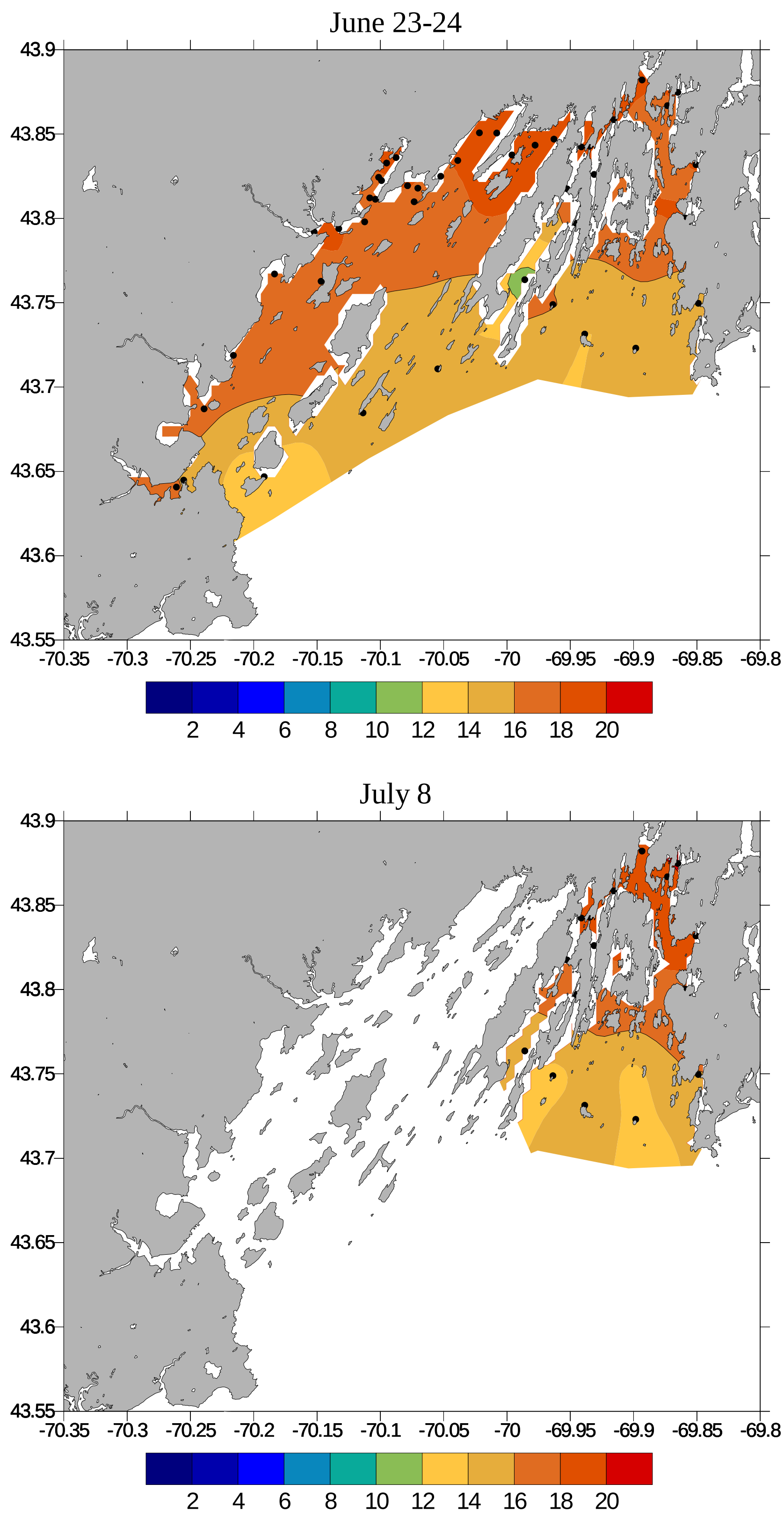


Figure 8. Surface water temperature (°C) on the June 23-24 and July 8, 2008 surveys. Station locations sampled denoted by black dots.

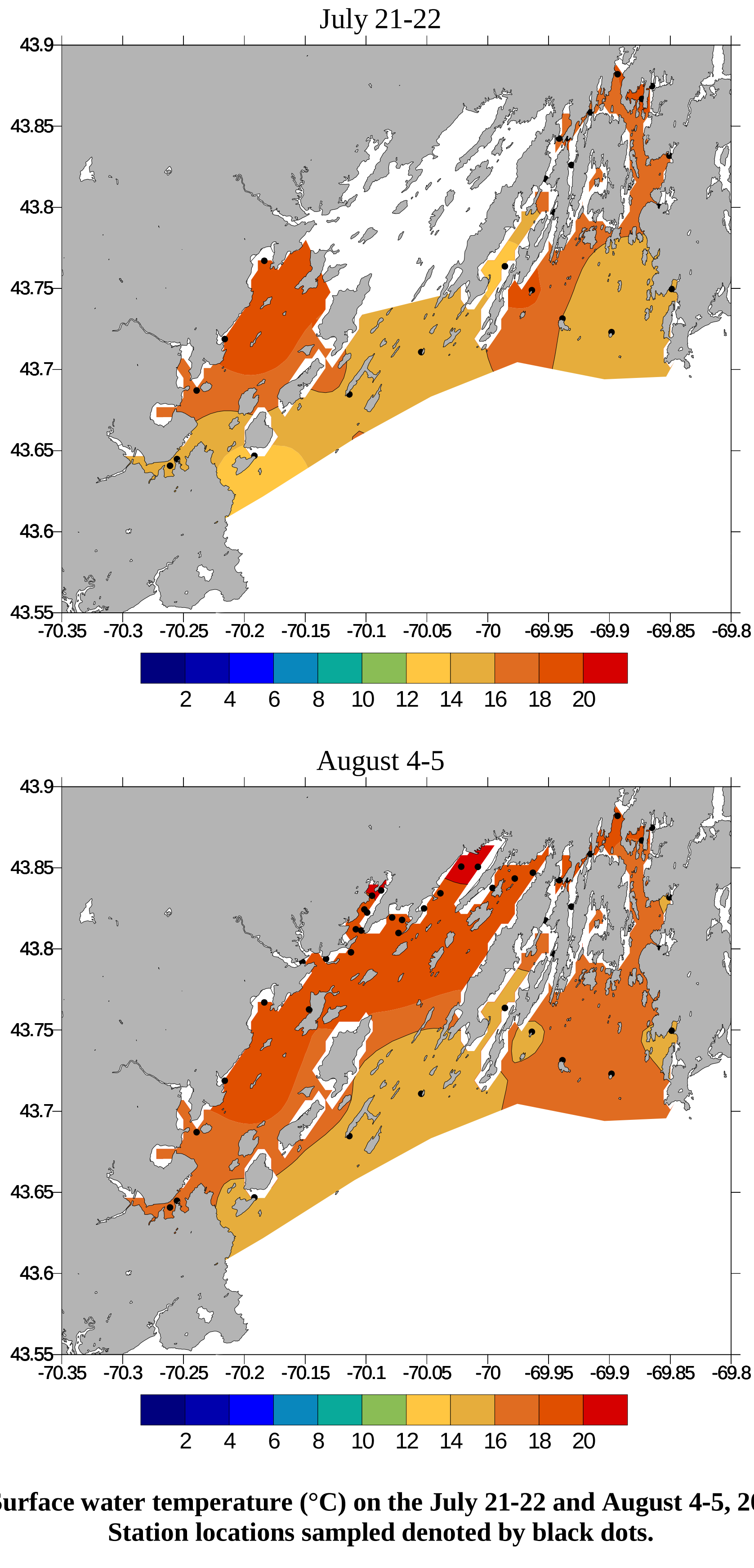
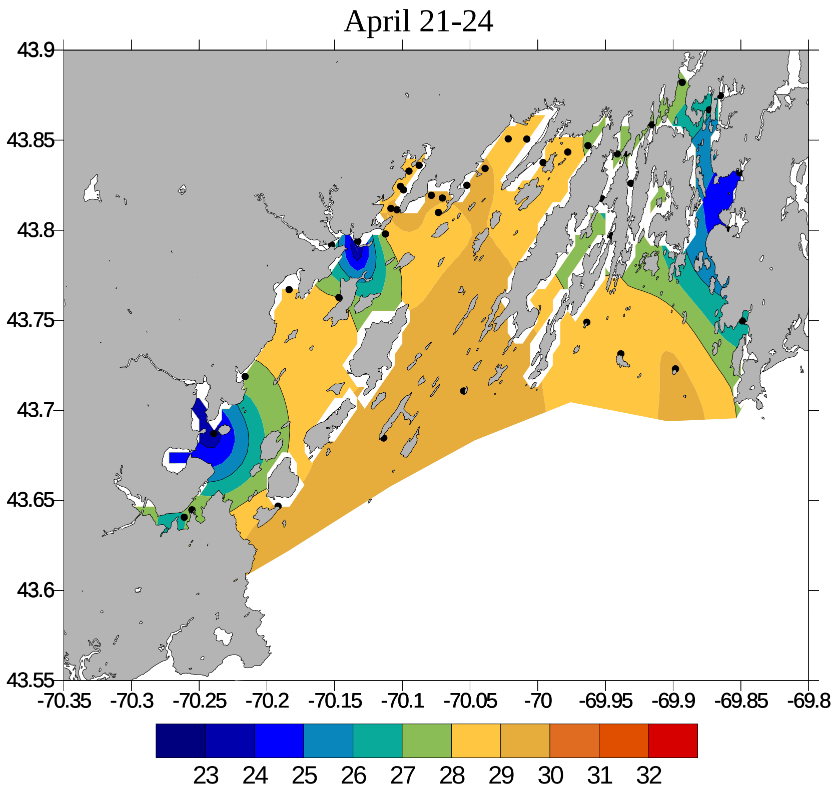


Figure 9. Surface water temperature (°C) on the July 21-22 and August 4-5, 2008 surveys. Station locations sampled denoted by black dots.



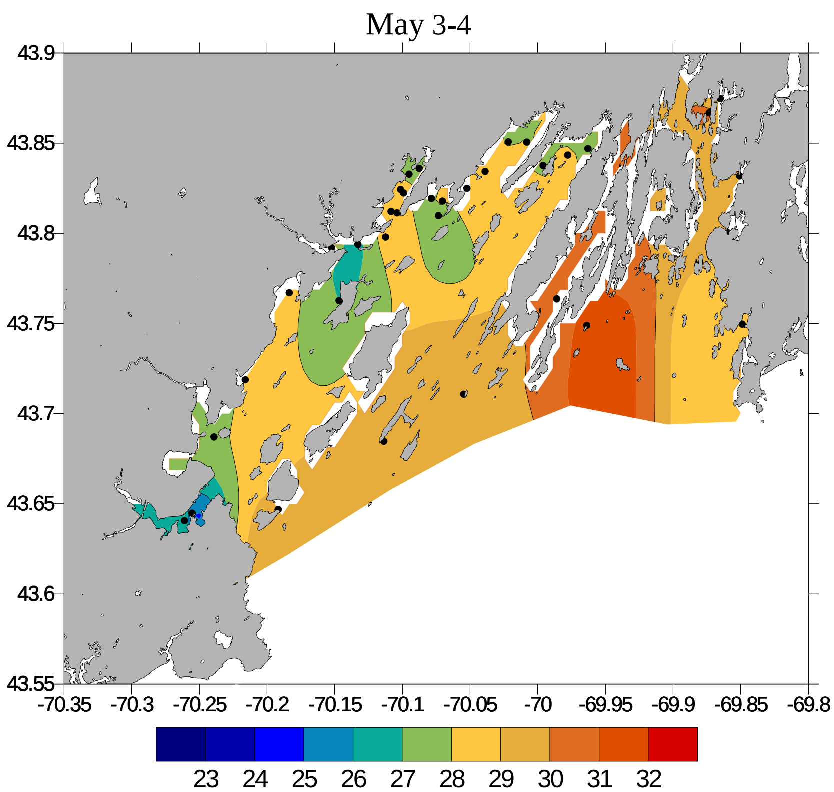


Figure 10. Surface water salinity (PSU) on the April 21-24 and May 3-4, 2007 surveys. Station locations sampled denoted by black dots.

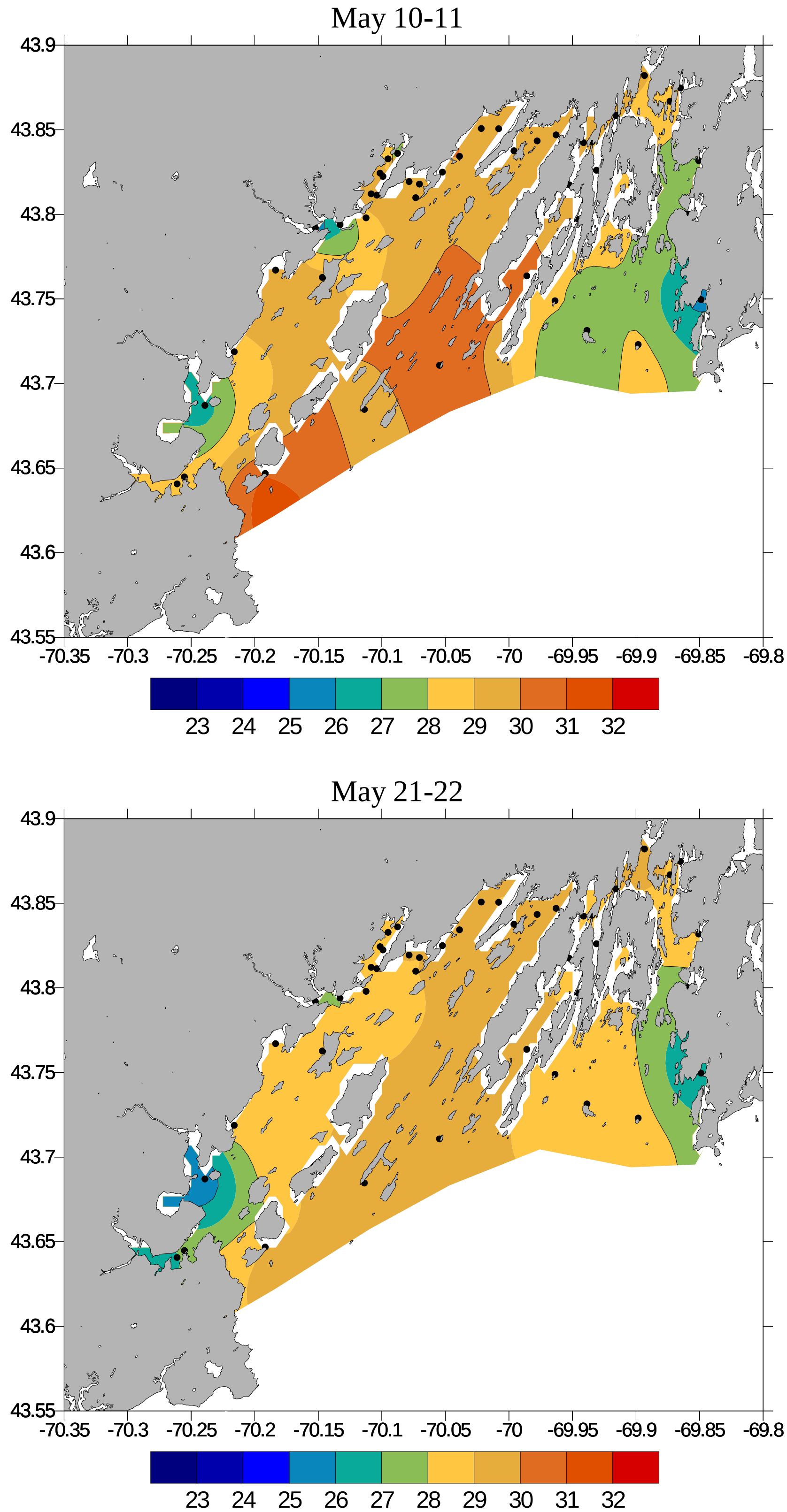


Figure 11. Surface water salinity (PSU) on the May 10-11 and May 21-22, 2007 surveys. Station locations sampled denoted by black dots.

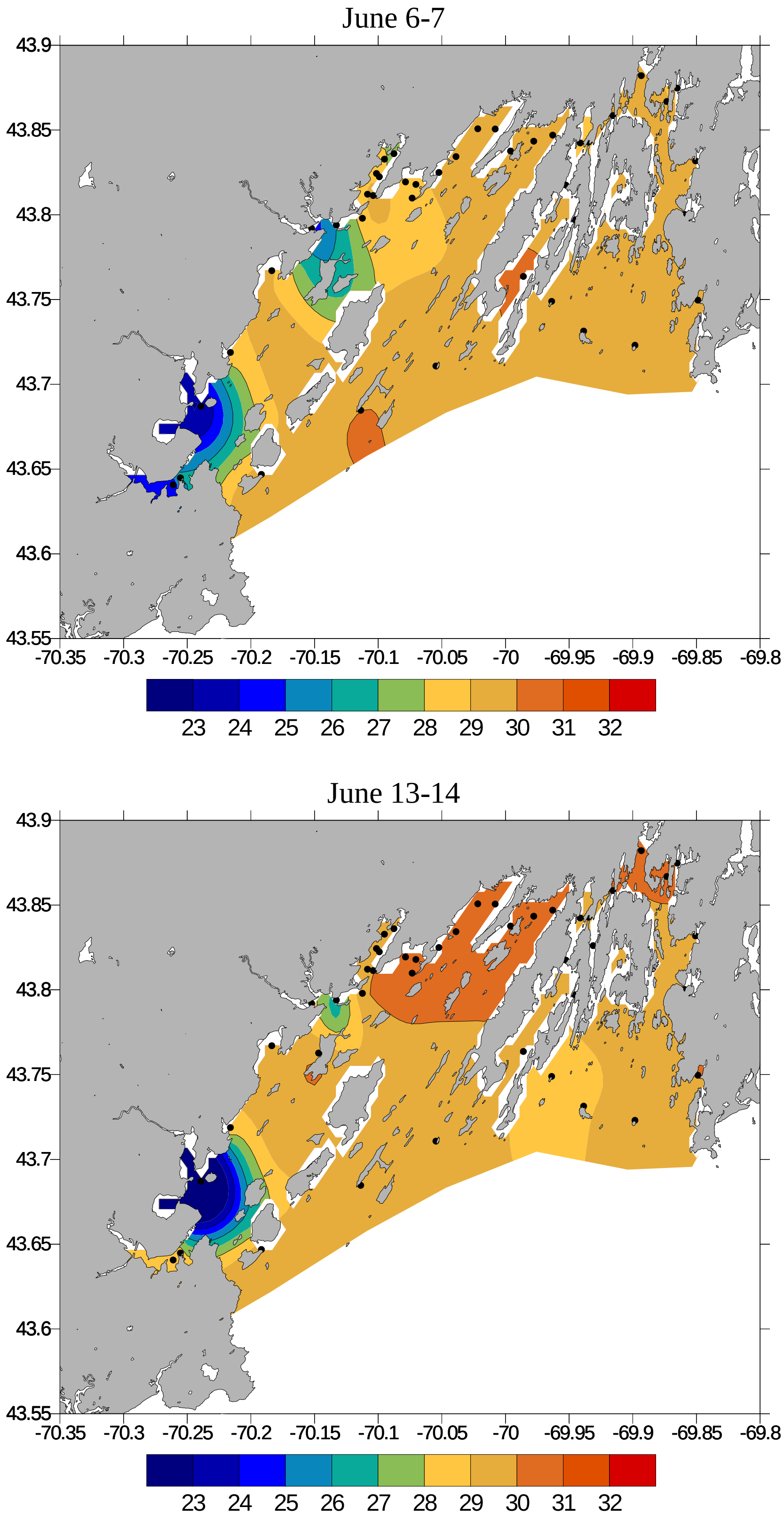


Figure 12. Surface water salinity (PSU) on the June 6-7 and June 13-14, 2007 surveys. Station locations sampled denoted by black dots.

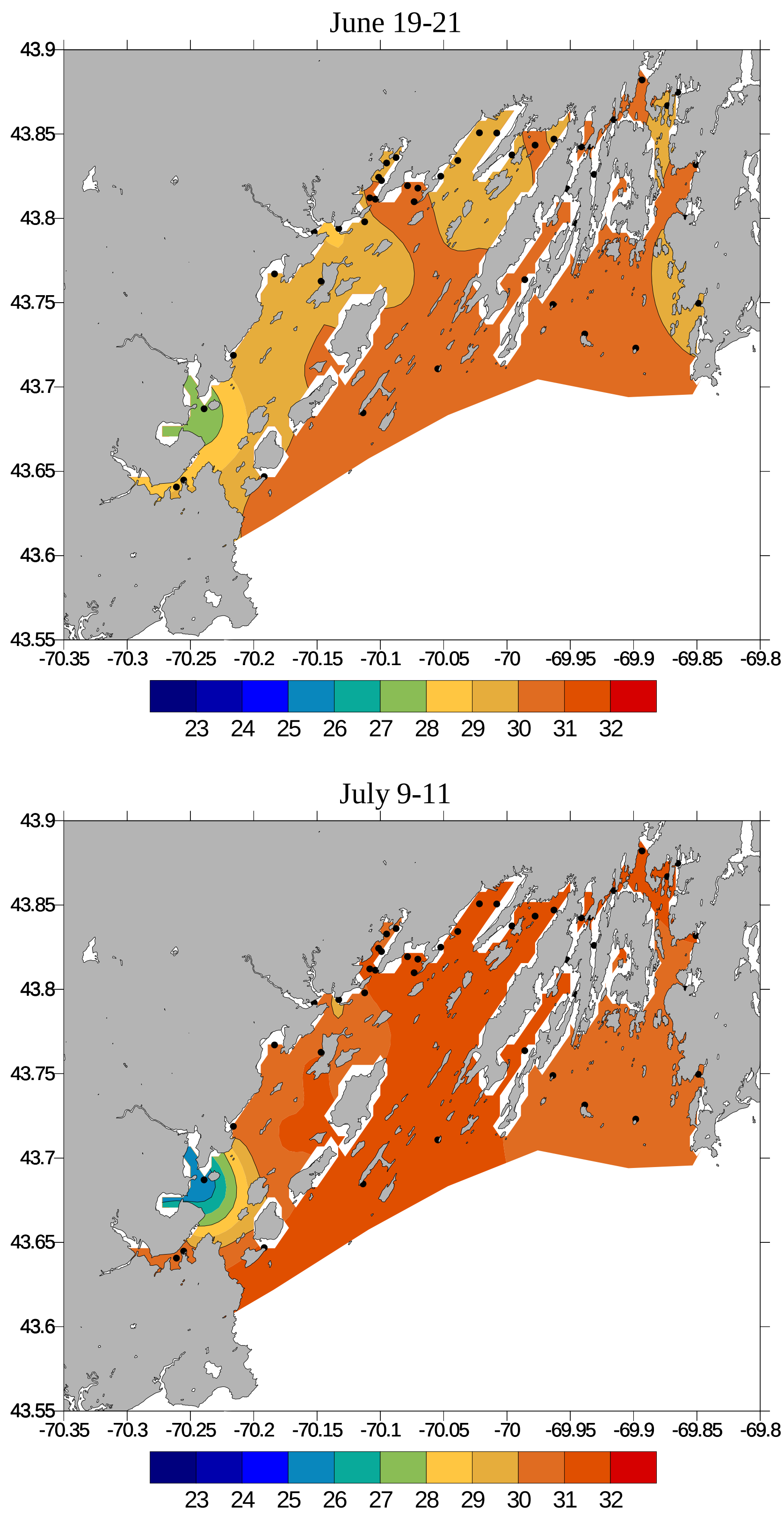


Figure 13. Surface water salinity (PSU) on the June 19-21 and July 9-11, 2007 surveys. Station locations sampled denoted by black dots.

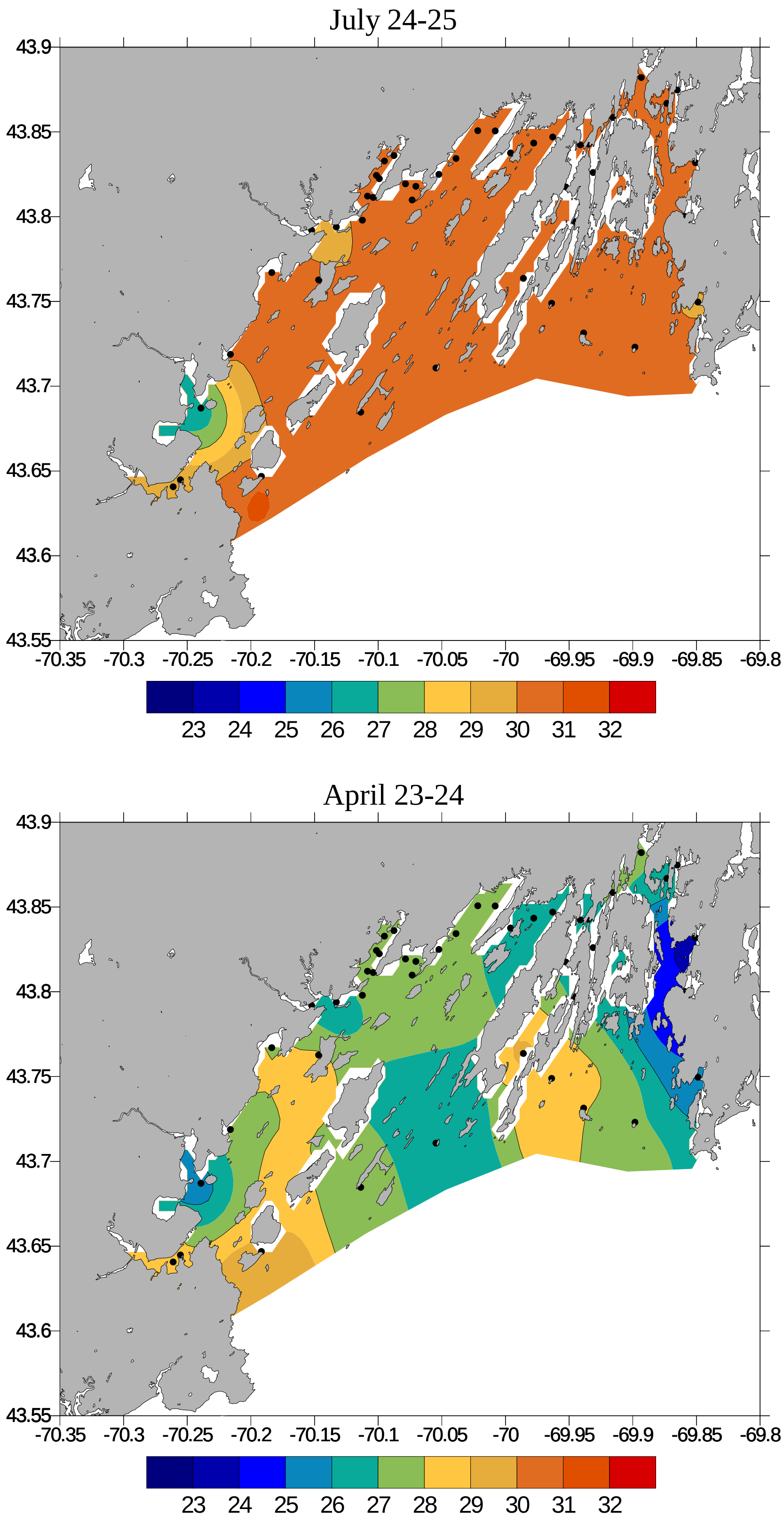


Figure 14. Surface water salinity (PSU) on the July 24-25, 2007 and April 23-24, 2008 surveys. Station locations sampled denoted by black dots.

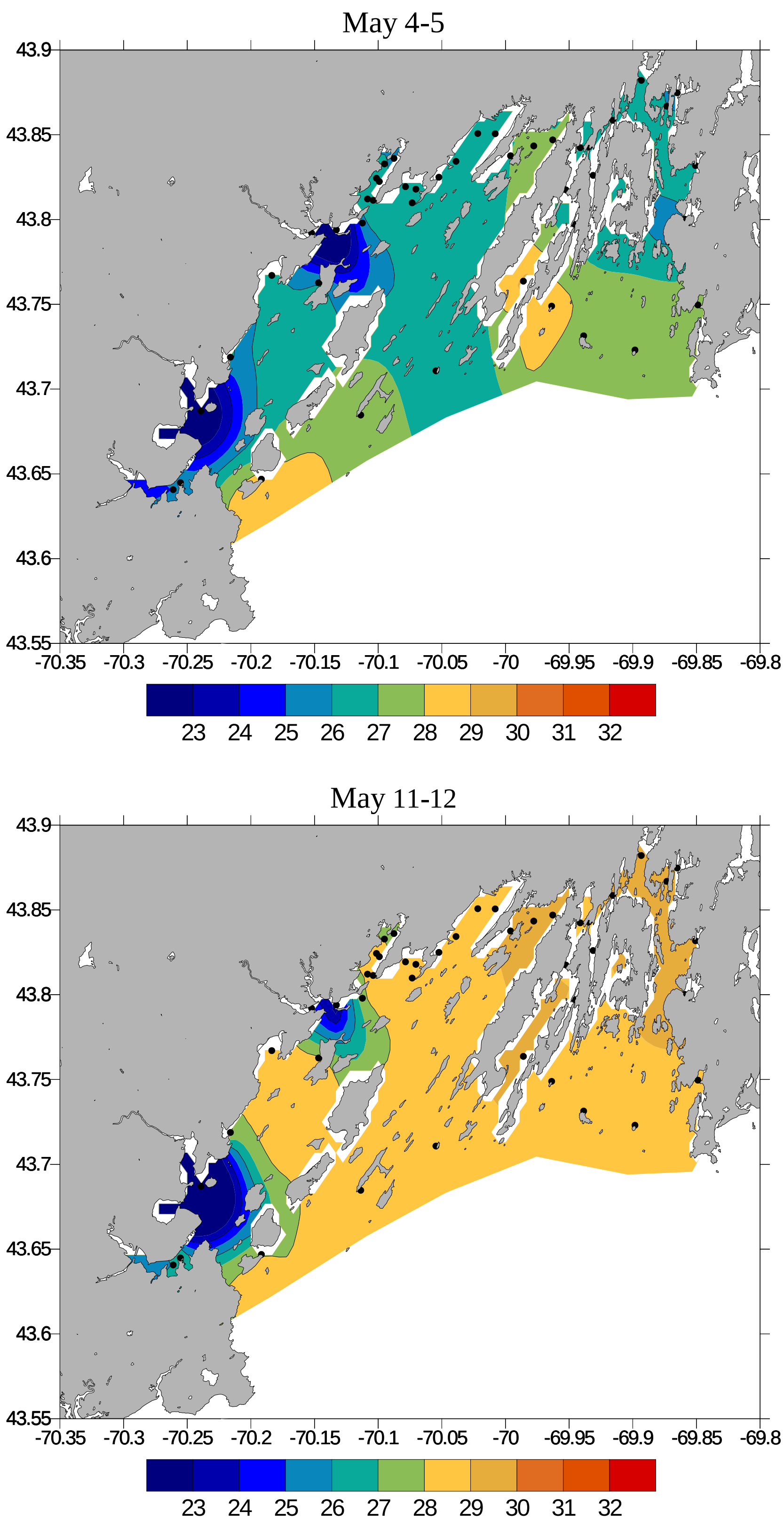
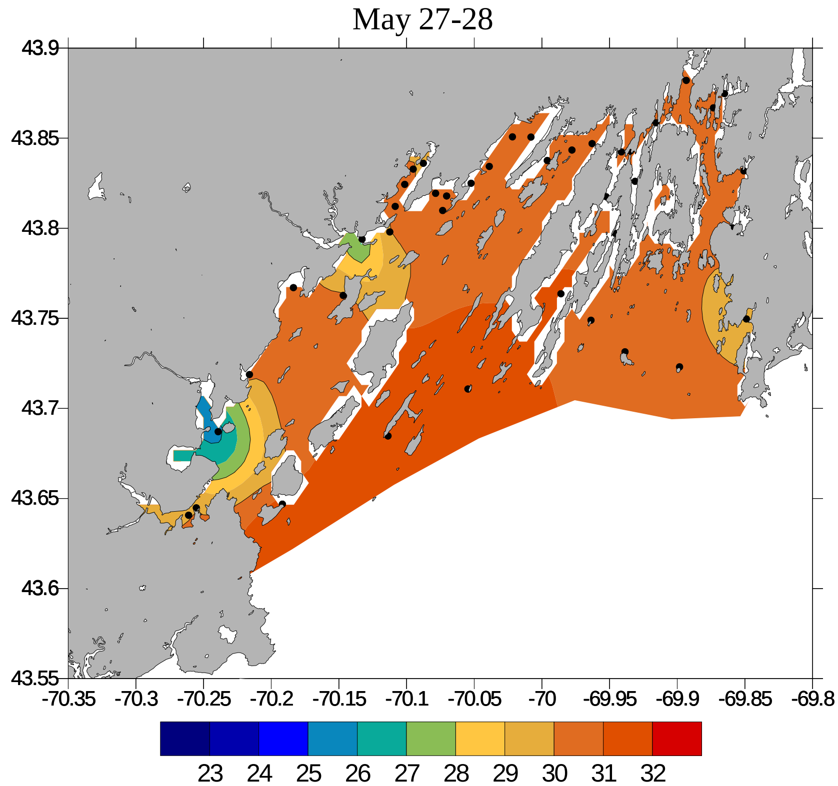


Figure 15. Surface water salinity (PSU) on the May 4-5 and May 11-12, 2008 surveys. Station locations sampled denoted by black dots.



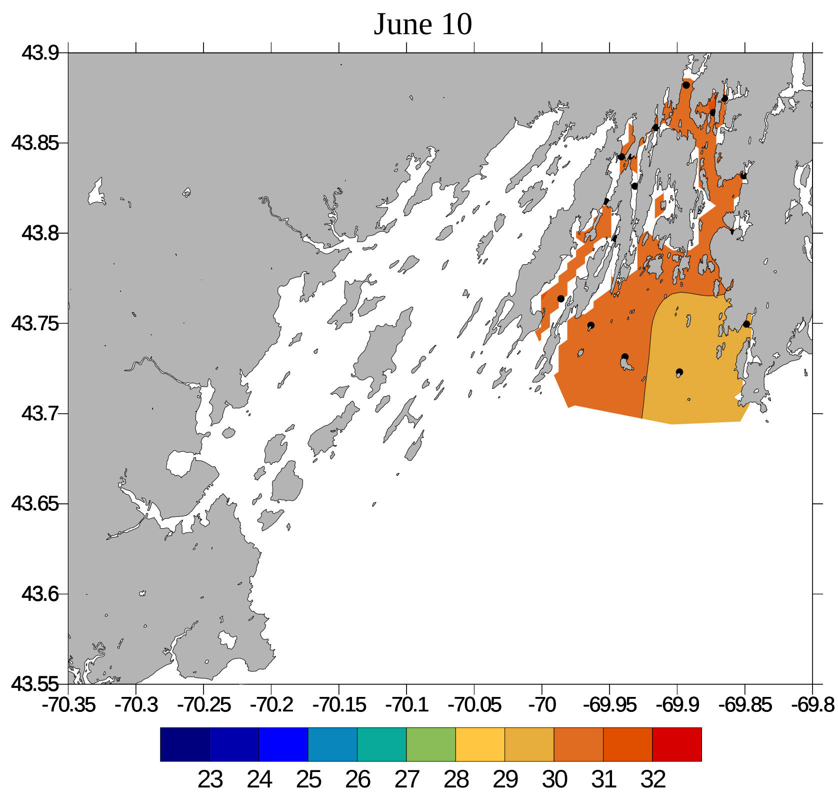


Figure 16. Surface water salinity (PSU) on the May 27-28 and June 10, 2008 surveys. Station locations sampled denoted by black dots.

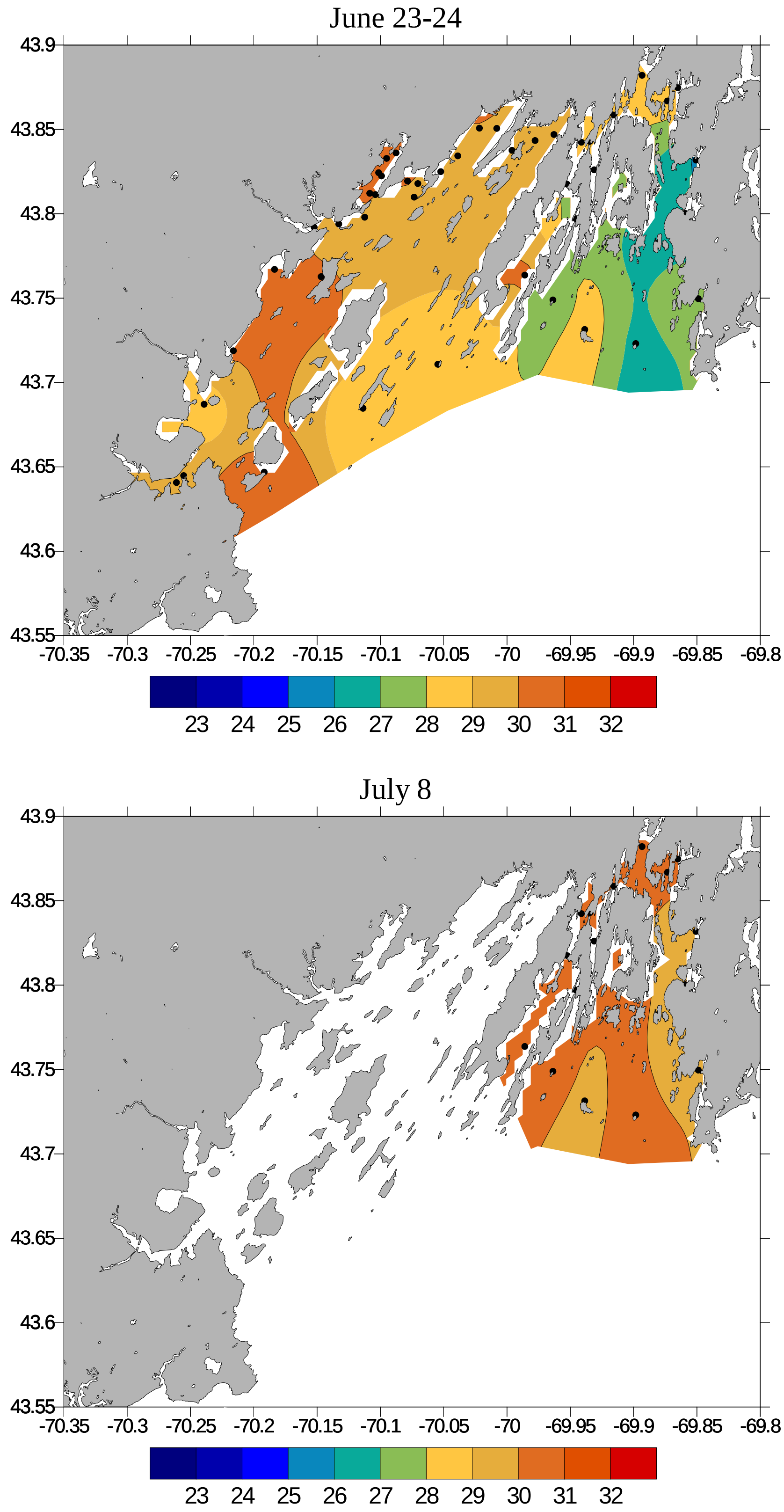
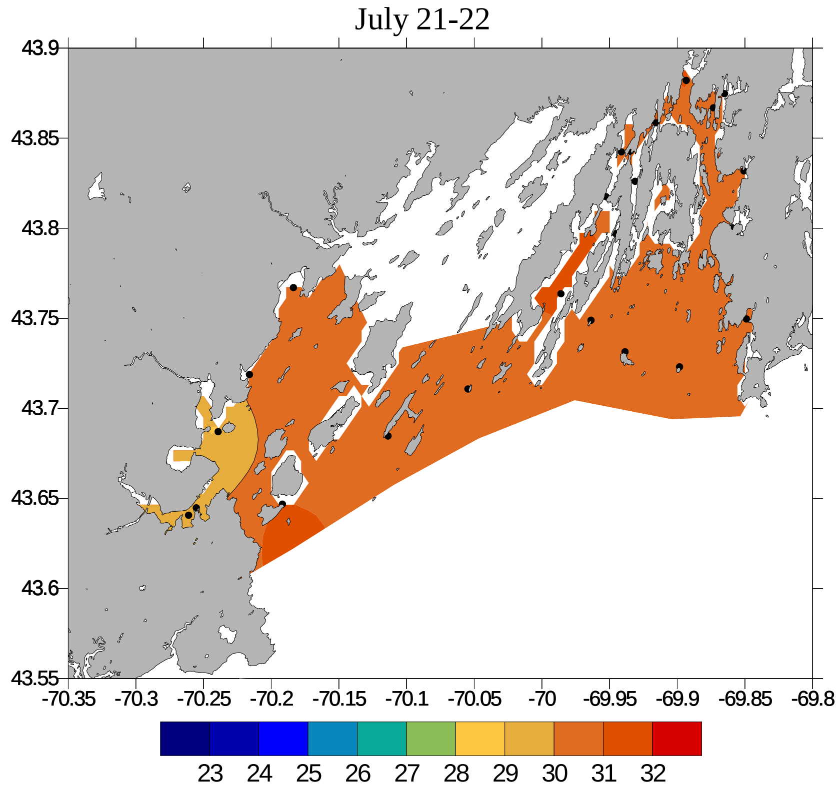


Figure 17. Surface water salinity (PSU) on the June 23-24 and July 8, 2008 surveys. Station locations sampled denoted by black dots.



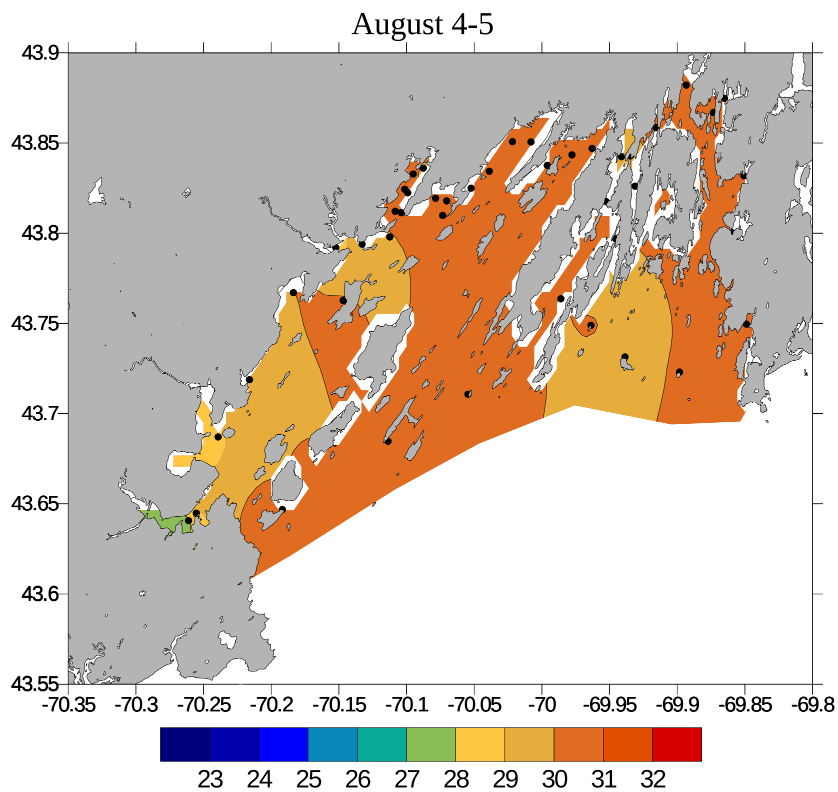
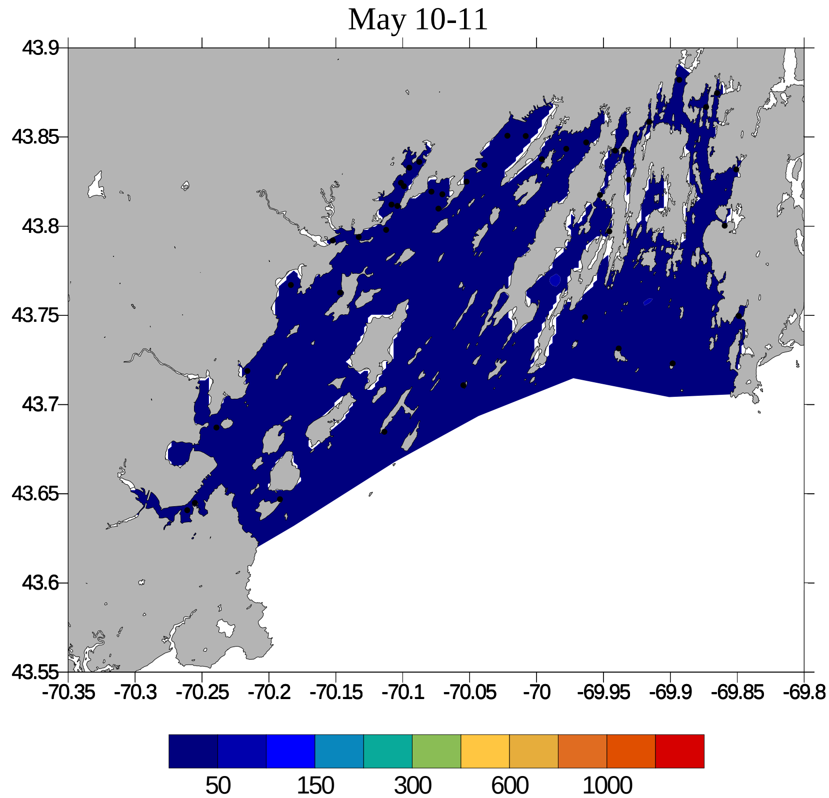


Figure 18. Surface water salinity (PSU) on the July 21-22 and August 4-5, 2008 surveys. Station locations sampled denoted by black dots.



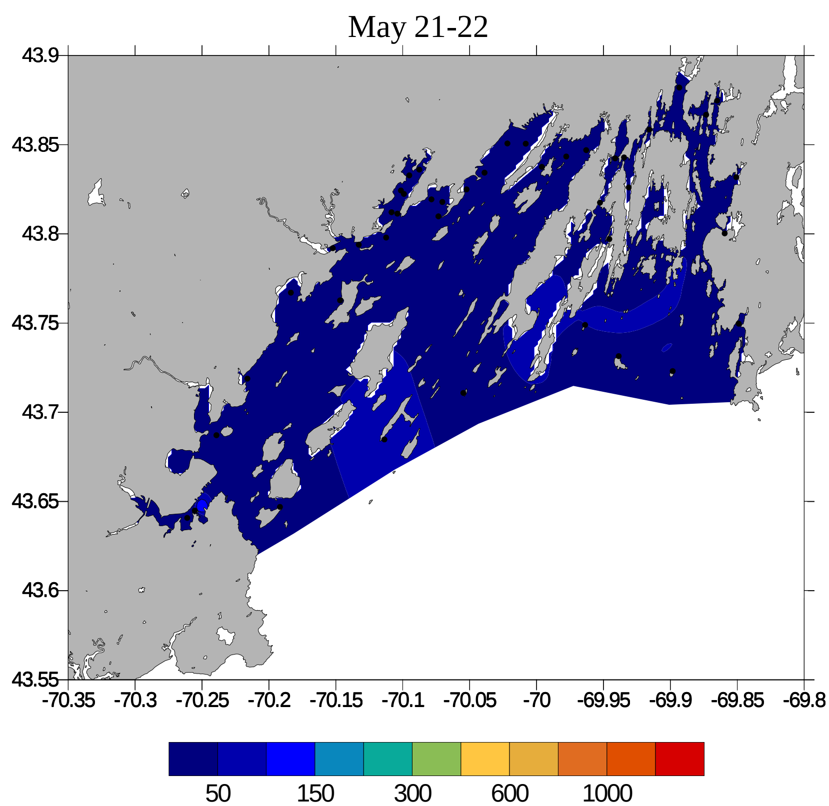
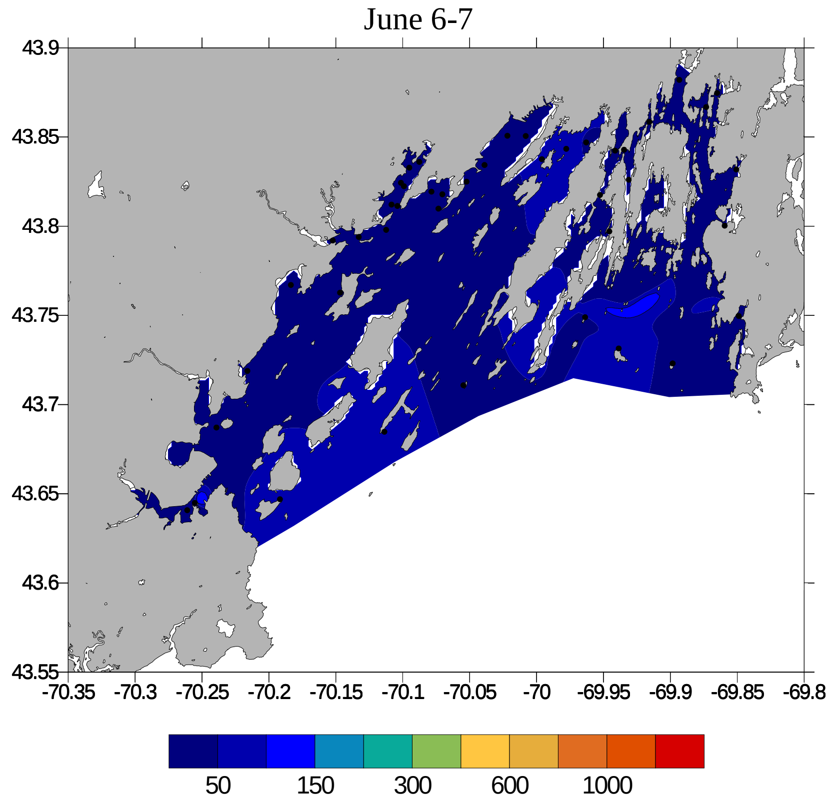


Figure 19. PSP toxicity (µg STX/100 g) on the May 10-11 and May 21-22, 2007 surveys. Station locations sampled denoted by black dots.



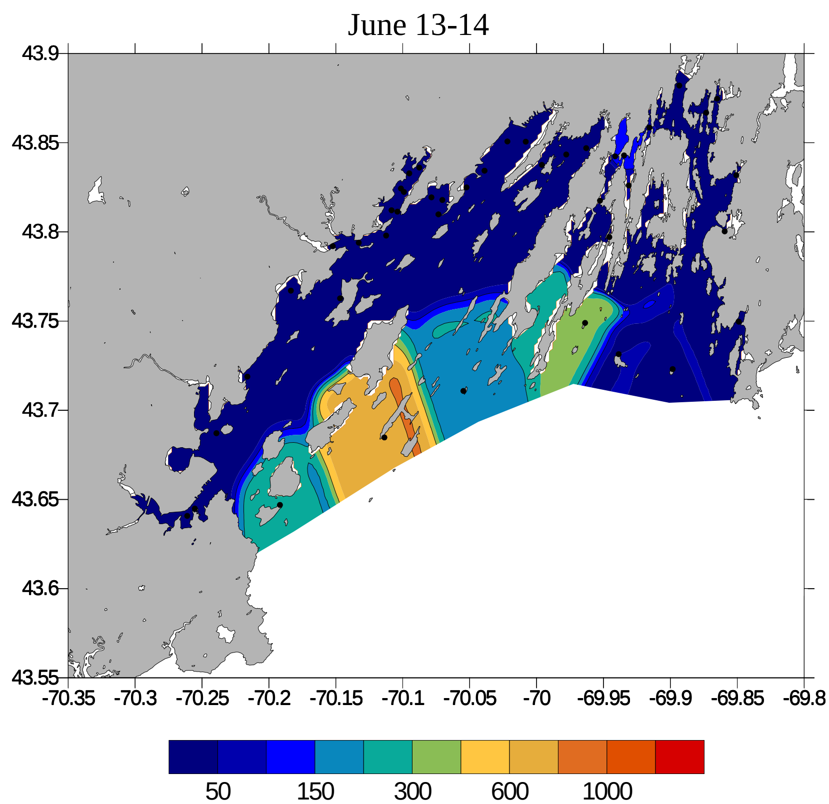
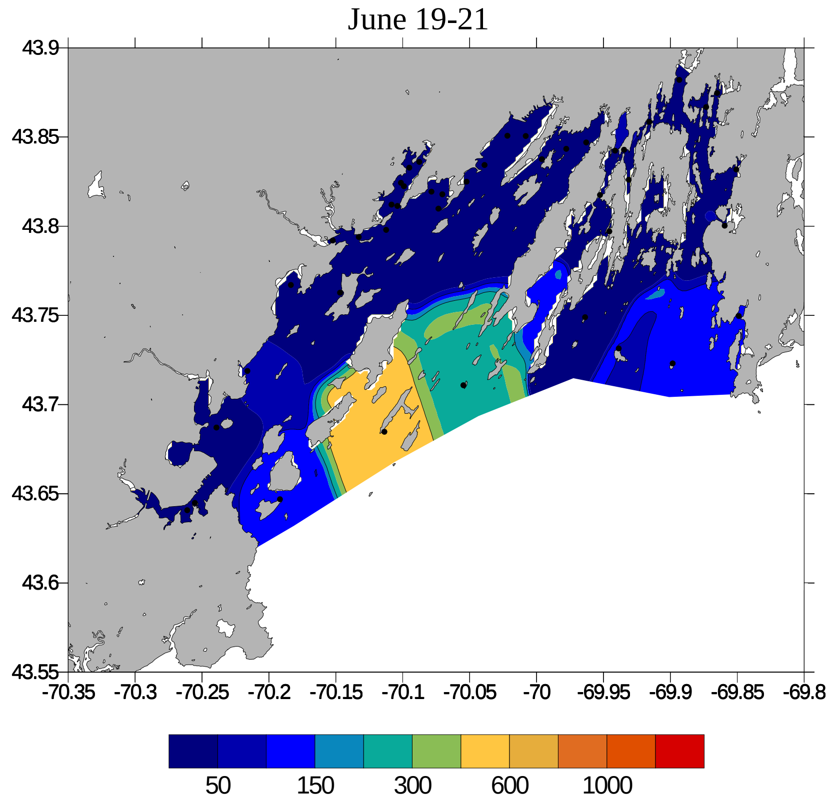


Figure 20. PSP toxicity (µg STX/100 g) on the June 6-7 and June 13-14, 2007 surveys. Station locations sampled denoted by black dots.



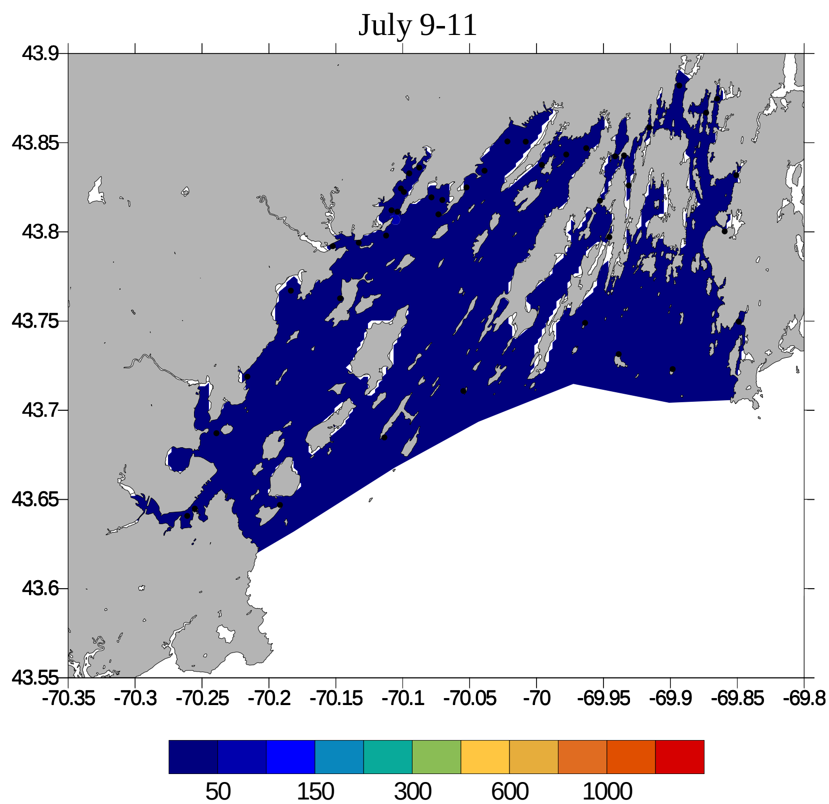


Figure 21. PSP toxicity (µg STX/100 g) on the June 19-21 and July 9-11, 2007 surveys. Station locations sampled denoted by black dots.

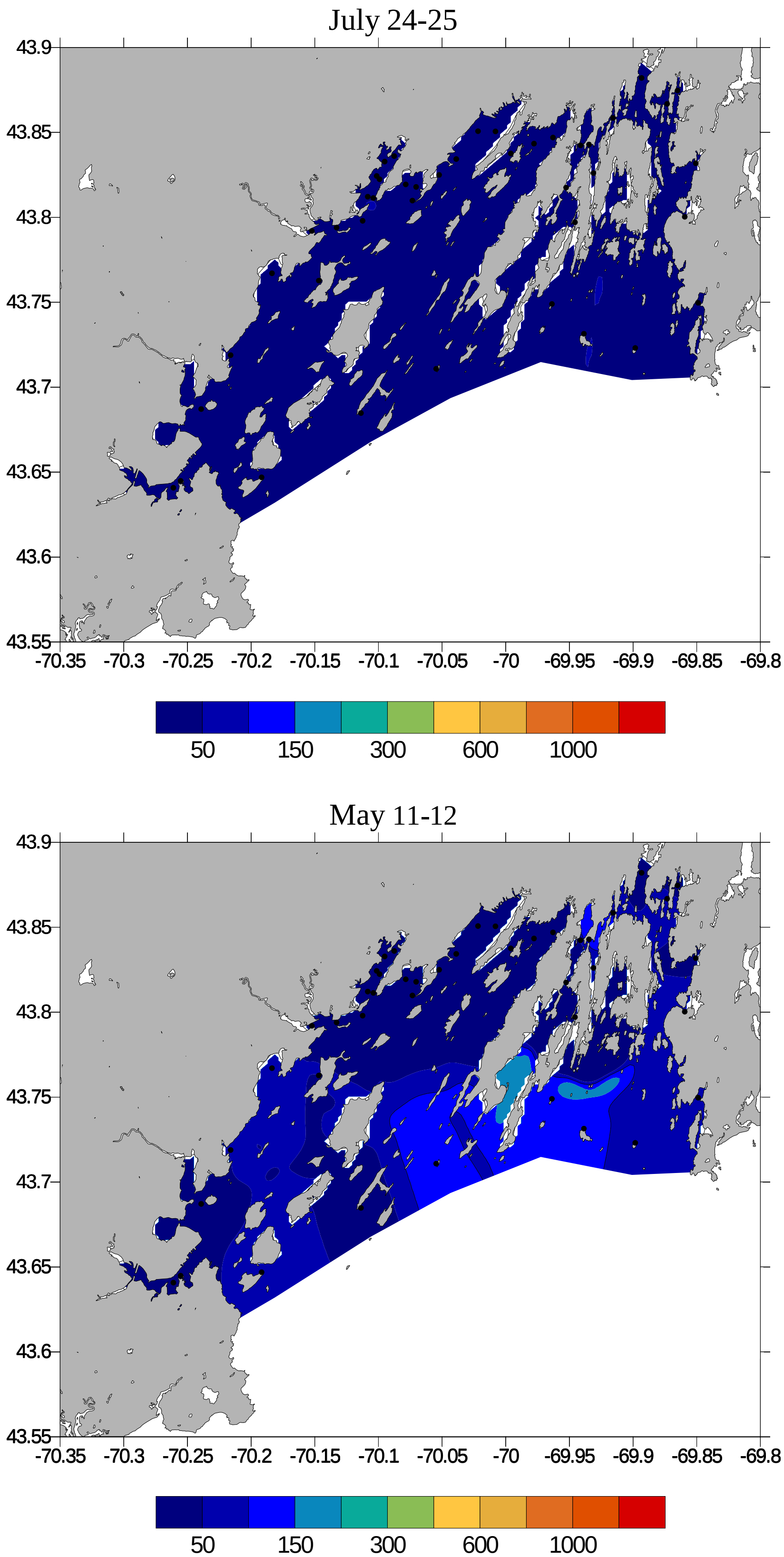
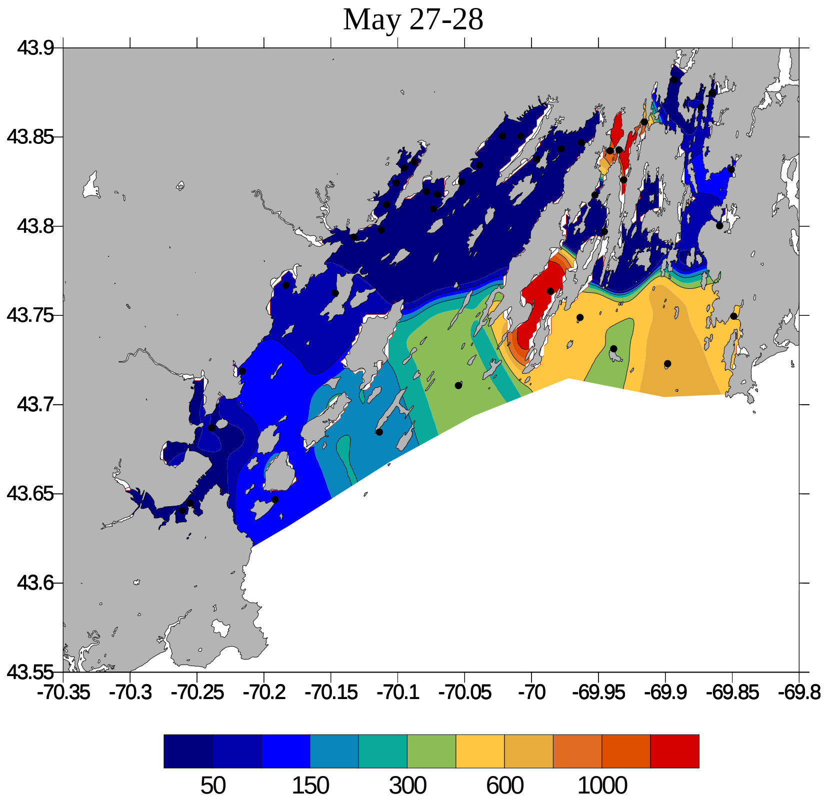


Figure 22. PSP toxicity (µg STX/100 g) on the July 24-25, 2007 and May 11-12, 2008 surveys. Station locations sampled denoted by black dots.



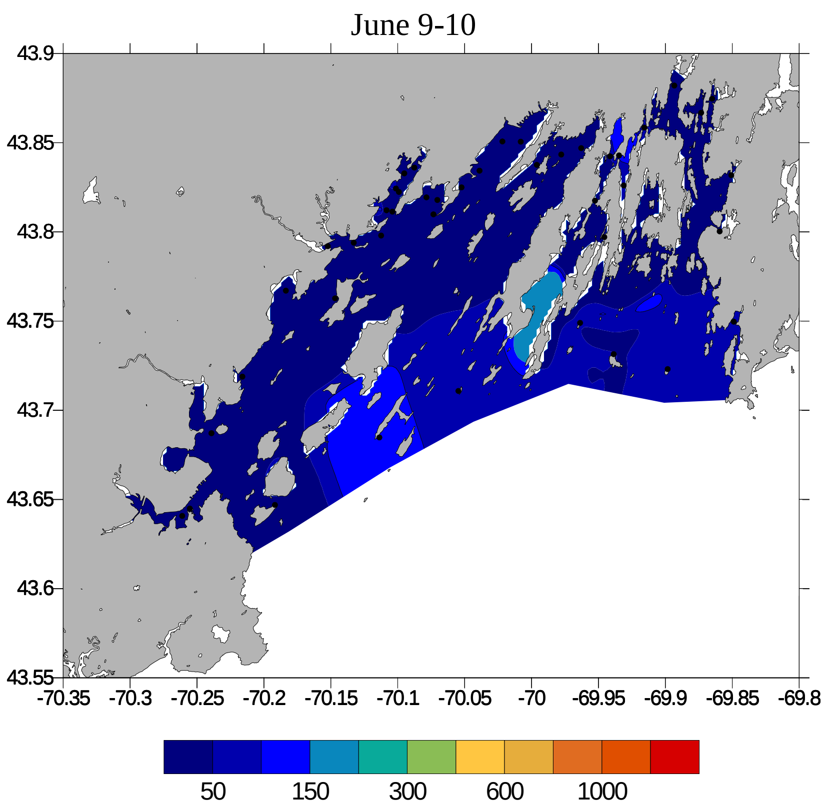


Figure 23. PSP toxicity (µg STX/100 g) on the May 27-28 and June 10, 2008 surveys. Station locations sampled denoted by black dots.

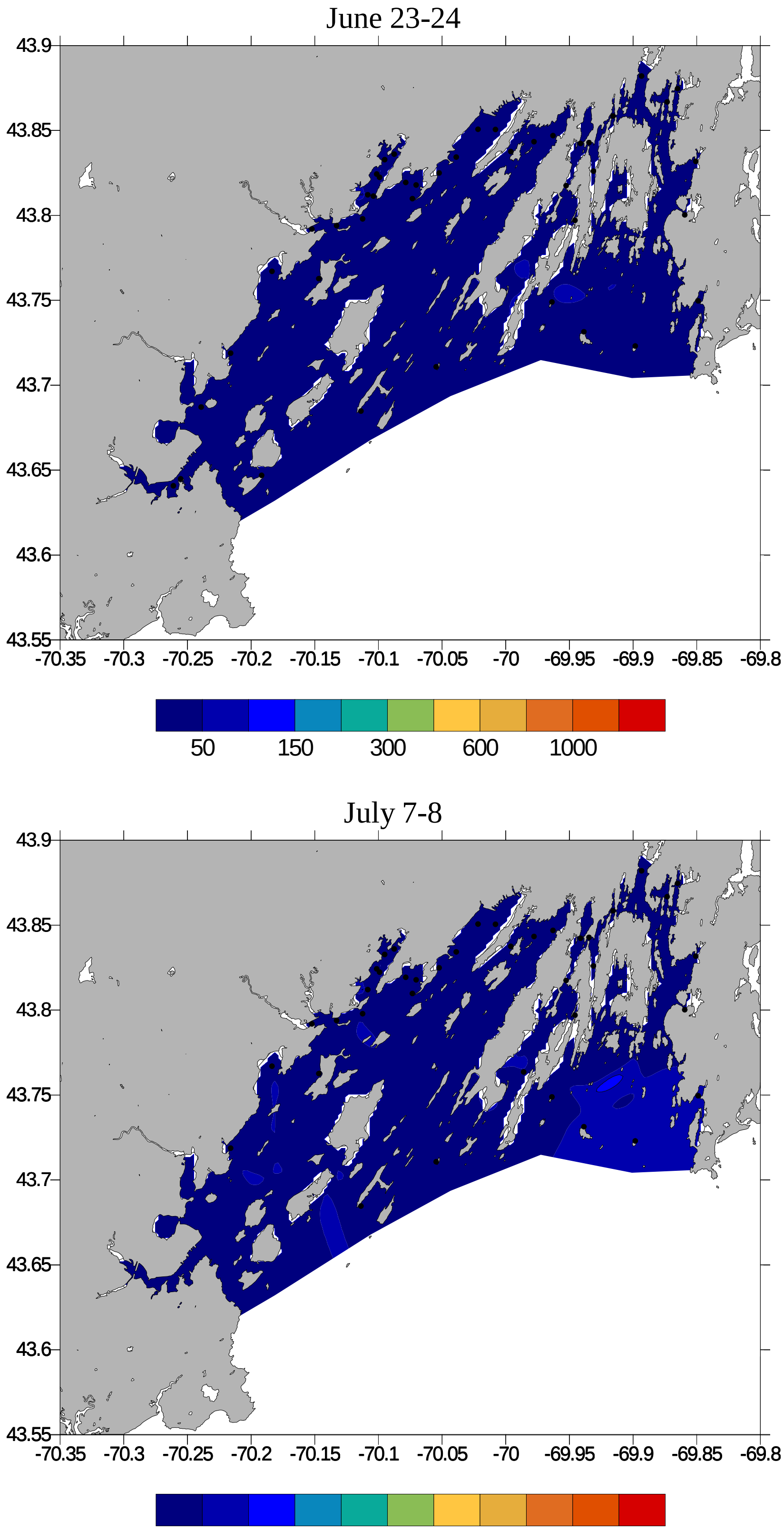
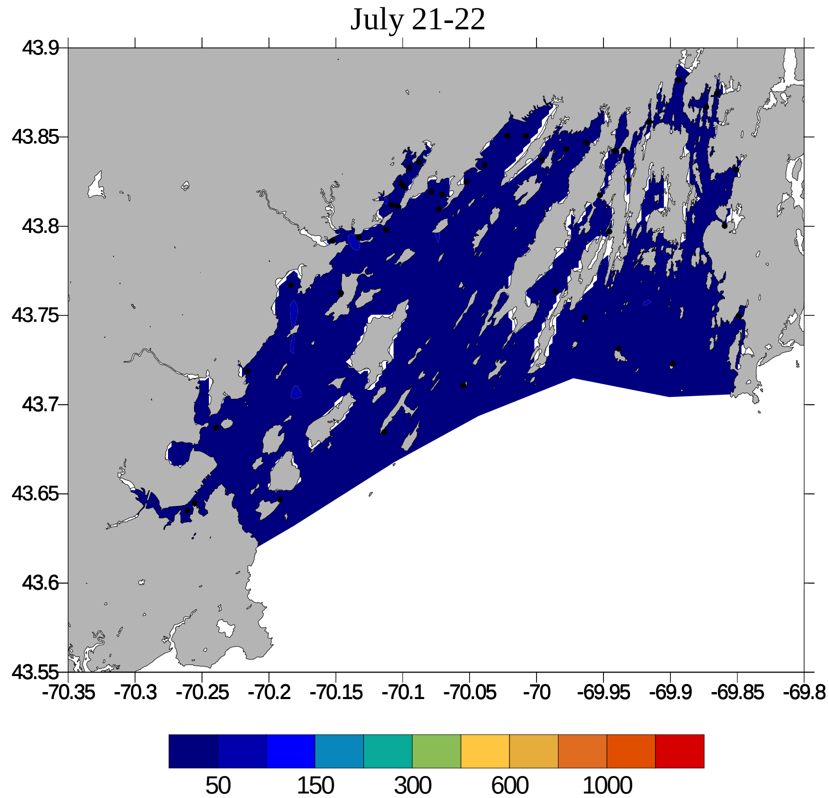


Figure 24. PSP toxicity (μg STX/100 g) on the June 23-24 and July 8, 2008 surveys. Station locations sampled denoted by black dots.



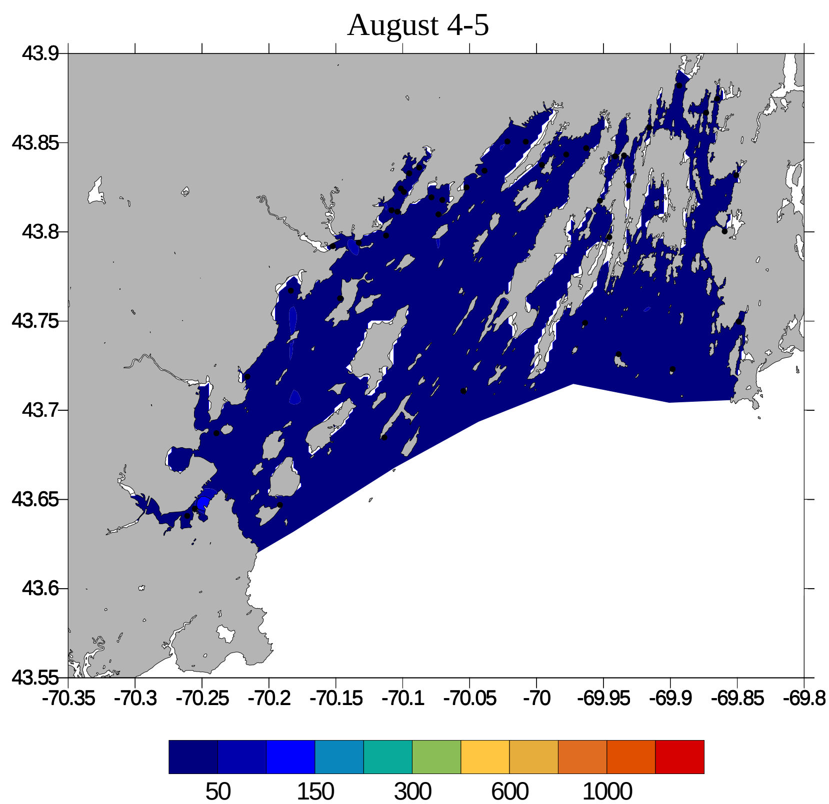
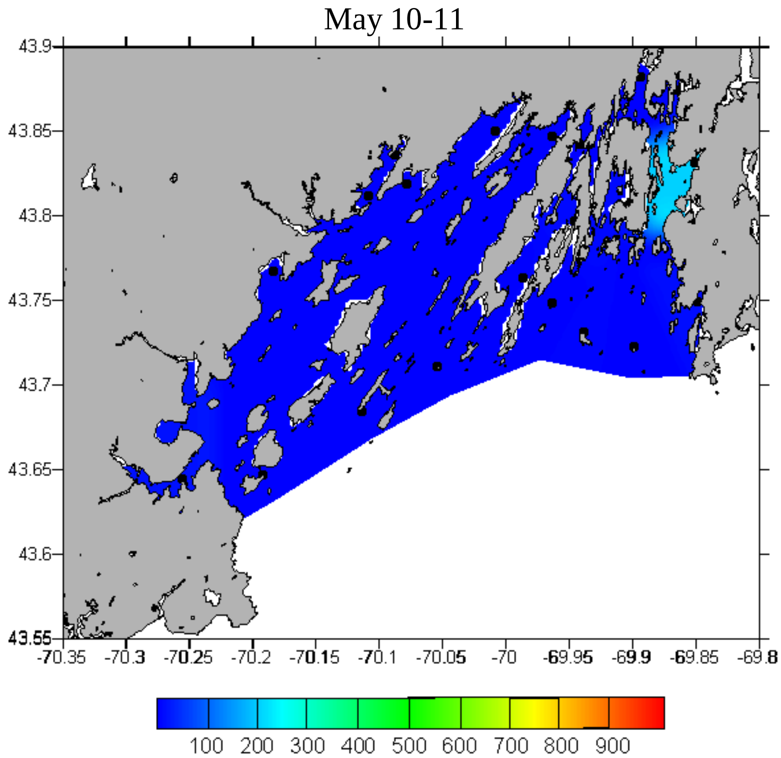


Figure 25. PSP toxicity (µg STX/100 g) on the July 21-22 and August 4-5, 2008 surveys. Station locations sampled denoted by black dots.



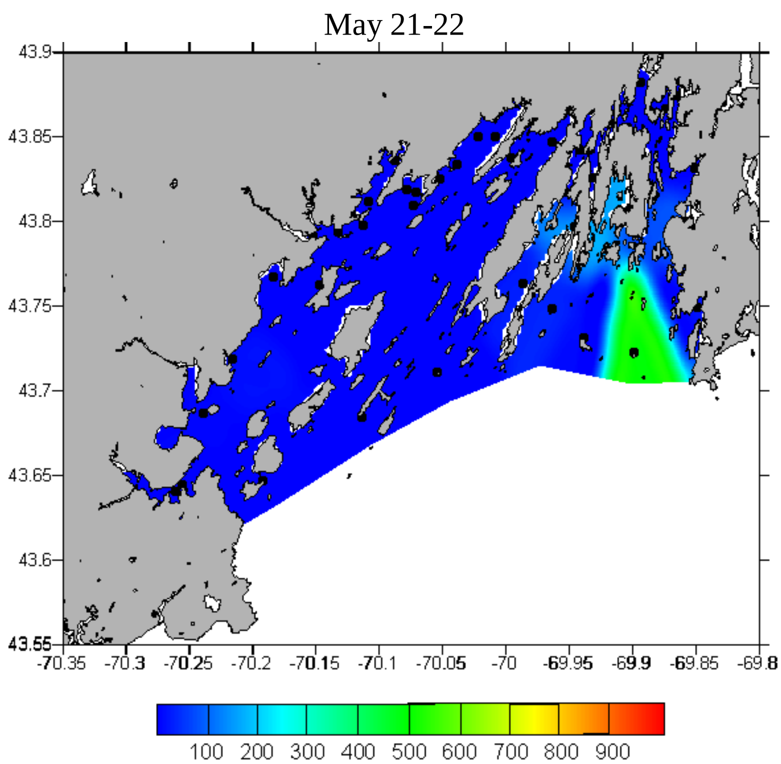


Figure 26. Surface water *Alexandrium* abundance (cells/L) on the May 10-11 and May 21-22, 2007 surveys. Station locations sampled denoted by black dots.

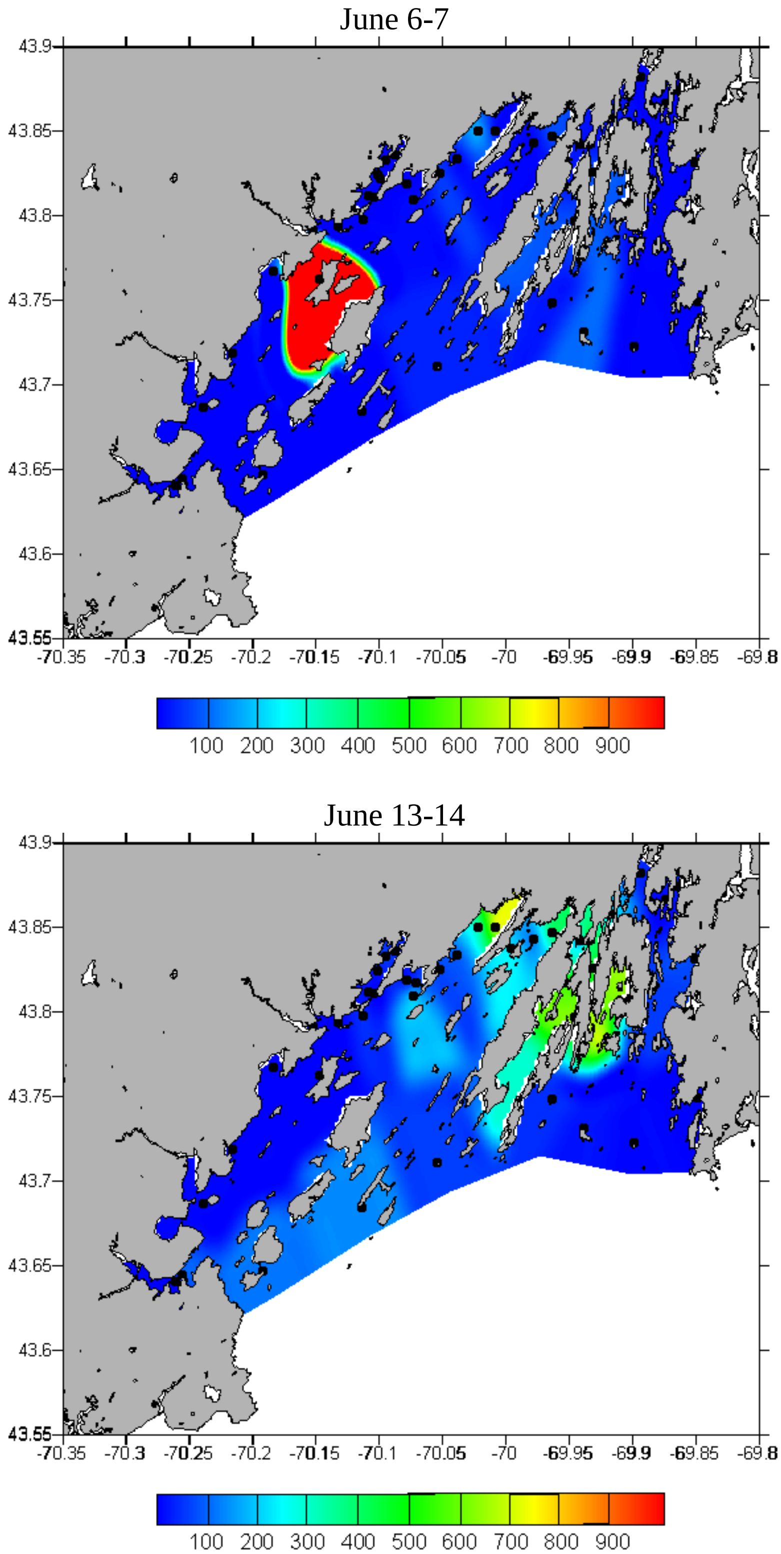


Figure 27. Surface water *Alexandrium* abundance (cells/L) on the June 6-7 and June 13-14, 2007 surveys. Station locations sampled denoted by black dots.

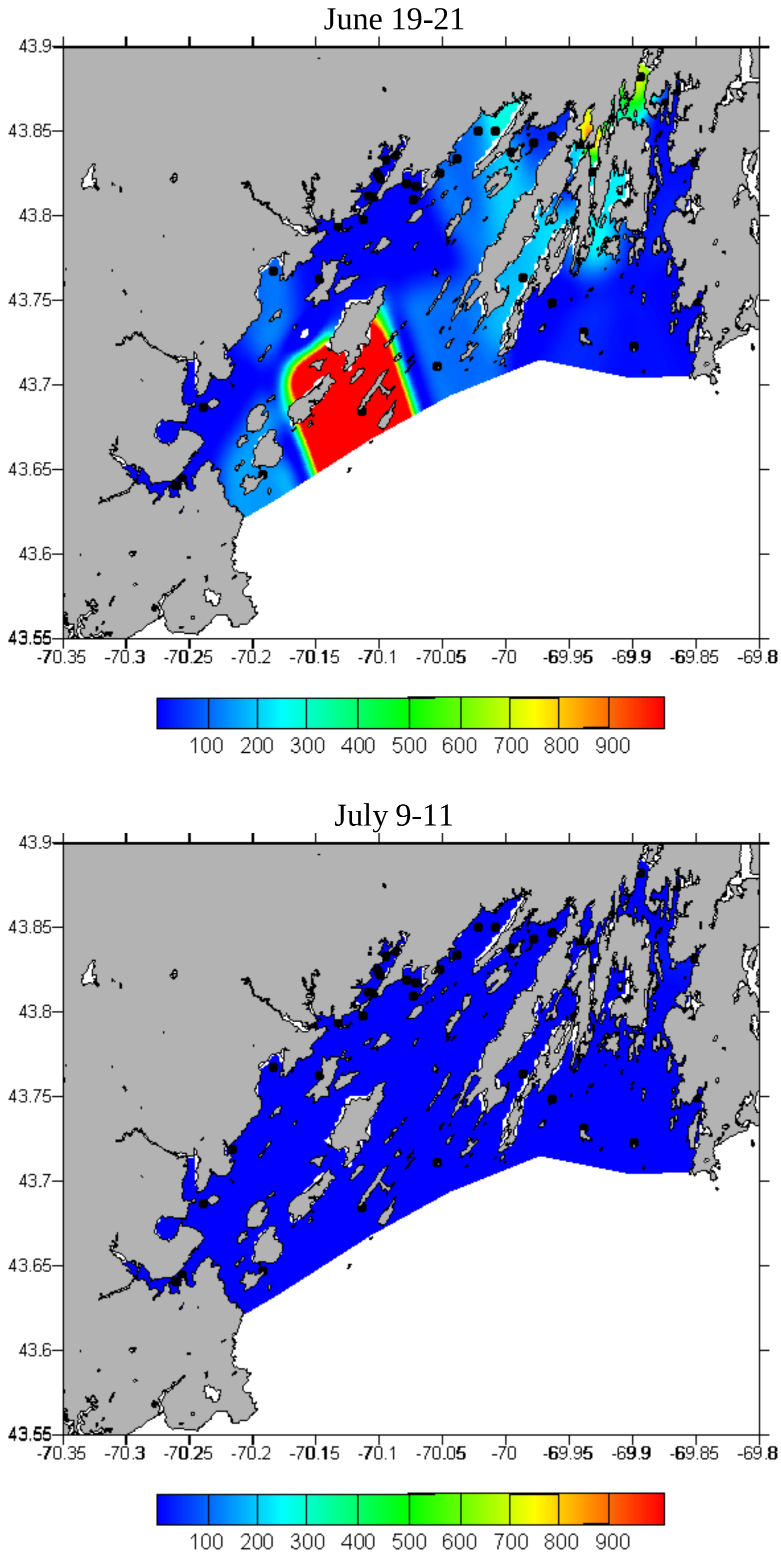


Figure 28. Surface water *Alexandrium* abundance (cells/L) on the June 19-21 and July 9-11, 2007 surveys. Station locations sampled denoted by black dots.

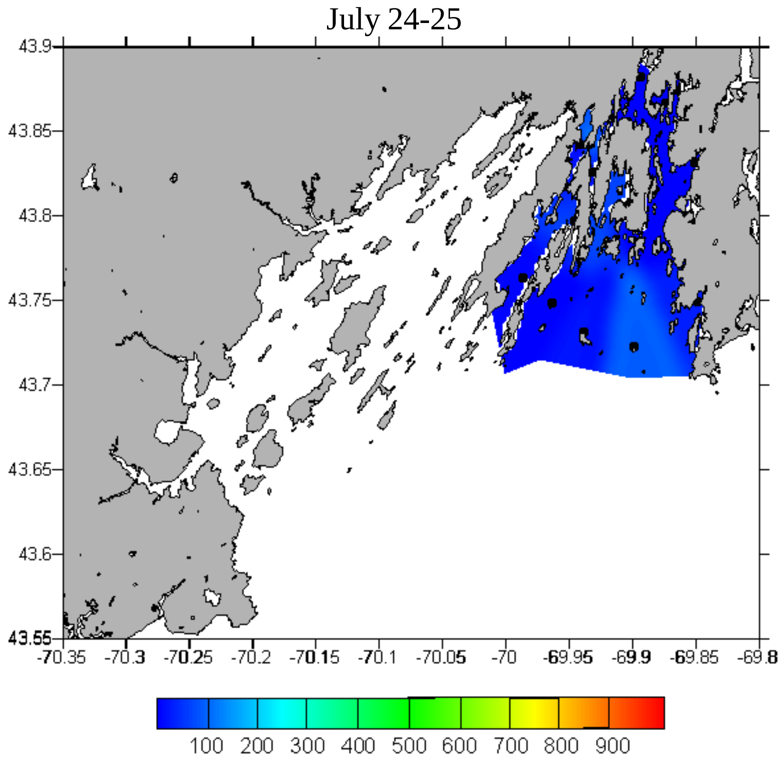


Figure 29. Surface water *Alexandrium* abundance (cells/L) on the July 24-25, 2007 survey. Station locations sampled denoted by black dots.

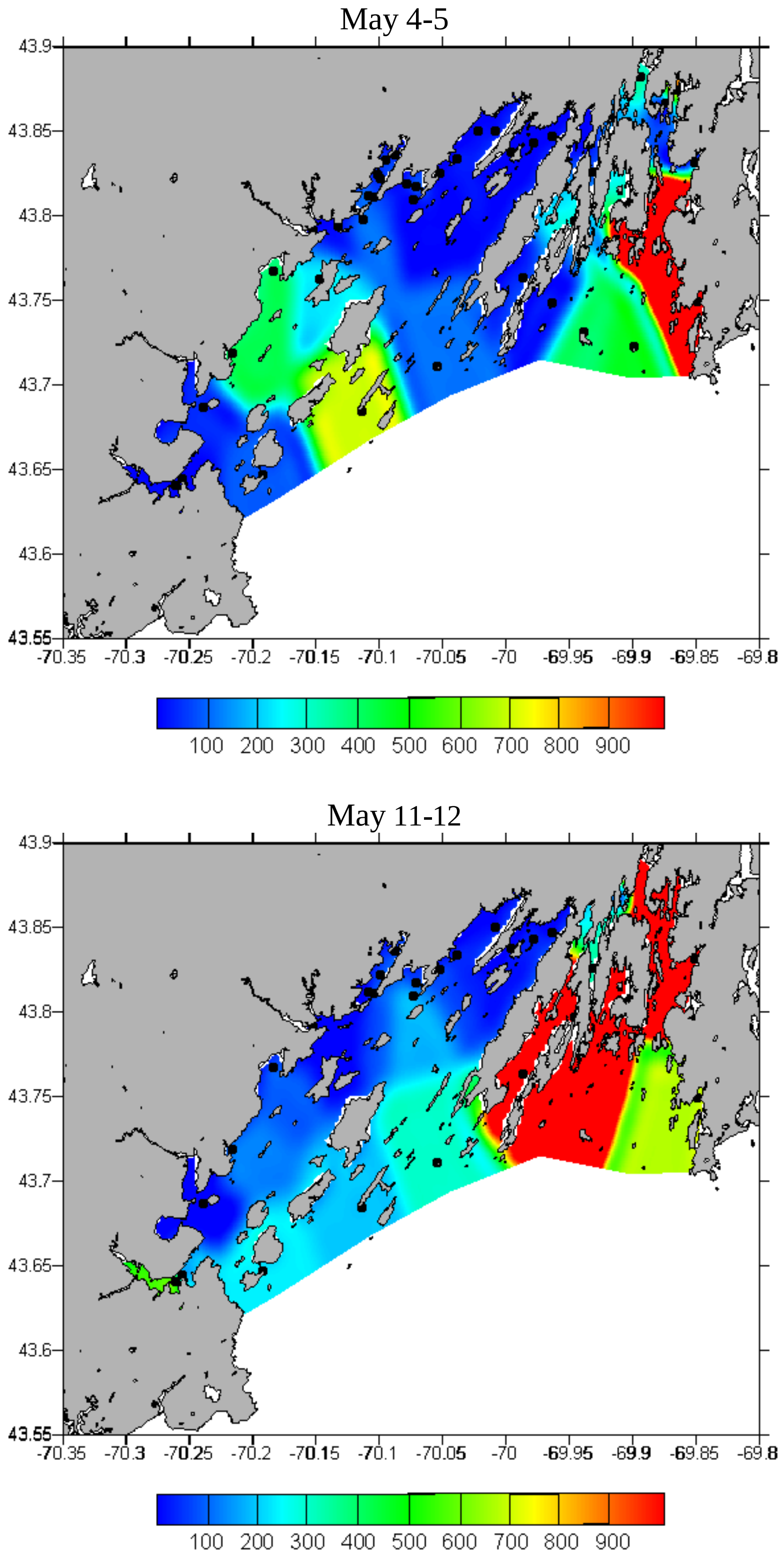


Figure 30. Surface water *Alexandrium* abundance (cells/L) on the May 4-5 and May 11-12, 2008 surveys. Station locations sampled denoted by black dots.

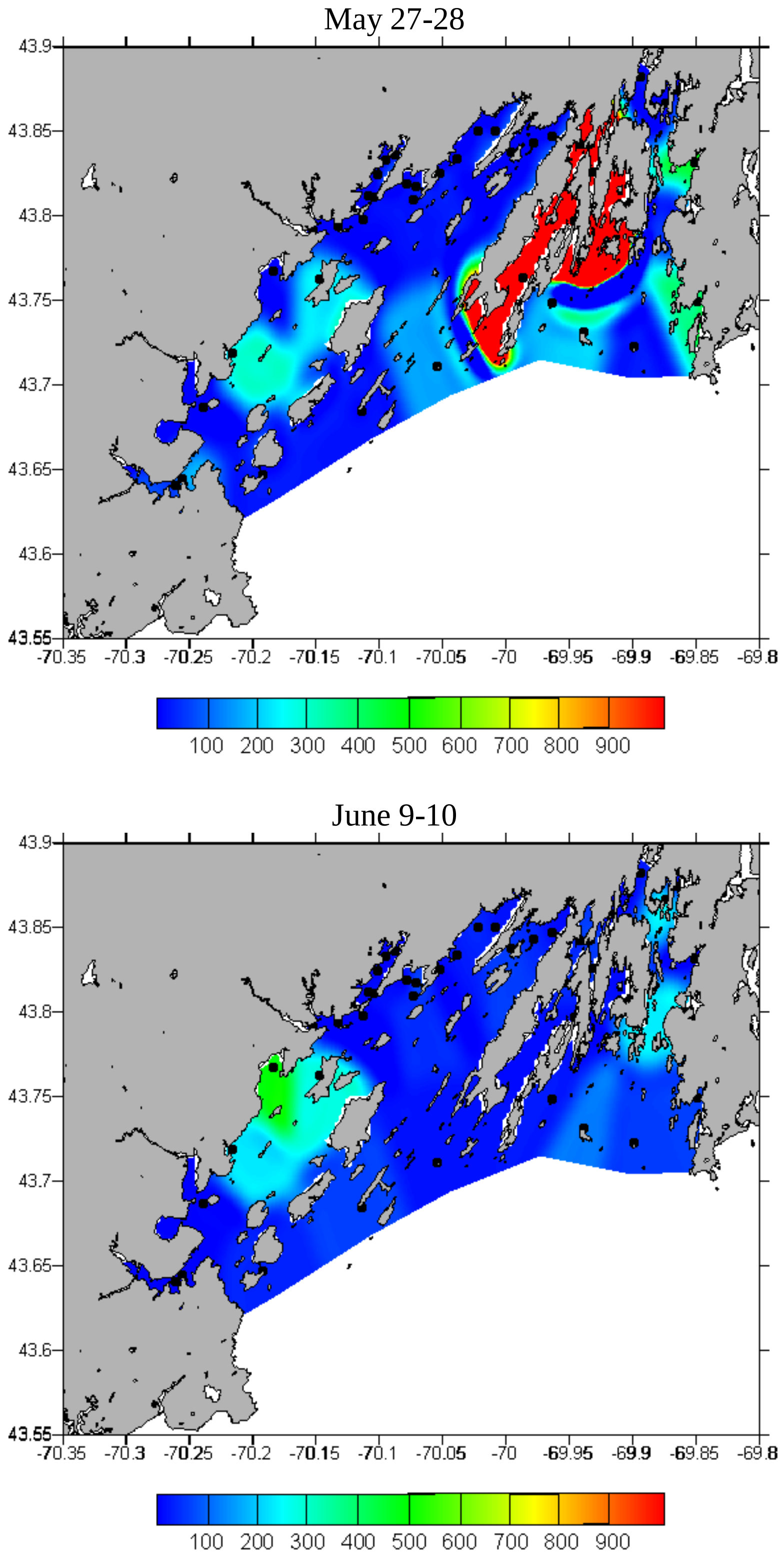
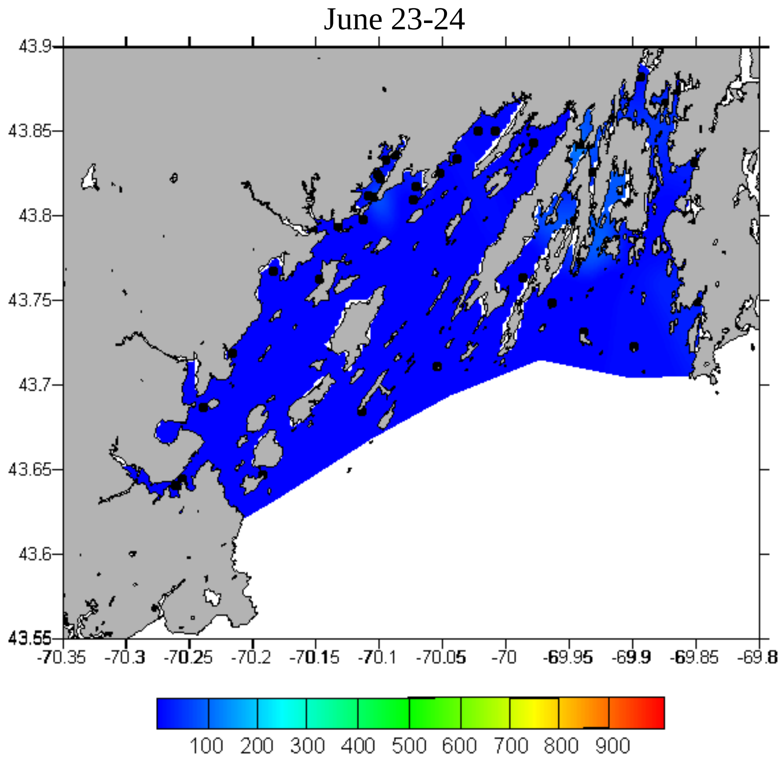


Figure 31. Surface water *Alexandrium* abundance (cells/L) on the May 27-28 and June 10, 2008 surveys. Station locations sampled denoted by black dots.



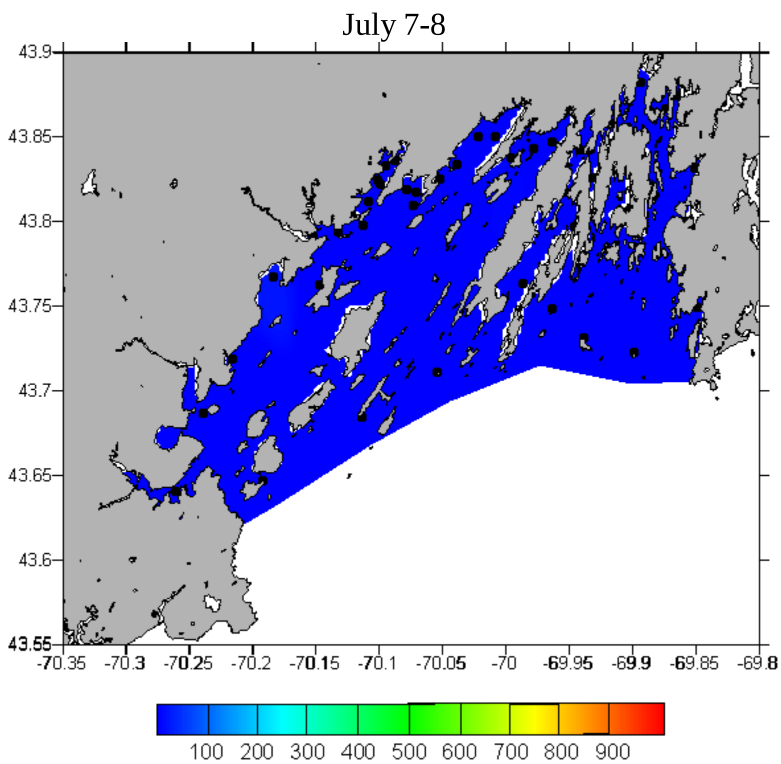


Figure 32. Surface water *Alexandrium* abundance (cells/L) on the June 23-24 and July 8, 2008 surveys. Station locations sampled denoted by black dots.

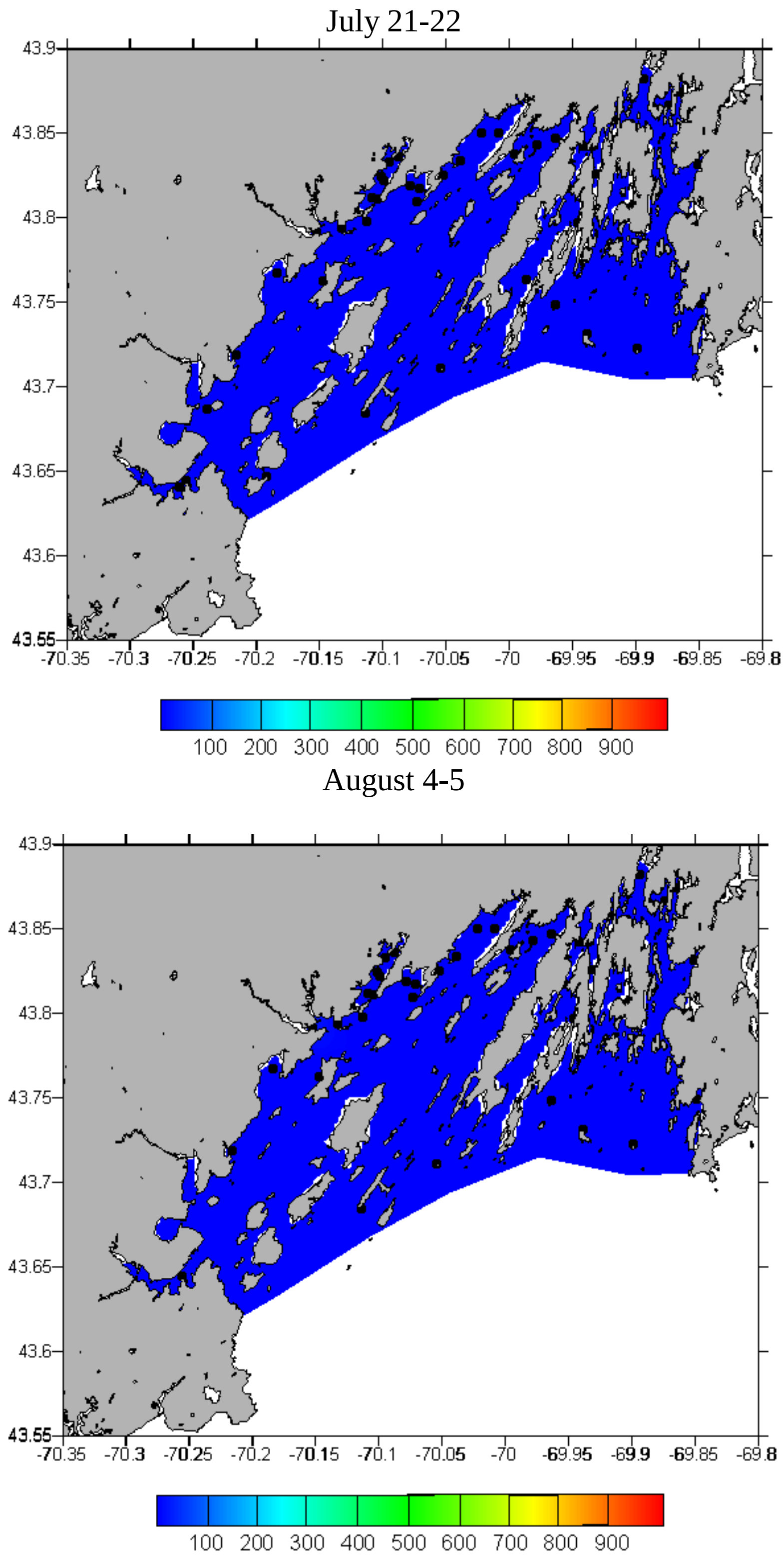
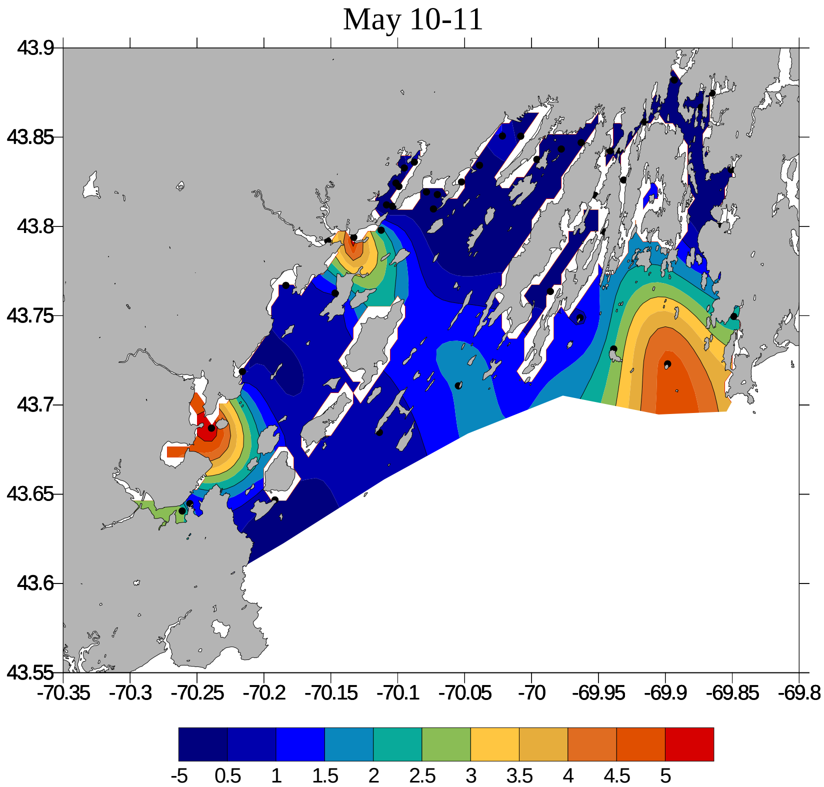


Figure 33. Surface water *Alexandrium* abundance (cells/L) on the July 21-22 and August 4-5, 2008 surveys. Station locations sampled denoted by black dots.



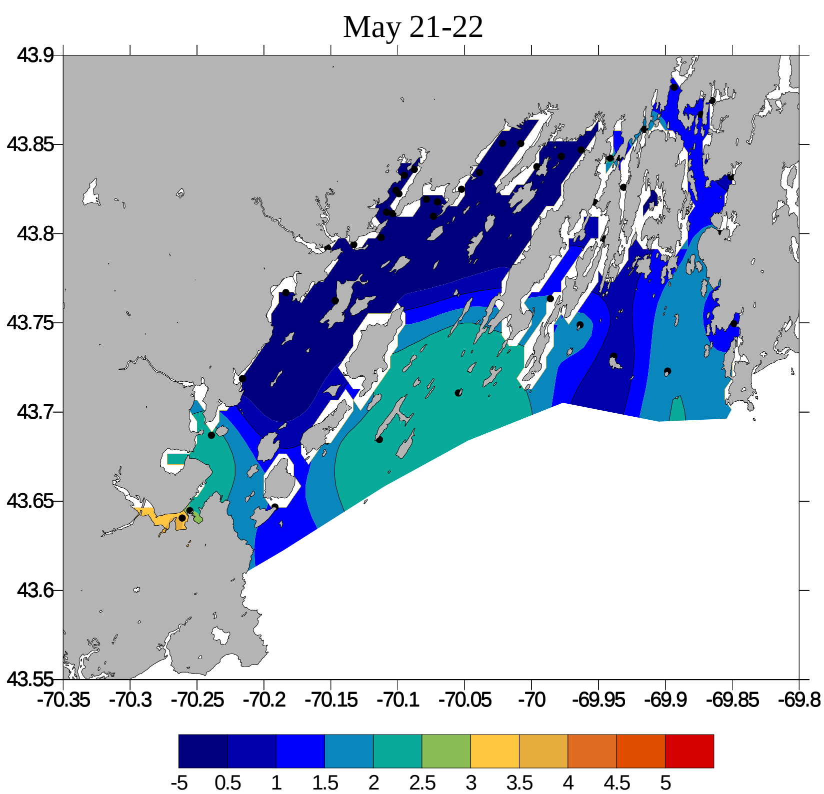
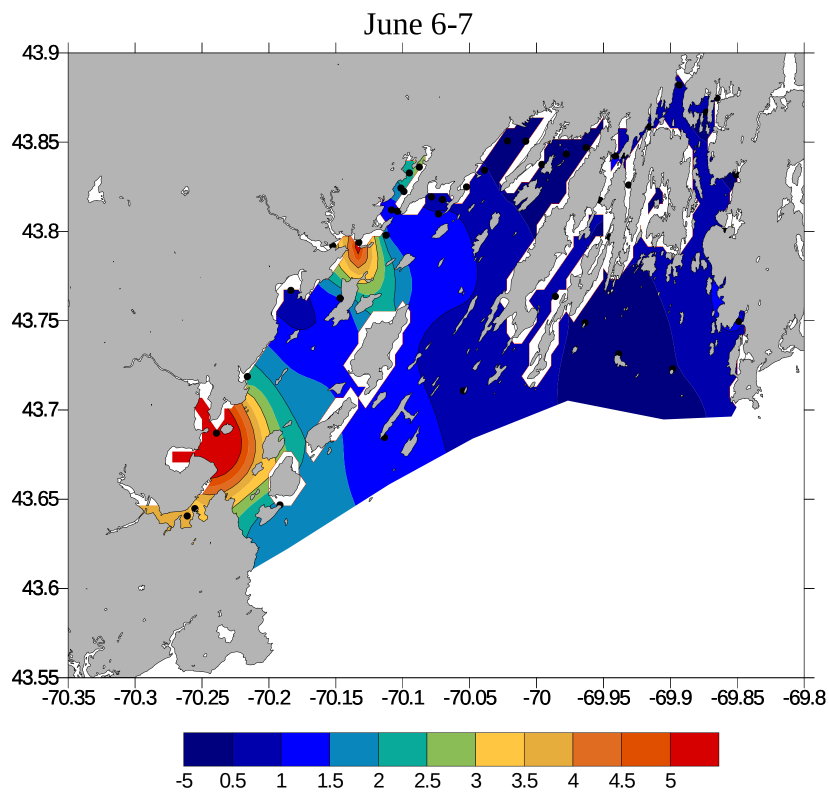


Figure 34. Surface water NO_3+NO_2 (µM) on the May 10-11 and May 21-22, 2007 surveys. Station locations sampled denoted by black dots.



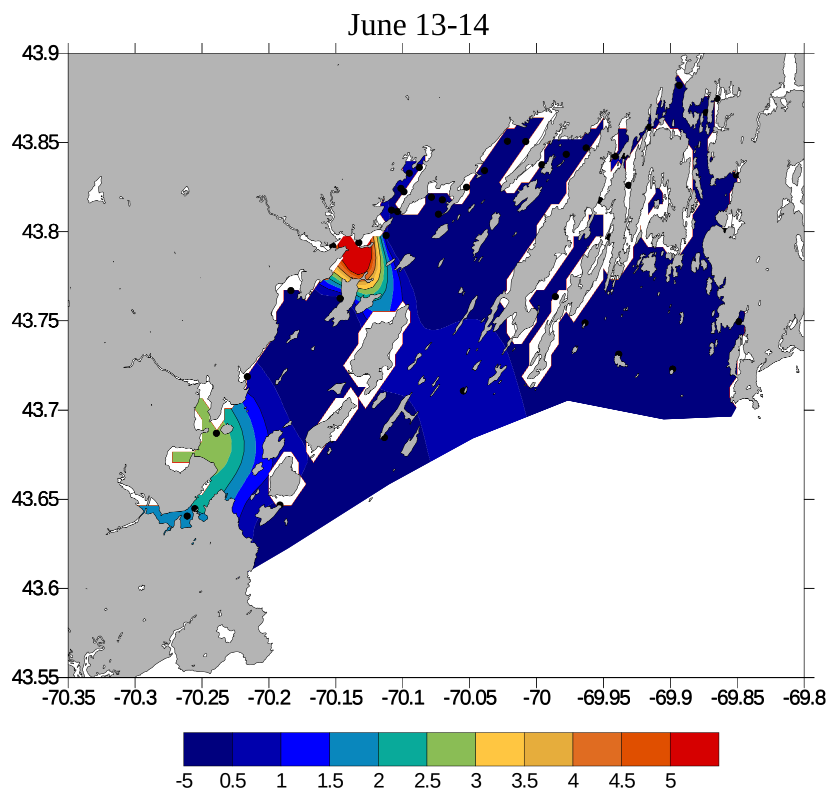
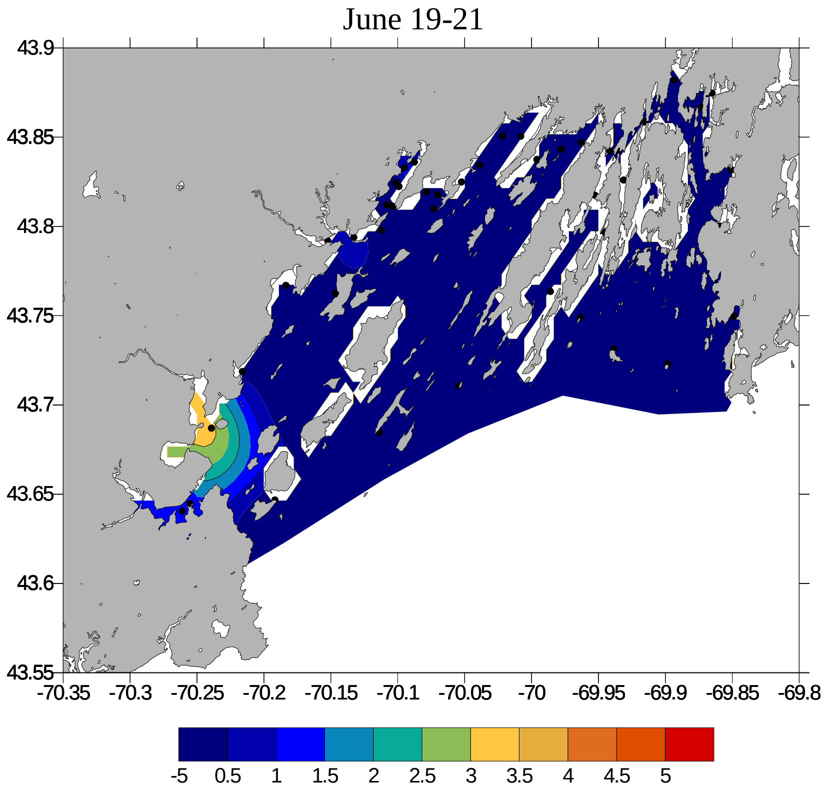


Figure 35. Surface water NO_3+NO_2 (µM) on the June 6-7 and June 13-14, 2007 surveys. Station locations sampled denoted by black dots.



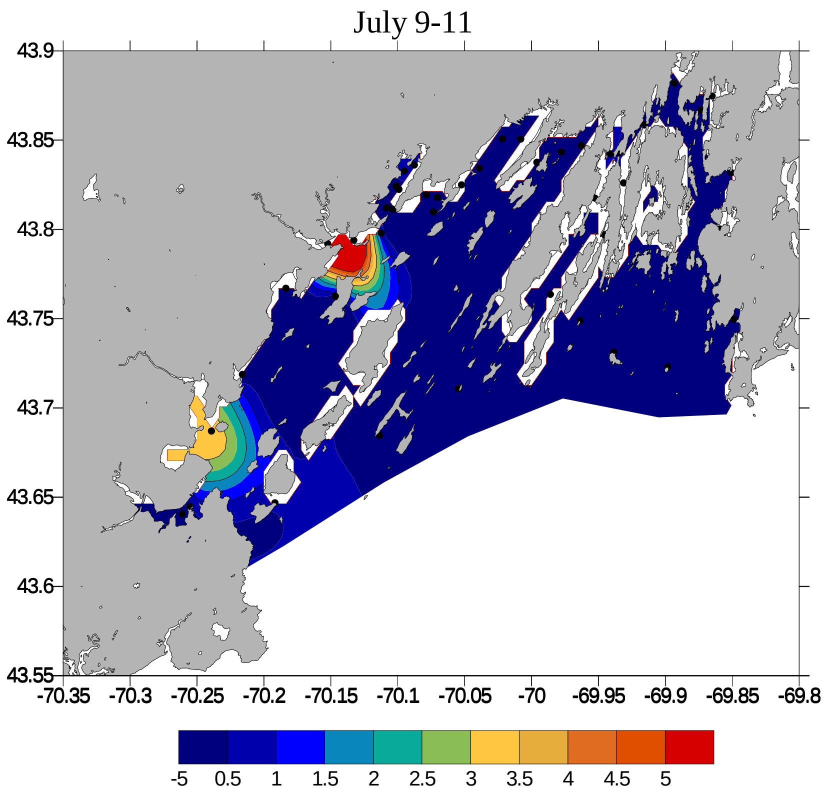


Figure 36. Surface water NO_3+NO_2 (μM) on the June 19-21 and July 9-11, 2007 surveys. Station locations sampled denoted by black dots.

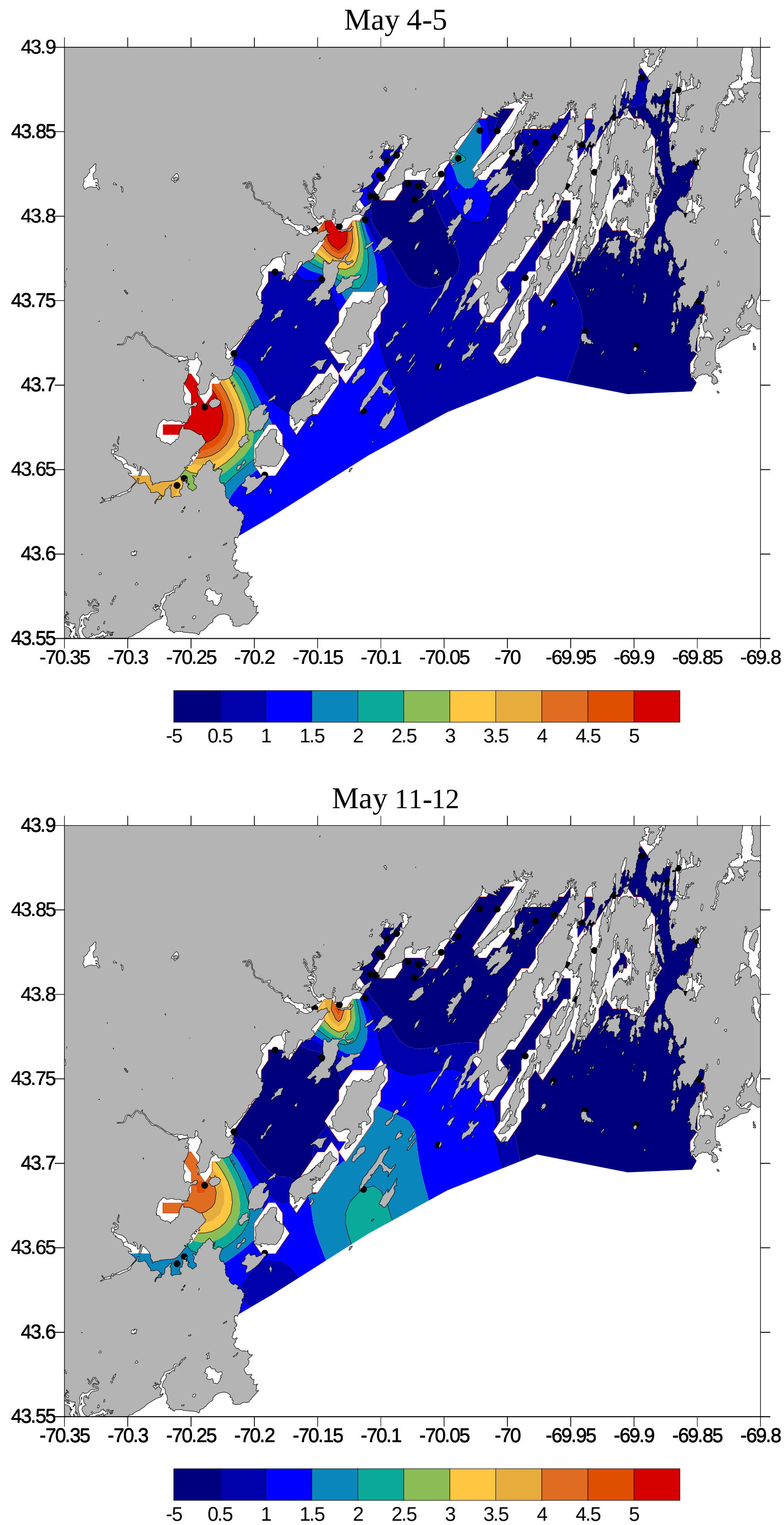


Figure 37. Surface water NO_3+NO_2 (µM) on the May 4-5 and May 11-12, 2008 surveys. Station locations sampled denoted by black dots.

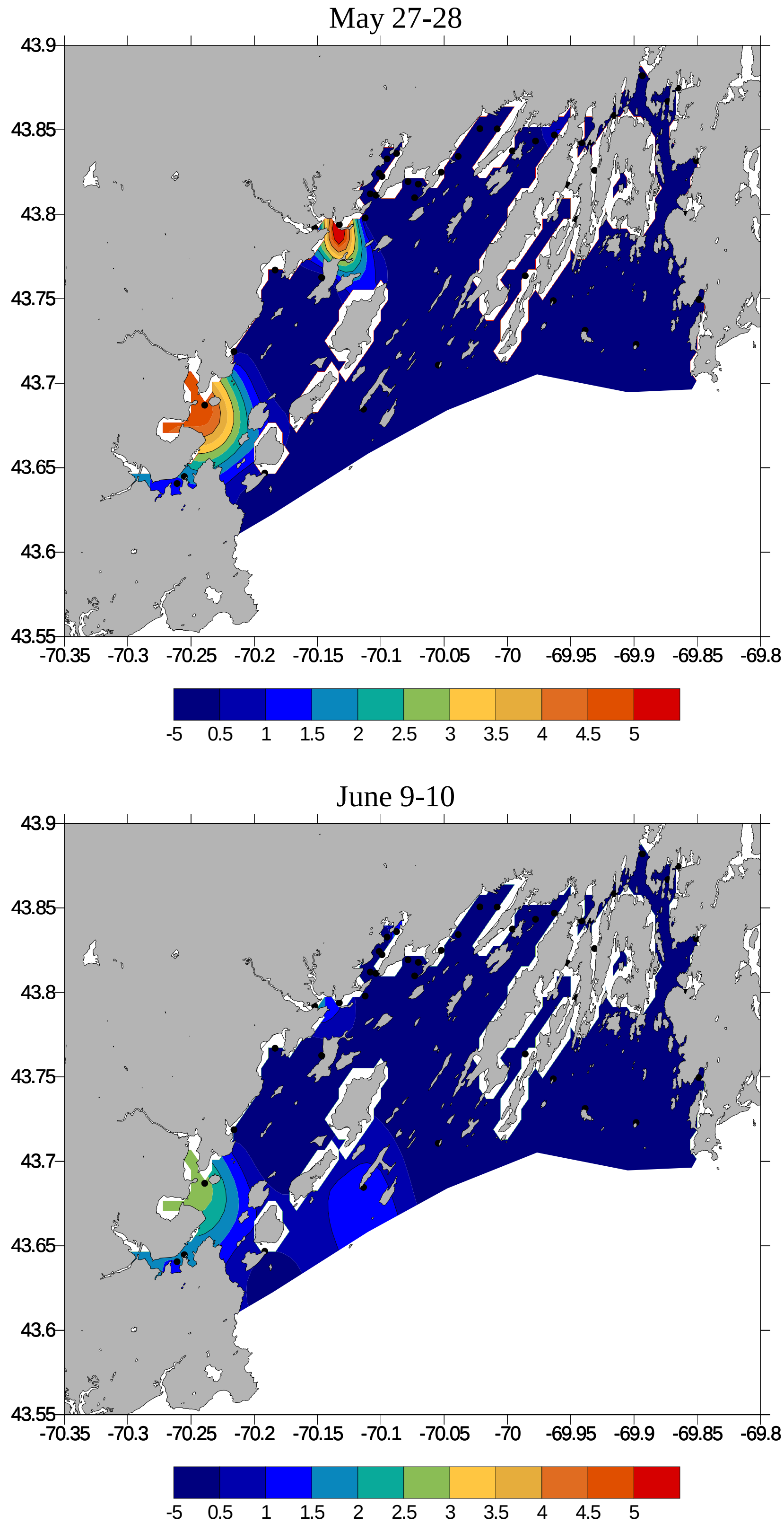
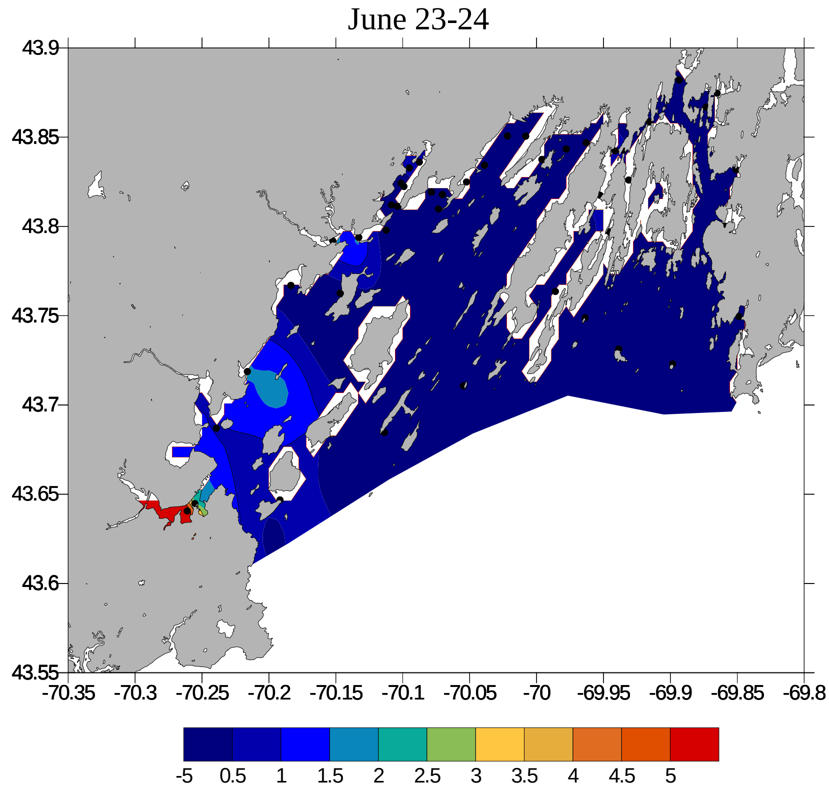


Figure 38. Surface water NO_3+NO_2 (µM) on the May 27-28 and June 10, 2008 surveys. Station locations sampled denoted by black dots.



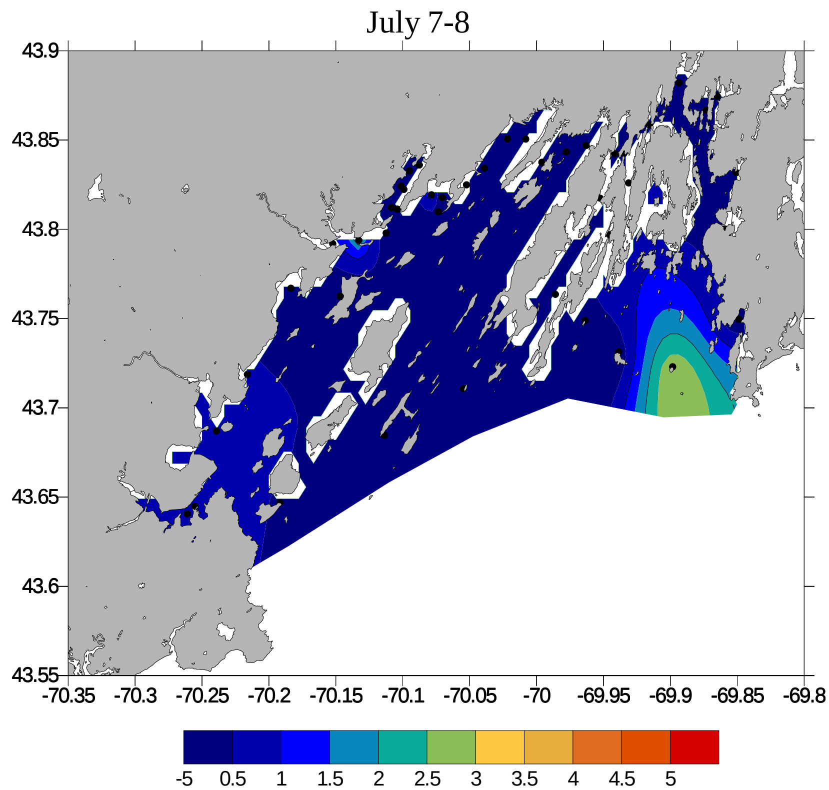


Figure 39. Surface water NO_3+NO_2 (µM) on the June 23-24 and July 8, 2008 surveys. Station locations sampled denoted by black dots.

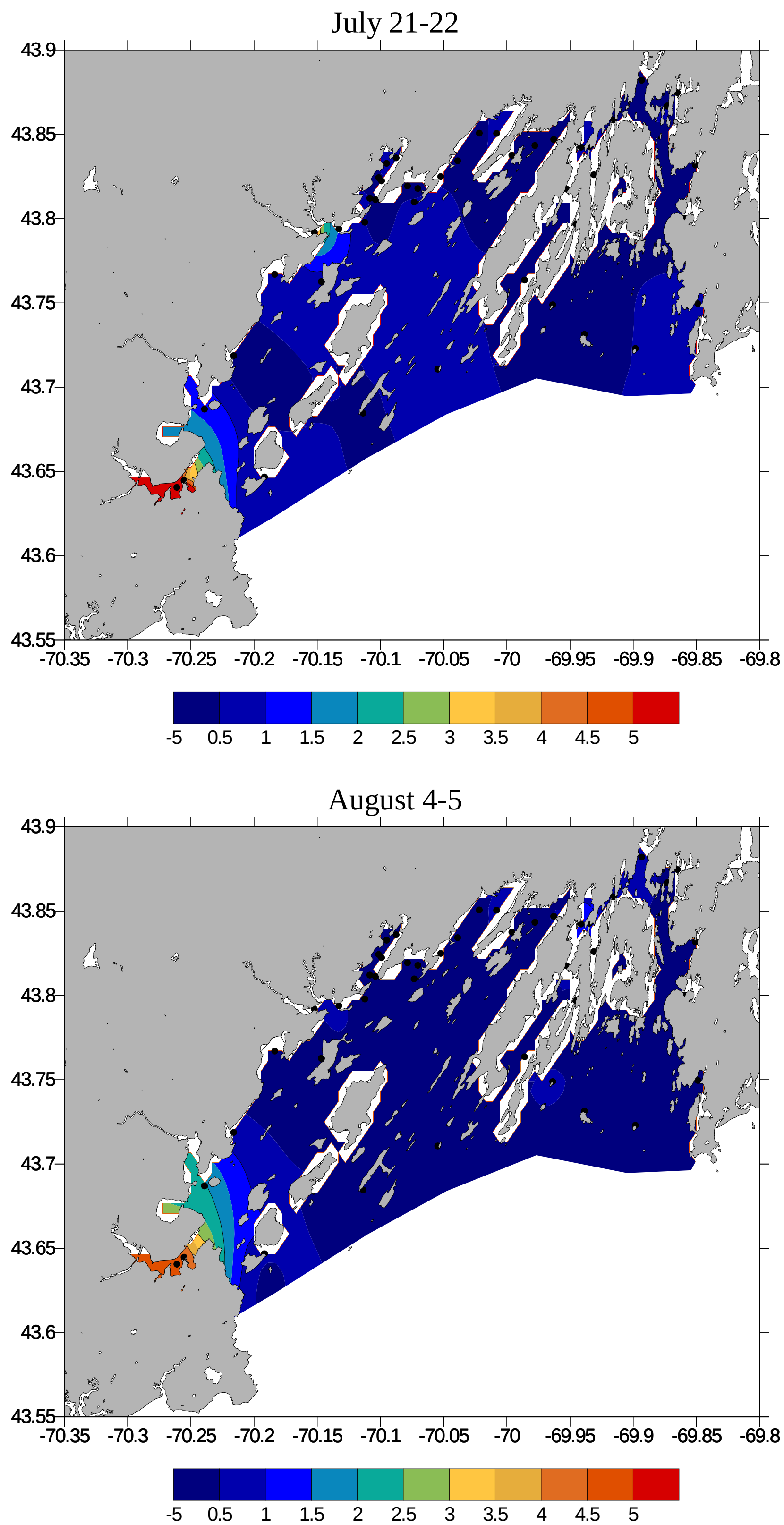


Figure 40. Surface water NO_3+NO_2 (µM) on the July 21-22 and August 4-5, 2008 surveys. Station locations sampled denoted by black dots.

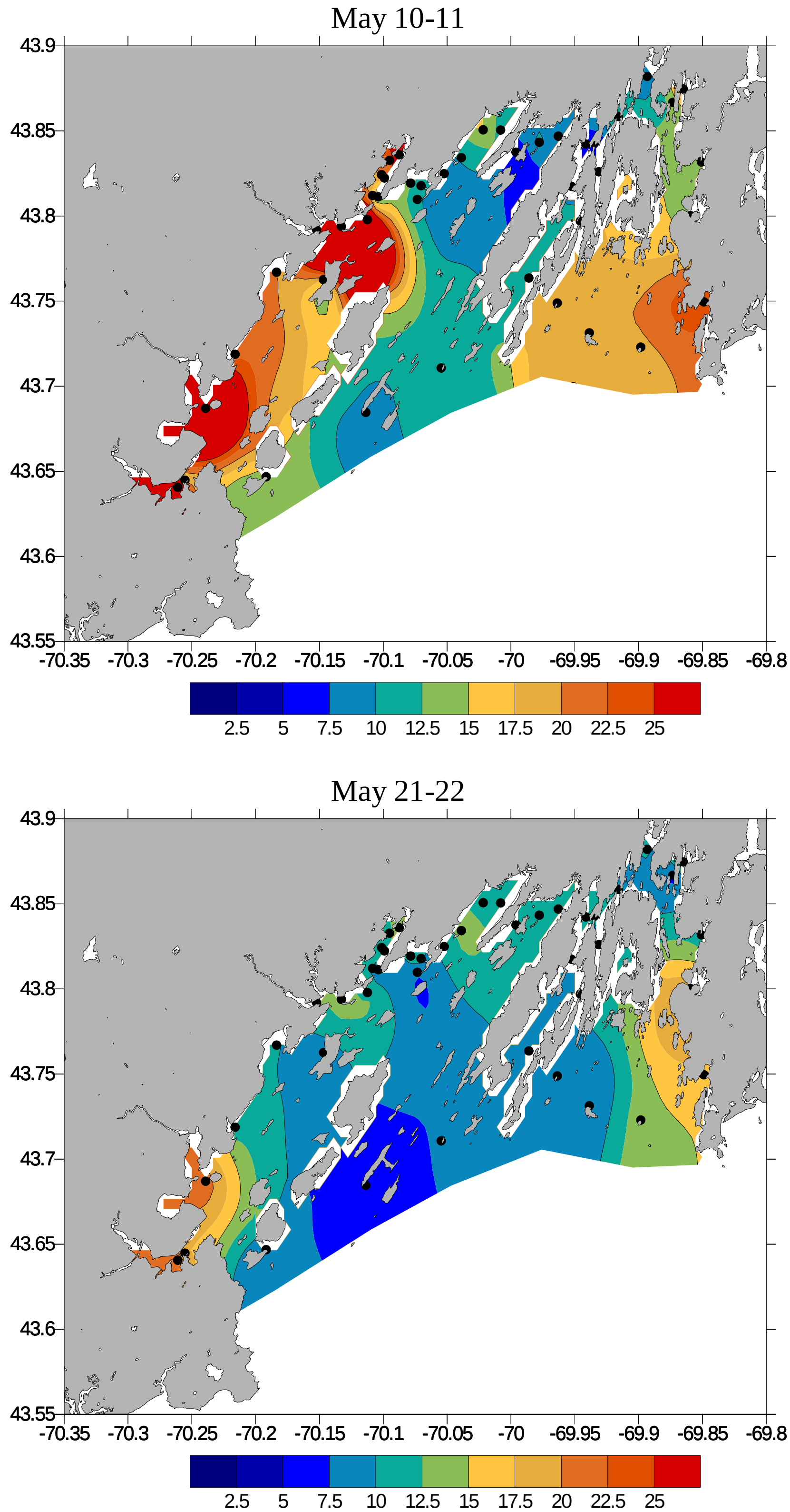
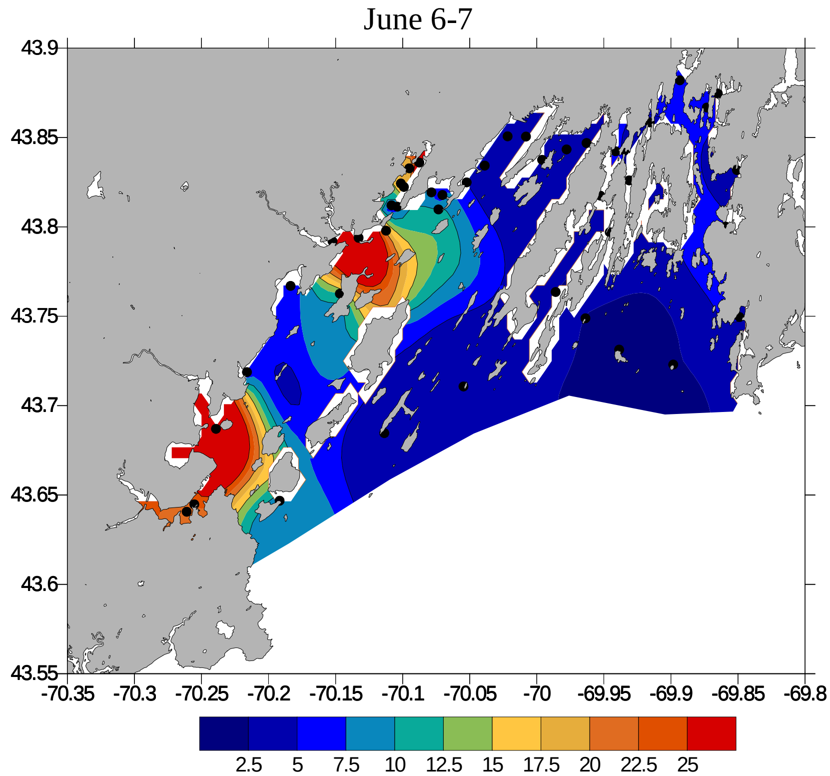


Figure 41. Surface water SiO_4 (μM) on the May 10-11 and May 21-22, 2007 surveys. Station locations sampled denoted by black dots.



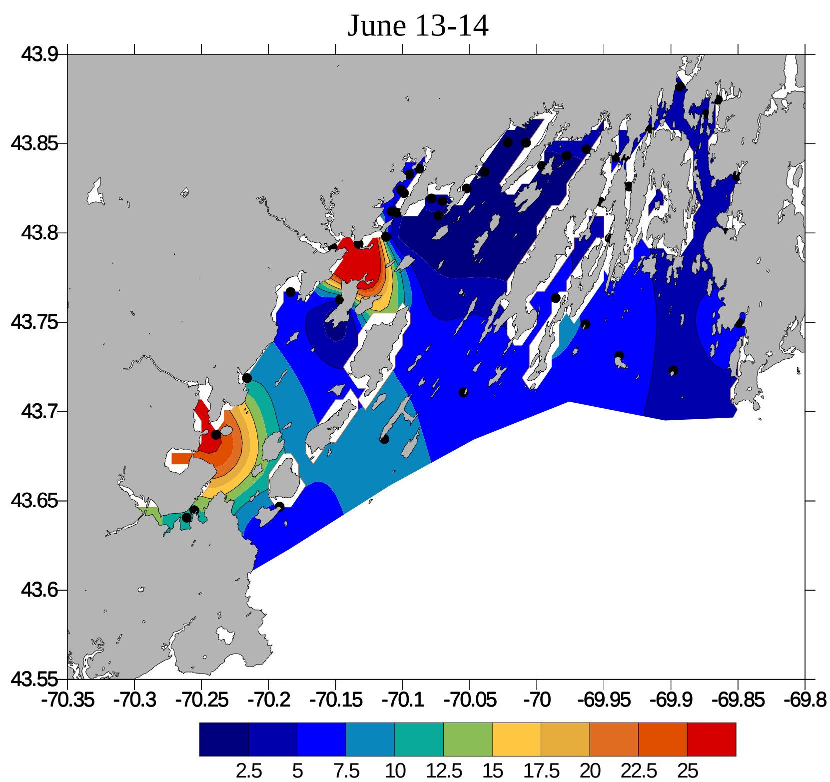


Figure 42. Surface water SiO_4 (µM) on the June 6-7 and June 13-14, 2007 surveys. Station locations sampled denoted by black dots.

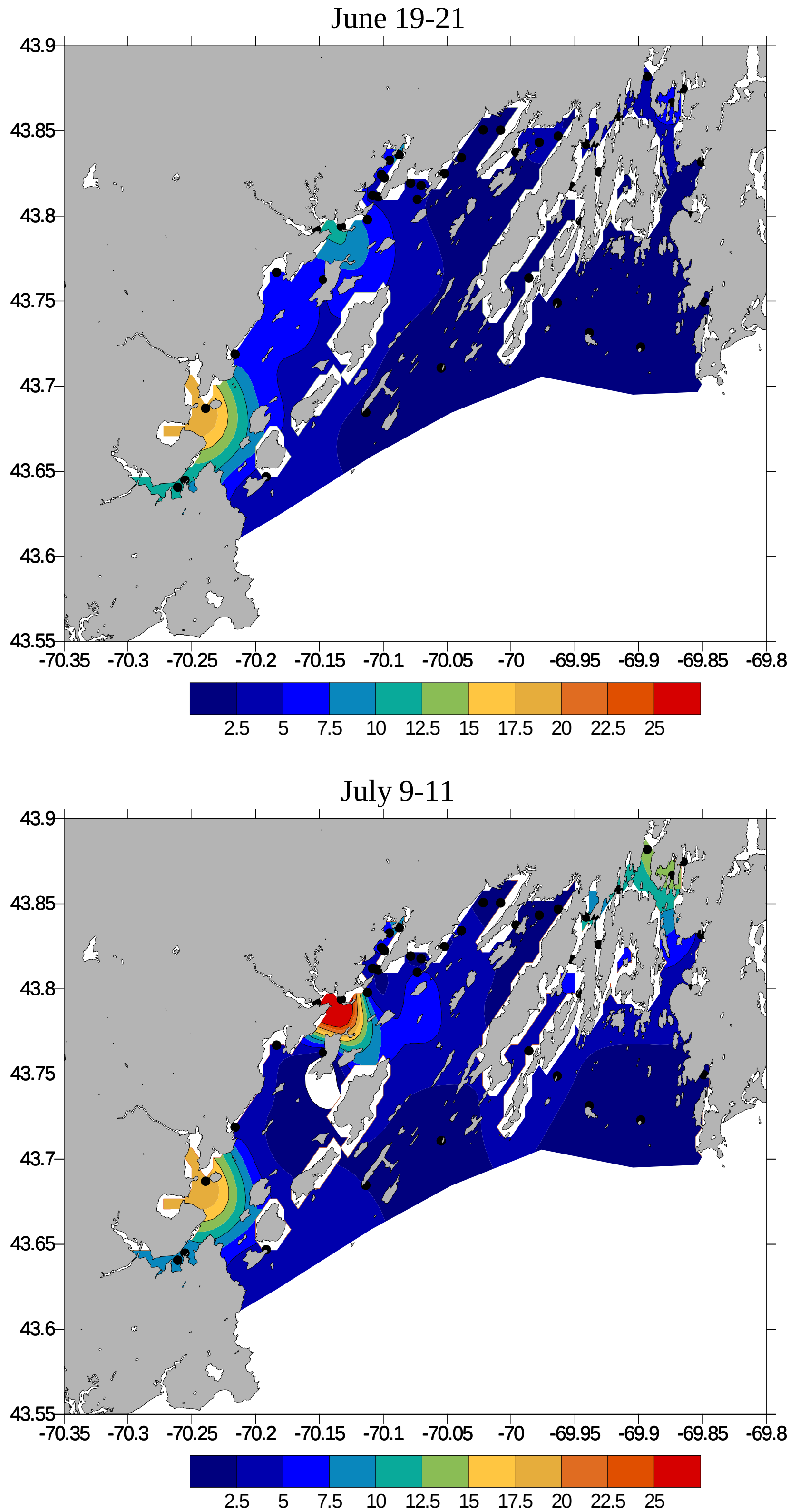


Figure 43. Surface water SiO_4 (µM) on the June 19-21 and July 9-11, 2007 surveys. Station locations sampled denoted by black dots.

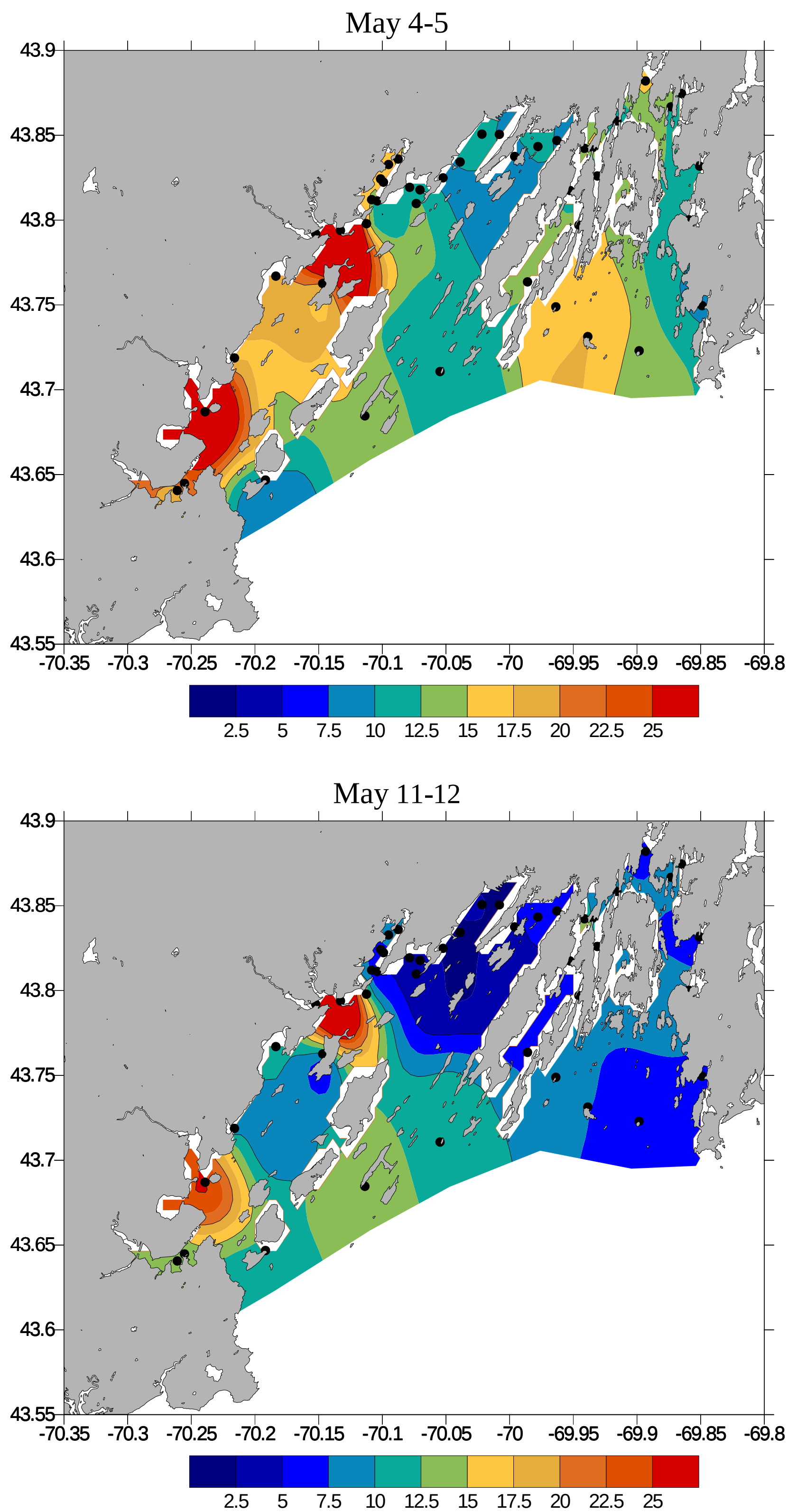
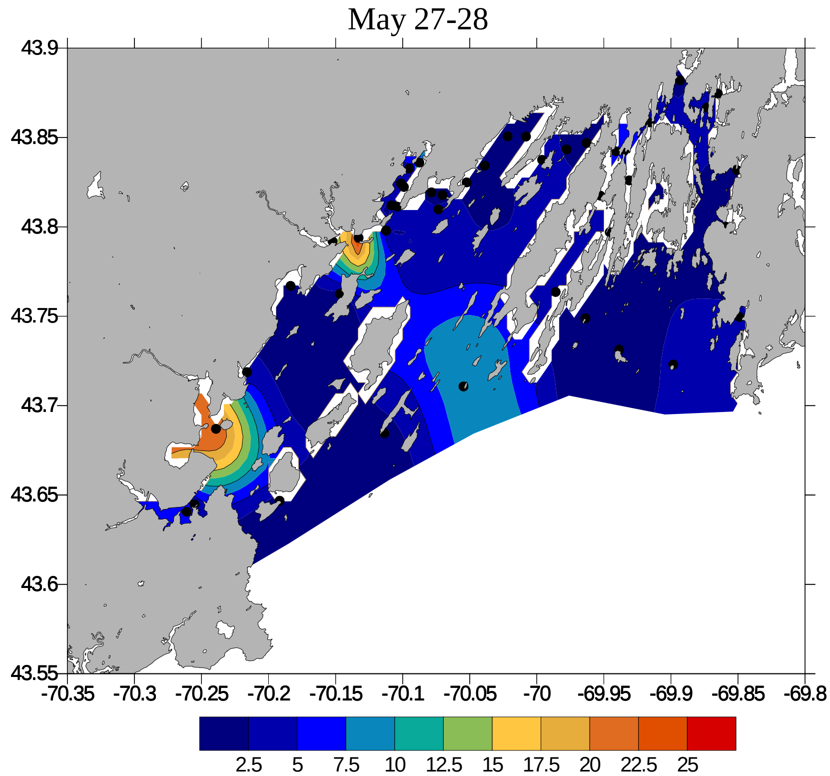


Figure 44. Surface water SiO_4 (µM) on the May 4-5 and May 11-12, 2008 surveys. Station locations sampled denoted by black dots.



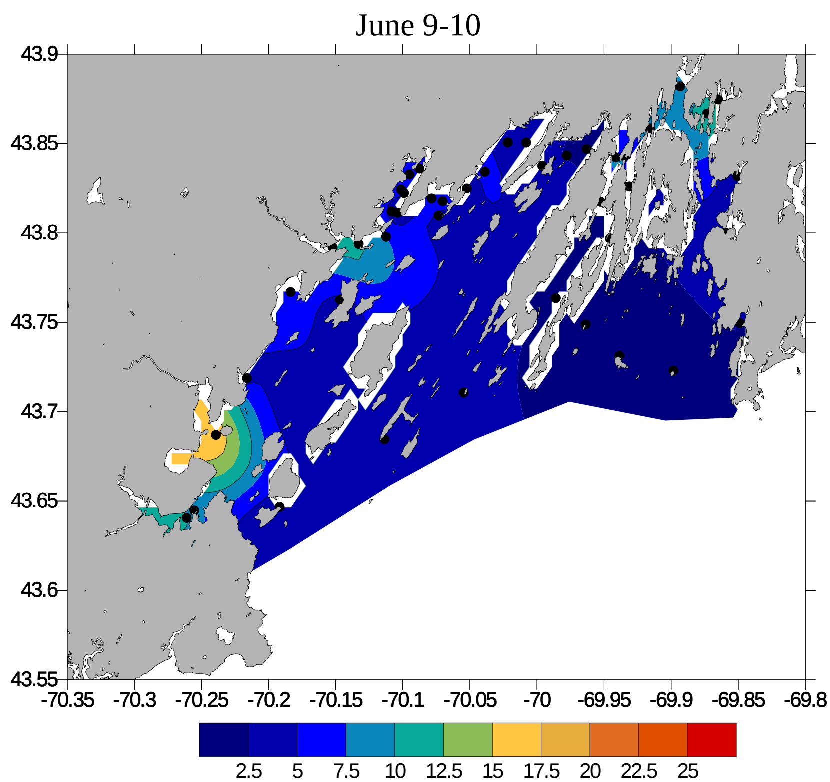


Figure 45. Surface water SiO_4 (µM) on the May 27-28 and June 10, 2008 surveys. Station locations sampled denoted by black dots.

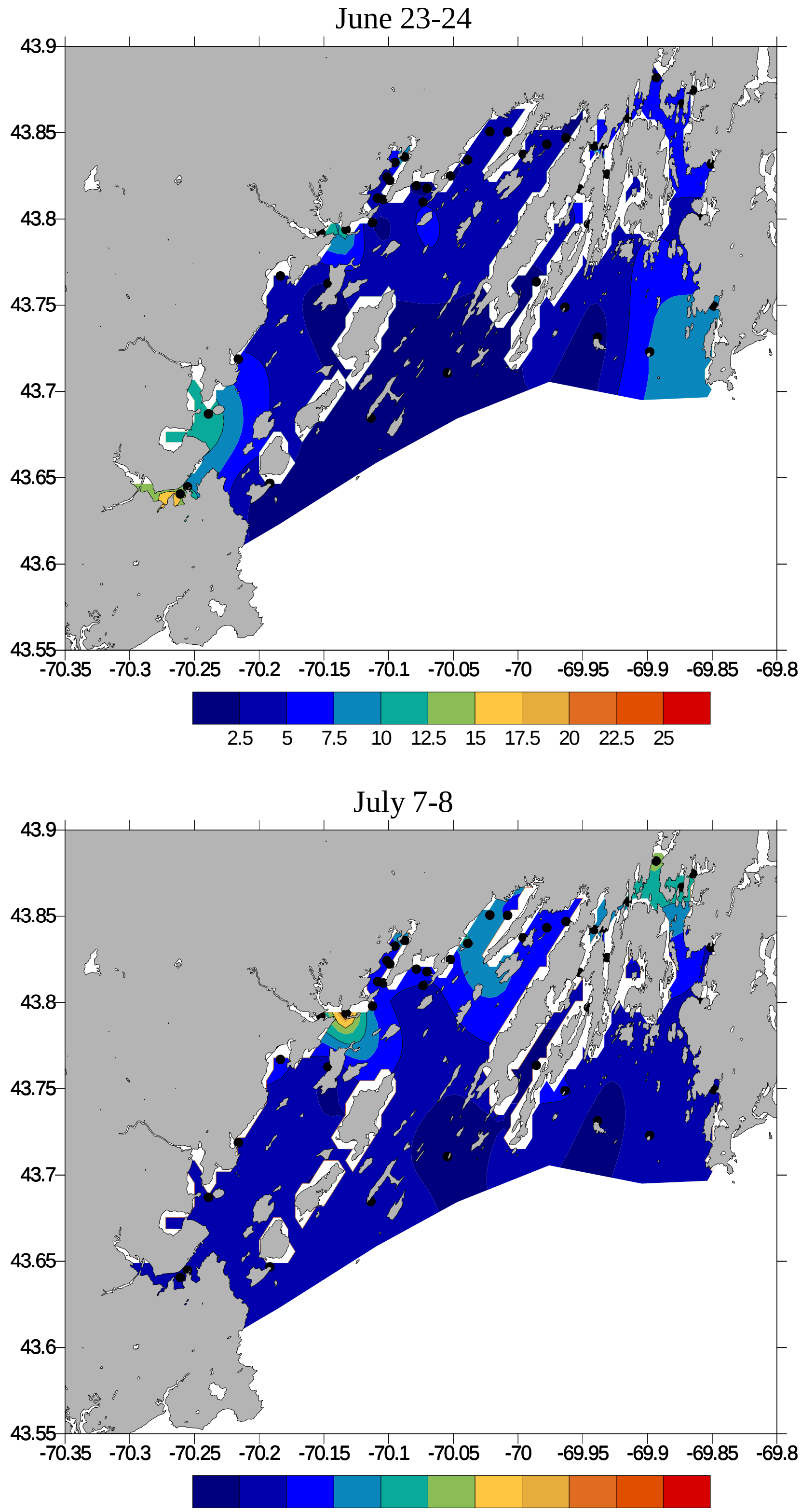


Figure 46. Surface water SiO_4 (µM) on the June 23-24 and July 8, 2008 surveys. Station locations sampled denoted by black dots.

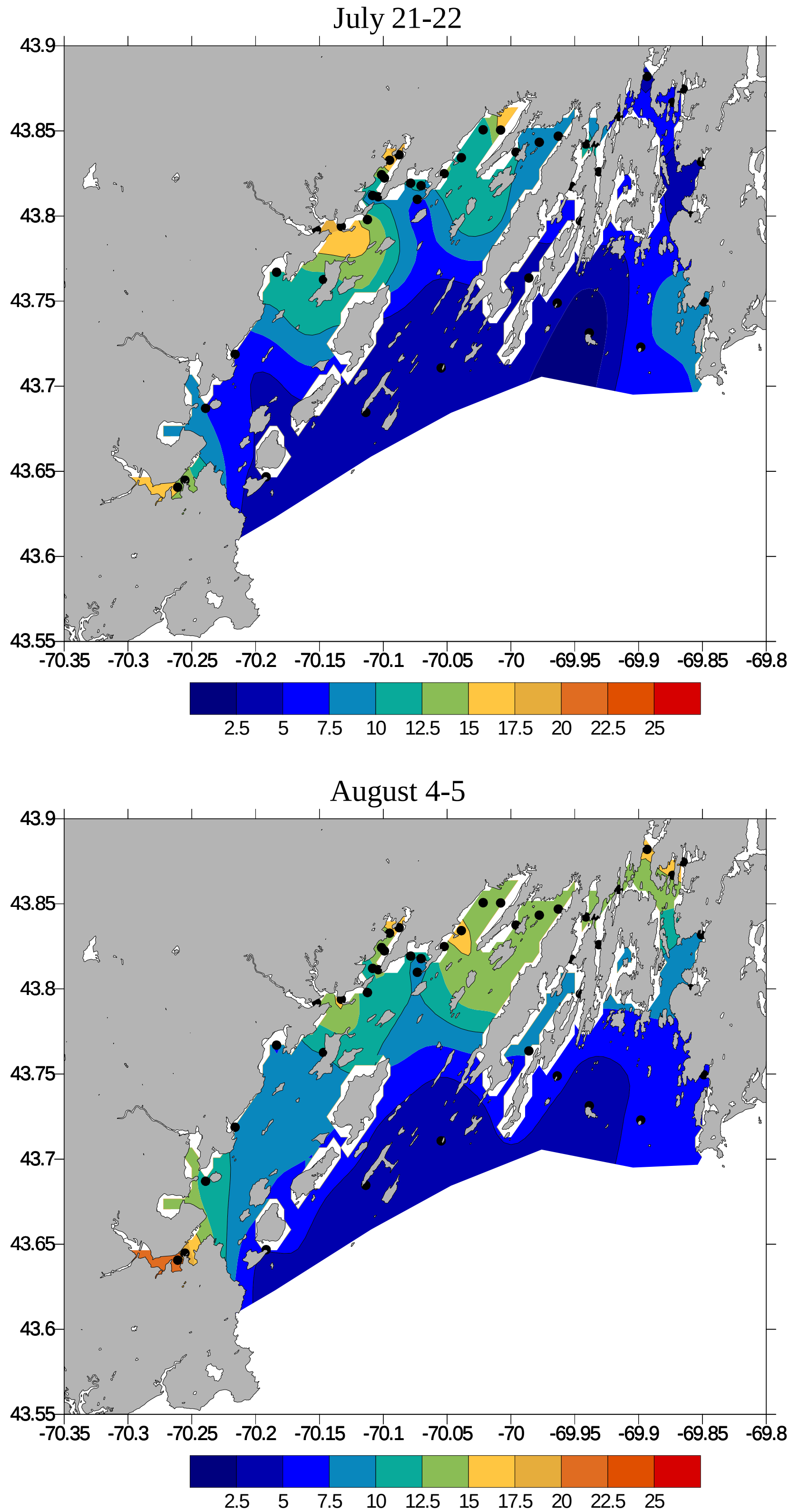


Figure 47. Surface water SiO_4 (µM) on the July 21-22 and August 4-5, 2008 surveys. Station locations sampled denoted by black dots.

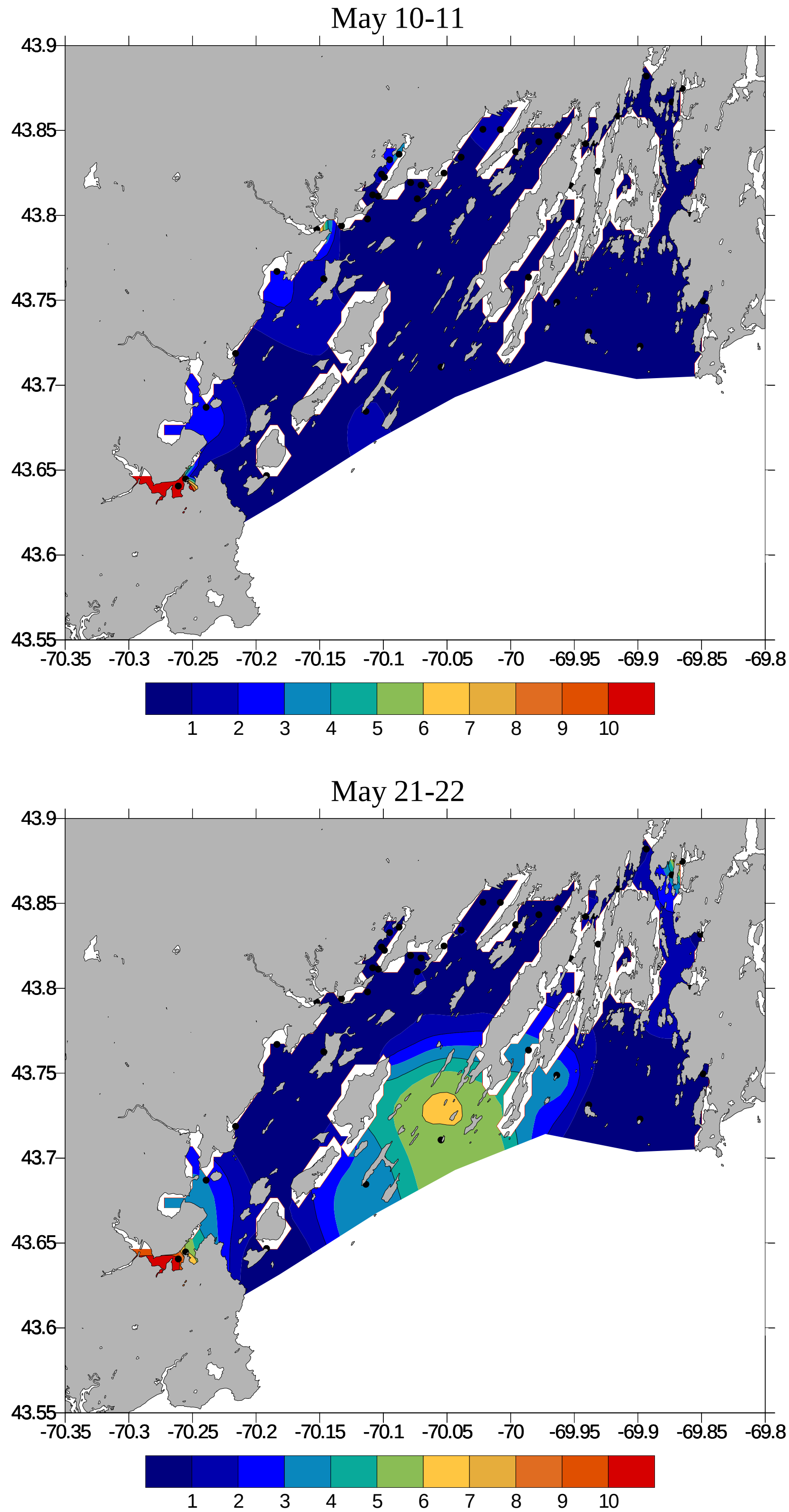


Figure 48. Surface water NH_4 (µM) on the May 10-11 and May 21-22, 2007 surveys. Station locations sampled denoted by black dots.

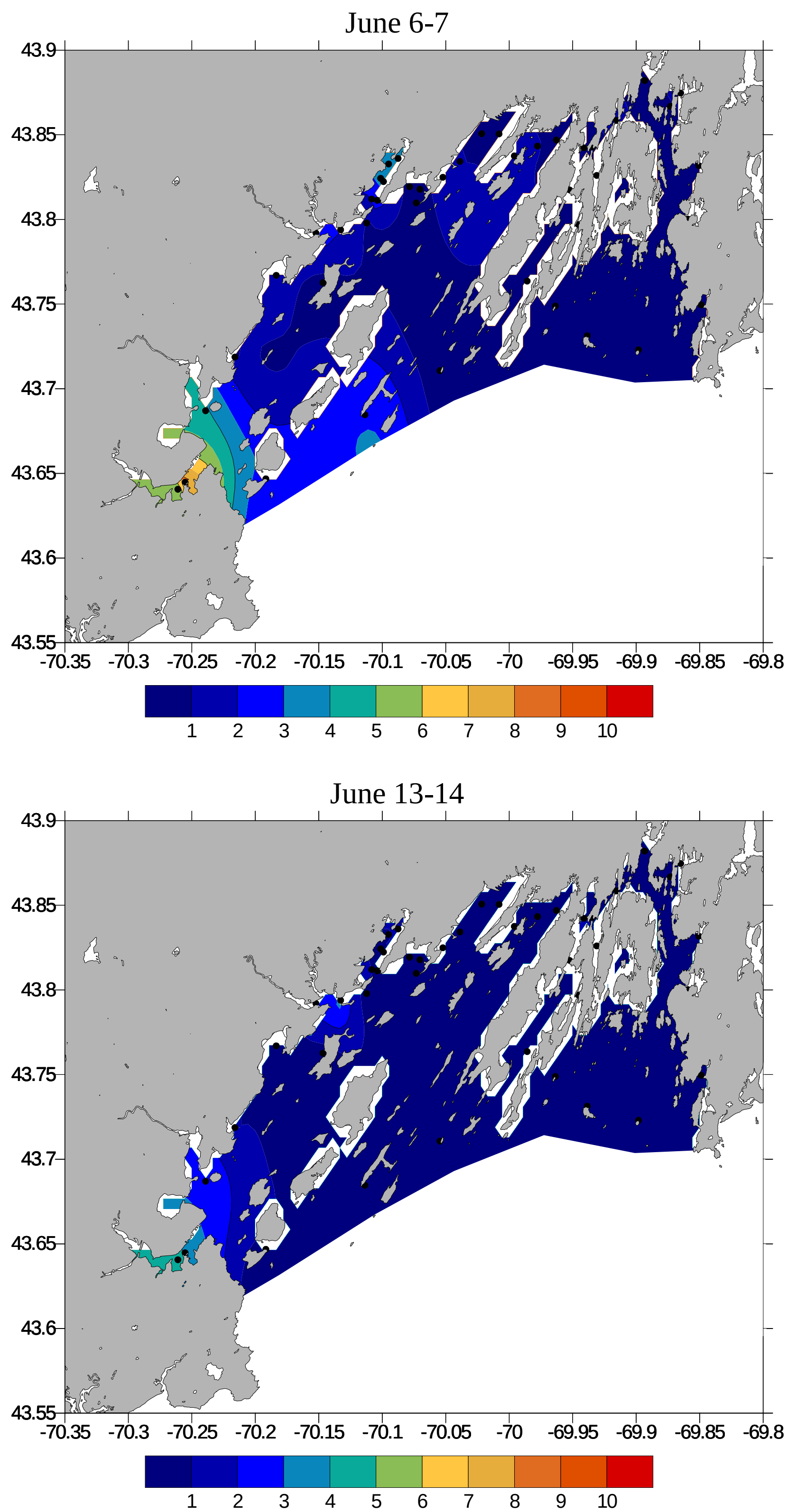


Figure 49. Surface water NH_4 (μM) on the June 6-7 and June 13-14, 2007 surveys. Station locations sampled denoted by black dots.

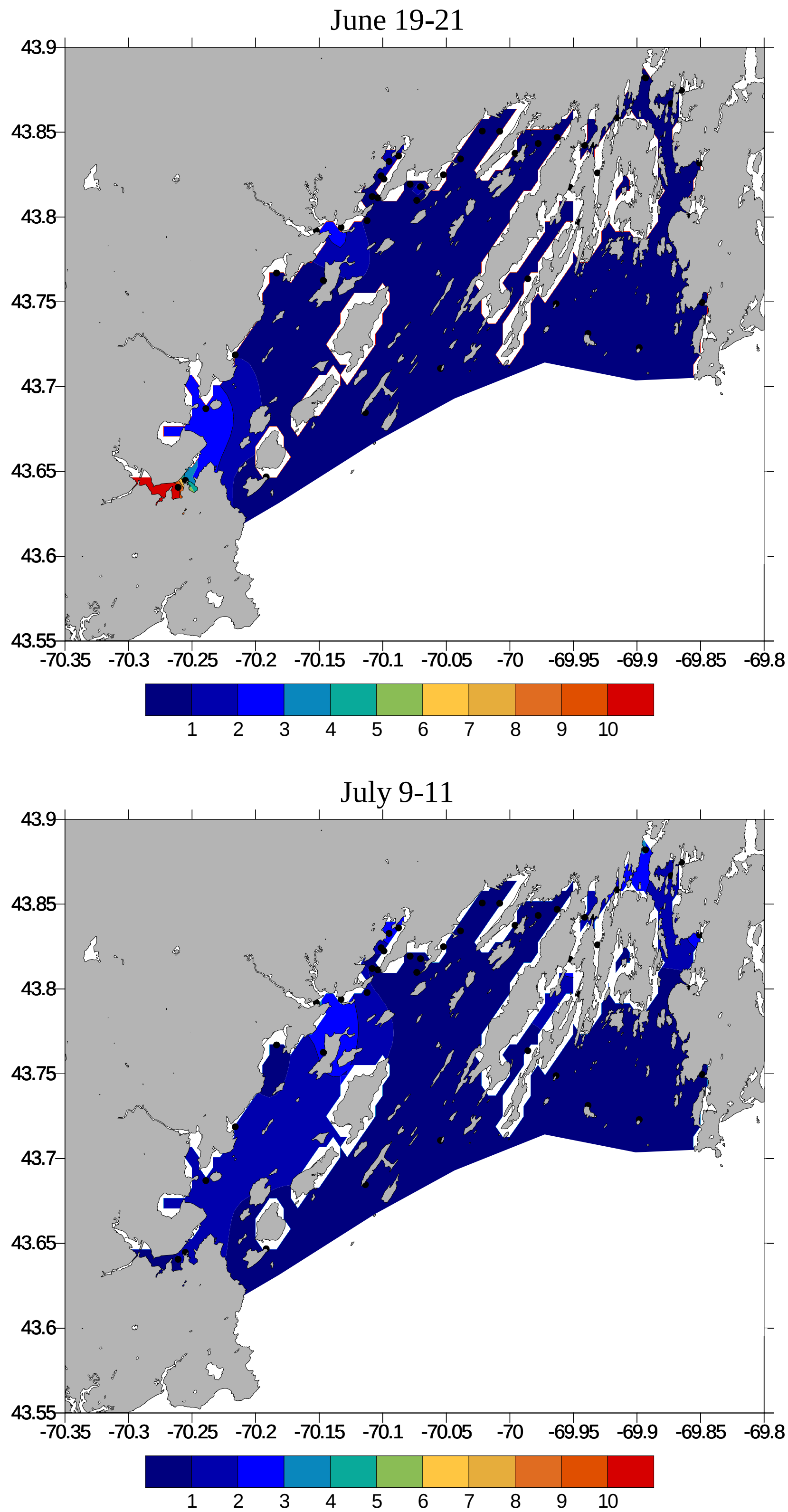
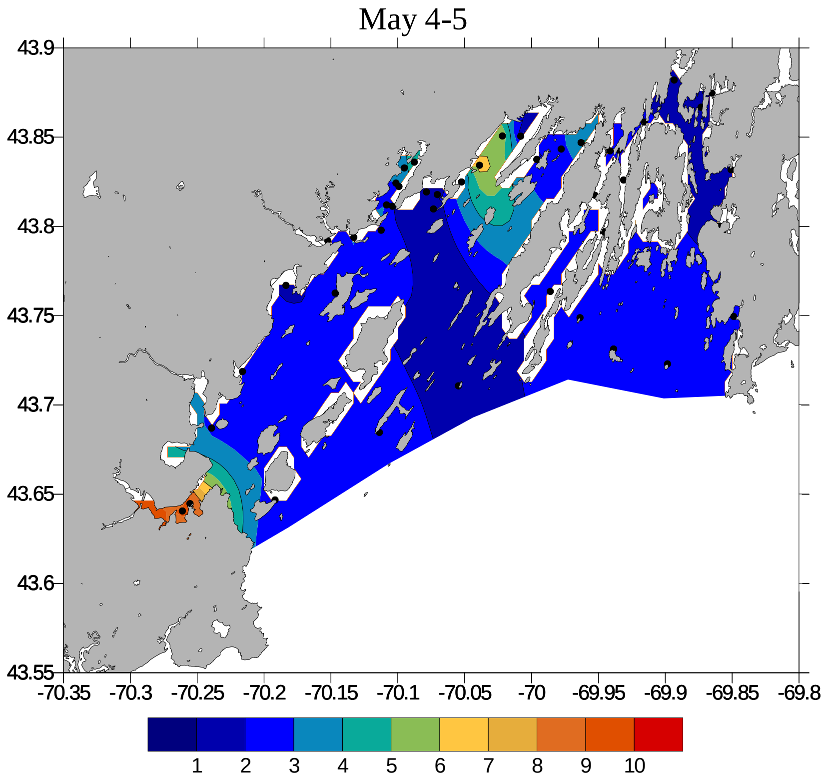


Figure 50. Surface water NH_4 (μM) on the June 19-21 and July 9-11, 2007 surveys. Station locations sampled denoted by black dots.



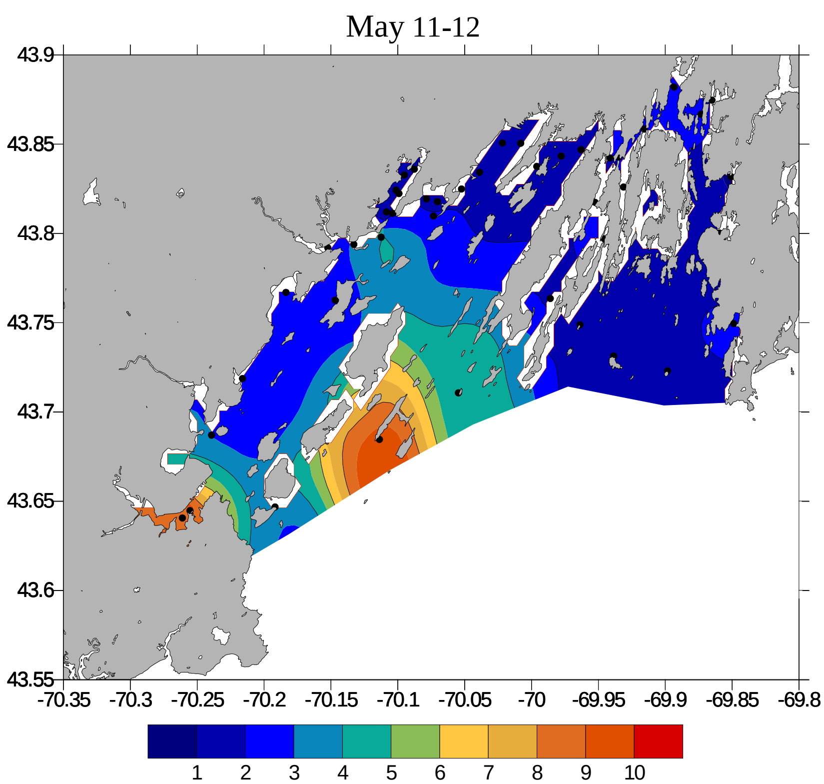


Figure 51. Surface water NH_4 (µM) on the May 4-5 and May 11-12, 2008 surveys. Station locations sampled denoted by black dots.

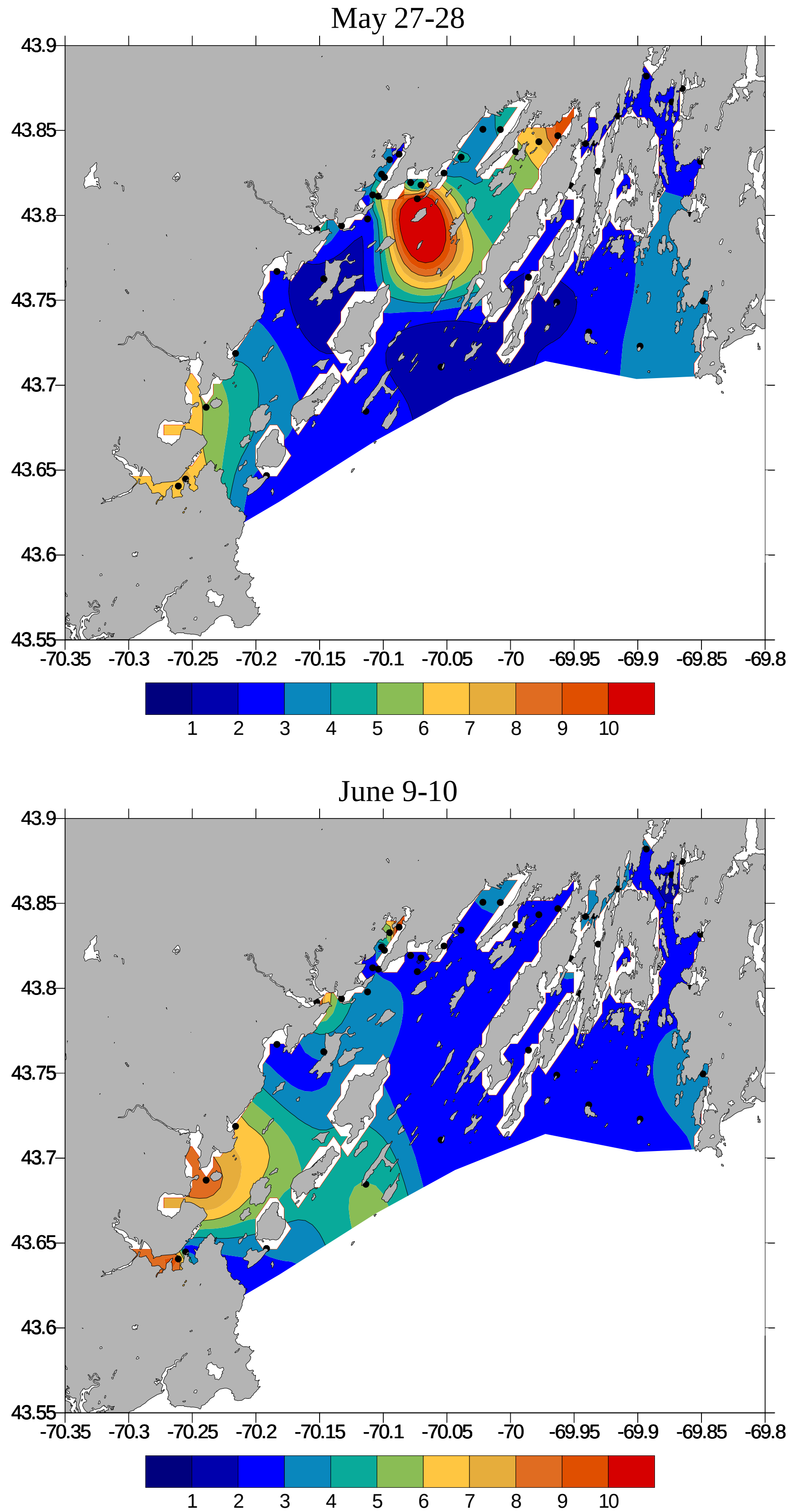
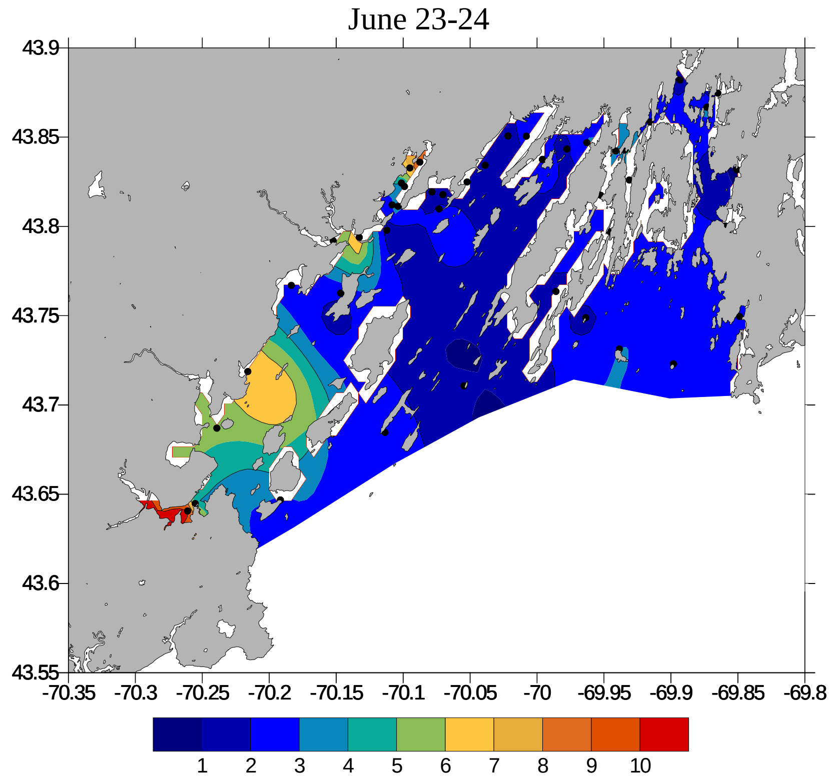


Figure 52. Surface water NH_4 (µM) on the May 27-28 and June 10, 2008 surveys. Station locations sampled denoted by black dots.



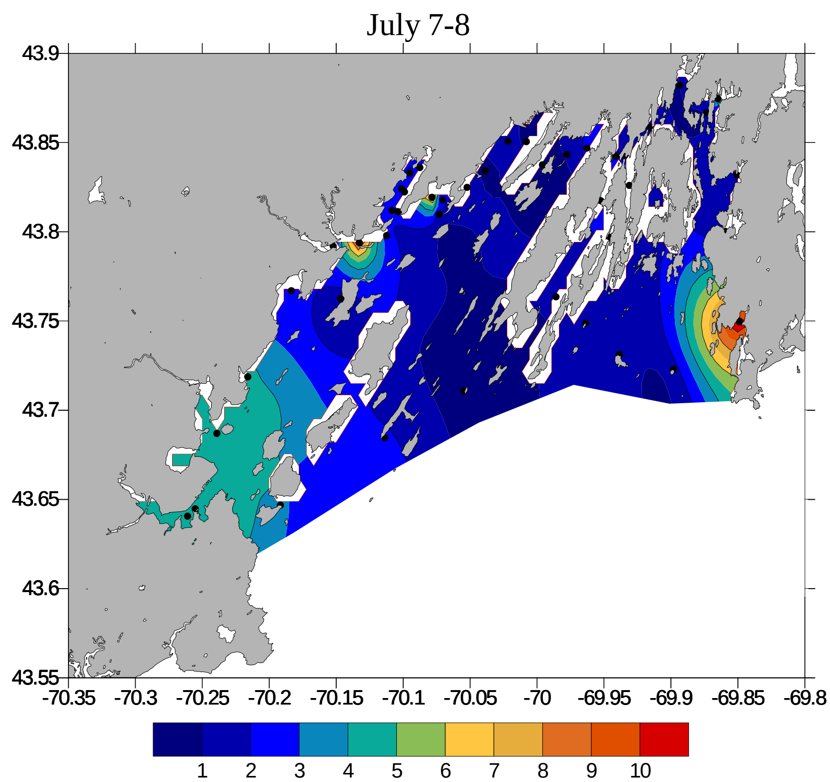


Figure 53. Surface water NH_4 (µM) on the June 23-24 and July 8, 2008 surveys. Station locations sampled denoted by black dots.

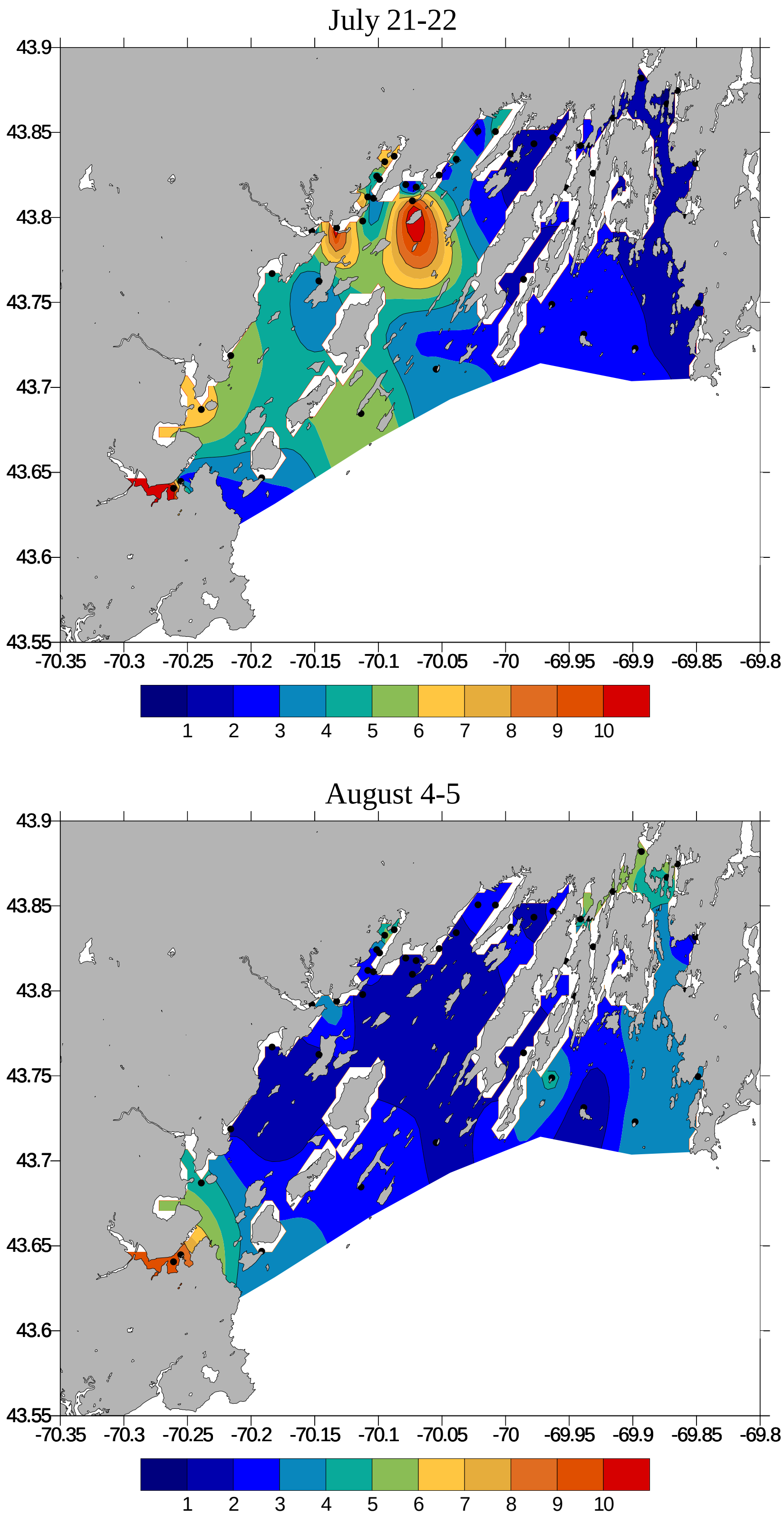


Figure 54. Surface water NH_4 (µM) on the July 21-22 and August 4-5, 2008 surveys. Station locations sampled denoted by black dots.

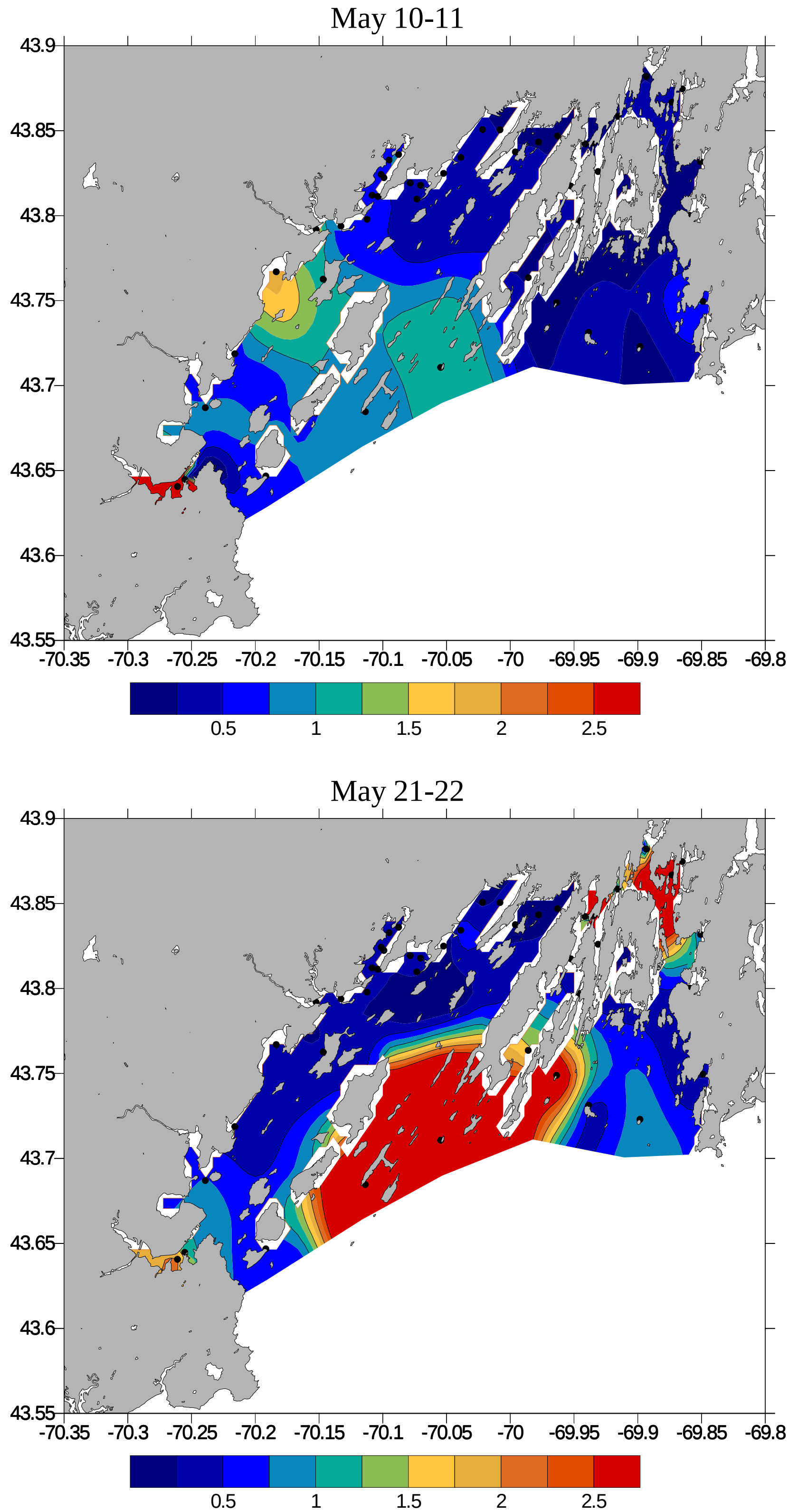


Figure 55. Surface water PO_4 (µM) on the May 10-11 and May 21-22, 2007 surveys. Station locations sampled denoted by black dots.

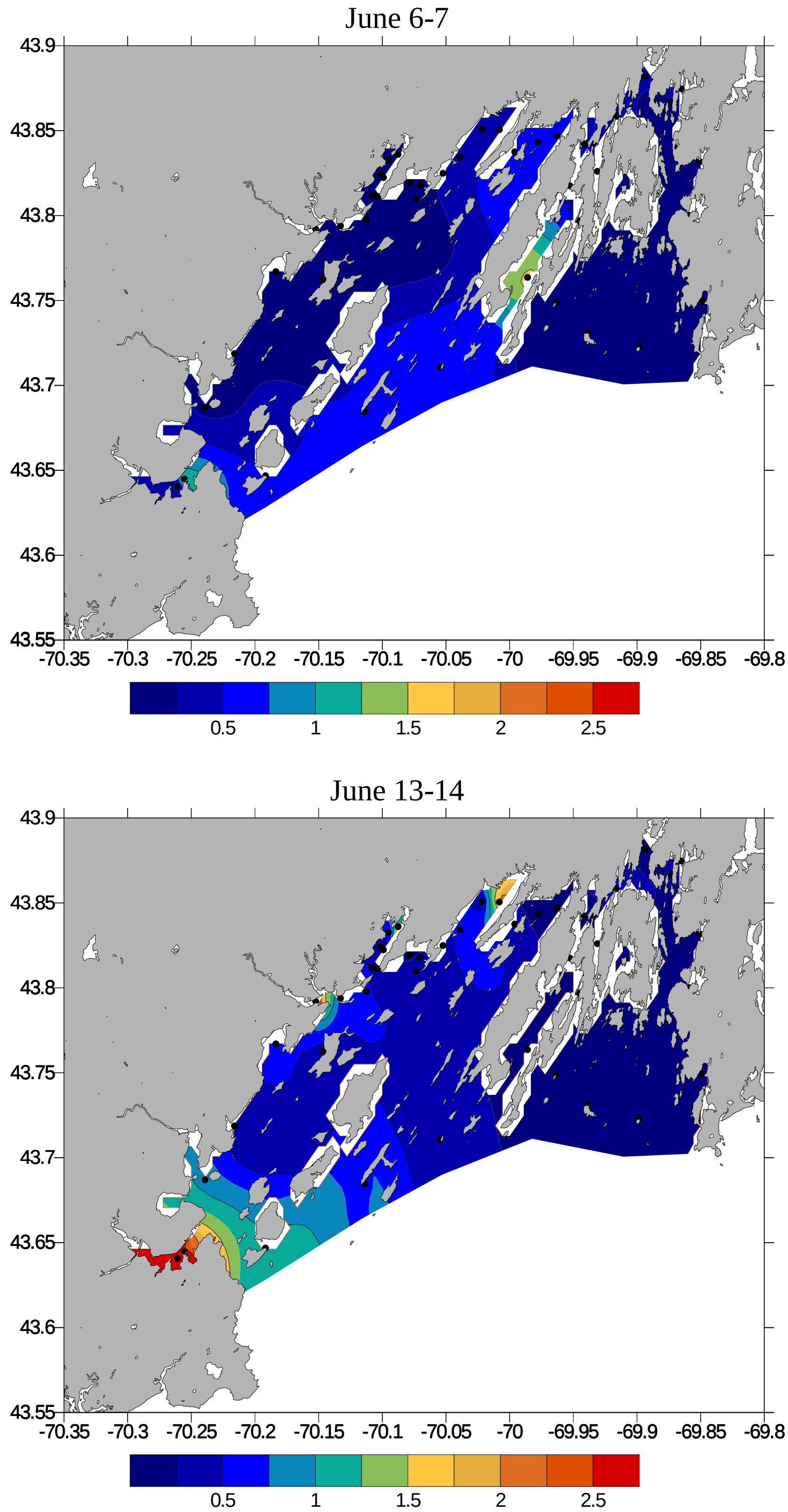
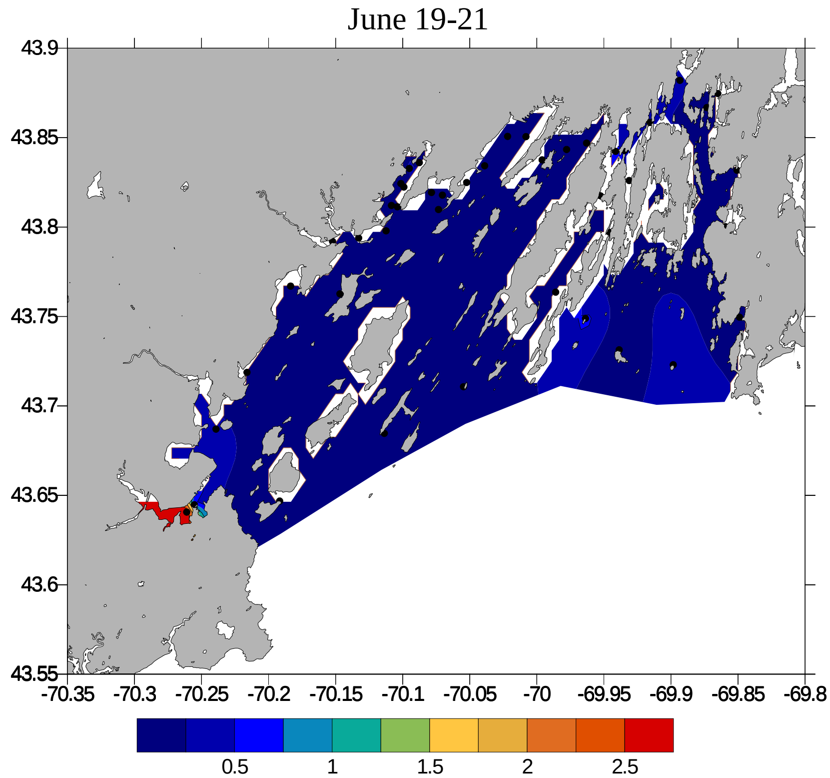


Figure 56. Surface water PO_4 (μM) on the June 6-7 and June 13-14, 2007 surveys. Station locations sampled denoted by black dots.



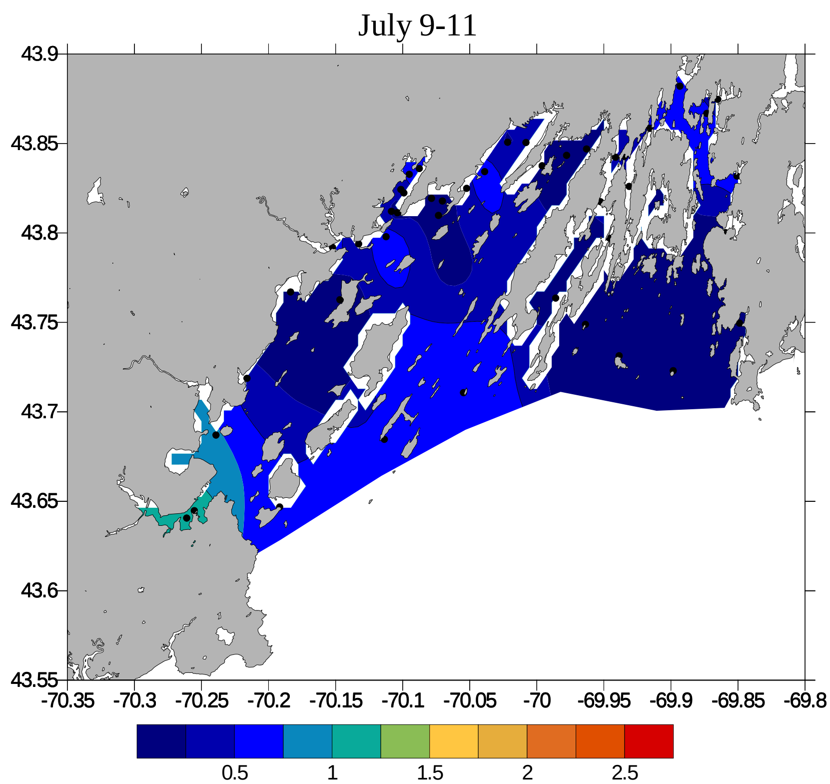
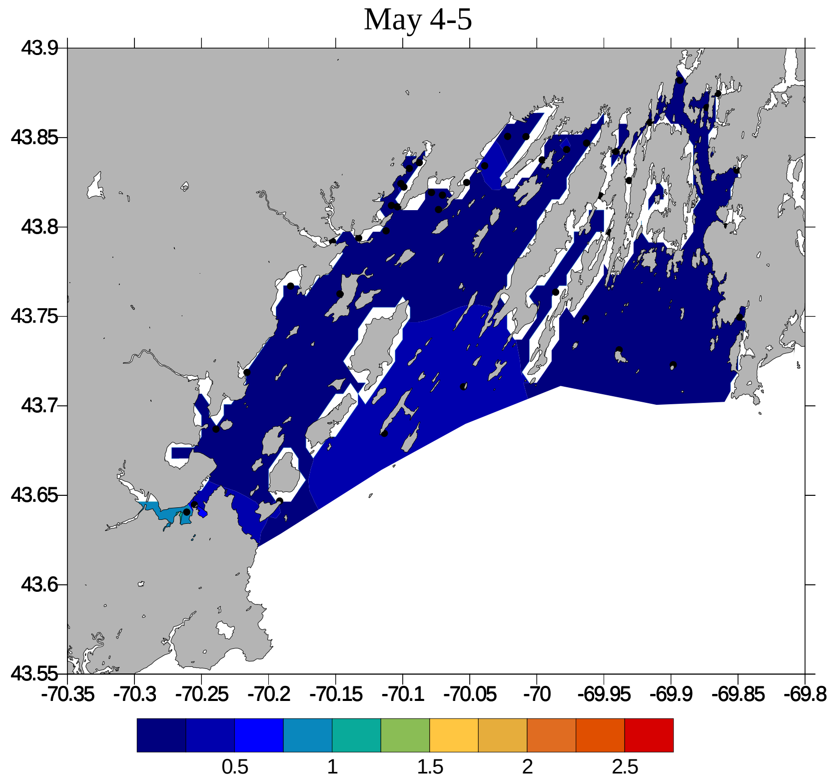


Figure 57. Surface water PO_4 (μM) on the June 19-21 and July 9-11, 2007 surveys. Station locations sampled denoted by black dots.



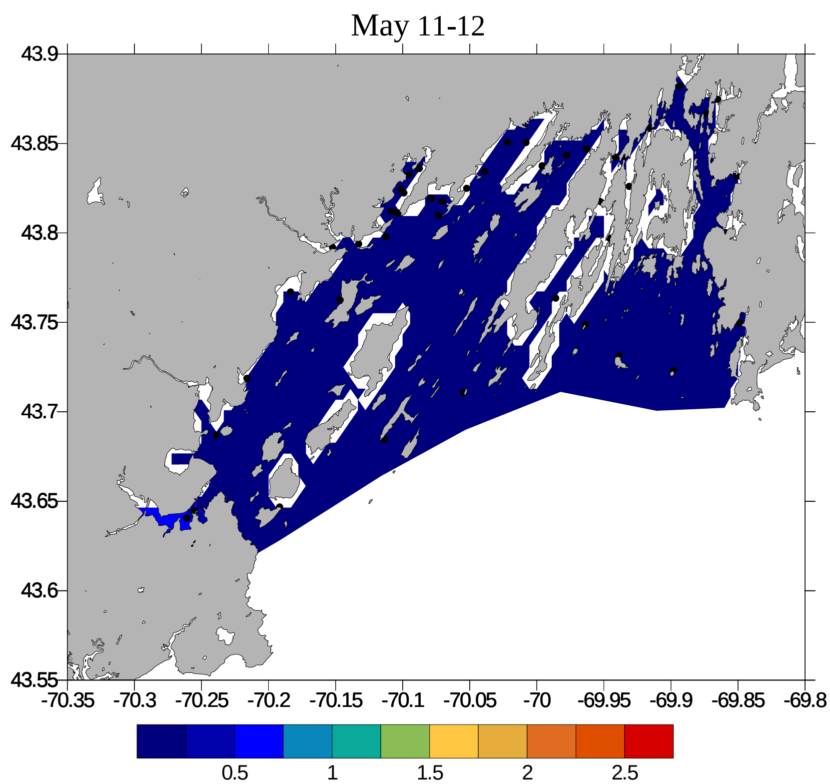


Figure 58. Surface water PO_4 (μM) on the May 4-5 and May 11-12, 2008 surveys. Station locations sampled denoted by black dots.

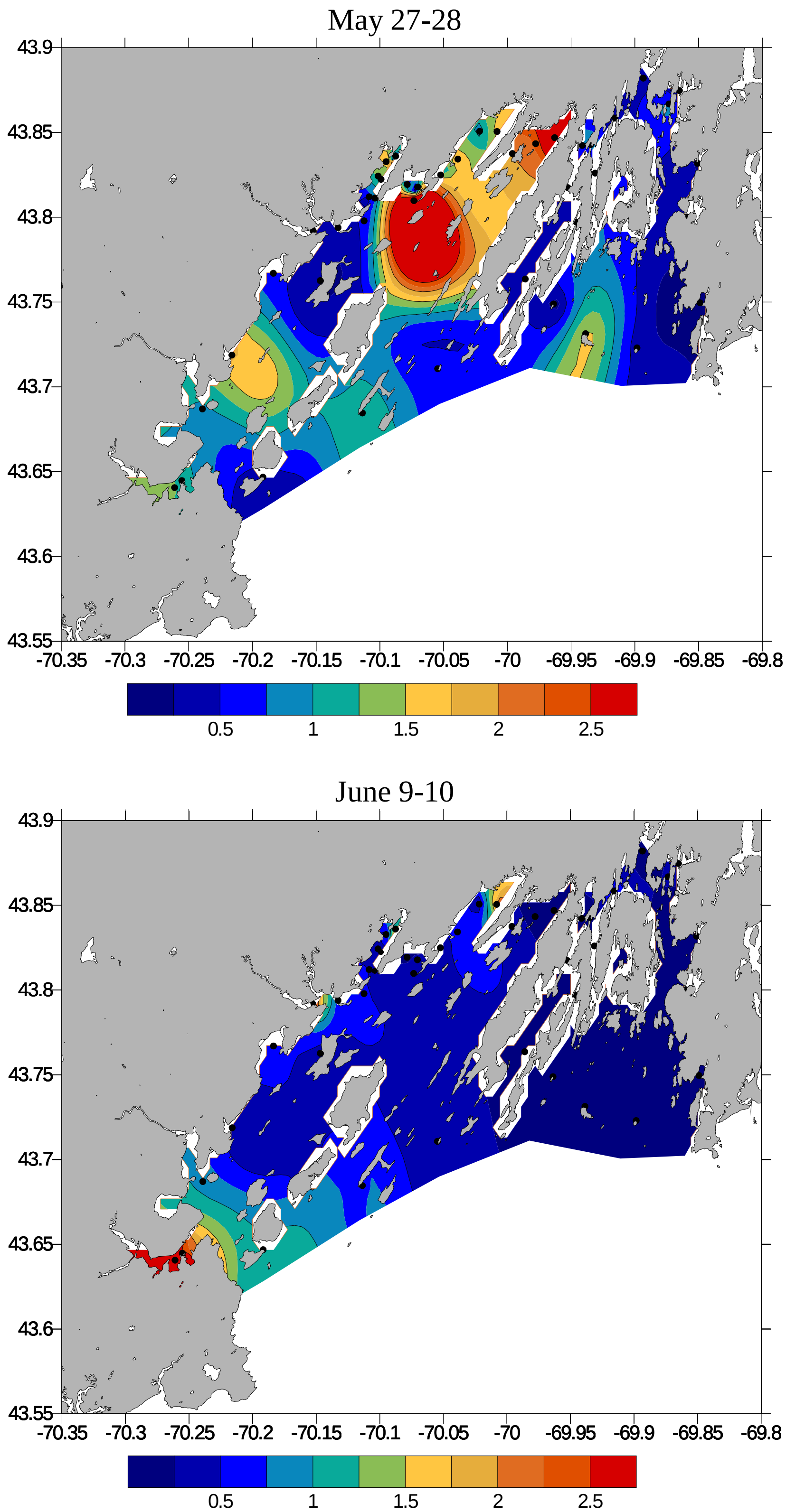


Figure 59. Surface water PO_4 (µM) on the May 27-28 and June 10, 2008 surveys. Station locations sampled denoted by black dots.

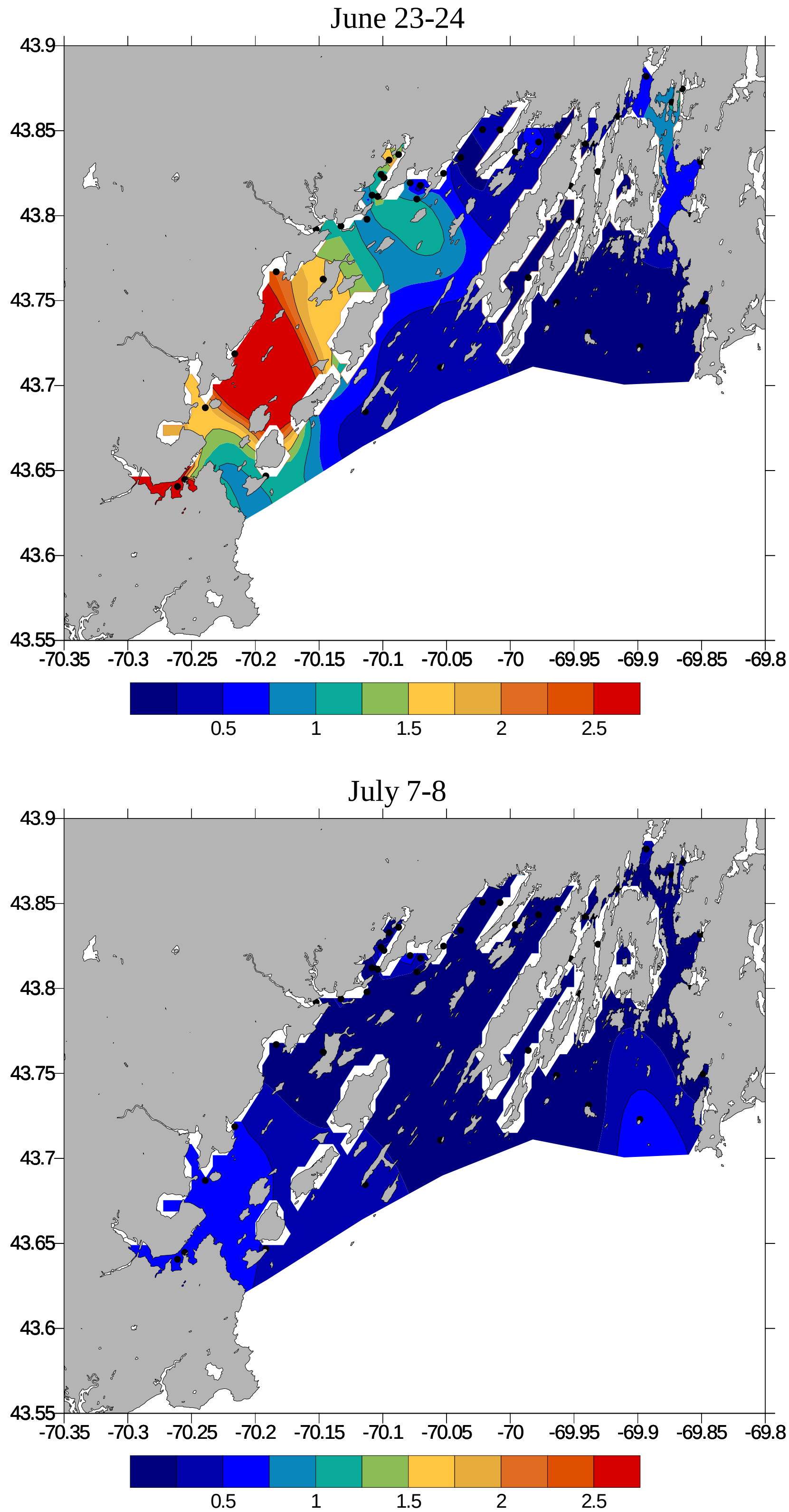
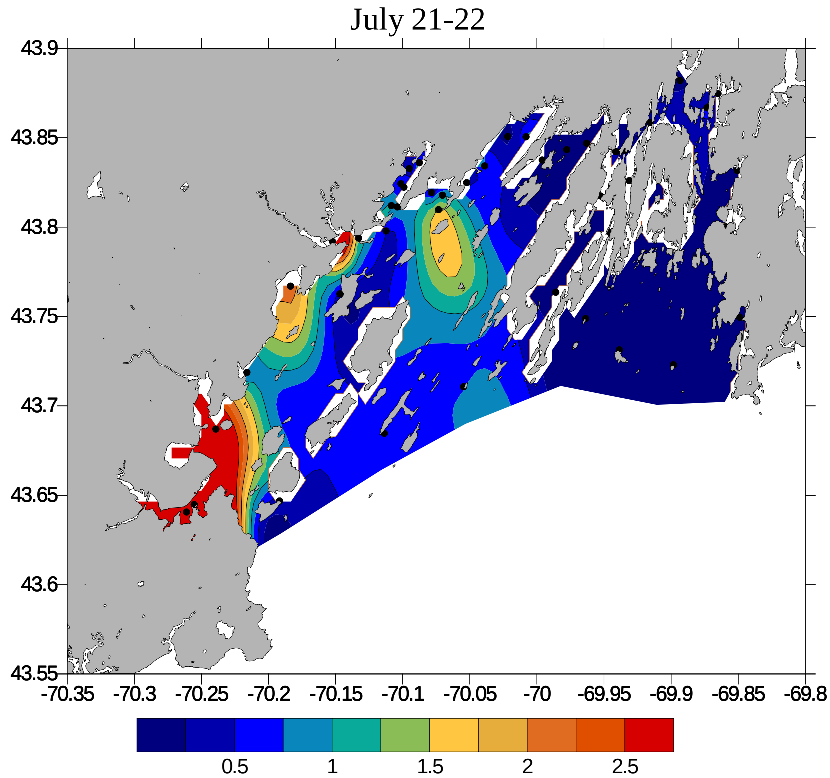


Figure 60. Surface water PO_4 (µM) on the June 23-24 and July 8, 2008 surveys. Station locations sampled denoted by black dots.



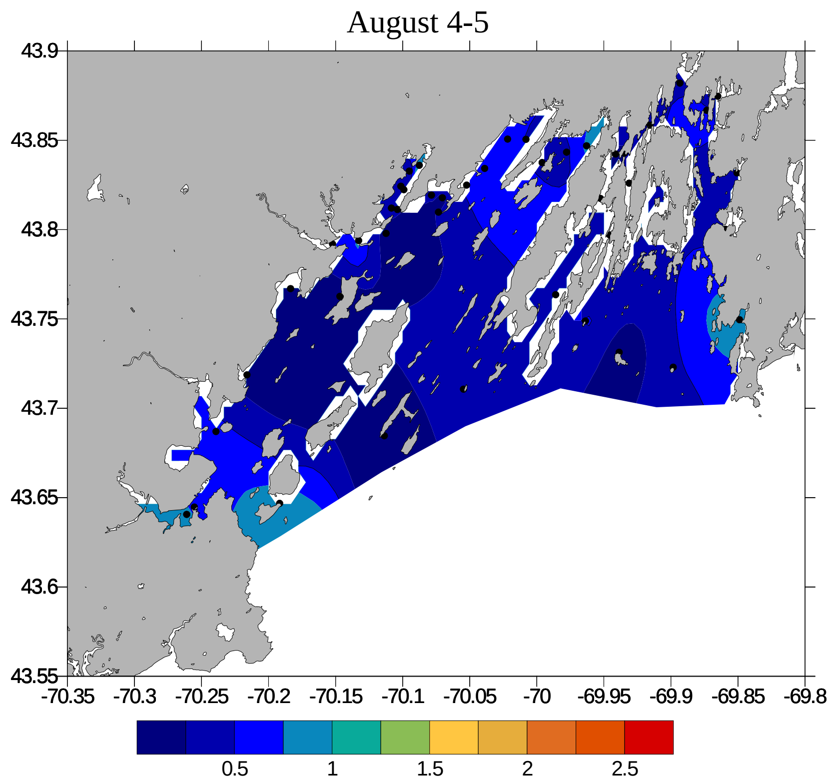


Figure 61. Surface water PO_4 (μM) on the July 21-22 and August 4-5, 2008 surveys. Station locations sampled denoted by black dots.