Semi-annual water column monitoring report: February - July 1997

Massachusetts Water Resources Authority

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February - July 1997

submitted to

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EXECUTIVE SUMMARY

The Massachusetts Water Resources Authority (MWRA) Harbor and Outfall Monitoring (HOM) Program has collected water quality data in Massachusetts and Cape Cod Bays since 1992. This monitoring is in support of the HOM Program mission to assess the potential environmental effects of effluent discharge relocation from Boston Harbor into Massachusetts Bay. The data are being collected to establish baseline water quality conditions and ultimately to provide the means to detect significant departure from that baseline. The data include physical water properties, nutrients, biological production and respiration, and plankton measurements. Two types of surveys are performed: nearfield surveys with stations located in the area around the future outfall site, and more comprehensive combined nearfield/farfield surveys that include stations in Boston Harbor, Massachusetts Bay, and Cape Cod Bay.

Water quality monitoring data presented in this report were collected during the first half of 1997 in the Massachusetts Bay system. The scope of this semi-annual report includes a synthesis of water column data, and a brief analysis of integrated physical and biological results. The objective of the report is to provide a visual presentation of the monitoring data submitted to MWRA five times per year in tabular format, and to discuss key biological events which occurred. To this end, graphical presentations of the horizontal and vertical distribution of water column parameters in the farfield and nearfield from the first nine surveys of 1997 are presented.

An overview of the data from the first semi-annual period is presented below. The Massachusetts Bay system undergoes strong seasonal stratification of the water column, and the timing of the onset of vertical stratification influences seasonal nutrient cycling and its effect on critical issues such as dissolved oxygen depletion in stratified bottom water. Results are discussed, therefore, in terms of the structure of the water column. In 1997, stratification began around the end of April, and was well established by mid-May.

During the first survey conducted during the pre-stratification period in early February of 1997, the water column was well mixed, and maximum regional nutrient concentrations for the reporting period were measured. Minimal phytoplankton activity was evident throughout the system, although somewhat lower nutrient concentrations in Cape Cod Bay were indicative of increased photosynthetic activity. Harbor stations were influenced by increased riverine discharge during the period. By the second survey in late February, the bloom in eastern Cape Cod Bay was fully developed. Primary productivity rates in the nearfield reached their seasonal maxima during this survey, and evidence from several supporting parameters indicated heightened activity throughout Massachusetts Bay. Activity at Harbor stations remained low.

By the third (nearfield only) survey conducted in March, surface algal activity in the nearfield appeared to decline. Nutrient uptake slowed, and surface chlorophyll and phytoplankton results were lower relative to the end of February. However, chlorophyll concentrations and particulate organic carbon did continue to increase in deeper water, resulting in high bottom water respiration. Primary production increased in the nearfield during the early April combined survey, and chlorophyll and carbon at depth reached their seasonal peak concentrations. A system-wide bloom of *Phaeocystis pouchetii* which began in late February reached its maximum concentrations during early April, with Cape Cod Bay densities reaching 15 million cellsL^{-1} and peak nearfield densities of around 7 million cellsL^{-1}. There was evidence that nutrient-limiting conditions had begun in the nearfield during this survey, and a seasonal peak in zooplankton abundance may have imparted substantial grazing pressure.

The onset of vertical stratification occurred in the inner nearfield by mid-April and was fully developed throughout the nearfield by mid-May. Stratification was augmented by an intrusion of low salinity surface water to the outer nearfield during late April and May resulting from a spring freshet. This intrusion apparently resupplied nutrients to the impoverished surface water, resulting in increased chlorophyll concentrations in the nearfield during May, particularly at mid-depth. In fact, mid-depth chlorophyll concentrations reached more than 12 µg/L and exceeded water column maxima reported during the late winter bloom by several-fold, producing substantial increases in primary production and respiration. Centric diatoms of the genus *Chaetoceros* were the dominant taxon responsible for this activity.

After the May survey, photosynthetic activity diminished in the more offshore regions of the nearfield, although heightened activity by the centric diatom *Rhizolsolenia fragilissima* and the dinoflagellate *Ceratium longipes* occurred offshore in late June. In Boston Harbor and coastal stations, a bloom developed in surface waters, producing the maximum surface chlorophyll concentrations measured during the reporting period. This bloom continued through most of June, and heavily influenced the inner nearfield stations. The inshore bloom was comprised primarily of *Chaetoceros* and *R. fragilissima.*

Peak bottom water dissolved oxygen (DO) concentrations were documented in late March, after which the seasonal decline of DO began. Following the mid-June survey, the steady decline in DO concentration reversed itself, and for the remaining two surveys in the period bottom water DO increased in both concentration and saturation. While localized primary productivity which was evident at mid-depth may have contributed to the observed increase, evidence from the USGS mooring suggests that a large-scale advection of oxygenated bottom water occurred in the nearfield during the period. This reversal in DO decline resulted in an increase in bottom water DO concentration of 1.5 mg/L.

1.0 INTRODUCTION

1.1 Program Overview

The Massachusetts Water Resources Authority (MWRA) has implemented a long-term Harbor and Outfall Monitoring (HOM) Program in the Massachusetts Bay system. The objective of the HOM Program is to verify compliance with the discharge permit, and to assess the potential environmental effects of the relocated effluent discharge into Massachusetts Bay. To establish baseline water quality conditions with respect to nutrients, water properties, phytoplankton and zooplankton, and water-column respiration and productivity, ENSR is conducting water quality surveys in the nearfield and farfield region of Massachusetts and Cape Cod Bays.

This semi-annual report summarizes water column monitoring results for the first 9 of 17 surveys conducted in 1997 (Table 1-1). Two types of surveys were performed during the first half of 1997: nine nearfield surveys with stations located in the area over the future outfall site (Figure 1-1), and four comprehensive surveys that included sampling of stations in Boston Harbor, Massachusetts Bay, and Cape Cod Bay (Figure 1-2). The stations in these surveys were further separated into regional groupings according to geographic location.

Raw data summaries, along with specific field information, are available in individual survey reports submitted immediately following each survey. In addition, nutrient data reports (including calibration information, sensor and water chemistry data), plankton data reports, and productivity and respiration data reports are each submitted five times annually. Raw data summarized within this or any of the other reports are available from MWRA in hard copy or electronic formats.

1.2 Organization of the Semi-Annual Report

The scope of the semi-annual report is focused primarily towards providing a compilation of all of the water column data collected during the reporting period. Secondarily, integrated physical and biological results are discussed for key water column events. The report first provides a summary of the survey and laboratory methods (Section 2). The bulk of the report, as discussed in further detail below, presents results of water column data from the first nine surveys of 1997 (Sections 3-5). Finally, the major findings of the semi-annual period, including integrated physical and biological water column results during water column events, are synthesized in Section 6.

In the results section, data are first provided in summary tables (Section 3). The data summary tables include the major results of water column surveys in the semi-annual period. A description of data selection, integration information, and summary statistics are included with that section.

Each of the summary results sections (Sections 4-5) includes presentation of the horizontal and vertical distribution of water column parameters in both the farfield and nearfield. The horizontal distribution of physical parameters is presented through regional contour plots. The vertical distribution of water column parameters is presented using both time-series plots of averaged surface and bottom water column parameters, and along vertical transects in the survey area (Figure 1-3). The time-series plots utilize average values of the surface water sample (the "A" depth, as described in Section 3), and the bottom water sample (the "E" depth). Examining data trends along three farfield transects (Boston-Nearfield, Cohassett, and Marshfield), and one nearfield transect, allows three-dimensional analysis of water column conditions during each survey.

Results of water column physical data, including water properties, nutrients, chlorophyll, and dissolved oxygen, are provided in Section 4. Survey results were organized according to the physical characteristics of the water column during the semi-annual period. The timing of water column vertical stratification, and the physical and biological status of the water column at the onset of stratification, to a large degree control ecological water quality parameters that are a major focus in assessing effects of the outfall. Because of the importance of this dynamic, this report describes the horizontal and vertical characterization of the water column during the pre-stratification stage (W9701-W9705), and then further delineates processes occurring during the early stratification stage (W9706-W9709). Time-series data are commonly provided for the entire semi-annual period for clarity of data presentation.

Productivity, respiration, and plankton measurements, along with corresponding discussion of chlorophyll and dissolved oxygen results, are provided in Section 5. Discussion of the biological processes and trends during the semi-annual period is included in this section. A summary of the major water column events of the semi-annual period is presented in Section 6, and finally, references are provided in Section 7.

TABLE 1-1

Water Quality Surveys for W9701-W9709
January to July 1997

Survey #	Type of Survey	Survey Dates
W9701	Nearfield/Farfield	February 1-6
W9702	Nearfield/Farfield	February 25 - March 1
W9703	Nearfield	March 17-18
W9704	Nearfield/Farfield	March 28 - April 6
W9705	Nearfield	April 22-23
W9706	Nearfield	May 12-13
W9707	Nearfield/Farfield	June 16-20
W9708	Nearfield	June 30 - July 1
W9709	Nearfield	July 21-22

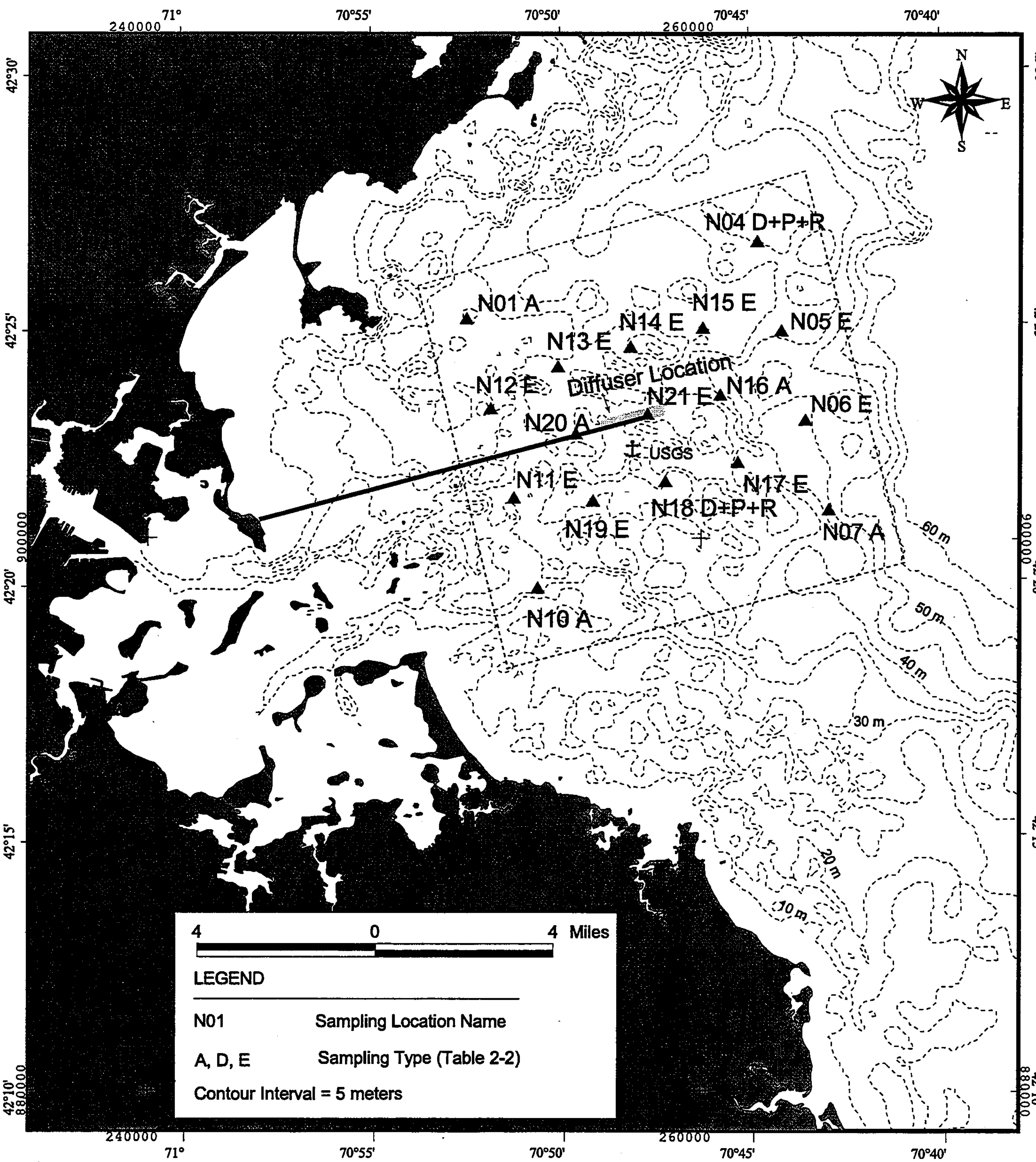


FIGURE 1-1
Location of Nearfield Stations

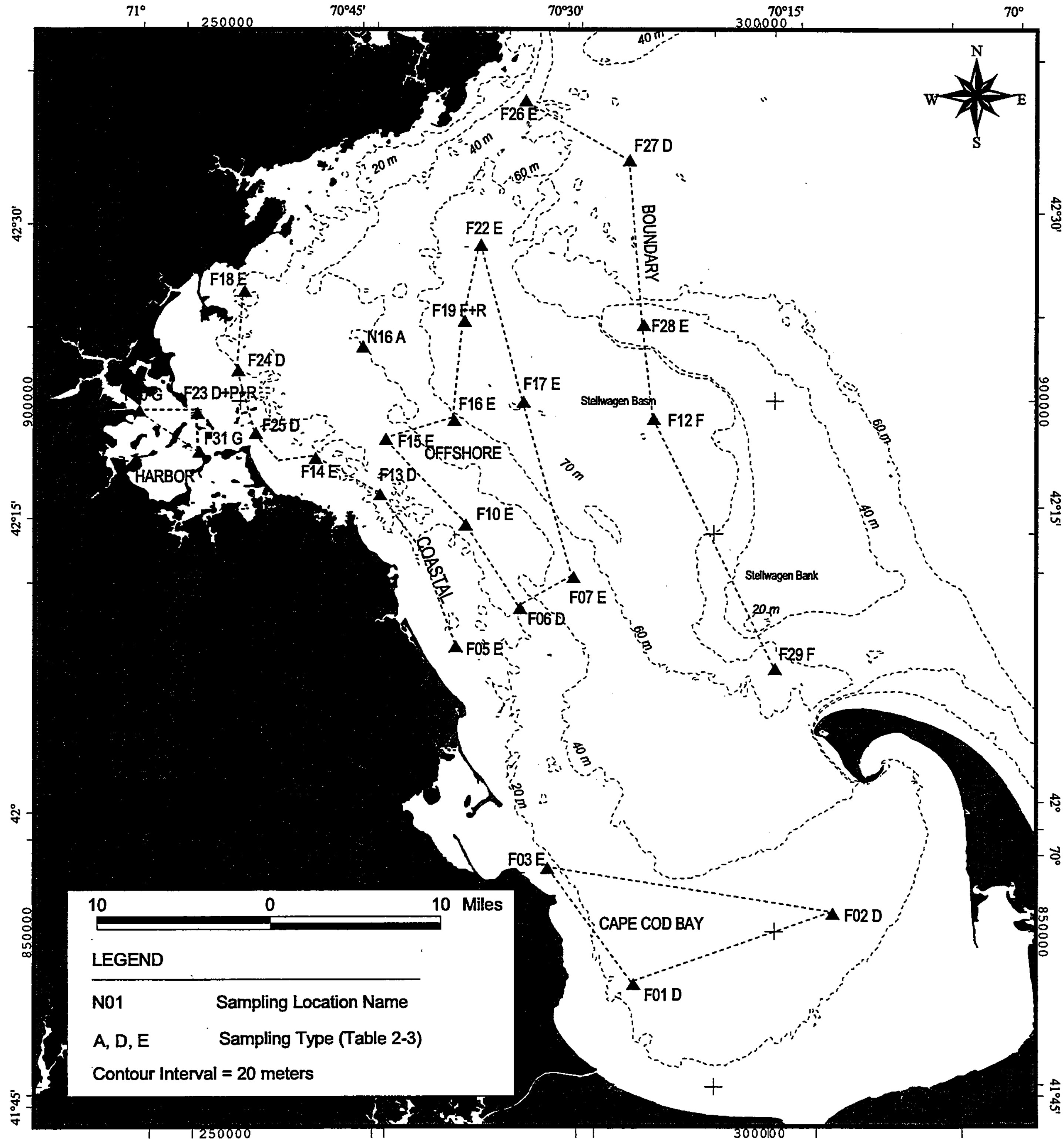


FIGURE 1-2

Location of Farfield Stations Showing Regional Geographic Classifications

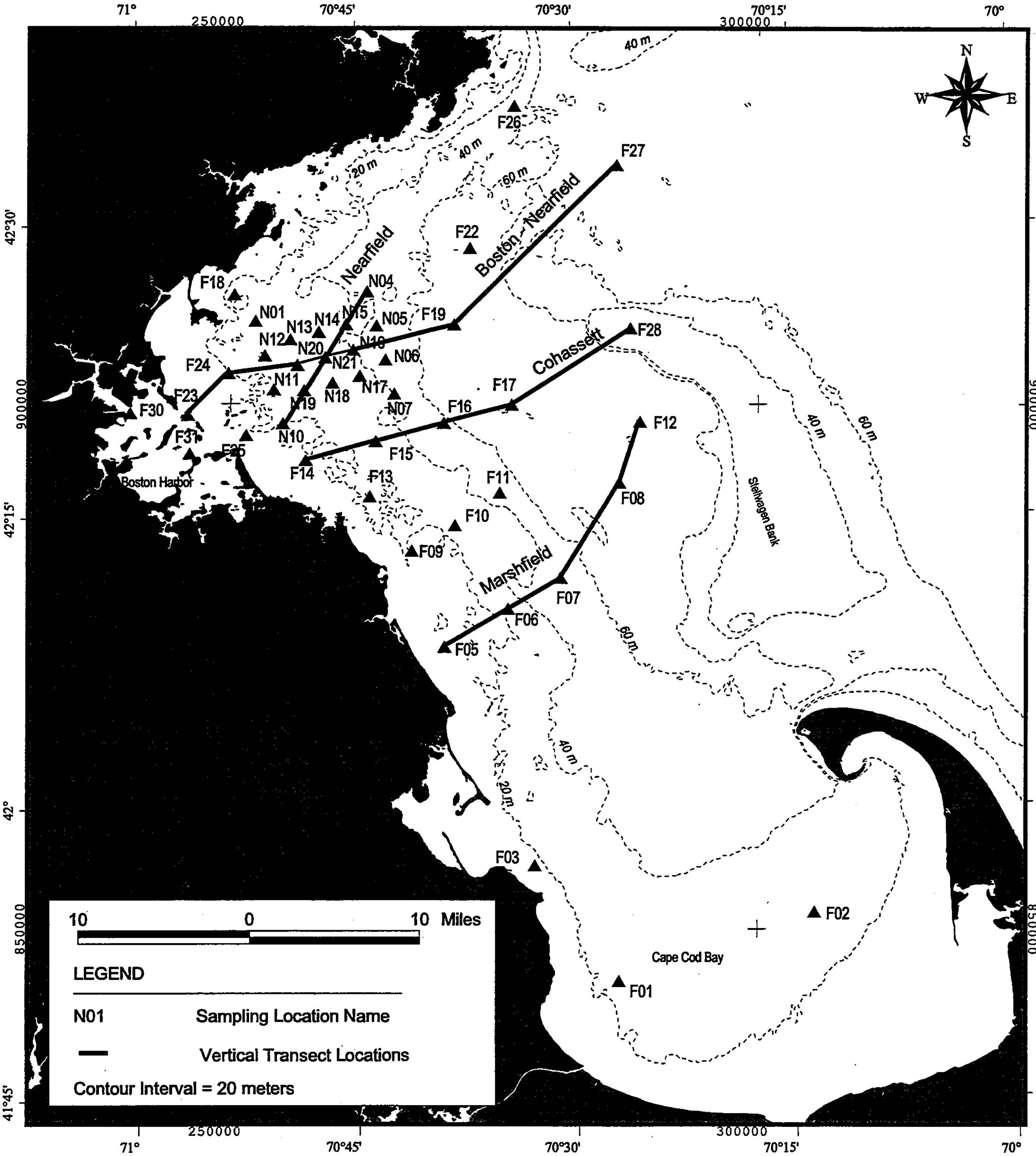


FIGURE 1-3

Location of Stations Selected for Vertical Transect Graphics

2.0 METHODS

This section describes general methods of data collection and sampling for the first nine water column monitoring surveys of 1997. Section 2.1 describes data collection methods, including survey dates, sampling platforms, and analyses performed. Section 2.2 describes the sampling schemes undertaken, and Section 2.3 details specific operations for the first 1997 semi-annual period. More specific details on field sampling and analytical procedures, laboratory sample processing and analysis, sample handling and custody, calibration and preventive maintenance, documentation, data evaluation, and data quality procedures are discussed in the Water Quality Monitoring CW/QAPP (Bowen *et al.*, 1997). Details on productivity sampling procedures and analytical methods are also available in the Water Quality Monitoring CW/QAPP (Bowen *et al.*, 1997).

2.1 Data Collection

Water quality data for this report were collected from the sampling platforms *R/V Christopher Andrew* and *R/V Isabel S.* Continuous vertical profiles of the water column and discrete water samples for analysis were collected using a CTD/Niskin Bottle Rosette system. This system includes a deck unit to control and store data, and an underwater unit comprised of several environmental sensors, including conductivity/salinity, temperature, depth, dissolved oxygen, transmissometry, irradiance, and relative fluorescence. These measurements were obtained at each station by deploying the CTD; in general, one cast was made at each station. Water column profile data were collected during the downcast, and water samples were collected during the upcast by closing the Niskin bottles at selected depths, as discussed below.

Water samples were collected at five depths at each station. These depths were selected during CTD deployment based on positions relative to the water column structure and presence of a subsurface chlorophyll maximum. The bottom depth (within 5 meters of the sea floor) and the surface depth (within 4 meters of the water surface) of each cast remained constant and the mid-bottom, middle and mid-surface depths were selected to represent any variability in the water column. In general, the selected middle depth corresponded with the chlorophyll maximum and/or pycnocline. Should the chlorophyll maximum have occurred closer to the surface or the bottom of the water column, the mid-surface or mid-bottom depths were selected to capture that layer. Water samples for analyses that are dependent on chlorophyll were taken from the bottles closed at the chlorophyll maximum, regardless of the depth at which the bottles were closed.

Exceptions to the water sampling procedure included productivity and respiration casts at Station F23 during each farfield survey, and at Stations N04 and N18 during each nearfield survey. At these stations, two casts were necessary in order to obtain a sufficient amount of water for the additional analyses. Productivity samples are also light dependent, and a "split-bottom" cast was sometimes necessary during the respiration and productivity cast in an attempt to capture not only bottom water, but also water associated with the 0.5% light level. This resulted in six to seven depths sampled, dependent upon the presence of stratification. These two casts were made in succession during a station visit, with time in between to relocate the vessel within a 300 meter radius of the station location.

Samples from each depth at each station were collected by subsampling from the Niskin bottles into the appropriate sample container. Analyses performed on the water samples are summarized in Table 2-1. Samples for dissolved inorganic nutrients (DINuts), dissolved organic carbon (DOC), total dissolved nitrogen (TDN) and phosphorous (TDP), particulate organic carbon (POC), biogenic silica, chlorophyll *a* and phaeopigments, total suspended solids (TSS), urea, and phytoplankton were filtered and preserved immediately after obtaining water from the appropriate Niskin bottles. Whole water phytoplankton samples (unfiltered) were obtained directly from the Niskin bottles and immediately preserved. Zooplankton samples were obtained by deploying a zooplankton net overboard and making an oblique tow of two-thirds of the water column or up to 30 meters of depth. In addition to survey replicates, ENSR added a rapid turnaround assessment of phytoplankton standing stock and presence of nuisance species dominant forms. Productivity and respiration samples were collected from the Niskin bottles and incubated on board the vessel during survey efforts.

2.2 Sampling Scheme

A synopsis of the sampling scheme for the analyses described above is outlined in Tables 2-1, 2-2, and 2-3. Stations were assigned a letter (A, D, E, F, or G) according to the types of analyses performed at that station. Productivity and respiration analyses were also conducted at certain stations and represented by the letters P and R, respectively. Since different analyses were performed at different depths, each depth at each station is assigned an analysis group (G1, G2, G3, G4, G5, G6, G7, G8, or G9; Table 2-1). Tables 2-2 (nearfield stations) and 2-3 (farfield stations) provide the station name and type, and give the analysis group that represents the analyses performed at each depth. Station N16 is considered both a nearfield station (where it is designated as type A) and a farfield station (where it is designated as type D).

2.3 Operations Summary

Changes in the 1997 sampling scheme from prior monitoring years included an alteration in sampling stations, and an increase in the number of samples taken at both "nearfield only" and combined nearfield/farfield stations and sample depths during stratified conditions. Together with existing sampling, productivity and respiration were measured at two stations, N04 and N18 during nine "nearfield only" surveys. Respiration analyses were measured at four stations (N04, N18, F19, and F23) during combined nearfield/farfield surveys. Respiration measurements were sampled at two additional depths during the stratified period. Productivity was measured at three stations (N04, N18, and F23) during the combined events, from the previous year's protocol. Additional areal productivity and respiration sampling at F23 during the flux survey was performed. DCMU fluorescence measurements were added at productivity stations to provide data supporting the development of proxy measurements of productivity using biooptical techniques. These results will be reported in the 1997 Annual Water Column Report. Exceptions to field operations for water column sampling and analysis during the first semi-annual period described above, are detailed below.

2.3.1 Deviations in Scope

Principal deviations from the CW/QAPP plan for each survey and the sampling scheme are described below. For additional information about a specific survey, the individual survey reports may be consulted.

Early February Nearfield/Farfield Survey (W9701):

- Triplicate samples were not taken at station N10 Due to a shortage in dissolved oxygen titration bottles.
- Screened phytoplankton samples were filtered with less than 4000 ml due to a shortage of water collected at several stations. The ANS laboratory was notified of these volumes.

Late February Nearfield/Farfield Survey (W9702):

- Per project management sampling effort and analysis of station N18 on Farfield Surveys was transferred to N16 for the remainder of all Combined Farfield/Nearfield Surveys.
- At Station F02, the tow volume might have been underestimated due to a high level of organics in the water column that clogged the zooplankton net.
- At Station F02, only 550#mls were filtered for POCN rather than the standard 650#mls due to the heavy organic content in the water column. The WHOI laboratory was notified of these volumes.
- DO duplicates were changed to F23 and F30 to coincide with the first and last station of the sampling effort.
- On March 5, 1997 the differential GPS radio beacon corrections were not available. Accurate on-station and off-station locations were obtained from the *Isabel S'* 12 channel GPS receiver with a 20'-40' accuracy.

Mid March Nearfield Survey (W9703):

- Due to the weather conditions, modifications in the planned survey track resulted in chlorophyll *a* duplicates taken at N16 and N04, and dissolved oxygen duplicates taken at N07 and N10.

Late March/Early April Nearfield/Farfield Survey (W9704):

- Due to modifications in the planned survey track on April 7, 1997, dissolved oxygen duplicates were taken at N10 instead of N01.

- No chlorophyll *a* duplicates were taken on April 7, 1997 as only three stations were sampled.

- Due to heavy volumes of debris which may have interfered with the tow meter rotation, tow volume may have been underestimated for all stations. The ANS Laboratory was notified.

- Due to a modification in the survey track, dissolved oxygen duplicates were obtained from F01 (bottom only), F02 (bottom only), F06, and F19. Duplicates and triplicates were obtained from N10, N07, and F27.

- Due to high concentrations of particulate matter in the water column, the volume filtered for POCN was modified, and the WHOI laboratory was notified of the changes.

Late April Nearfield Survey (W9705):

- To capture the chlorophyll peak at station N07, analyses performed at the B and C depths were switched.

Mid May Nearfield Survey (W9706):

- No deviations from the CW/QAPP occurred during this survey.

Mid June Nearfield/Farfield Survey (W9707):

- Due to a modification in the survey track, DO duplicates were taken at F02 instead of F01.

Early July Nearfield Survey (W9708):

- To capture the chlorophyll peak at station N18, analyses performed at the C and D depths were switched.

Late July Nearfield Survey (W9709):

- No deviations from the CW/QAPP occurred during this survey.

TABLE 2-1

Water Column Sample Analyses

Analysis	Analysis Group										
	G1	G2	G3	G4	G5	G6	G7	G8	G9	P	R
Dissolved Inorganic Nutrients	X	X	X	X	X	X	X	X			
Dissolved Organic Carbon	X	X	X								
Total Dissolved N & P	X	X	X								
Particulate C & N	X	X	X								
Particulate P	X	X	X								
Biogenic Silica	X	X	X								
Chlorophyll & Phaeopigments	X	X	X	X	X	X			X	X[1]	
Total Suspended Solids	X	X	X	X					X		
Dissolved Oxygen	X	X	X	X	X		X		X		X[1]
Urea	X	X									
All Phytoplankton	X	X									
Screened Phytoplankton	X	X									
Zooplankton	X										
Areal Productivity										X	
Respiration											X

X[1] Stratification dependent (see text)

TABLE 2-2

Analysis Group for Each Nearfield Station and Depth

Station Name	N01	N04	N05	N06	N07	N10	N11	N12	N13	N14	N15	N16	N17	N18	N19	N20	N21
Station Type	A	D+P+R*	E	E	A	A	E	E	E	E	E	A	E	D+P+R*	E	A	E
Nearfield Stations																	
Surface	G3	G1+P+R	G8	G8	G3	G3	G8	G8	G8	G8	G8	G3	G8	G1+P+R	G8	G3	G8
Mid-surface	G6	G6+P	G8	G8	G6	G6	G8	G8	G8	G8	G8	G6	G8	G6+P	G8	G6	G8
Middle	G3	G2+P+R	G8	G8	G3	G3	G8	G8	G8	G8	G8	G3	G8	G2+P+R	G8	G3	G8
Mid-bottom	G5	G5+P+R	G8	G8	G5	G8	G8	G8	G8	G8	G8	G5	G8	G5+P+R	G8	G5	G8
Bottom	G4	G3+P+R	G8	G8	G4	G8	G8	G8	G8	G8	G8	G4	G8	G3+P+R	G8	G4	G8

* Stratification dependent

TABLE 2-3

Analysis Group for Each Farfield Station and Depth

Station Name[1]	F01	F02	F03	F05	F06	F07	F10	F12	F13	F14	F15	F16	F17	F18	F19	F22	F23	F24	F25	F26
Station Type	D	D	E	E	D	E	E	F	D	E	E	E	E	E	F+R	E	D+P+R*	D	D	E
Farfield Stations																				
Surface	G1	G1	G8	G8	G1	G8	G8	G7	G1	G8	G8	G8	G8	G8	G7+R	G8	G1+P+R	G1	G1	G8
Mid-surface	G6	G6	G8	G8	G6	G8	G8	G8	G6	G8	G8	G8	G8	G8	G8	G8	G6+P	G6	G6	G8
Mid-depth	G2	G2	G8	G8	G2	G8	G8	G7	G2	G8	G8	G8	G8	G8	G7+R	G8	G2+P+R	G2	G2	G8
Mid-bottom	G5	G5	G8	G8	G5	G8	G8	G7	G5	G8	G8	G8	G8	G8	G7	G8	G5+P+R	G5	G5	G8
Bottom	G3	G3	G8	G8	G3	G8	G8	G7	G3	G8	G8	G8	G8	G8	G7+R	G8	G3+P+R	G3	G3	G8

Station Name	F27	F28	F29	F30	F31	N16
Station Type	D	E	F	G	G	D
Surface	G1	G8	G7	G1	G1	G1
Mid-surface	G6	G8	G8	G0	G0	G6
Mid-depth	G2	G8	G7	G2	G2	G2
Mid-bottom	G5	G8	G7	G0	G0	G5
Bottom	G3	G8	G7	G4	G4	G3

[1]Stations F04, F08, F09, F11, F20 and F21 have been replaced by or changed to stations F27, F28, F29, F30, F31 and N16.

*Stratification dependent

3.0 DATA SUMMARY PRESENTATION

Data from each survey were compiled from the complete HOM Program 1997 database and organized to facilitate regional comparisons between surveys (Tables 3-1 through 3-9). Each table provides summary data from one survey; the survey dates are provided at the top of each table. A discussion of which parameters were selected, how the data were grouped and integrated, and the assumptions behind the calculation of statistical values (average, minimum, and maximum), are provided below. All raw data summarized in this report are available from MWRA either in hard copy or electronic form.

The spatial pattern of data summary follows the sample design over major geographic areas of interest in Massachusetts Bay, Cape Cod Bay, and Boston Harbor (Section 3.1). Compilation of data both horizontally by region and vertically over the entire water column was conducted in order to provide an efficient way of assessing the status of the regions during a particular survey. Maximum and minimum values are provided because of the need to assess extremes of pre-outfall conditions relative to criteria being developed for contingency planning purposes (MWRA, 1997).

Regional compilations of nutrient and biological water column data were conducted first by averaging individual laboratory replicates, followed by field duplicates, and then by station visit. Significant figures for average values were selected based on the precision of the specific dataset. Detailed considerations for individual datasets are provided in the sections below.

3.1 Defined Geographic Areas

The primary partitioning of data is between the nearfield and farfield stations (Figures 1-1 and 1-2). Farfield data were additionally segmented into five geographic areas: three stations in Boston Harbor (F23, F30, and F31), six coastal stations (F05, F13, F14, F18, F24, F25), eight offshore stations (F06, F07, F10, F15, F16, F17, F19, and F22), five boundary region stations (F12, F26, F27, F28, F29), and three Cape Cod Bay stations (F01, F02, and F03). These regions are shown in Figure 1-2.

The data summary tables include data that are derived from all of the station data collected in each region. Average, maximum, and minimum values are reported from the cumulative horizontal and vertical dataset as described for each data type below.

3.2 Sensor Data

The six CTD profile parameters provided in the data summary tables include temperature, salinity, density (σ_t), fluorescence (chlorophyll *a*), transmissivity, and dissolved oxygen (DO) concentration. Statistical parameters (maximum, minimum, and average) were calculated from the five upcast sensor readings collected at five depths through the water column (defined as A-E). The five depth values, rather than the entire set of profile data, were selected in order to reduce the statistical weighting of deep water data at the offshore and boundary stations. Generally, the samples were collected in an even depth-distributed pattern. One of the mid-depth samples (B, C, or D) was typically located at the fluorescence (chlorophyll) peak in the water column (when present), depending on the relative depth of the chlorophyll maximum. Details of the collection, calibration, and processing of CTD data are available in the Water Column Monitoring CW/QAPP (Bowen *et al.*, 1997), and are summarized in Section 2.

Following standard oceanographic practice, patterns of variability in water density will be described using the derived parameter σ_t, which is calculated by subtracting 1,000 kg/m^3 from the recorded density. During this semi-annual period, density varied from 1,021.8 kg/m^3 to 1,025.7 kg/m^3, equivalent to σ_t values from 21.8 kg/m^3 to 25.7 kg/m^3.

Fluorescence data were calibrated to the amount of chlorophyll *a* in discrete water samples collected at the depth of the sensor reading for a subset of the stations (see CW/QAPP or Tables 2-1, 2-2, 2-3). The calibrated chlorophyll sensor values were used for all discussions of chlorophyll in this report. Phaeopigment concentrations were also included in the summary results.

In addition to DO concentration, the derived percent saturation was also provided. Percent saturation was calculated prior to averaging station visits from the potential saturation value of the water (a function of the physical properties of the water) and the calibrated DO concentration (see CW/QAPP). Beam attenuation was calculated from the ratio of light transmission relative to the initial light incidence, over a particular distance in the water column, and is provided in units of m^{-1}.

3.3 Nutrients

Analytical results for nutrient concentration more typically NO_3 + NO_2 were extracted from the HOM database, and include: ammonium (NH_4), nitrite (NO_2), nitrite + nitrate (NO_2 + NO_3), phosphate (PO_4), and silicate (SiO_4). Nutrients were measured in water samples collected at each of the A-E depths during the CTD casts. Information on the collection, processing, and analysis of nutrient samples can be found in the CW/QAPP (Bowen *et al.*, 1997).

3.4 Biological Water Column Parameters

Three productivity parameters were selected for inclusion in the data summary tables. Areal production, which is determined by integrating the measured productivity over the photic zone, is included for the productivity stations (F23 representing the harbor; N04 and N18 representing the nearfield). Because areal production is already depth-integrated, averages were calculated only among productivity stations for the two regions sampled. The derived parameters α (gC[gChla]$^{-1}$h^{-1}[μEm^{-2}s^{-1}]$^{-1}$), and Pmax (gC[gChla]$^{-1}$h^{-1}) were also included.

Respiration rates were averaged over the respiration stations (the same harbor and nearfield stations as productivity, and additionally one offshore station, F19), and over the three to five water column depths sampled (dependent upon stratification). The water column depths of the respiration samples typically coincided with the water depths of the productivity measurements.

Dissolved and particulate organic parameters also summarized for the tables include: biogenic silica (BIOSI), dissolved and particulate organic carbon (DOC and POC), particulate and total dissolved phosphate (PART P, TDP), particulate organic and total dissolved nitrogen (PON and TDN), and urea. Total suspended solids (TSS) data were provided as a baseline for total particulate matter in the water column. Dissolved and particulate constituents were measured from water samples collected from each of the five (A-E) depths during CTD casts. Detailed methods of sample collection, processing, and analysis are available in the CW/QAPP (Bowen *et al.*, 1997).

3.5 Plankton

Plankton results were extracted from the HOM database and include whole water phytoplankton, screened phytoplankton, and zooplankton. Phytoplankton measurements included whole-water collections at the surface (A depth) and at the water column chlorophyll *a* maximum (C depth) during the water column casts. Additional samples were taken at these two depths and screened through 20μm Nitex mesh to retain and concentrate dinoflagellate species and other larger taxa. Zooplankton measurements were collected through oblique tows at all stations. Detailed methods of sample collection, processing, and analysis are available in the CW/QAPP (Bowen *et al.*, 1997).

Final plankton values were derived for each cast by first averaging analytical replicates, then averaging station visits. Values were calculated from the data for the following parameters: nuisance algae (*Alexandrium tamarense, Phaeocystis pouchetii, and Pseudo-nitzschia pungens*), total phytoplankton, total zooplankton, and total centric diatoms. Only the maximum of each plankton parameter is presented in the summary tables due to the program emphasis on the magnitude of plankton response to nutrient concentrations.

3.6 Additional Data

Additional data sources were utilized during interpretation of HOM Program semi-annual water column data. Continuous monitoring data, collected from a mooring located between nearfield stations N21 and N18 (Figure 1-1) were provided by the USGS. Hourly temperature and salinity data from 22.4 m and 27.8 m USGS buoy data were averaged over each day, and plotted with HOM survey data from station. Discrete data from N16 were selected from water depths that were most consistent with the depths of mooring data, and plotted with the continuous data for comparison. Finally, major meteorological events that occurred over the year, including hurricanes, northeasters, and records of precipitation, were summarized for additional data interpretation.

TABLE 3-1
Semi-Annual Data Summary Table
Event W9701 (2/04/97 - 2/06/97)
Combined Nearfield/Farfield Survey

Region		Nearfield			Farfield															
					Harbor			Coastal			Offshore			Boundary			Cape Cod Bay		
Parameter	Unit	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
In-situ																			
Chlorophyll a	µg/L	0.00	0.50	0.16	0.00	0.25	0.12	0.00	0.38	0.16	0.00	0.58	0.16	0.00	0.47	0.19	0.36	0.98	0.56
Salinity	psu	30.8	32.1	31.7	29.5	31.2	30.5	30.6	31.8	31.3	31.2	32.3	31.7	31.3	32.4	31.9	30.8	31.3	31.1
Sigma_T	kg/m^3	24.6	25.4	25.2	23.5	24.9	24.3	24.4	25.3	24.9	24.8	25.5	25.2	24.8	25.6	25.3	24.6	24.9	24.8
Temperature	°C	2.3	4.7	3.6	2.1	3.1	2.6	2.2	3.8	2.9	2.7	5.0	3.9	3.7	5.3	4.4	2.7	3.2	2.9
Transmissivity	m-1	0.67	2.39	0.99	1.40	2.92	1.86	0.97	1.75	1.41	0.66	1.17	0.85	0.66	1.91	0.88	0.92	1.44	1.09
Nutrients																			
NH_4	µM	0.49	6.21	1.24	4.90	9.62	6.74	0.69	7.20	2.83	0.42	1.70	0.81	0.41	1.24	0.68	0.68	1.22	0.86
NO_2	µM	0.10	0.29	0.14	0.25	0.36	0.29	0.12	0.32	0.20	0.09	1.07	0.18	0.12	0.16	0.14	0.14	0.19	0.15
$NO_2 + NO_3$	µM	8.3	10.8	8.9	10.0	11.9	10.6	7.9	10.5	9.2	7.8	9.4	8.7	8.0	9.5	8.8	6.4	7.5	6.9
PO_4	µM	0.83	1.14	0.91	1.01	1.29	1.15	0.84	1.24	1.00	0.83	1.09	0.90	0.90	1.01	0.96	0.81	0.88	0.84
SIO_4	µM	8.1	12.4	9.2	11.9	14.9	13.5	7.5	13.0	10.3	7.7	10.5	9.1	9.0	12.0	9.8	7.2	9.6	7.6
Phaeopigment	µg/L	0.01	0.13	0.04	0.02	0.12	0.06	0.01	0.10	0.05							0.02	0.22	0.07
DO																			
Concentration	mg/l	9.7	10.6	10.4	10.3	10.7	10.5	10.2	10.9	10.6	9.7	10.8	10.4	9.5	10.6	10.2	8.4	11.0	10.7
Saturation	%	94	99	97	93	96	95	95	99	97	94	100	98	93	100	97	76	101	98
Productivity																			
Alpha	see text	0.01	0.04	0.02	0.01	0.01	0.01												
Areal Production	$mgC/m^2/d$	155.2	336.4	245.8	13.2	13.2	13.2												
Pmax	see text	1.3	4.6	2.9	0.6	1.8	1.2												
Respiration	µmol/h	0.03	0.05	0.04	0.06	0.37	0.22				0.01	0.03	0.02						
Water Column																			
BIOSI	µM	0.8	3.3	1.5	1.4	2.4	2.0	0.8	2.8	2.3	0.9	1.3	1.1	0.8	4.5	2.2	1.4	1.9	1.6
DOC	mg/L	0.9	1.4	1.1	1.1	1.4	1.3	1.0	1.4	1.2	1.1	1.2	1.1	0.9	1.1	1.0	1.0	1.3	1.2
PART P	µM	0.05	0.28	0.12	0.28	0.45	0.37	0.11	0.34	0.21	0.08	0.14	0.10	0.07	0.16	0.10	0.12	0.14	0.13
POC	µM	7.1	22.9	11.7	20.9	90.1	35.7	8.1	24.4	16.0	7.6	11.7	9.3	11.0	14.4	12.3	16.3	19.4	17.8
PON	µM	0.80	2.55	1.44	2.11	7.87	3.79	0.97	4.07	2.18	1.11	1.36	1.24	1.52	1.52	1.52	1.70	2.27	1.93
TDN	µM	12.3	23.2	15.4	22.1	30.1	25.5	12.9	24.7	17.6	11.7	12.4	12.0	13.0	14.0	13.4	11.8	13.7	12.8
TDP	µM	1.01	1.36	1.17	1.18	1.58	1.36	0.90	1.33	1.17	1.05	1.13	1.08	1.17	1.23	1.20	0.84	1.00	0.91
TSS	mg/L	0.0	4.2	0.9	1.1	3.8	2.0	1.1	3.6	2.0	0.1	0.9	0.4	0.2	2.4	1.0	0.2	1.6	1.0
Urea	µM																		
Plankton																			
Total Phytoplankton	Mcell/L		0.57			0.39			0.43			0.59			0.52			0.71	
Centric diatoms	Mcell/L		0.03			0.02			0.02			0.07			0.02			0.08	
Alexandrium tamarense	Mcell/L		NP			NP			NP			NP			NP			NP	
Phaeocystis pouchetii	Mcell/L		1.19E-03			NP			NP			1.21			6.60E-05			9.23E-02	
Pseudo-nitzschia sp	Mcell/L		8.53E-04			1.22E-04			1.11E-04			9.42E-04			2.78E-03			4.71E-04	
Total Zooplankton	$\#/m^3$		51094			7659			8713			36532			5644			28562	

NP - Not Present

TABLE 3-2
Semi-Annual Data Summary Table
Event W9702 (2/25/97 - 2/27/97)
Combined Nearfield/Farfield Survey

Region		Nearfield			Farfield														
					Harbor			Coastal			Offshore			Boundary			Cape Cod Bay		
Parameter	Unit	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
In-situ																			
Chlorophyll *a*	µg/L	0.20	2.72	1.23	0.22	0.51	0.32	0.00	1.70	0.59	0.00	1.64	0.56	0.00	1.47	0.71	0.03	6.27	2.80
Salinity	psu	31.5	32.2	32.0	29.7	31.4	30.9	31.3	31.9	31.6	31.5	32.2	31.9	31.6	32.3	32.0	31.4	31.5	31.4
Sigma_T	kg/m^3	25.1	25.5	25.4	23.6	25.0	24.5	24.9	25.4	25.1	25.0	25.5	25.3	25.1	25.6	25.4	25.0	25.1	25.0
Temperature	°C	3.7	4.4	4.0	3.5	4.5	3.6	3.3	3.8	3.6	3.4	4.6	3.9	3.5	4.7	4.1	3.1	3.5	3.3
Transmissivity	m-1	0.80	1.24	0.89	0.90	1.32	1.13	0.79	1.05	0.90	0.73	2.55	0.92	0.69	1.05	0.79	0.91	1.44	1.20
Nutrients																			
NH_4	µM	0.05	2.58	0.49	4.43	9.88	6.23	0.17	4.39	1.88	0.42	1.81	1.01	0.40	1.13	0.63	0.41	1.04	0.62
NO_2	µM	0.13	0.21	0.17	0.26	0.33	0.29	0.14	0.27	0.21	0.17	0.24	0.20	0.14	0.22	0.20	0.08	0.18	0.14
$NO_2 + NO_3$	µM	4.1	7.9	6.3	7.8	10.7	8.4	5.4	8.6	7.5	6.1	8.5	7.5	4.6	7.8	6.9	1.3	6.0	3.9
PO_4	µM	0.58	0.91	0.74	0.97	1.17	1.03	0.71	1.00	0.86	0.71	1.01	0.85	0.71	1.00	0.88	0.59	0.82	0.72
SIO_4	µM	3.0	7.6	4.9	7.0	11.8	8.3	4.3	9.0	6.5	4.8	8.7	6.9	5.9	8.7	7.1	6.2	7.5	6.9
Phaeopigment	µg/L	0.01	0.48	0.11	0.04	0.13	0.08	0.01	0.17	0.09	0.04	0.32	0.15	0.06	0.12	0.08	0.02	1.16	0.32
DO																			
Concentration	mg/l	10.2	11.5	10.8	10.7	11.0	10.9	10.4	11.2	10.8	10.0	11.0	10.6	9.9	11.2	10.5	11.0	11.8	11.3
Saturation	%	97	109	102	99	102	101	98	106	101	96	104	100	95	105	100	101	110	104
Productivity																			
Alpha	see text	0.04	0.18	0.13	0.03	0.06	0.04												
Areal Production	$mgC/m^2/d$	2119.7	2563.7	2341.7	214.9	214.9	214.9												
Pmax	see text	6.6	30.6	24.0	5.6	7.7	6.5												
Respiration	µmol/h	0.04	0.10	0.07	0.07	0.08	0.07				0.04	0.05	0.04						
Water Column																			
BIOSI	µM	2.2	4.5	3.3	1.3	1.8	1.5	1.1	3.5	2.0	1.4	6.1	3.0	1.2	2.0	1.6	1.3	1.4	1.3
DOC	mg/L	1.0	1.4	1.1	1.2	1.8	1.4	1.0	1.3	1.1	1.2	1.3	1.3	1.0	1.3	1.2	1.1	1.5	1.3
PART P	µM	0.21	0.39	0.29	0.36	0.42	0.38	0.06	0.36	0.23	0.14	0.27	0.19	0.15	0.21	0.18	0.22	0.29	0.25
POC	µM	8.9	23.5	17.3	17.4	27.6	21.4	6.3	24.0	14.7	9.9	16.7	12.6	10.4	15.3	12.9	15.2	27.8	22.8
PON	µM	1.02	4.31	2.80	2.60	4.15	3.29	0.69	3.57	2.21	1.01	2.50	1.68	1.05	1.85	1.53	2.19	4.70	3.65
TDN	µM	8.7	20.8	14.0	23.6	29.6	25.7	12.7	22.4	16.1	14.1	17.4	16.0	15.3	15.3	15.3	9.4	12.1	11.0
TDP	µM	0.62	1.23	0.88	1.20	1.51	1.32	0.91	1.19	1.03	1.01	1.12	1.08	0.96	1.06	1.00	0.81	0.92	0.86
TSS	mg/L	0.5	1.5	0.8	0.7	1.1	0.9	0.4	1.2	0.7	0.7	3.9	1.8	0.3	0.9	0.5	0.8	1.0	0.9
Urea	µM	0.36	0.92	0.64	0.36	2.10	0.98	0.44	1.23	0.82	1.32	2.73	2.03	0.58	0.69	0.63	1.03	2.08	1.44
Plankton																			
Total Phytoplankton	Mcell/L		0.66			0.48			0.70			0.43			0.47			5.55	
Centric diatoms	Mcell/L		0.24			0.06			0.15			0.02			0.13			0.18	
Alexandrium tamarense	Mcell/L		NP			NP			NP			NP			NP			NP	
Phaeocystis pouchetii	Mcell/L		4.88E-02			6.13E-03			4.57E-03			4.59E-02			2.44E-02			5.74	
Pseudo-nitzschia sp	Mcell/L		9.88E-04			4.29E-05			4.71E-04			1.02E-05			9.90E-04			1.85E-05	
Total Zooplankton	$\#/m^3$		14759			19115			30700			9155			14858			9827	

NP - Not Present

TABLE 3-3
Semi-Annual Data Summary Table
Event W9703 (3/18/97)
Nearfield Survey

Region		Nearfield		
Parameter	Unit	Min	Max	Avg
In-situ				
Chlorophyll *a*	µg/L	0.00	5.99	1.38
Salinity	psu	31.5	32.1	32.0
Sigma_T	kg/m³	25.1	25.5	25.5
Temperature	°C	3.0	3.8	3.7
Transmissivity	m-1	0.82	1.01	0.87
Nutrients				
NH_4	µM	0.90	4.12	1.53
NO_2	µM	0.11	0.18	0.14
$NO_2 + NO_3$	µM	4.0	5.5	4.6
PO_4	µM	0.46	0.84	0.67
SIO_4	µM	2.7	4.8	3.4
Phaeopigment	µg/L	0.01	0.23	0.05
DO				
Concentration	mg/l	10.3	11.4	10.9
Saturation	%	97	108	102
Productivity				
Alpha	see text	0.01	0.08	0.04
Areal Production	mgC/m²/d	712.3	2086.4	1399.4
Pmax	see text	6.0	21.8	11.7
Respiration	µmol/h	0.07	0.10	0.08
Water Column				
BIOSI	µM	0.6	2.3	1.3
DOC	mg/L	1.0	1.3	1.1
PART P	µM	0.08	0.22	0.14
POC	µM	9.3	21.0	14.2
PON	µM	1.24	3.34	2.28
TDN	µM	10.9	18.1	12.7
TDP	µM	0.65	0.92	0.75
TSS	mg/L	0.3	0.7	0.5
Urea	µM	0.26	0.51	0.36
Plankton				
Total Phytoplankton	Mcell/L		0.99	
Centric diatoms	Mcell/L		0.13	
Alexandrium tamarense	Mcell/L		NP	
Phaeocystis pouchetii	Mcell/L		0.671	
Pseudo-nitzschia sp	Mcell/L		5.36E-04	
Total Zooplankton	#/m³		18588	

NP - Not Present

TABLE 3-4
Semi-Annual Data Summary Table
Event W9704 (3/31/97 - 4/02/97)
Combined Nearfield/Farfield Survey

Region		Nearfield			Farfield															
					Harbor			Coastal			Offshore			Boundary			Cape Cod Bay		
Parameter	Unit	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
In-situ																			
Chlorophyll *a*	µg/L	0.00	9.12	1.87	0.00	1.68	0.68	0.00	2.06	0.69	0.11	8.73	1.07	0.14	2.41	0.83	0.38	3.45	1.13
Salinity	psu	31.2	32.1	31.8	27.8	31.1	30.5	30.9	31.9	31.3	30.8	32.3	31.8	30.3	32.5	31.7	31.2	31.6	31.5
Sigma_T	kg/m^3	24.7	25.5	25.2	21.9	24.6	24.1	24.4	25.4	24.8	24.4	25.6	25.2	24.0	25.7	25.2	24.7	25.1	24.9
Temperature	°C	3.8	5.2	4.3	4.7	5.8	5.2	4.0	5.3	4.7	3.7	5.9	4.2	3.8	5.2	4.2	3.7	5.0	4.4
Transmissivity	m-1	0.99	3.60	1.63	1.33	4.70	2.45	1.36	3.71	2.68	0.93	4.78	1.74	1.08	2.44	1.60	1.27	3.73	2.98
Nutrients																			
NH_4	µM	0.05	2.54	0.67	2.98	5.08	3.89	0.36	3.70	2.04	2.00	0.07	0.68	1.28	0.23	0.64	1.18	0.06	0.56
NO_2	µM	0.02	0.16	0.10	0.17	0.32	0.21	0.08	0.19	0.13	0.15	0.02	0.08	0.15	0.03	0.10	0.13	0.02	0.08
$NO_2 + NO_3$	µM	0.1	4.3	2.2	2.5	7.5	3.4	0.9	2.6	1.9	7.0	0.1	1.8	8.7	0.3	3.2	1.5	0.1	0.7
PO_4	µM	0.32	1.42	0.48	0.39	0.76	0.54	0.37	0.62	0.49	0.77	0.28	0.51	0.76	0.33	0.51	0.50	0.38	0.44
SIO_4	µM	0.9	3.4	1.6	2.8	8.2	3.8	1.1	3.5	2.4	6.3	0.4	2.4	7.2	1.3	3.1	5.1	2.1	3.5
Phaeopigment	µg/L	0.06	1.56	0.30	0.09	0.97	0.32	0.02	0.52	0.28	0.60	0.05	0.23	0.61	0.10	0.28	0.50	0.05	0.32
DO																			
Concentration	mg/l	8.9	12.2	11.0	10.5	11.3	10.9	10.5	11.6	10.9	10.2	12.2	11.0	9.8	11.3	10.8	10.7	11.5	11.0
Saturation	%	84	116	105	101	109	105	99	111	104	96	116	105	95	108	103	100	109	105
Productivity																			
Alpha	see text	0.04	0.22	0.09	0.09	0.12	0.10												
Areal Production	$mgC/m^2/d$	1173.5	1390.5	1282.0	1090.5	1090.5	1090.5												
Pmax	see text	7.3	24.0	13.0	19.0	23.7	21.3												
Respiration	µmol/h	0.07	0.14	0.10	0.10	0.12	0.11				0.06	0.10	0.08						
Water Column																			
BIOSI	µM	1.8	12.9	4.1	2.5	7.1	4.2	1.5	7.4	4.4	2.2	4.4	3.3	3.7	13.7	7.1	1.4	6.0	3.8
DOC	mg/L	1.1	1.4	1.2	1.3	1.6	1.4	1.1	1.4	1.2	1.0	1.1	1.0	1.0	1.3	1.1	1.2	1.9	1.5
PART P	µM	0.10	0.58	0.26	0.38	0.73	0.56	0.22	0.50	0.36	0.18	0.25	0.22	0.15	0.42	0.26	0.15	0.44	0.35
POC	µM	13.4	49.8	27.3	24.2	56.2	33.6	23.5	38.0	30.9	12.6	33.6	24.0	18.9	32.1	24.0	21.7	76.2	44.9
PON	µM	2.20	8.20	4.12	4.22	8.95	5.62	2.83	5.44	4.55	1.42	4.91	3.38	2.39	3.98	3.01	1.95	9.69	5.42
TDN	µM	6.3	14.4	9.7	16.3	22.8	18.2	8.1	27.8	15.4	7.6	9.9	8.8	9.2	15.2	12.2	6.3	10.0	8.2
TDP	µM	0.54	0.94	0.67	0.77	0.92	0.86	0.59	0.90	0.75	0.73	0.78	0.75	0.53	0.97	0.74	0.47	0.84	0.68
TSS	mg/L	0.7	6.5	2.1	1.3	8.1	3.9	1.0	5.1	3.0	1.6	2.6	2.1	1.3	5.7	2.9	1.1	4.3	3.2
Urea	µM	0.17	1.06	0.63	0.70	1.87	1.03	0.25	0.99	0.67	0.17	0.33	0.25	0.23	0.83	0.53	0.25	0.35	0.29
Plankton																			
Total Phytoplankton	Mcell/L		5.46			2.82			2.92			1.32			1.30			4.74	
Centric diatoms	Mcell/L		0.65			0.38			0.46			0.03			0.14			0.11	
Alexandrium tamarense	Mcell/L		NP			NP			NP			NP			NP			NP	
Phaeocystis pouchetii	Mcell/L		7.72			2.09			1.59			5.60			0.49			14.94	
Pseudo-nitzschia sp	Mcell/L		5.39E-03			1.06E-04			1.18E-03			1.89E-03			3.15E-05			1.65E-02	
Total Zooplankton	$\#/m^3$		63620			28221			20340			42175			61647			18722	

NP - Not Present

TABLE 3-5
Semi-Annual Data Summary Table
Event W9705 (4/23/97)
Nearfield Survey

		Nearfield		
Region				
Parameter	Unit	Min	Max	Avg
In-situ				
Chlorophyll *a*	µg/L	0.42	5.33	1.74
Salinity	psu	30.3	32.1	31.4
Sigma_T	kg/m^3	23.7	25.5	24.8
Temperature	°C	4.1	7.4	5.4
Transmissivity	m-1	1.00	2.10	1.33
Nutrients				
NH_4	µM	0.17	3.65	0.85
NO_2	µM	0.02	0.17	0.08
$NO_2 + NO_3$	µM	0.0	5.5	1.7
PO_4	µM	0.32	0.92	0.52
SIO_4	µM	2.4	8.0	5.8
Phaeopigment	µg/L	0.05	0.72	0.33
DO				
Concentration	mg/l	9.4	12.1	10.9
Saturation	%	89	118	106
Productivity				
Alpha	see text	0.03	0.09	0.06
Areal Production	mgC/m^2/d	454.8	687.1	570.9
Pmax	see text	6.2	15.7	10.7
Respiration	µmol/h	0.04	0.14	0.09
Water Column				
BIOSI	µM	1.7	5.2	2.8
DOC	mg/L	1.1	1.6	1.2
PART P	µM	0.1	0.4	0.3
POC	µM	17.42	49.26	27.82
PON	µM	2.2	7.0	3.9
TDN	µM	5.92	13.85	8.91
TDP	µM	0.40	1.03	0.65
TSS	mg/L	0.7	2.2	1.3
Urea	µM	0.26	0.42	0.35
Plankton				
Total Phytoplankton	Mcell/L		1.51	
Centric diatoms	Mcell/L		0.19	
Alexandrium tamarense	Mcell/L		NP	
Phaeocystis pouchetii	Mcell/L		2.56	
Pseudo-nitzschia sp	Mcell/L		9.42E-04	
Total Zooplankton	#/m^3		27688	

NP - Not Present
NA - Not Analyzed

TABLE 3-6
Semi-Annual Data Summary Table
Event W9706 (5/13/97)
Nearfield Survey

		Nearfield		
Region				
Parameter	Unit	Min	Max	Avg
In-situ				
Chlorophyll *a*	μg/L	0.39	29.22	2.83
Salinity	psu	31.0	32.2	31.6
Sigma_T	kg/m^3	24.2	25.5	24.8
Temperature	°C	4.5	7.8	6.0
Transmissivity	m-1	0.74	5.35	1.17
Nutrients				
NH_4	μM	0.24	3.91	1.34
NO_2	μM	0.01	0.20	0.09
$NO_2 + NO_3$	μM	0.1	7.4	2.4
PO_4	μM	0.22	0.99	0.56
SIO_4	μM	0.4	8.8	3.7
Phaeopigment	μg/L	0.02	0.82	0.34
DO				
Concentration	mg/l	9.0	11.5	10.3
Saturation	%	87	115	101
Productivity				
Alpha	see text	0.02	0.18	0.06
Areal Production	$mgC/m^2/d$	939.9	1816.3	1378.1
Pmax	see text	3.1	26.7	8.4
Respiration	μmol/h	0.02	0.08	0.06
Water Column				
BIOSI	μM	1.0	13.6	5.4
DOC	mg/L	1.1	1.4	1.2
PART P	μM	0.06	0.63	0.27
POC	μM	11.5	65.1	27.6
PON	μM	1.40	9.05	3.95
TDN	μM	6.4	17.2	11.1
TDP	μM	0.53	1.15	0.86
TSS	mg/L	0.4	2.4	1.1
Urea	μM	0.29	0.88	0.48
Plankton				
Total Phytoplankton	Mcell/L		0.86	
Centric diatoms	Mcell/L		0.15	
Alexandrium tamarense	Mcell/L		NP	
Phaeocystis pouchetii	Mcell/L		3.05E-03	
Pseudo-nitzschia sp	Mcell/L		3.77E-02	
Total Zooplankton	$\#/m^3$		43262	

NP - Not Present

TABLE 3-7
Semi-Annual Data Summary Table
Event W9707 (6/17/97 - 6/19/97)
Combined Nearfield/Farfield Survey

Region		Nearfield			Farfield														
					Harbor			Coastal			Offshore			Boundary			Cape Cod Bay		
Parameter	Unit	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
In-situ																			
Chlorophyll *a*	µg/L	0.02	7.52	1.06	0.89	8.73	3.72	0.32	4.69	1.93	0.00	1.90	0.58	0.00	1.51	0.50	0.00	3.84	1.01
Salinity	psu	30.6	32.0	31.1	30.1	31.1	30.6	30.5	31.5	31.0	30.4	32.2	31.2	30.0	32.3	31.5	30.9	31.7	31.3
Sigma_T	kg/m^3	22.4	25.3	23.8	21.8	23.7	22.6	22.5	24.6	23.4	22.3	25.5	24.0	22.0	25.6	24.3	22.2	24.9	23.6
Temperature	°C	4.8	15.9	10.7	11.3	16.7	14.8	7.6	15.6	12.1	4.7	16.2	9.7	4.5	15.9	8.8	6.9	17.6	12.0
Transmissivity	m-1	0.63	2.81	1.04	1.39	3.75	2.33	0.81	2.78	1.36	0.65	1.55	0.90	0.69	1.17	0.91	0.81	1.93	1.14
Nutrients																			
NH_4	µM	0.03	3.01	0.73	0.72	11.09	2.47	0.05	2.05	0.53	0.06	3.29	0.96	0.03	3.97	1.29	0.18	2.78	0.76
NO_2	µM	0.01	0.33	0.10	0.07	0.14	0.09	0.01	0.15	0.07	0.02	0.38	0.13	0.02	0.38	0.16	0.02	0.31	0.09
$NO_2 + NO_3$	µM	0.0	5.9	1.2	0.2	0.9	0.5	0.0	1.8	0.4	0.0	8.3	1.8	0.0	11.1	3.6	0.0	2.4	0.5
PO_4	µM	0.11	0.92	0.37	0.42	1.03	0.54	0.09	0.63	0.35	0.11	1.07	0.44	0.11	1.30	0.60	0.16	0.89	0.40
SIO_4	µM	0.5	7.1	2.4	2.0	4.2	2.9	0.5	6.0	2.5	0.3	11.4	2.8	0.6	21.1	5.1	1.1	10.5	3.7
Phaeopigment	µg/L	0.01	0.38	0.18	0.28	1.28	0.57	0.01	0.31	0.19	0.05	0.20	0.09	0.02	0.42	0.21	0.01	0.23	0.08
DO																			
Concentration	mg/l	8.4	10.3	9.4	8.0	9.1	8.7	8.6	10.0	9.3	8.5	10.9	9.5	8.3	10.9	9.3	6.9	10.1	8.9
Saturation	%	82	119	103	96	110	103	88	118	105	82	115	103	80	115	98	70	111	101
Productivity																			
Alpha	see text	0.00	0.06	0.02	0.09	0.16	0.12												
Areal Production	$mgC/m^2/d$	692.2	1236.4	964.3	1714.1	1714.1	1714.1												
Pmax	see text	0.4	12.9	5.5	29.6	59.4	43.7												
Respiration	µmol/h	0.06	0.26	0.18	0.18	0.52	0.39				0.05	0.24	0.12						
Water Column																			
BIOSI	µM	0.2	3.3	0.9	2.2	5.3	3.6	0.5	2.5	1.4	0.1	0.2	0.2	0.2	3.4	1.4	0.1	3.1	1.2
DOC	mg/L	0.9	1.5	1.3	1.3	1.8	1.5	1.1	1.6	1.3	1.2	1.3	1.2	1.0	1.4	1.2	0.9	1.2	1.1
PART P	µM	0.08	0.55	0.19	0.22	0.66	0.49	0.12	0.56	0.26	0.07	0.20	0.14	0.06	0.09	0.07	0.10	0.47	0.25
POC	µM	10.9	62.7	24.9	22.4	59.9	43.6	11.6	59.5	33.4	14.3	27.3	20.1	7.6	16.2	12.3	15.1	87.1	39.7
PON	µM	1.42	9.01	3.12	2.79	9.76	6.79	0.99	9.13	4.69	1.70	3.25	2.39	1.26	1.61	1.43	1.37	10.15	4.85
TDN	µM	7.1	15.7	9.9	12.1	27.4	16.8	9.1	16.8	11.9	6.2	8.0	7.4	8.1	20.4	15.6	7.1	13.5	9.8
TDP	µM	0.14	1.06	0.51	0.61	1.39	0.90	0.32	0.79	0.52	0.12	0.29	0.21	0.21	1.10	0.74	0.22	1.00	0.62
TSS	mg/L	0.3	12.5	1.4	0.8	3.4	2.1	0.4	1.8	0.9	0.2	0.6	0.4	0.3	1.0	0.6	0.3	2.1	1.2
Urea	µM	0.54	1.22	0.79	0.35	0.59	0.49	0.41	0.82	0.57	1.45	2.34	1.89	0.54	0.58	0.56	1.60	1.86	1.73
Plankton																			
Total Phytoplankton	Mcell/L		1.02			9.51			5.77			1.10			1.31			0.96	
Centric diatoms	Mcell/L		0.09			1.28			1.17			NP			0.01			0.01	
Alexandrium tamarense	Mcell/L		NP			NP			NP			NP			NP			NP	
Phaeocystis pouchetii	Mcell/L		NP			NP			1.83E-02			NP			NP			NP	
Pseudo-nitzschia sp	Mcell/L		NP			7.85E-03			9.42E-03			NP			4.71E-04			NP	
Total Zooplankton	$\#/m^3$		93149			63746			98367			65094			61710			30260	

NP - Not Present

TABLE 3-8
Semi-Annual Data Summary Table
Event W9708 (7/01/97)
Nearfield Survey

Region		Nearfield		
Parameter	Unit	Min	Max	Avg
In-Situ				
Chlorophyll *a*	µg/L	0.10	3.32	0.95
Salinity	psu	30.7	32.1	31.4
Sigma_T	kg/m^3	22.2	25.3	24.0
Temperature	°C	5.2	17.7	10.3
Transmissivity	m-1	0.72	1.91	0.99
Nutrients				
NH_4	µM	0.03	1.94	0.59
NO_2	µM	0.02	0.39	0.11
$NO_2 + NO_3$	µM	0.0	5.7	1.0
PO_4	µM	0.13	0.79	0.37
SIO_4	µM	1.0	8.2	3.1
Phaeopigment	µg/L	0.01	0.38	0.14
DO				
Concentration	mg/l	8.9	11.4	9.8
Saturation	%	89	119	106
Productivity				
Alpha	see text	0.01	0.03	0.02
Areal Production	$mgC/m^2/d$	1317.5	1647.2	1482.3
Pmax	see text	0.6	27.4	8.9
Respiration	µmol/h	0.02	0.38	0.14
Water Column				
BIOSI	µM	0.2	2.5	0.7
DOC	mg/L	0.8	1.7	1.3
PART P	µM	0.06	0.69	0.20
POC	µM	8.8	54.4	22.6
PON	µM	0.74	8.29	3.13
TDN	µM	6.7	12.5	8.8
TDP	µM	0.40	0.93	0.61
TSS	mg/L	0.3	2.1	0.7
Urea	µM	0.77	1.37	1.12
Plankton				
Total Phytoplankton	Mcell/L		2.42	
Centric diatoms	Mcell/L		0.56	
Alexandrium tamarense	Mcell/L		NP	
Phaeocystis pouchetii	Mcell/L		NP	
Pseudo-nitzschia sp	Mcell/L		NP	
Total Zooplankton	$\#/m^3$		44822	

NP - Not Present

TABLE 3-9
Semi-Annual Data Summary Table
Event W9709 (7/22/97)
Nearfield Survey

Region		Nearfield		
Parameter	Unit	Min	Max	Avg
In-situ				
Chlorophyll *a*	µg/L	0.03	1.72	0.51
Salinity	psu	30.9	32.0	31.4
Sigma_T	kg/m^3	22.0	25.2	23.6
Temperature	°C	5.6	18.8	12.4
Transmissivity	m-1	0.76	1.84	0.97
Nutrients				
NH_4	µM	0.03	1.35	0.40
NO_2	µM	0.01	1.00	0.09
$NO_2 + NO_3$	µM	0.0	4.9	0.5
PO_4	µM	0.17	0.71	0.32
SIO_4	µM	1.6	11.3	3.4
Phaeopigment	µg/L	0.01	0.23	0.09
DO				
Concentration	mg/l	8.2	11.3	9.7
Saturation	%	90	120	110
Productivity				
Alpha	see text	0.01	0.06	0.03
Areal Production	$mgC/m^2/d$	981.3	1521.1	1251.2
Pmax	see text	1.5	9.5	5.6
Respiration	µmol/h	0.04	0.32	0.12
Water Column				
BIOSI	µM	0.1	1.6	0.5
DOC	mg/L	0.6	10.8	1.7
PART P	µM	0.09	0.53	0.19
POC	µM	11.8	41.2	23.3
PON	µM	0.99	5.99	2.95
TDN	µM	5.2	11.2	7.3
TDP	µM	0.32	0.66	0.42
TSS	mg/L	0.1	1.2	0.4
Urea	µM	0.46	1.11	0.71
Plankton				
Total Phytoplankton	Mcell/L		0.86	
Centric diatoms	Mcell/L		0.01	
Alexandrium tamarense	Mcell/L		NP	
Phaeocystis pouchetii	Mcell/L		NP	
Pseudo-nitzschia sp	Mcell/L		NP	
Total Zooplankton	$\#/m^3$		76047	

NP - Not Present

4.0 RESULTS OF WATER COLUMN MEASUREMENTS

The timing of the annual setup and breakdown of vertical stratification in the water column is an important determinant of water quality, primarily because of the trend towards continuously decreasing dissolved oxygen in bottom water in the summer and early fall. The onset of water column stratification early in the year effectively "caps" the bottom water, and water column conditions at the onset effectively "set up" the seasonal decline. The seasonal breakdown of stratification terminates this decline through vertical mixing. The pycnocline, defined as a shallow water depth interval over which density increases rapidly, is caused by salinity (freshwater input from riverine discharges, which is typically more important in the spring) and temperature (seasonal warming of surface water, which dominates stratification during the summer).

The surface water layer is generally well mixed above the pycnocline during the stratified period, while density typically increases more gradually below the pycnocline (e.g. surveys 6 and 7 in Figure 4-1). For purposes of this report, vertical stratification will be defined when the difference between bottom density and surface density ($\Delta\sigma_t$) is greater than 1. Using this definition, a stable pycnocline developed by late April (W9705) in the inner nearfield, and by early May (W9706) in the outer nearfield (Figure 4-2).

Four of the nine surveys conducted during the semi-annual period were combined nearfield/farfield surveys. The first three combined surveys, conducted during February (W9701, W9702) and April (W9704), took place prior to stratification of the water column, while the last survey in June (W9707) was conducted after stratification had set up. Data from these surveys were evaluated for trends in regional water masses throughout Boston Harbor, Massachusetts Bay, and Cape Cod Bay. Regional water characteristics are presented using contour plots of surface water parameters, derived from the "A depth" (surface) water sample. A complete set of surface contour maps of water properties during farfield surveys is included in Appendix A.

The vertical distribution of water column parameters is presented in the following section along three farfield transects in the farfield survey area, and one transect across the nearfield (Figure 1-3). Examining data trends along transects provides a three-dimensional perspective of water column conditions during each survey. Nearfield surveys (W9701-W9709) were conducted more frequently than farfield surveys, allowing better temporal resolution of the changes in water column parameters and onset stratification, especially when combined with continuous monitoring data provided by the USGS. In addition to the nearfield transect, vertical characteristics in nearfield results are examined and presented by comparing surface and bottom water concentrations ("A" and "E" depths), and by plotting individual parameters with depth in the water column.

Results presented in this section were organized by data type. Physical data (temperature, salinity, and density), are presented in Section 4.1. Transmissometer data are reported in Section 4.2. Nutrient results are presented in Section 4.3, chlorophyll *a* in Section 4.4, and dissolved oxygen in Section 4.5. Finally, a summary of the results of water column measurements (excepting biological measurements) is provided in Section 4.6.

4.1 Physical Characteristics

4.1.1 Horizontal Distribution

In early February (W9701), surface water temperatures were coolest in the Harbor (minimum of 2.1°C at Harbor station F31) and coastal areas and warmest offshore (maximum of 4.9°C at Boundary station F27, Figure 4-3). Surface water in the harbor was also the least saline (approximately 30 PSU, Figure 4-4), apparently influenced by a seasonal discharge peak from the Charles River (Figure 4-5). Massachusetts and Cape Cod Bay had salinities between 31 and 32.1 PSU (Figure 4-4). In late February (W9702), regional surface water characteristics were more uniform, primarily due to the relative warming of Harbor and coastal waters, while surface salinities were largely unchanged (Appendix A).

By April (W9704), regional surface water temperatures remained relatively uniform, with a range of 4.0° to 5.9° (Appendix A). Harbor and coastal waters continued to warm faster than offshore waters. Surface salinity exceeded 31 PSU at most stations, except for Boston Harbor and adjacent coastal stations, which were again influenced by relatively high discharge rates from the Charles River (Figure 4-5). During the final farfield survey in June (W9707), surface temperatures had warmed considerably. Massachusetts Bay ranged from 14.2° (station F05) to 16.2°, and maximum surface temperatures were found in Cape Cod Bay (17.6°, station F02, Appendix A). Surface salinities showed a narrow range between around 30 - 31 PSU.

4.1.2 Vertical Distribution

Farfield. Regionally, the water column in Massachusetts Bay was well mixed throughout the winter and early spring. Density data indicated that the water column was well mixed in all regions through the April survey (W9704), although Boston Harbor did show salinity stratification throughout the semi-annual period (Figures 4-6 and 4-7). The water column was largely isothermal during the first three farfield surveys (Figure 4-8), with a substantial degree of surface water heating evident by mid-June (W9707). All regions were strongly stratified by June except for the harbor, which remained only modestly stratified (Figure 4-6).

Vertical cast data and cross-sections of west to east transects in Massachusetts Bay (Figure 1-3) illustrate the vertical distribution of physical characteristics within the water column from Boston Harbor and coastal stations seaward (Appendix B). For example, the winter survey in early February (W9701) showed a horizontal surface density gradient ($\Delta\sigma_t$), ranging from 24 kg/m^3 in the harbor (station F23) to greater than

25.6 kg/m^3 at Boundary station F27 (Figure 4-9). Vertical density structure in early February was largely restricted to the harbor and adjacent coastal stations, a function of both temperature and salinity (Appendix B). This vertical structure appeared to break down somewhat by late February (W9702), but the horizontal gradient off Boston Harbor remained (Appendix B).

Fresh water intrusions from both the Harbor and from around Cape Ann were evident during early April (e.g. W9704, stations F23 and F27 in Figure 4-10; also see salinity plots in Appendix B). Evidence of continued increases in discharges from both the Merrimack and Charles Rivers through mid-April (Figure 4-5), combined with salinity results from nearfield sampling presented below, suggested that a strong spring freshet dominated Massachusetts Bay for several weeks. During the final farfield survey of the semi-annual period in June, the water column was vertically stratified, with few horizontal gradients evident (W9707 in Figure 4-10).

Nearfield. More frequent sampling of the nearfield stations provides a more comprehensive documentation of the onset of vertical stratification, as well as local variability, within the nearfield water column. As discussed previously, the onset of vertical stratification in the nearfield occurred relatively early in 1997. By mid-April (W9705), the inner nearfield and Broad Sound were already stratified and remained stratified through the semi-annual period (Figure 4-2). The onset of stratification was evident in the outer nearfield by April but was not quite as intense.

The nearfield water column was largely isothermal through the first three nearfield surveys (Figure 4-11). Surface warming was evident in early April (W9704), and began in earnest after early May (W9706) when temperatures increased 8.0°C by the June survey. Surface water temperatures continued to increase throughout the remainder of the semi-annual period. Bottom water temperatures rose relatively slowly throughout the period, with more pronounced warming evident around early June (Figure 4-11). Surface temperatures reached maxima of around 18.0°C by the end of the semi-annual period. Bottom temperature maxima ranged from 10 °C inshore to 6.5°C in the deeper water offshore.

After an initial increase, nearfield salinity inshore showed an overall decrease in both surface and bottom water through the period (Figure 4-12a and b), although a temporary increase was noted in early May (W9706) which was most pronounced in the inner nearfield. An increase in surface water salinity in the outer nearfield was evident after the June survey (W9707), although bottom water salinity continued to decline (Figure 4-12c).

Continuously recorded data from the USGS mooring in the center of the nearfield are shown in Figure 4-13. Unfortunately, the surface sensors were not functional during the period. Available data from sensors located at mid-depth (22m) and 1m above bottom (28m) were plotted. Temperature data from each depth showed early water column warming during February followed by decreasing temperatures during March, also documented by survey results (Figure 4-11). Rapid increases in mid-depth and bottom readings during early June and late July were either an indication of potential water column mixing or attributable to advection.

Rapid decreases in bottom water salinity during the latter part of April, early June, and late July provided further evidence that substantial changes in water column characteristics occurred during these periods (Figure 4-13; see also Figure 4-12). The April event coincided with peak discharges from the Charles and Merrimack Rivers (Figure 4-5), and was produced by storm-related rainfall and snowmelt. Each of these three events has the potential to affect the chemical and biological processes that occurred during the reporting period, and will be discussed further in later sections of this report.

4.1.3 Regional Characteristics

Regional water masses were identifiable from distinct TS (temperature and salinity) characteristics plotted for each survey (Figure 4-14). During W9701, for example, the harbor and boundary regions were easily distinguishable from Cape Cod Bay and coastal water masses (Figure 4-8a). The boundary and offshore regions had the highest TS values, while Harbor and coastal stations had the lowest.

From late February into April, temperatures were much more uniform, but there was a distinct inshore-offshore salinity gradient (Figure 4-14b and c). Note also the similarity in surface Boundary samples and those from the Harbor (salinity < 31PSU in Figure 4-14c and d), further indicative of freshwater intrusions into both regions during April (preceding section and Figure 4-10). As the period progressed, Cape Cod Bay and coastal stations were most similar, with the highest temperature and salinity values.

4.2 Transmissometer Results

Water column beam attenuation was measured for each CTD cast at all nearfield and farfield stations. The transmissometer determines beam attenuation by measuring the percent transmission of light over a given path length in the water. Given that light transmission decays exponentially with beam attenuation and path length (which varies between instruments), the beam attenuation coefficient is computed over a standardized path length of 1 meter, signifying that the value is independent of light path length.

The beam attenuation coefficient is indicative of particulate concentration in the water column. The two possible sources of particles in coastal waters are biogenic material (plankton or organic detritus), or suspended sediment. To evaluate the contribution of biogenic material in the total particulate matter, beam attenuation was compared to fluorescence data (calibrated to chlorophyll *a*). Non-biogenic material may originate from suspended matter in coastal runoff or from resuspension of bottom sediment.

Transmissometer data from the combined nearfield/farfield surveys documented an inshore/offshore gradient. In February (W9701), the highest surface water beam attenuation (2.9 m^{-1}) was measured at Boston Harbor station F23, and the lowest (0.7 m^{-1}) at the Boundary stations F27 and F28 (Figure 4-15; see also cross-sectional plots in Appendix B). The Nearfield, Offshore, Cape Cod Bay and Boundary regions showed little variation from approximately 1.0 m^{-1}, with near-coastal stations showing the highest values. Low fluorescence values during this period (Section 4.4) indicate that the low transmissivity inshore was due to non-biogenic material. The second farfield/nearfield survey (W9702) showed an overall increase in water clarity except in eastern Cape Cod Bay (Appendix A), where the late winter bloom was well developed (Section 4.4).

By the April survey (W9704), higher beam attenuation was evident system-wide, with Harbor and near-coastal stations all above 3.0 m^{-1} (Figure 4-16). Boundary stations F26, F27, and F28 all exceeded values reported for central Massachusetts Bay, suggesting higher particulate concentrations in a freshet moving in from around Cape Ann (see Section 4.1.2). Fluorescence data indicate that the high surface attenuation results during April were caused by non-biogenic material, whereas a near-bottom attenuation peak off Cohasset at Offshore station F16 (Appendix B) appeared to be derived from sinking material from the late winter phytoplankton bloom (Section 4.4).

Maximum surface attenuation values for the reporting period (3.75 m^{-1}) occurred in the Harbor during July (W9707), with values above 1.0 m^{-1} largely restricted to the adjacent stations outside of the Harbor (Appendix B). In this case, the surface attenuation those in June appeared to be the result of localized primary productivity (Section 4.4).

4.3 Nutrients

Regional and nearfield nutrient data from the first semi-annual period of 1997 demonstrate the typical progress of seasonal events in the Massachusetts Bay system. Maximum nutrient concentrations were measured throughout the water column during the well-mixed early winter surveys. The late winter bloom results in regional depletion of nutrients throughout the water column. The onset of stratification traps nutrients below the pycnocline, while nutrients are stripped from the surface mixed layer.

Nutrient data from the reporting period were investigated using surface water contour maps (Appendix B) and vertical cross sections (Appendix B). Plots of nutrient relationships for each survey were also developed: nutrients vs. depth, nutrient:nutrient relationships; and nutrient:salinity relationships (Appendix D).

4.3.1 Horizontal Distribution

Boston Harbor and coastal stations consistently had the highest concentration of all nutrients measured during the pre-stratification period. Surface water concentrations throughout Massachusetts Bay were only slightly lower for most nutrient parameters (except ammonia) outside of the Harbor during early February (W9701, e.g., Figure 4-17). Surface dissolved inorganic nitrogen (DIN) concentrations typically were around 10 µM, with Boston Harbor nearly double that due to the relatively high concentrations of ammonia

(Appendix D). Lowest concentrations were reported in Cape Cod Bay, indicative of activity associated with the late winter bloom (Section 4.4).

By the second survey in late February (W9702), nutrient concentrations for most of Massachusetts Bay had been reduced, although Boston Harbor remained relatively high (Figure 4-18). DIN concentrations in Massachusetts Bay were typically between 5 µM to 10 µM, with Boston Harbor still around 15 µM (Appendix C). Minimum concentrations were reported in Cape Cod Bay, indicating a substantial bloom had occurred between surveys (Appendix A and C). Biogenic silica approximately doubled in the nearfield relative the first survey (ca. 4 µM), indicating increased diatom activity was occurring (Appendix C).

Surface nutrient concentrations continued to diminish through the final pre-stratification survey in April (W9704), with DIN concentrations less than 5 µM except in or near the Harbor (Appendix A and C). Nutrients had been entirely stripped in all regions by the final farfield survey in June (W9707), even in the Harbor.

4.3.2 Vertical Distribution

Farfield. Both transect plots (Appendix B) and scatterplots (Appendix C) for nutrient concentrations showed that the late winter water column was vertically replete with nutrients. Surface water samples in the Offshore and Boundary regions were similar to results from deep water (Appendix C). A modest inshore/offshore gradient was still evident for all nutrients despite the high offshore concentrations. By the second farfield survey in late February, algal uptake was evident as surface water concentrations had diminished, including evidence of locally higher uptake in the nearfield (see Boston-NF transect in Figure 4-19).

Water column nutrient concentrations continued to decline through April (W9704). Both results for nitrogen concentration and N:P ratios indicated that nitrogen limitation may have been occurring in some areas by April (e.g., Appendix C). By June (W9707), when stratification was well in place, all stations outside of Boston Harbor showed depleted surface water concentrations. Nutrient concentrations were much higher in deeper water below the pycnocline (e.g. Figures 4-10 and 4-20; Appendix C). Only a slight coastal influence from the Harbor was evident during the period (e.g. Boston-NF transect in Figure 4-20 and 4-21), consistent with the low river discharge at the time (Figure 4-5) and high algal activity within the Harbor (Section 4.4).

Nearfield. Because of increased frequency of sampling, the nearfield sampling allowed higher temporal resolution of nutrient concentrations throughout the monitoring period. DIN concentrations remained around 5-6 µM throughout the water column during March (W9703), while biogenic silica concentrations fell off to < 2.0 µM (Appendix C). Nutrient concentrations continued to decline between surveys W9704 and W9706, with decreasing surface water DIN concentrations and a resurgence of biogenic silica (2-13 µM in W9704, 2-5 μM in W9705; 1-14 μM during W9706). In contrast, by W9707 biogenic silica was generally less than 2 μM in the nearfield but remained comparable to W9704 results in the Harbor (Appendix C). Scatterplots from surveys W9708 and W9709 confirmed low surface concentrations for all parameters.

To further demonstrate the progression of the late winter-early spring diatom bloom, surface and bottom water SiO4 concentrations from five nearfield stations spanning the nearfield grid (N01, N04, N07, and N10 and N18) were plotted (Figure 4-22). Overall, the highest concentrations were measured during the first semi-annual survey in early February. Elevated surface concentrations at N01 and N10 during this mixed water column period (Figure 4-5a and d) may have been due to coastal runoff.

Concentrations fell in both surface and bottom samples through early April (W9704), although surface concentrations rebounded at N10 during this survey. Surface concentrations also increased rapidly at other stations in late April (W9705). Coastal runoff may have produced these rapid increases at the surface as they coincide with periods of peak river discharge, however, it would not explain a similar increase at the inner nearfield stations N10 and N01 during early July. Following concentration minima in April (W9704), bottom water concentrations generally increased, and the gradient between surface and bottom water nutrient concentrations largely remained throughout the spring and summer. Interestingly, bottom water concentrations fell during June and July in most cases (Figure 4-22c, d and e).

Based on these concentration data, productivity associated with the late winter/spring diatom bloom appears to have occurred from February to early April. Increases in surface water silicate concentrations in April, perhaps due to resupply by the freshet moving into Massachusetts Bay, appeared to be rapidly removed. This is consistent with the observed rebound in biogenic silica seen in early May (W9706) described above, and would indicate a bimodal sequence of seasonal bloom formation. This perspective will be further evaluated in Section 5.

4.4 Chlorophyll *a*

In situ fluorescence results, calibrated to chlorophyll *a* discrete samples, are presented in this section and are simply referred to as chlorophyll.

4.4.1 Horizontal Distribution

Surface water concentrations were regionally low during the first semi-annual survey in early February, ranging from to 0-0.6 µg/L (station F19, Appendix A). The maximum value occurred at Offshore station F19, followed by concentrations in Cape Cod Bay of 0.36-0.39 µg/L. By late February (W9702), chlorophyll concentrations had increased to 4.27 µg/L in Cape Cod Bay, indicating that the late winter bloom was well underway there (Figure 4-23).

By the third combined nearfield/farfield survey in early April (W9704), chlorophyll concentrations were reduced generally to <1 µg/L throughout Massachusetts and Cape Cod Bays, except for a fairly localized area > 1.0 µg/L at nearfield station N16 and farfield station F19 (Appendix A). During the final farfield survey in June (W9707), chlorophyll concentrations throughout most of Massachusetts and Cape Cod Bays were around 0.5 µg/L or less (Figure 4-24). However, concentrations in Boston Harbor and adjacent coastal stations reached maxima of 8.5 and 7.5 µg/L, respectively, with relatively high algal activity evident in Broad Sound and the inner nearfield (Figure 4-24).

4.4.2 Vertical Distribution

Farfield. The three farfield cross-sectional transects (Figure 1-3) were used to illustrate the vertical distribution of chlorophyll in the water column across regions (Appendix B). As described above, the first survey in early February was conducted during a period of a relatively low biomass. Areas of highest biomass included the surface at F19 and inshore stations along the Marshfield transect (Appendix B). The winter bloom in late February (W9702) produced chlorophyll concentrations >1.0 µg/L throughout the water column off the coast in the Boston-NF and Cohasset transects (Figures 4-25 and 4-26). Localized subsurface maxima > 1.5 µg/L occurred in the nearfield and Offshore station F16 (see individual plots in Appendix B for detail).

The third combined nearfield/farfield survey in April (W9704) suggested that the late winter bloom had settled near the bottom. While widespread concentrations of 1-2 µg/L were evident throughout the water column, localized areas of as much as 8 µg/L were found at stations N21, F16, and F07 (plot for W9704 in Figures 4-25, 4-26, and 4-27, respectively; Appendix B). By the final combined survey of the period, offshore stations showed subsurface chlorophyll maxima of 1-2 µg/L at around 20m. Higher concentrations of 4-5 µg/L were found to a depth of 10-15m at the Harbor and Coastal stations, confirming the high activity evident inshore in other parameters.

Nearfield. To show the progression of nearfield chlorophyll concentrations throughout the period, a plot similar to that developed for silicate (Figure 4-22) was prepared (Figure 4-28). The most striking feature of the late winter bloom is the low concentrations at the surface relative to mid-depth and bottom samples.

Surface samples reached a peak during late February (W9702) at concentrations less than 2 µg/L, compared with mid-depth maxima in March up to 4 µg/L and peak concentrations at the bottom in early April of up to 7 µg/L. Surface concentrations remained low during most of the reporting period except at station N10 and N01, which showed increases in May and June.

Even more noteworthy is the continued increase in chlorophyll concentrations in mid-depth samples during late April and May, indicating a continuation of the seasonal bloom. Concentrations exceeded 12 µg/L at station N01 during May (W9706), with each nearfield station showing mid-depth maxima in excess of that reported during the earlier peak in February/March. The increase in surface water concentrations at station N10 after late April was the only case where surface results exceeded mid-depth concentrations. This surface activity continued through its peak in mid-June (W9707). These results will be further investigated in the phytoplankton discussion in Section 5.

Available data from the WETLabs spectrophotometer, located at a depth of 12.5 meters on the USGS mooring near the center of the nearfield (Figure 1-1), provided additional detail on chlorophyll concentrations. The sensor collected data from February to the end of July, which were plotted along with survey results from station N18 for the period (Figure 4-29). Average daily chlorophyll concentrations were initially around 1.4 μgL^{-1} in mid-February, and increased to around 5 μgL^{-1} in early March. Concentrations declined to around 1 µg/L following this weeklong period of activity, which is consistent with previous observations for nutrients and chlorophyll discussed above. Note that surveys W9702 and W9703 were conducted before and after this peak activity.

A second weeklong period of peak activity occurred around the end of March, with average concentrations exceeding 6 μgL^{-1}, and hourly peaks exceeding 9 µg/L. However, daily averages remained above 3 µg/L through the end of April, followed by average concentrations of 4-6 µg/L through the first two weeks of May. This climb culminated in a 5-day peak around May 20th which exceeded 10 µg/L. Concentrations remained below 1.5 µg/L after the beginning of June.

These results document that substantial, prolonged primary productivity occurred during the months of April and May in 1997, with the bulk occurring between farfield surveys W9704 and W9707. The horizontal and vertical distributions of this bloom event throughout Massachusetts Bay have direct implications on the fate of the carbon produced and its subsequent impact on bottom water dissolved oxygen during the stratified period. This will be further evaluated in subsequent sections of this report, and addressed in detail in the 1997 Annual Report.

4.5 Dissolved Oxygen

The distribution of dissolved oxygen (DO) in the water column was examined first for temporal and spatial trends in the farfield (Section 4.5.1) and then in the nearfield (Section 4.5.2). For contingency planning purposes, individual bottom water DO minima were investigated.

4.5.1 Regional Distribution

DO was measured throughout the study area during the two combined farfield/nearfield surveys in February (W9701 and W9702), and in April (W9704) and June (W9707). Average regional bottom water DO concentrations at farfield stations ranged from 10.3 to 11.4 mg/L throughout the winter and spring (Figure 4-30a). During the final combined nearfield/farfield survey in June (W9707), DO concentrations in bottom water had decreased to a range of 8.6 to 9.4 mg/L. Boston Harbor had the lowest average bottom water concentration, while Cape Cod Bay (F01) had the lowest individual concentration (6.9 mg/L, Table 3-7).

Bottom water DO saturation averaged between 95 and 100 percent in all regions at the beginning of the year (Figure 4-30b). All regions increased in saturation during late February, with bottom water in Cape Cod Bay becoming over-saturated due to the bloom activity there. By early April (W9704), bottom water saturation in all regions was between 98 and 105 percent. By the June combined survey (W9707), all regions were again below 100 percent saturation, with the highest values (95 to 99 percent) reported in the Harbor and adjacent coastal stations. The other regions fell below 90 percent, with the lowest average (84 percent) reported in Cape Cod Bay.

Average DO concentration and saturation from stations in Stellwagen Basin (stations F12, F17, F19, and F22) were plotted for surface (A) and bottom (E) water samples (Figure 4-31). Both surface and bottom water concentrations in Stellwagen peaked in early April, with bottom water increasing from about 10 mg/L in early February to around 10.5 mg/L. A decline of almost 2 mg/L had occurred by mid-June. DO saturation in surface water was around 110 percent in April, and was even higher during the June event. Bottom water saturation also increased during the first three surveys, from 95 percent in February to 100 percent in April, but declined to around 84 percent in June.

The vertical distribution of DO saturation through the first four combined surveys (Appendix B) showed the deeper offshore water to have relatively low saturation early in the year. With the exception of the deeper offshore water, saturation increased throughout most of the water column by late February (Figure 4-32). Over-saturated conditions due to algal productivity were evident in the surface water of the nearfield and offshore regions, with the center of the nearfield showing the highest activity (e.g., 108 percent at N20). This pattern became more pronounced during both the April and June combined surveys, with surface saturation approaching 120 percent in the nearfield and offshore during both surveys (Appendix B).

4.5.2 Nearfield Distribution

Nearfield DO results for concentration and saturation from surface (A) and bottom (E) samples were averaged by survey for the 17 nearfield stations and plotted (Figure 4-33). The average surface water DO concentration showed an initial peak of 11.2 mg/L in late February (W9702), but after a brief decline increased through late March and April to a seasonal peak of around 11.3 mg/L in late April (W9705; Figure 4-33a). Average surface water concentration declined continuously through the end of the semi-annual period as the surface water warmed, reaching a minimum of around 8.6 mg/L. However, in terms of saturation, DO remained over-saturated throughout the period, with peaks in saturation evident during late February (W9702), mid-April (W9705), and again in late June (W9708; Figure 4-33b). In many parts of the nearfield, over-saturation was evident to depths exceeding 20m (Appendix B).

The average bottom water DO concentration was typically around 1 mg/L lower than the surface average during the pre-stratification period (Figure 4-33a). It reached its seasonal peak of around 10.6 mg/L in mid-March and then began its seasonal decline. In late June (W9708), the average bottom water DO concentration showed a pronounced upward inflection that continued through the last survey of the reporting period (W9709). The average bottom water concentration ended up more than 1 mg/L higher than the surface water.

Average bottom water DO saturation increased through March, reaching 100 percent (W9704) before starting its decline (Figure 4-33b). Minimum average bottom water saturation (around 85 percent) occurred in strongly stratified water in mid-June (W9707). A sharp upturn in percent saturation followed, consistent with the upward inflection seen in average bottom water concentration. By the end of the reporting period, average bottom water saturation actually exceeded 100 percent.

In order to gain further insight into the increases in concentration and saturation during the last two surveys, DO saturation during the last three surveys of the period was plotted for the stations comprising the nearfield transect (see Figure 1-3). During mid-June (W9707), DO saturation at the bottom was <90 percent (Figure 4-34). Although the water column remained stratified through the period (Section 4.1), saturation increased throughout the water column during the next two surveys. By late July, saturation increased to over 115 percent between a depth of 10 to 20m, with saturation >100 percent almost to the bottom. With a pycnocline depth of approximately 10-15m at N04 during the period (Figure 4-1), and measurable algal productivity to depths reaching 30m (Section 5.1), *in situ* production may have been responsible for some portion of the observed increase in saturation.

Advection of higher-saturated bottom water may also have contributed to the increase. While bottom water temperature was slowly increasing during the period (Figure 4-11), bottom salinity was still decreasing (Figure 4-12). With no evidence of substantial mixing during this highly stratified period, the salinity change could only be due to horizontal advection. Current meter data from the USGS mooring indicated that indeed the bottom water was moving through the nearfield from the northeast to southwest for almost the entire period between W9707 and W9709, reaching velocities of up to 6 cm/second (Figure 4-35).

In any event, the observed DO increase of almost 1.5 mg/L certainly mitigated the seasonal decline of bottom water DO concentration in the nearfield. As stated in the introductory text to this section, "setup" conditions at the onset of stratification set the stage for the seasonal decline in bottom water DO. Given these observations, both physical and biological processes during the stratified period can also play a substantial role in the outcome of that decline. Further discussion of the biological processes follows in Section 5.

4.6 Summary of Water Column Results

Physical Characteristics

- Harbor and coastal stations were colder and less saline relative to Massachusetts Bay stations early in the season, but quickly warmed relative to more offshore areas.

- Lower salinity in the harbor during February appeared to be associated with a peak in discharge from the Charles River, which resulted in salinity-driven stratification in the Harbor.

- A large increase in river discharge from the Charles and Merrimack Rivers during April appeared to result in a strong freshet into Massachusetts Bay that lasted for several weeks.

- Stratification developed by mid- to late-April (W9705) in the inner nearfield, and by mid-May (W9706) in the outer nearfield. The onset of stratification appeared to be promoted by the large spring freshet.

- Beam attenuation data indicated a pronounced inshore (Harbor and near-coastal station) influence from fluvial runoff in surface water in February and April. There was also an offshore bottom water particulate component, apparently related to sinking of the late-winter bloom into deeper water.

- Maximum beam attenuation values were reported form the coastal and harbor stations during W9707, which coincided with peak inshore chlorophyll activity.

Nutrients

- Maximum regional nutrient concentrations were measured throughout the water column during the first survey in February (W9701).

- Nutrient depletion in eastern Cape Cod Bay during late February (W9702) was indicative of an advanced late winter bloom. Nutrient depletion in Massachusetts Bay was relatively small, but increased biogenic silica indicated diatom activity was occurring throughout Massachusetts Bay.

- Depletion of water column nutrients appeared to slow during March (W9703), and biogenic silica results indicated diatom activity had diminished. Afterwards, accelerated nutrient depletion was evident through the development of stratification.

- Nitrogen limitation appeared to occur in some areas by early April (W9704), however, nutrient resupply by the strong spring freshet appeared to fuel a second pulse of primary production.

- After the onset of stratification, nutrients were quickly stripped from the surface mixed layer.

Chlorophyll *a*

- Peak regional surface chlorophyll production occurred during late February (W9702) in Cape Cod Bay, and in Boston Harbor and adjacent coastal stations in June (W9707).

- Bloom activity in most of Massachusetts Bay occurred in late February and again in April and May, apparently interrupted to some degree by diminished concentrations during March.

- The Massachusetts Bay bloom in March and April was much more pronounced at depth, often surpassing surface concentrations by several-fold. Conversely, the strong bloom that was reported in the Harbor and adjacent coastal stations was more surface-oriented.

Dissolved Oxygen

- The minimum measured bottom water DO concentration during the semi-annual period was 8.2 mg/L in the nearfield in July (W9709). Regionally, the minimum measured bottom water DO concentration was 6.9 mg/L in Cape Cod Bay during June (W9707);

- Bottom water DO peaked in mid-March (W9703) at around 10.6 mg/L, and then started its seasonal decline. Bottom water DO in Stellwagen Basin peaked two weeks later (W9704) at 10.5 mg/L.

- Following the mid-June survey (W9707), bottom water DO concentration and saturation increased in the nearfield, rising 1.5 mg/L by mid-July and effectively mitigating the seasonal decline of bottom water DO. Both in situ production and horizontal advection into the nearfield may have contributed to the observed increase.

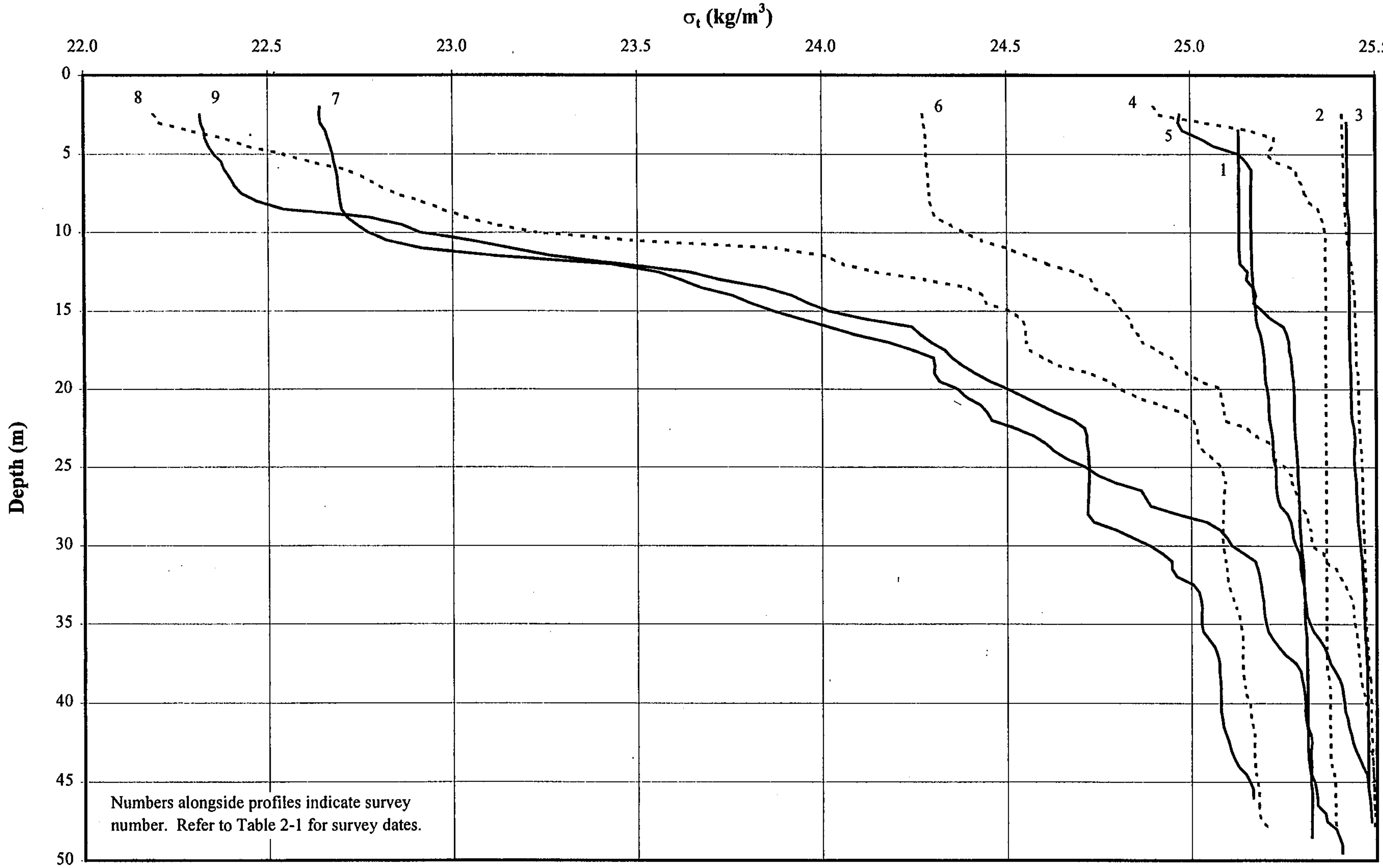


FIGURE 4-1
Density (σ_t) Profiles at Station N04

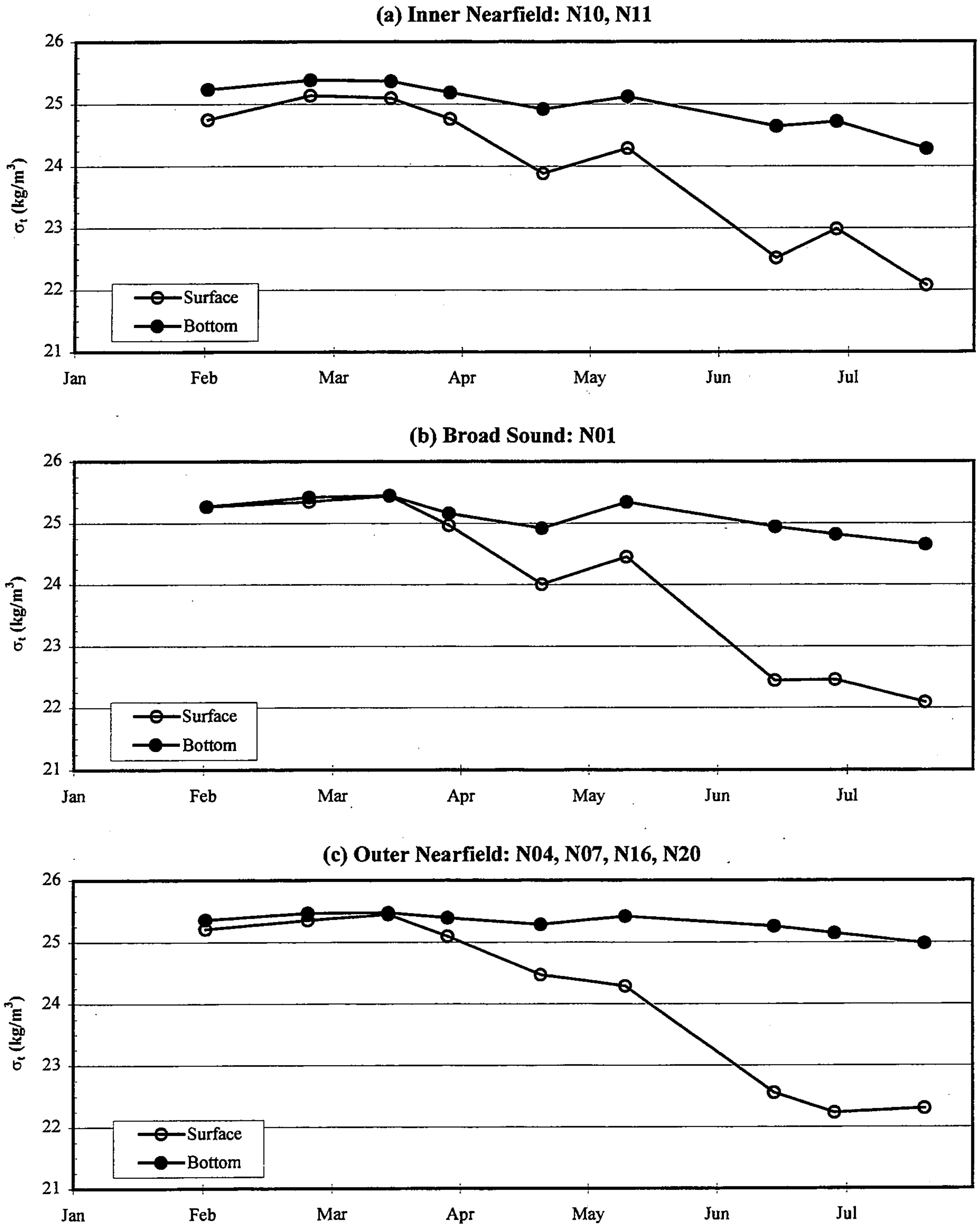


FIGURE 4-2

Time-Series of Average Surface and Bottom Water Density (σ_t) in the Nearfield

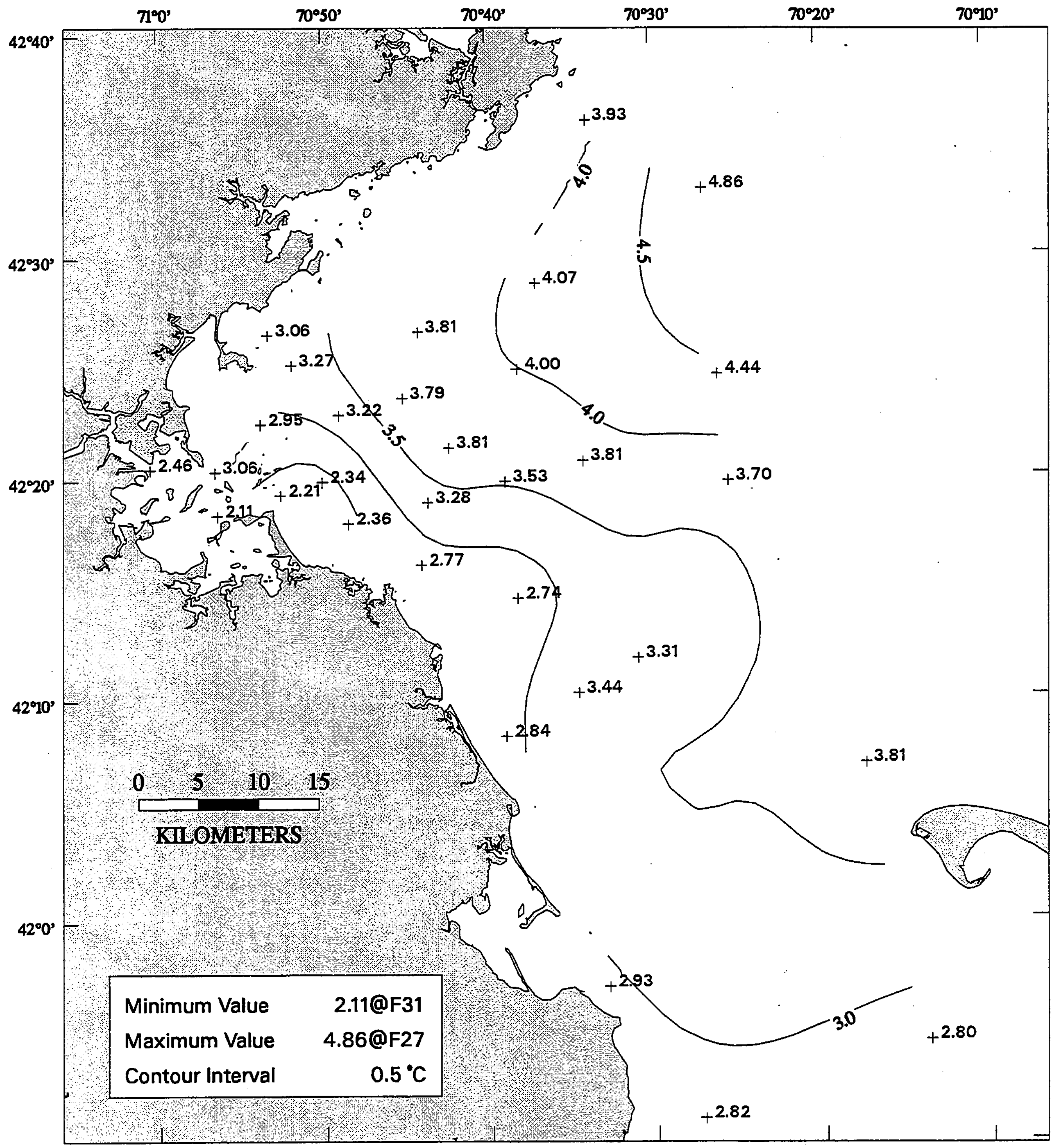


FIGURE 4-3
Surface Water Contour Plot of Temperature (°C) in early February (W9701)

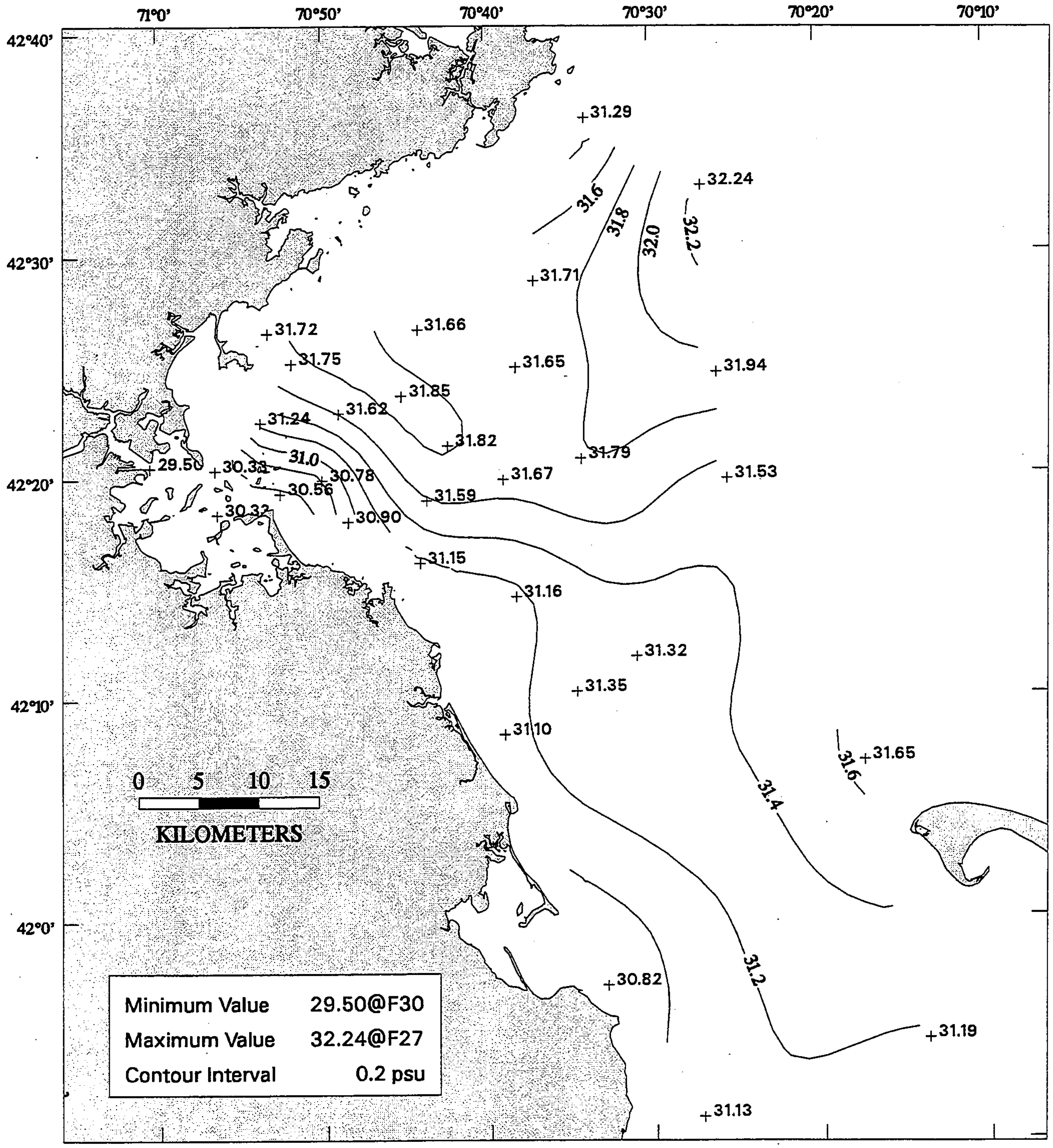


FIGURE 4-4
Surface Water Contour Plot of Salinity (PSU) in Early February (W9701)

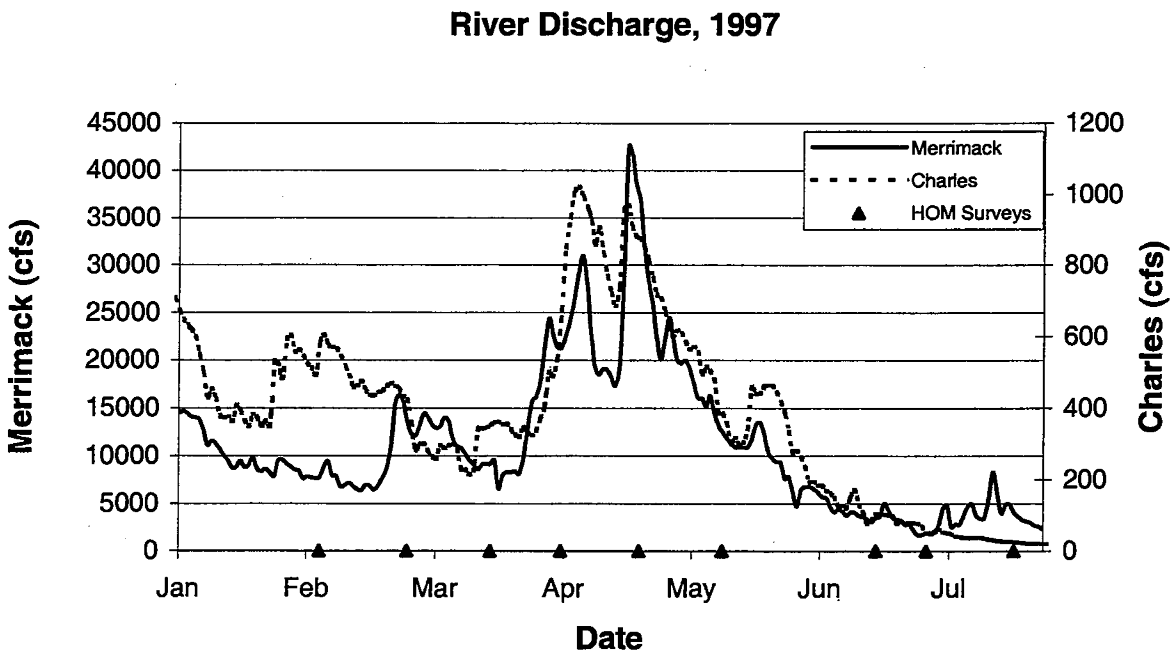


Figure 4-5
River Discharge from the Merrimack and Charles Rivers

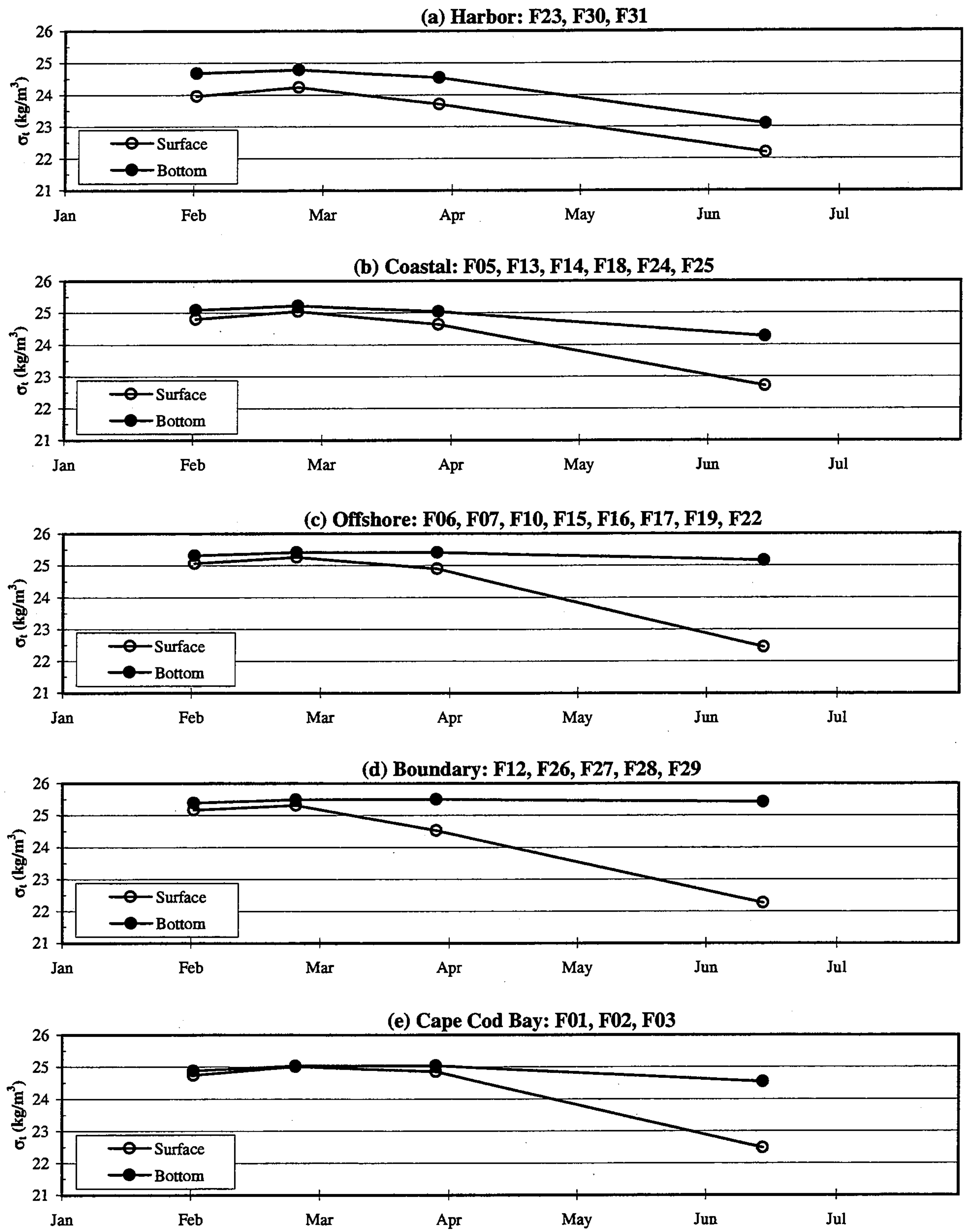


FIGURE 4-6

Time-Series of Average Surface and Bottom Water Density (σ_t) in the Farfield

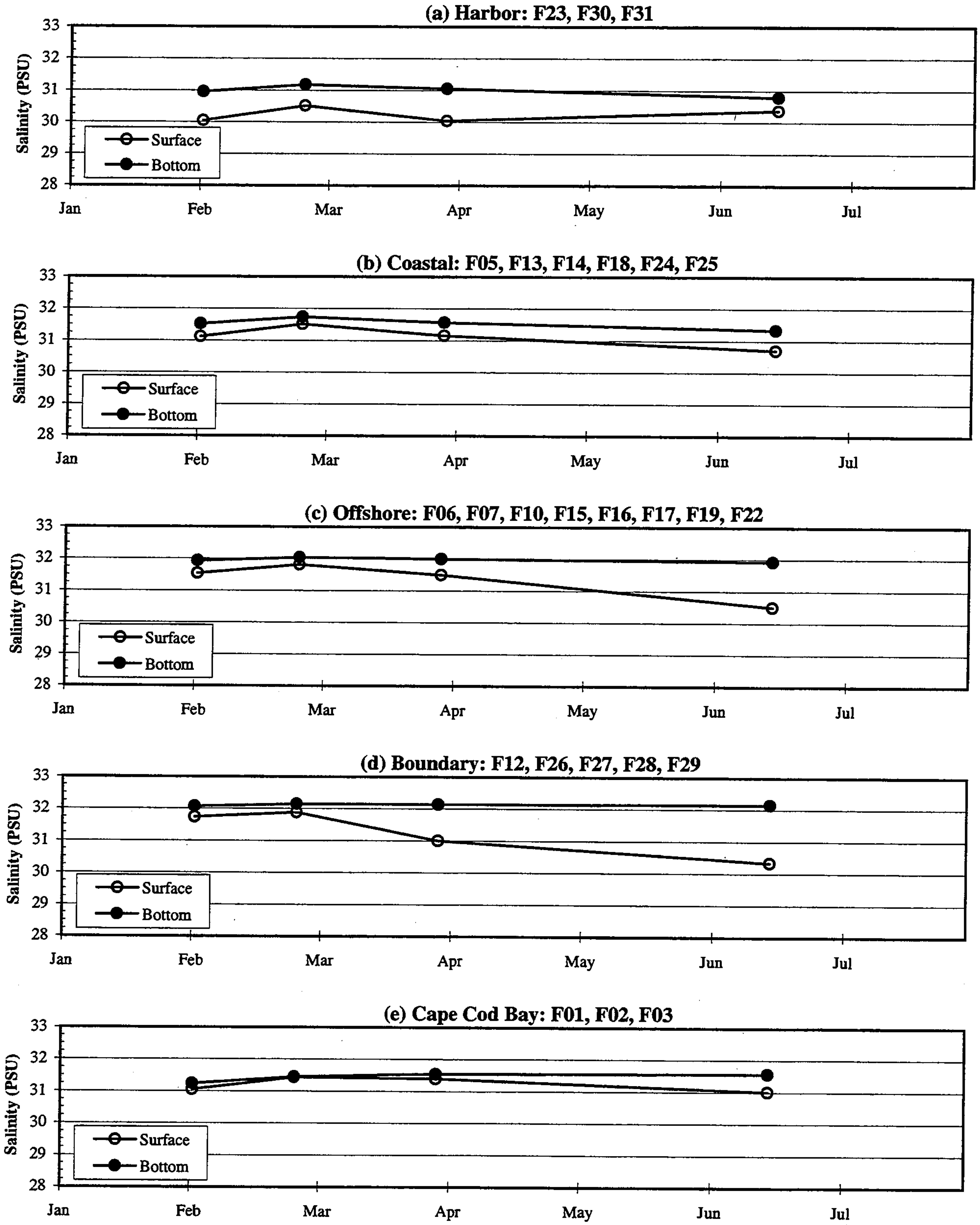


FIGURE 4-7
Time-Series of Average Surface and Bottom Water Salinity (PSU) in the Farfield

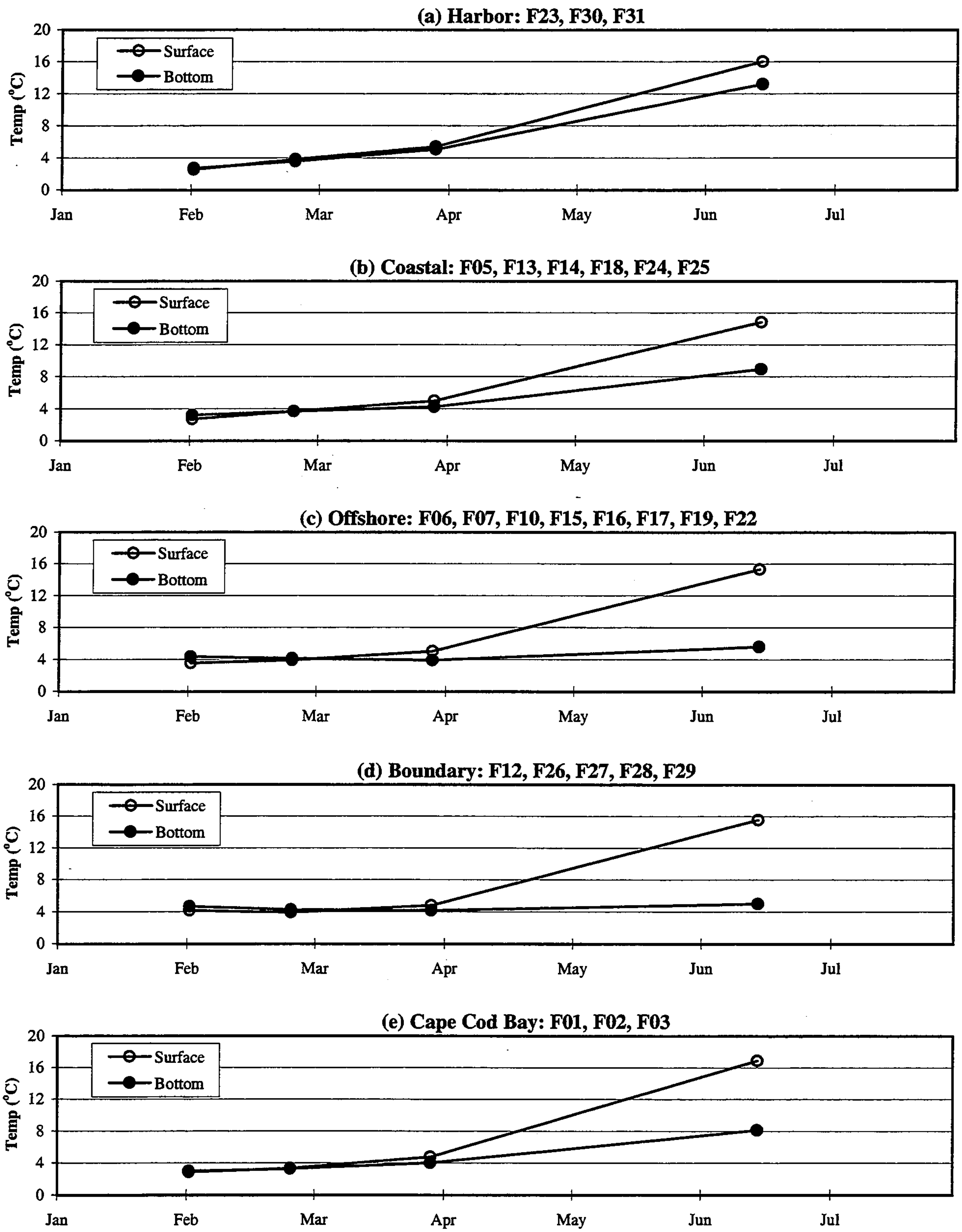


FIGURE 4-8

Time-Series of Average Surface and Bottom Water Temperature (°C) in the Farfield

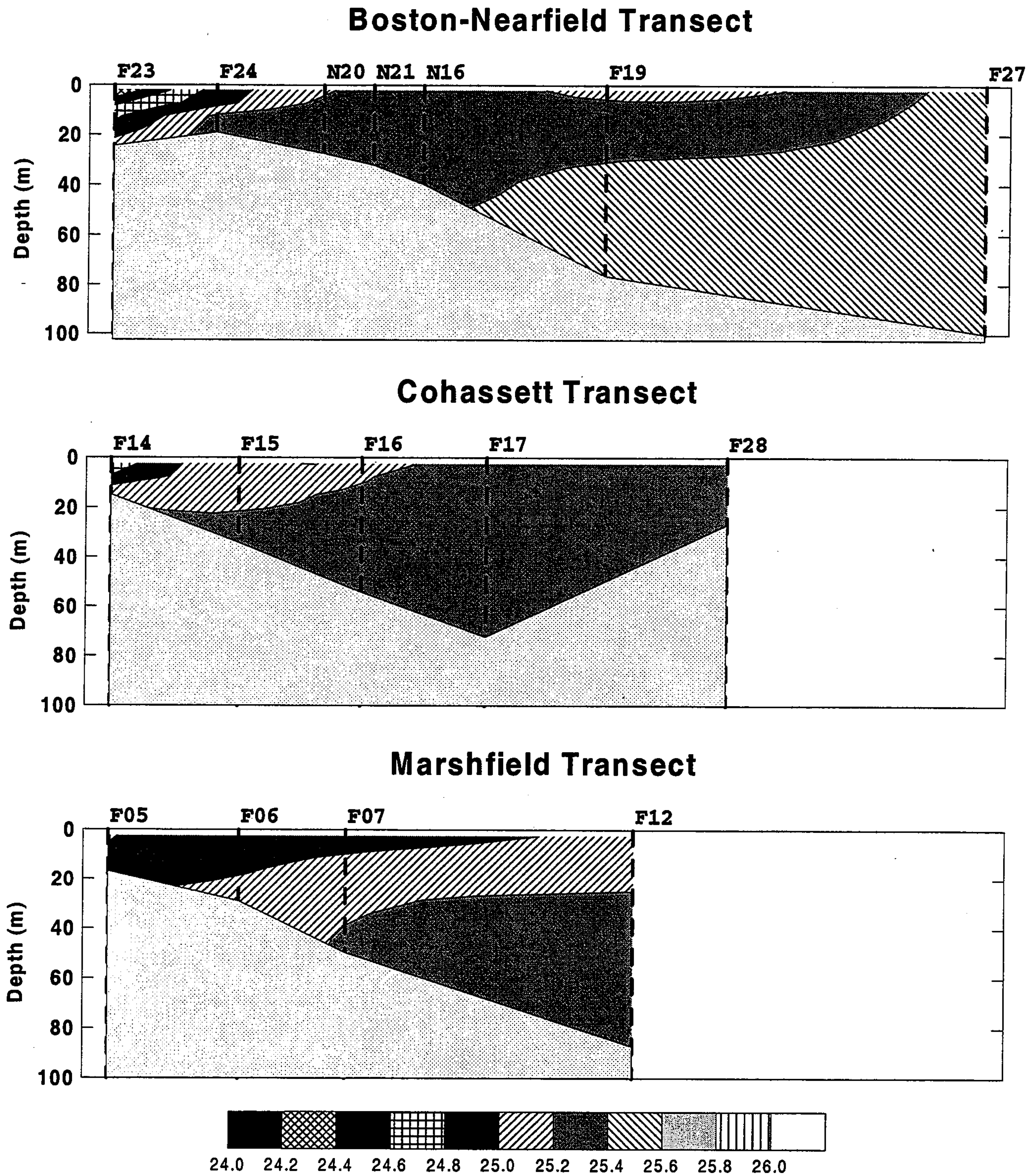


FIGURE 4-9
Density (σ_t) Contours Along Three Farfield Transects in Early February (W9701)

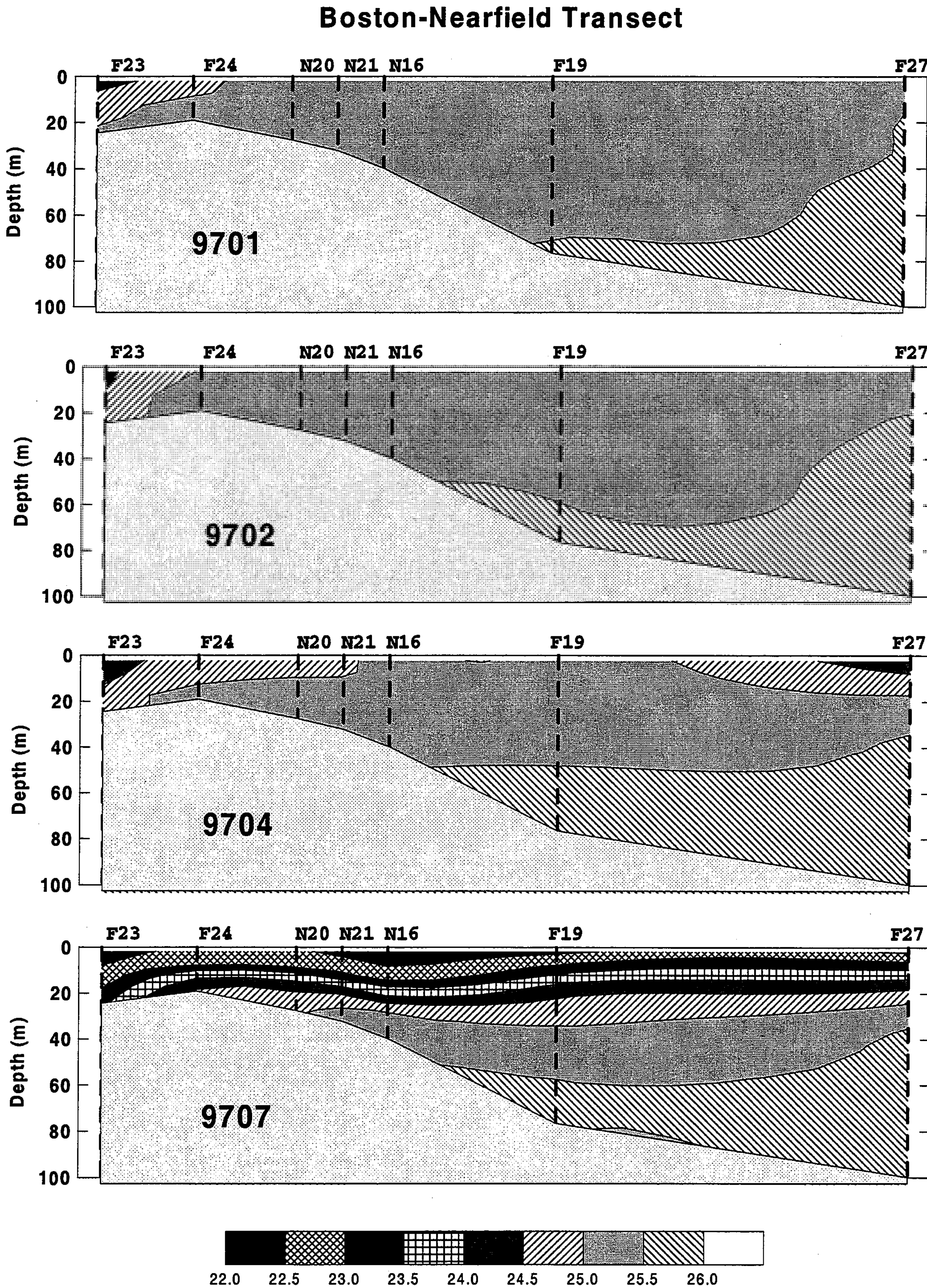


FIGURE 4-10
Density (σ_t) Contours Along the Boston-Nearfield Transect
February 1997 to June 1997

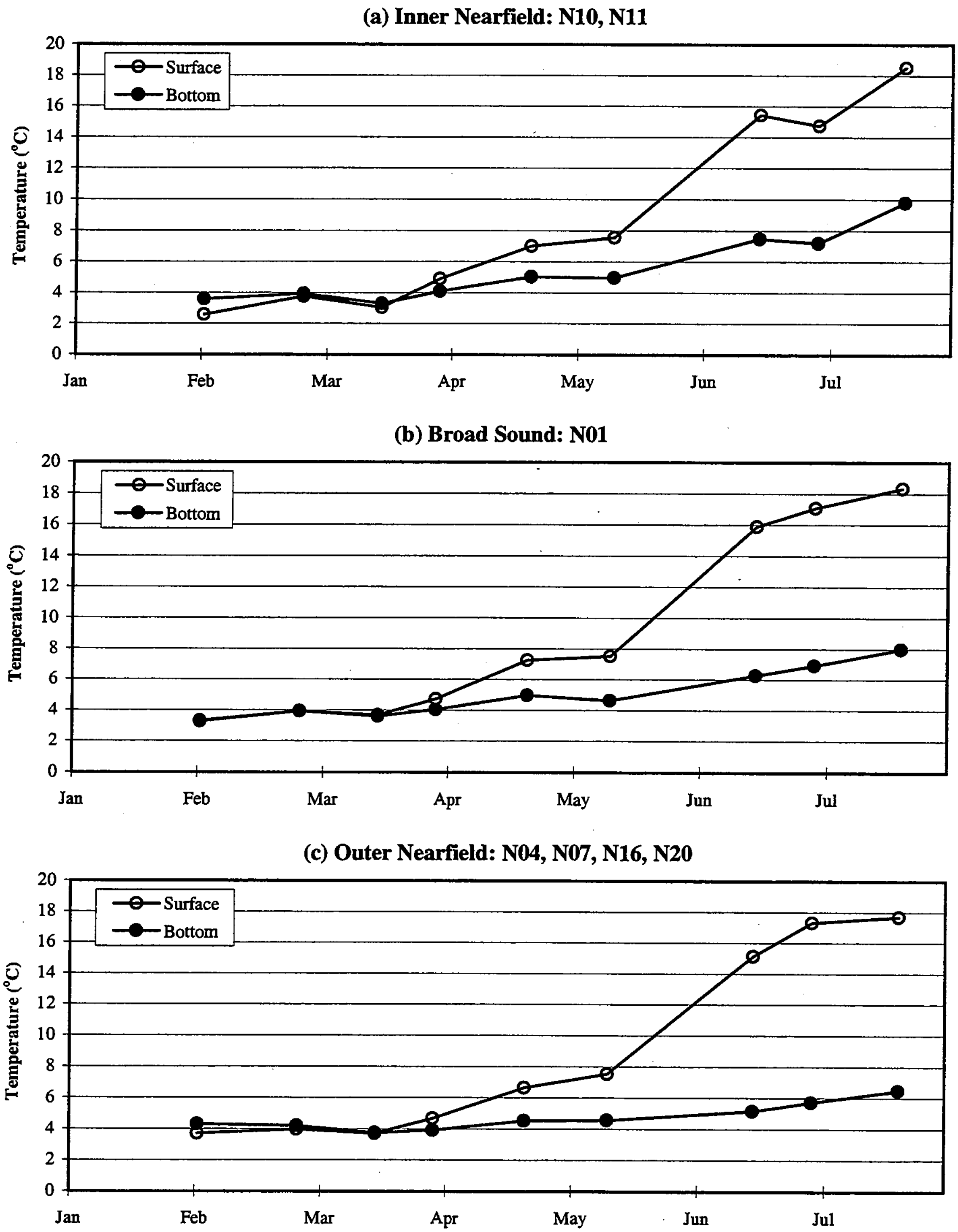


FIGURE 4-11

Time-Series of Average Surface and Bottom Water Temperature (°C) in the Nearfield

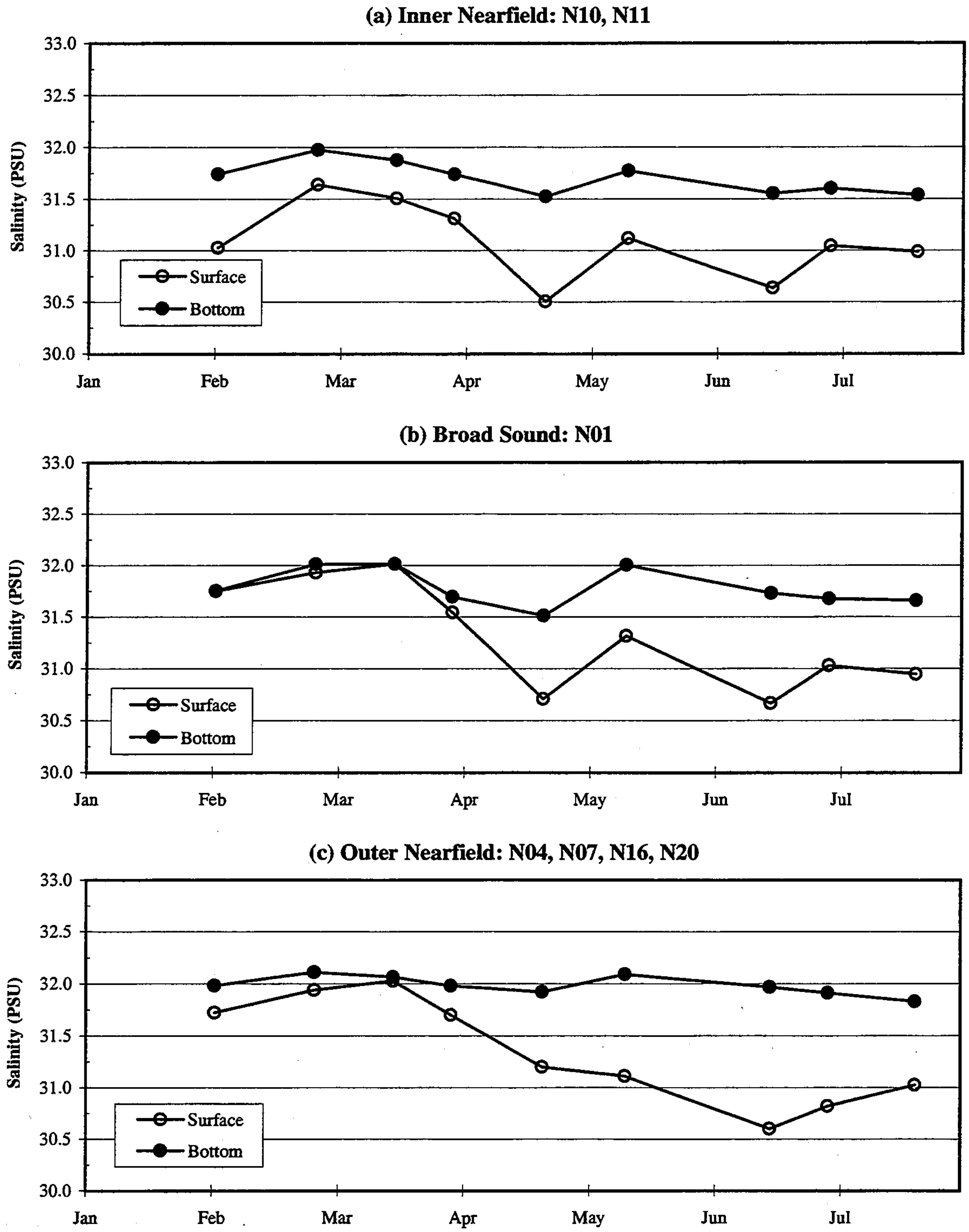


FIGURE 4-12
Time-Series of Average Surface and Bottom Water Salinity (PSU) in the Nearfield

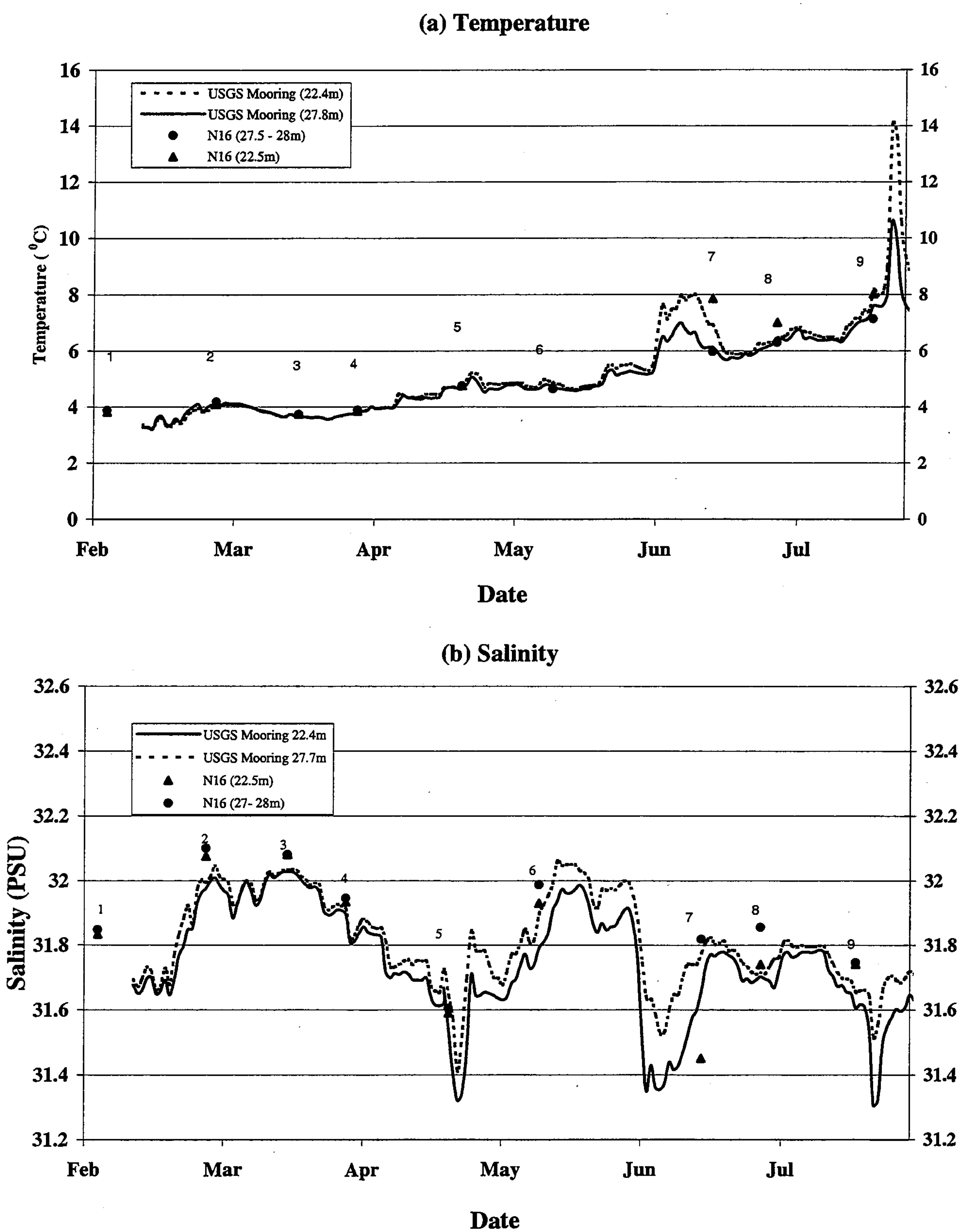


Figure 4-13

Moored Temperature and Salinity Sensor Data: February - July, 1997

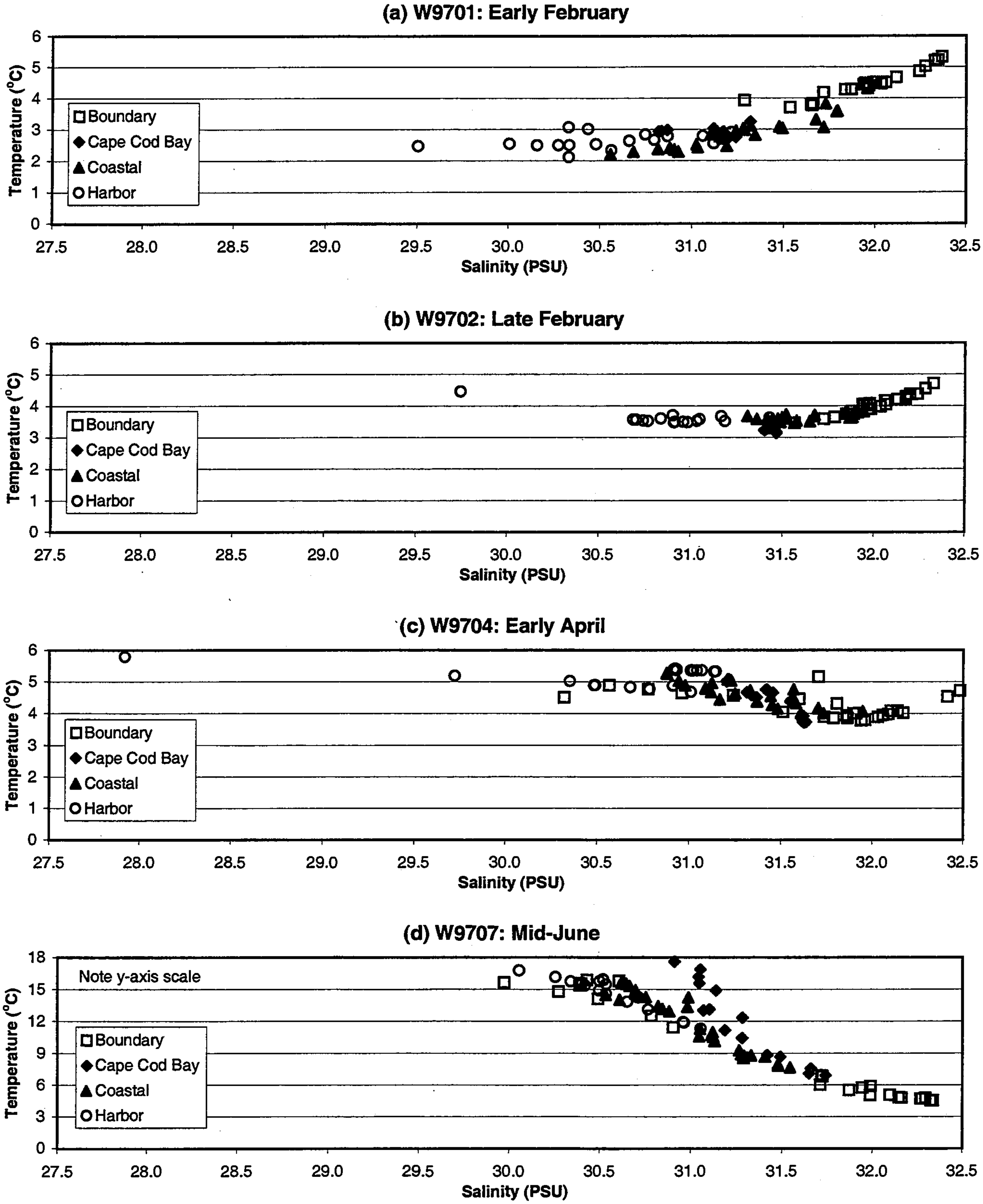


FIGURE 4-14

Temperature/Salinity Distribution February-June

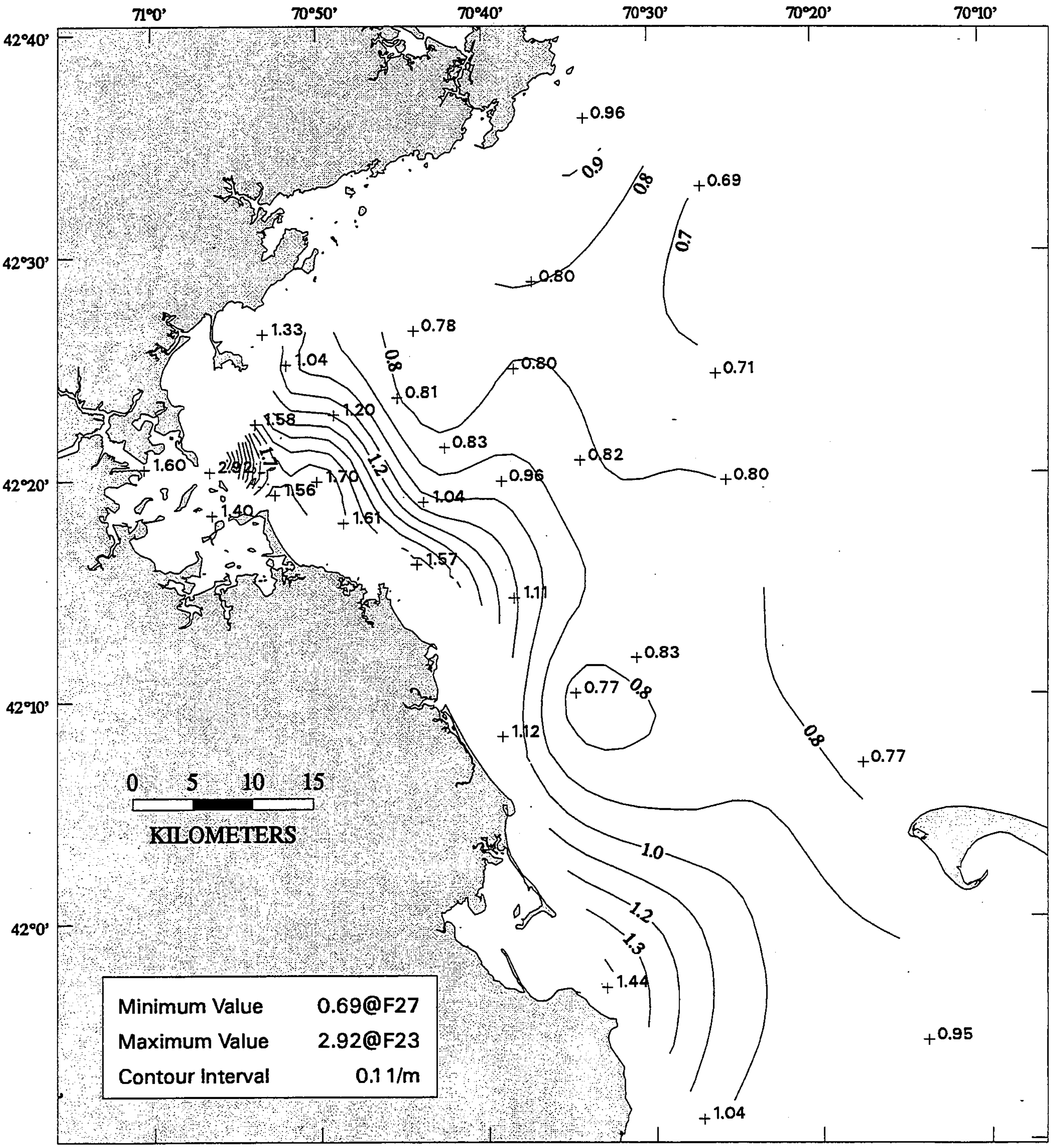


FIGURE 4-15
Surface Water Contour Plot of Beam Attenuation (/m) in early February (W9701)

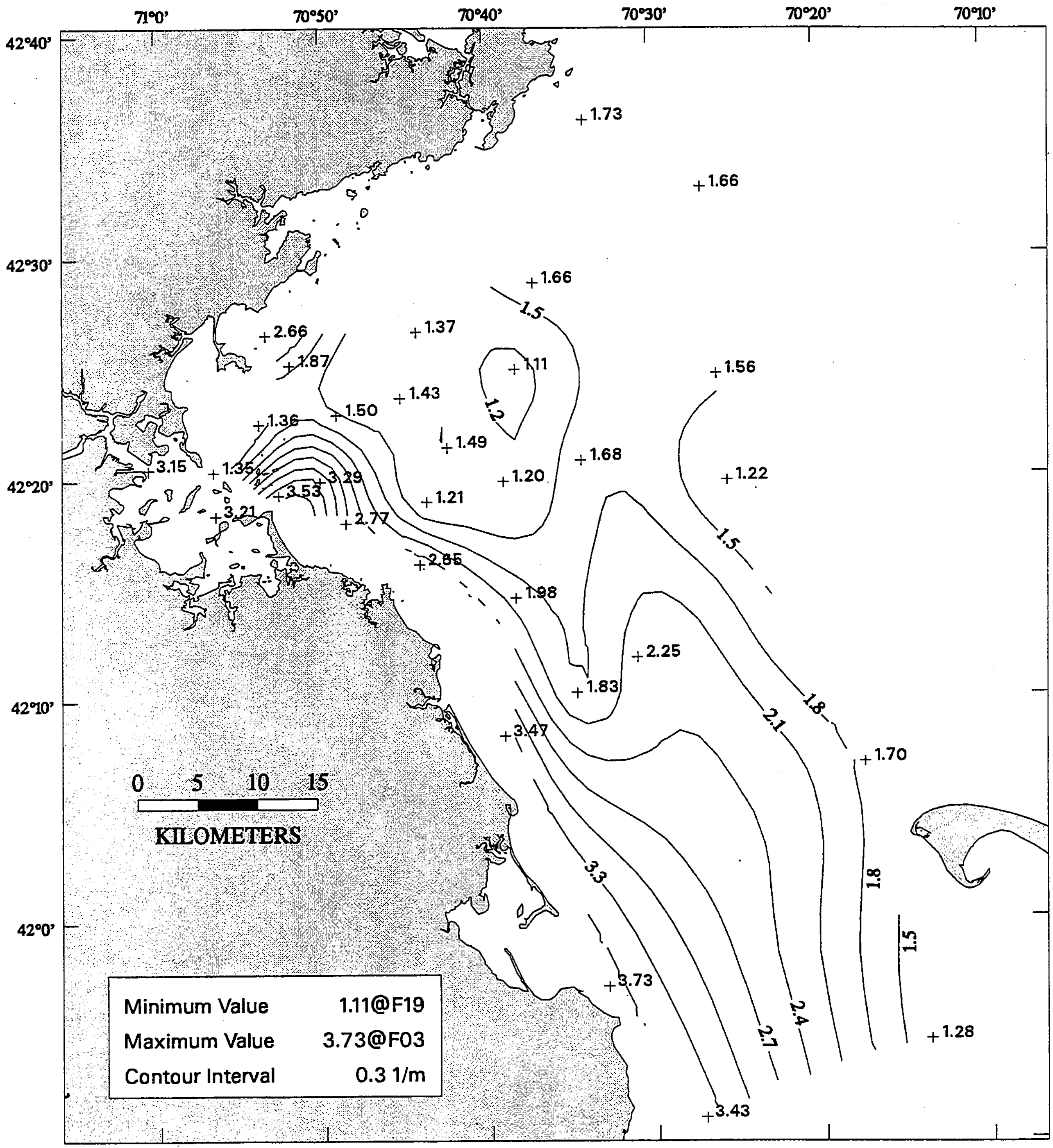


FIGURE 4-16
Surface Water contour Plot of Beam Attenuation (/m) in Early April (W9704)

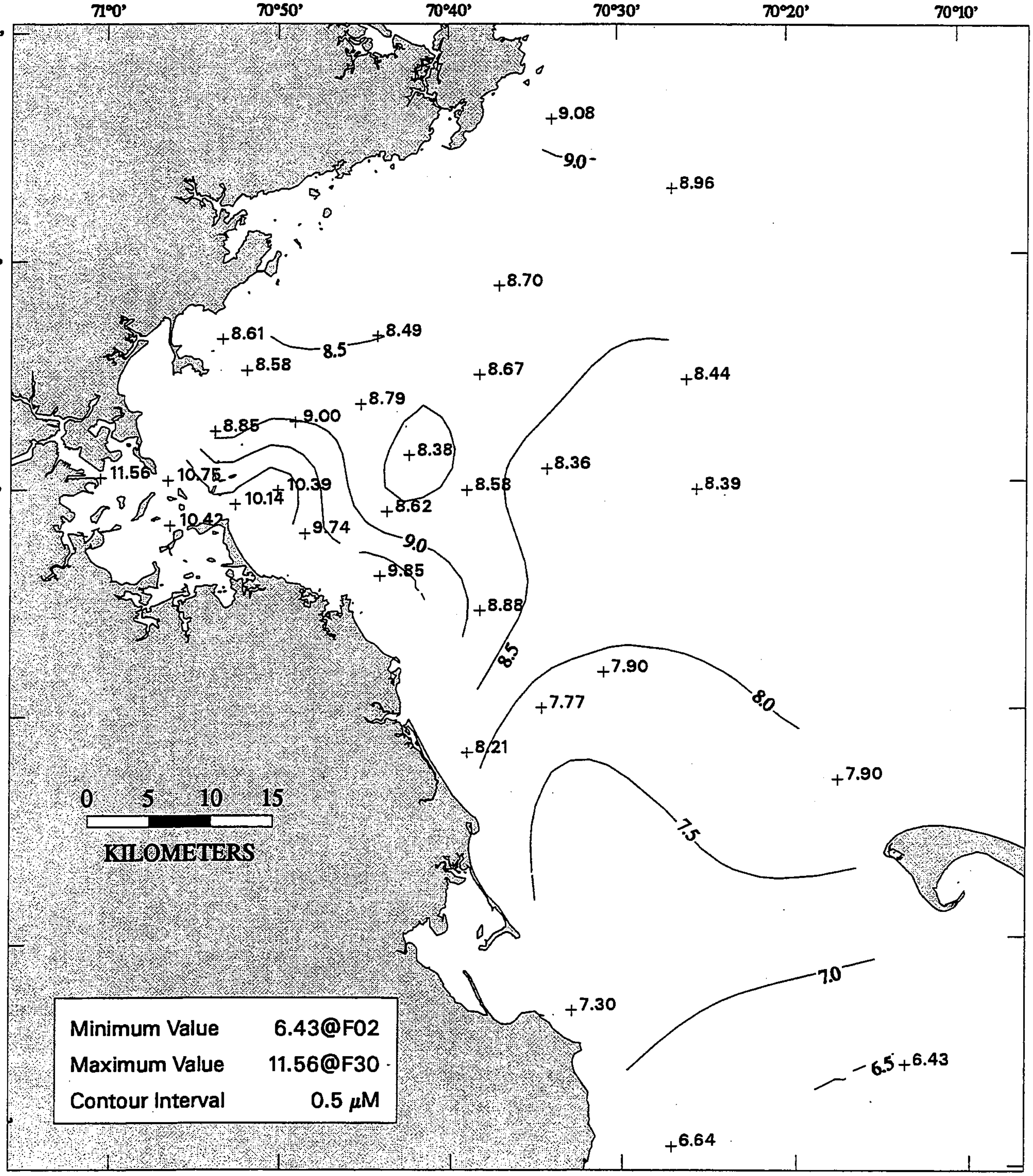


FIGURE 4-17
Surface Water Contour Plot of Nitrate in Early February (W9701)

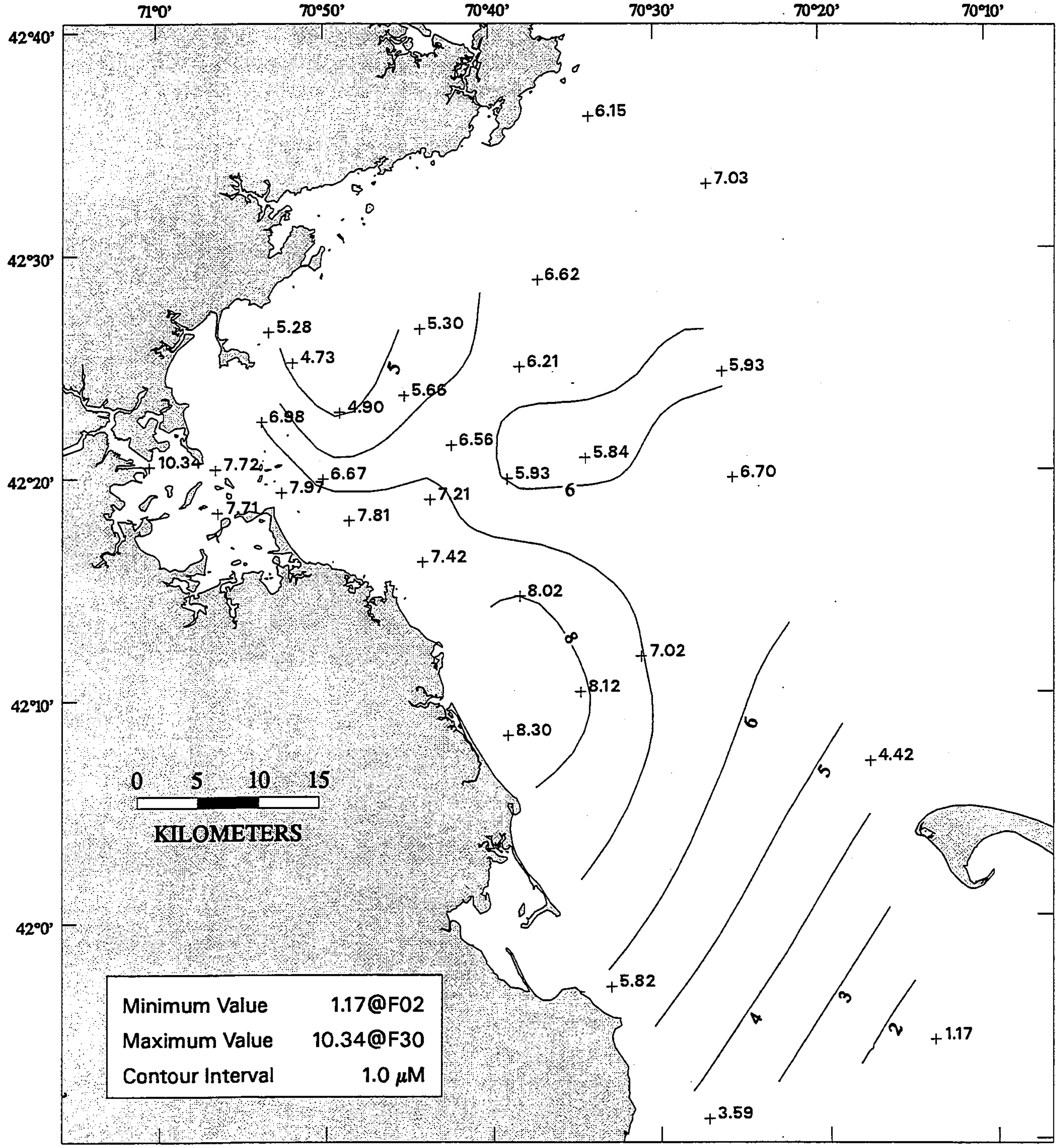


FIGURE 4-18
Surface Water Contour Plot of Nitrate in Late February (W9702)

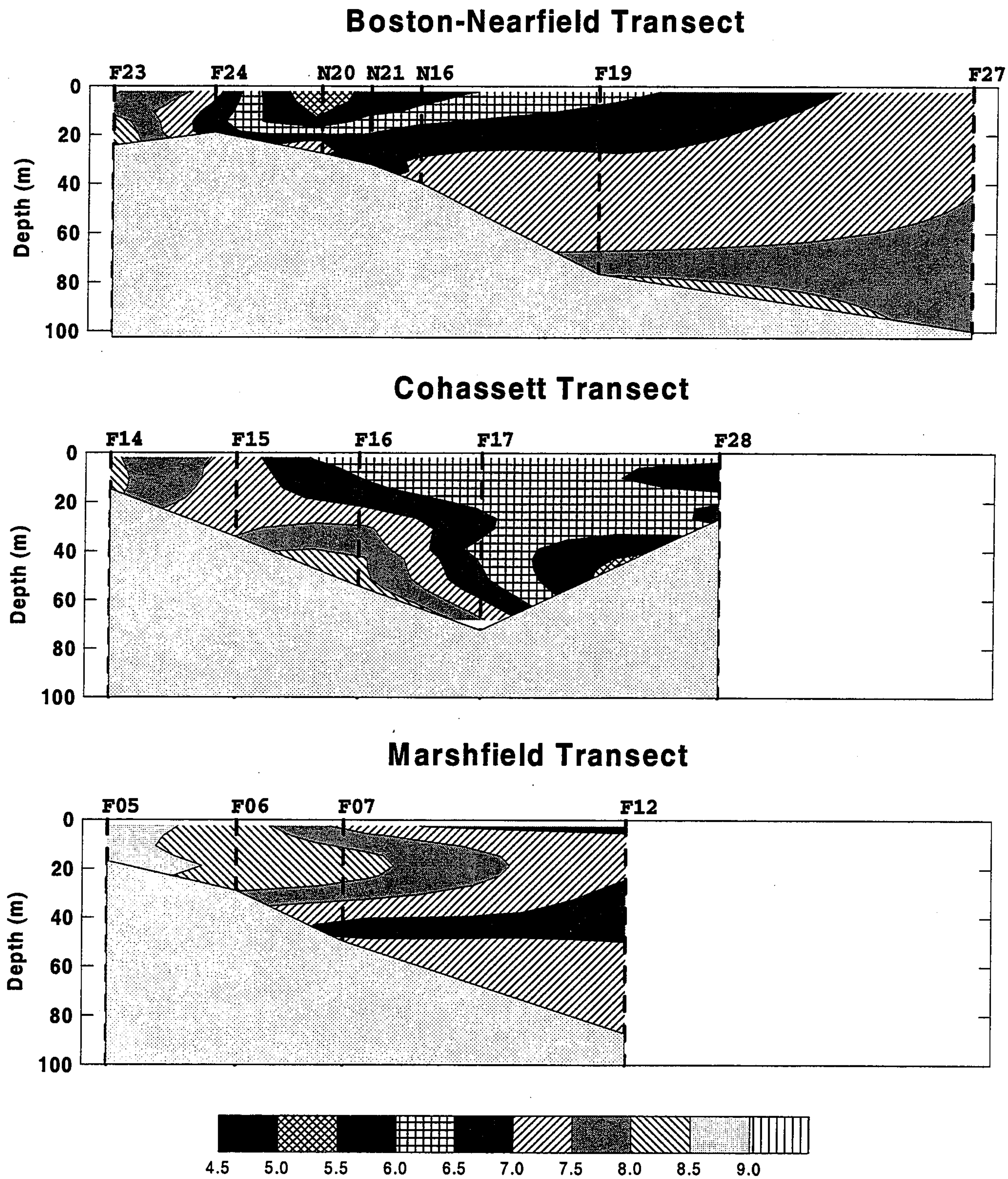


FIGURE 4-19
Nitrate + Nitrate Contours (µm) Along Three Farfield Transects in Late February (W9702)

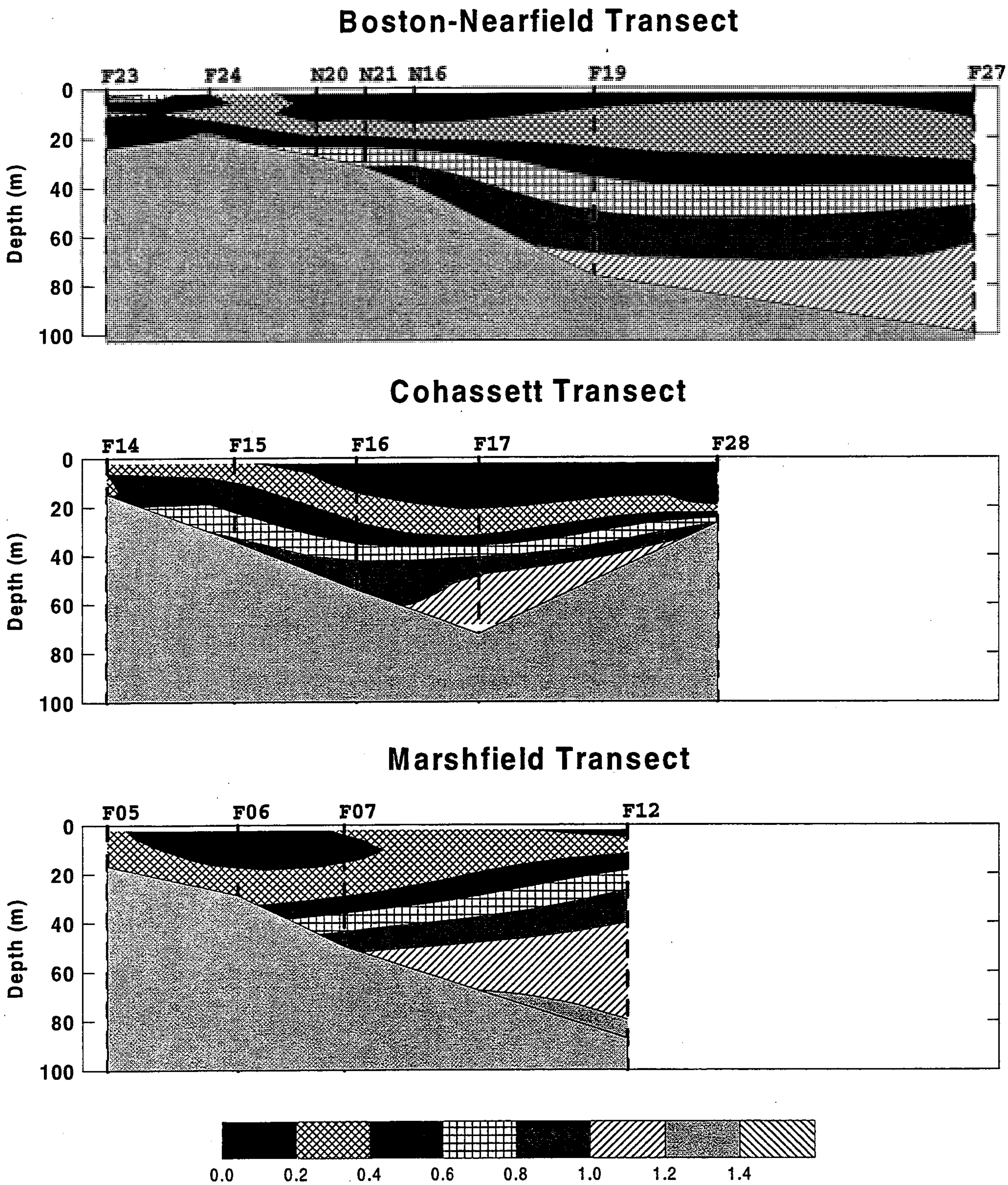


FIGURE 4-20
Phosphate Contours Along Three Nearfield Transects in June (W9707)

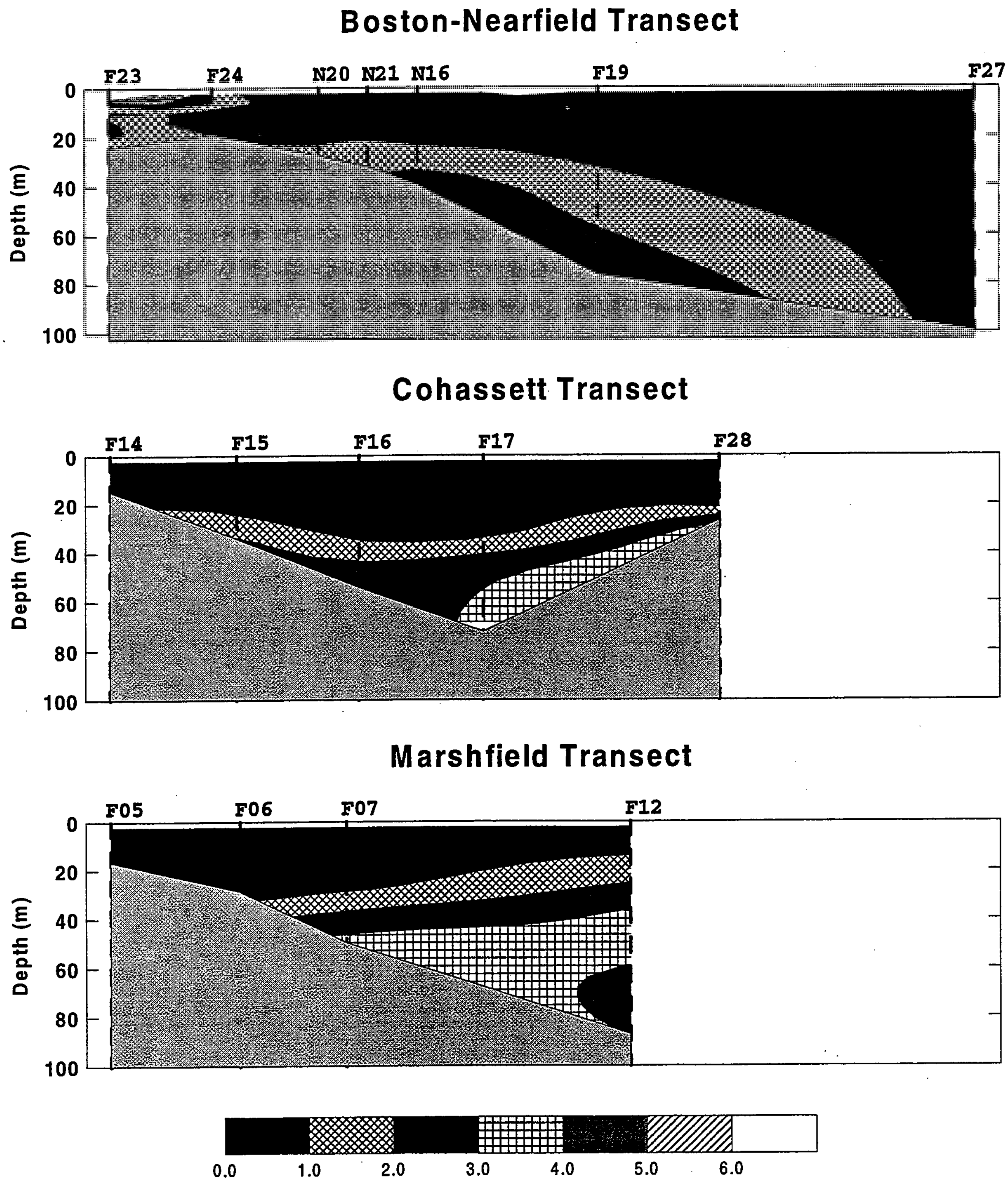


FIGURE 4-21
Ammonium Contours Along Three Nearfield Transects in June (W9707)

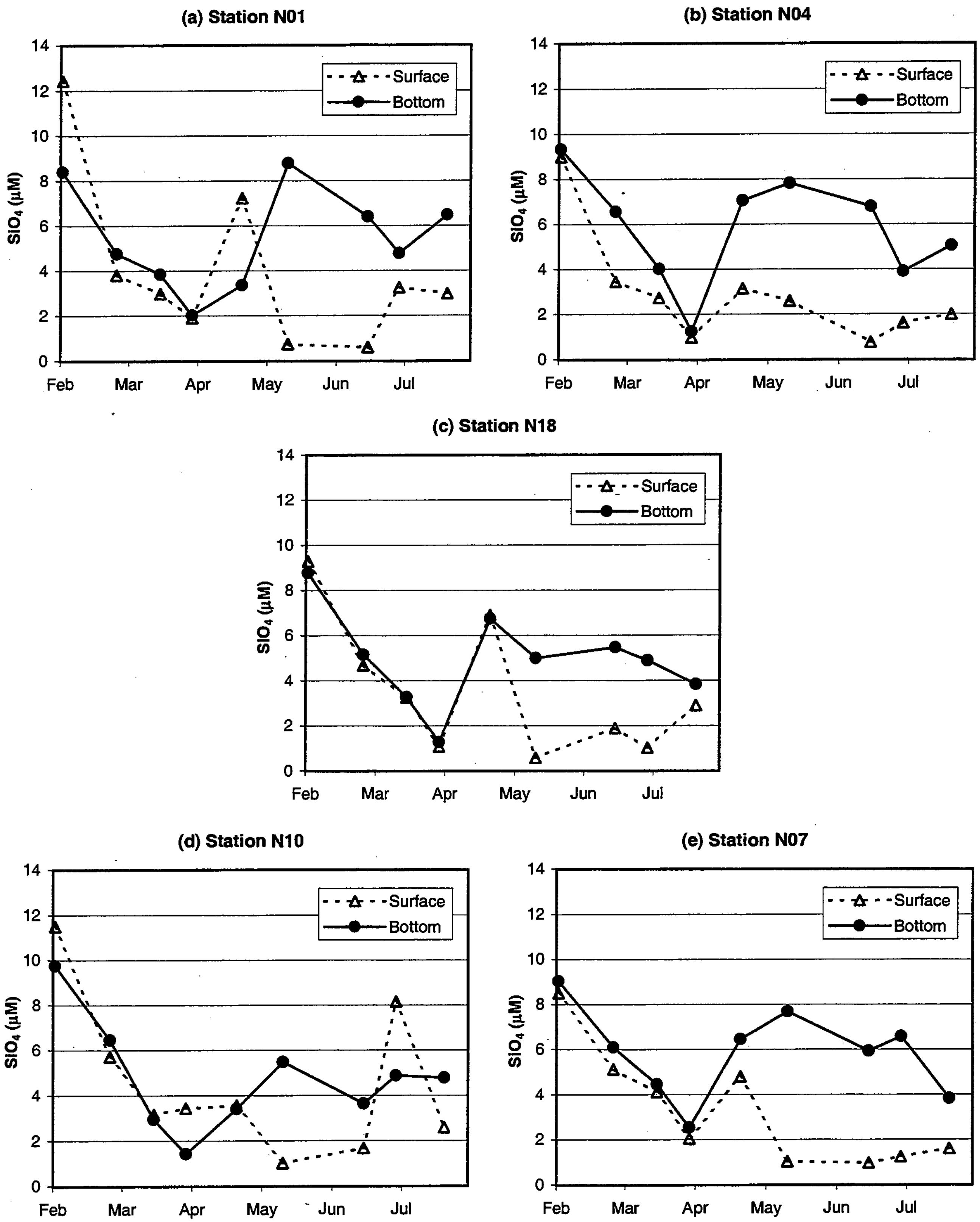


FIGURE 4-22
Time-Series of Surface and Bottom Water Silicate Concentration at Five Nearfield Stations

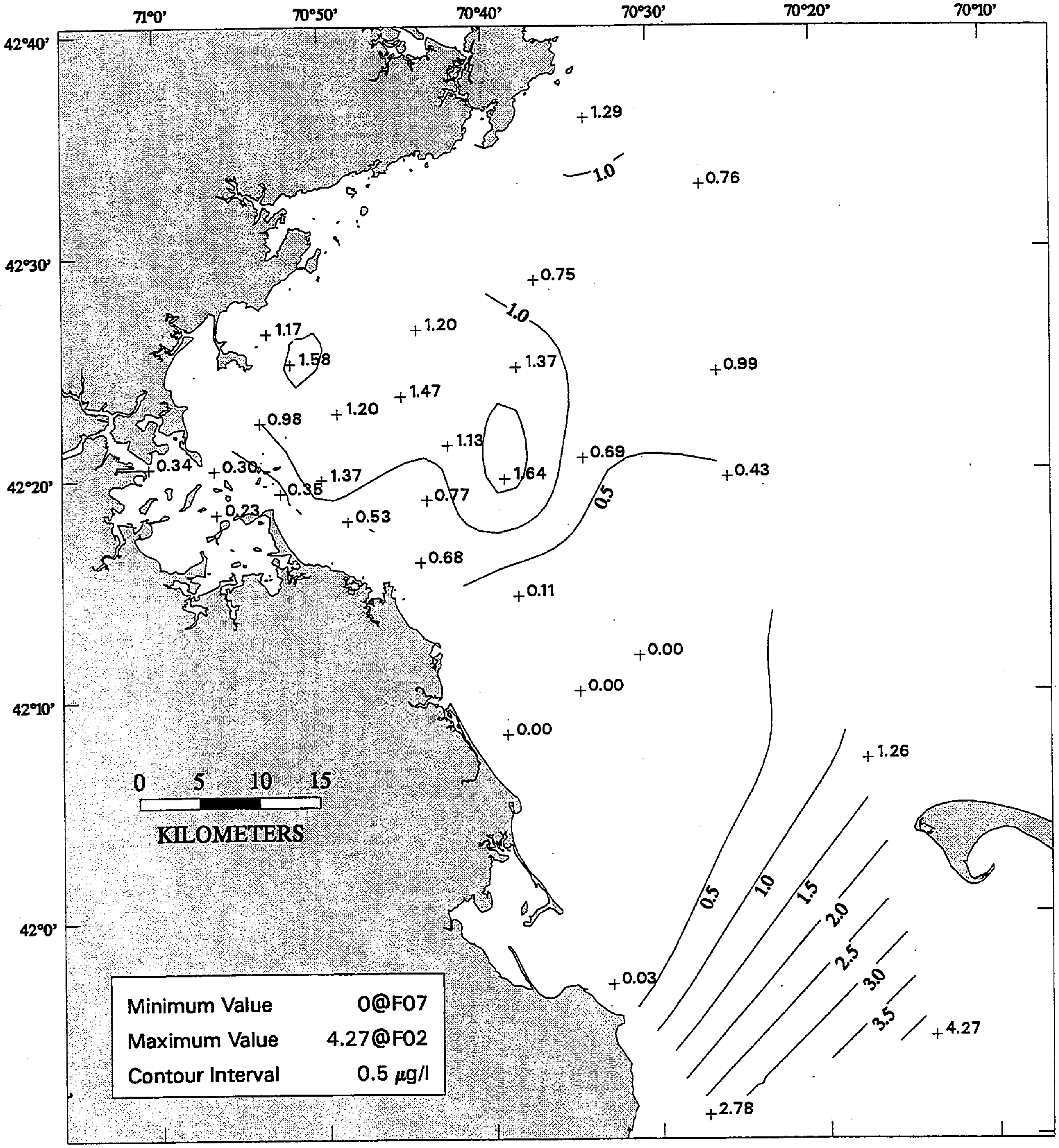


FIGURE 4-23
Surface Water Contour Plot of Chlorophyll *a* (µg/L) in Late February (W9702)

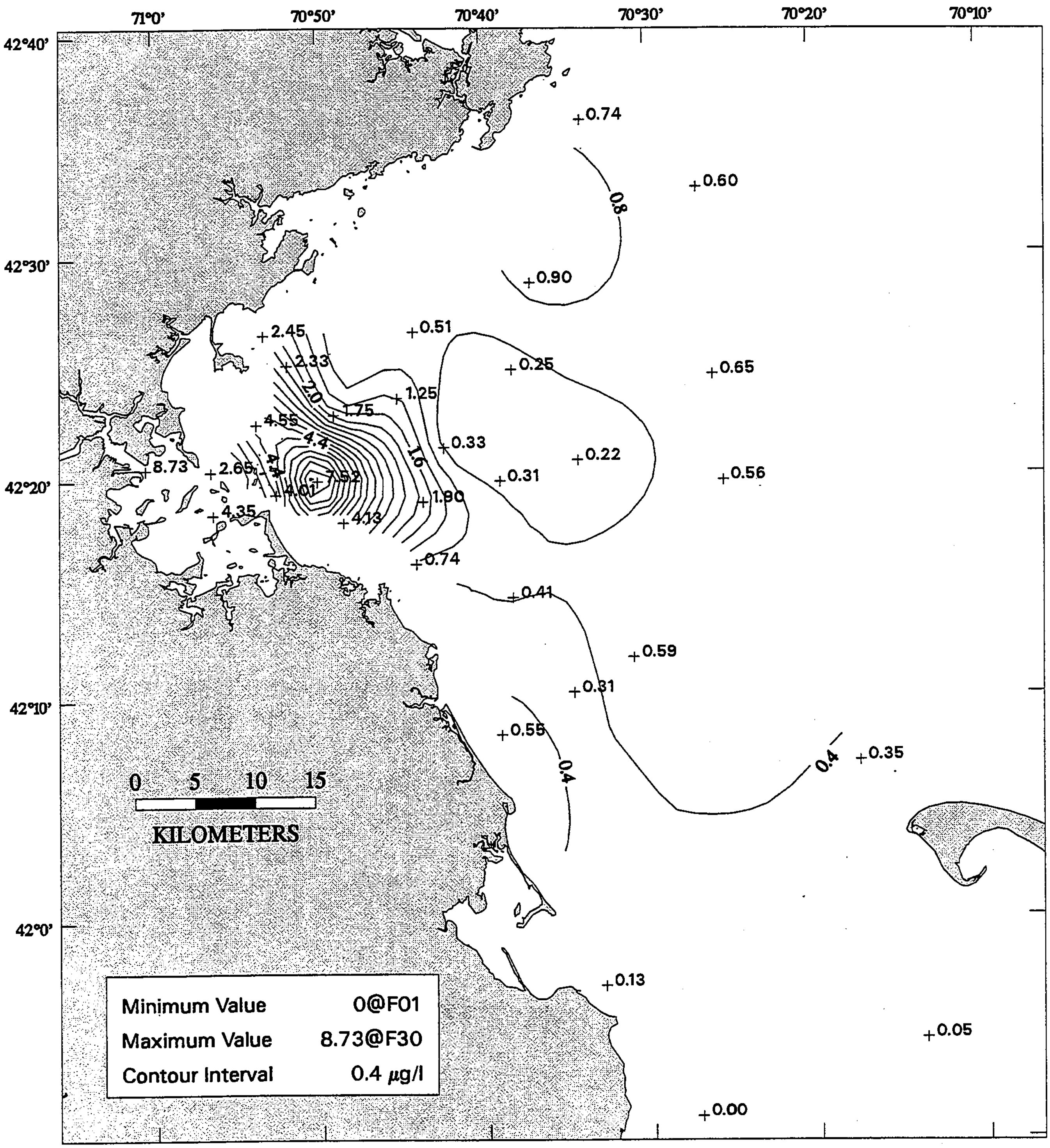


FIGURE 4-24
Surface Water Contour Plot of Chlorophyll *a* (μg/L) in June (W9707)

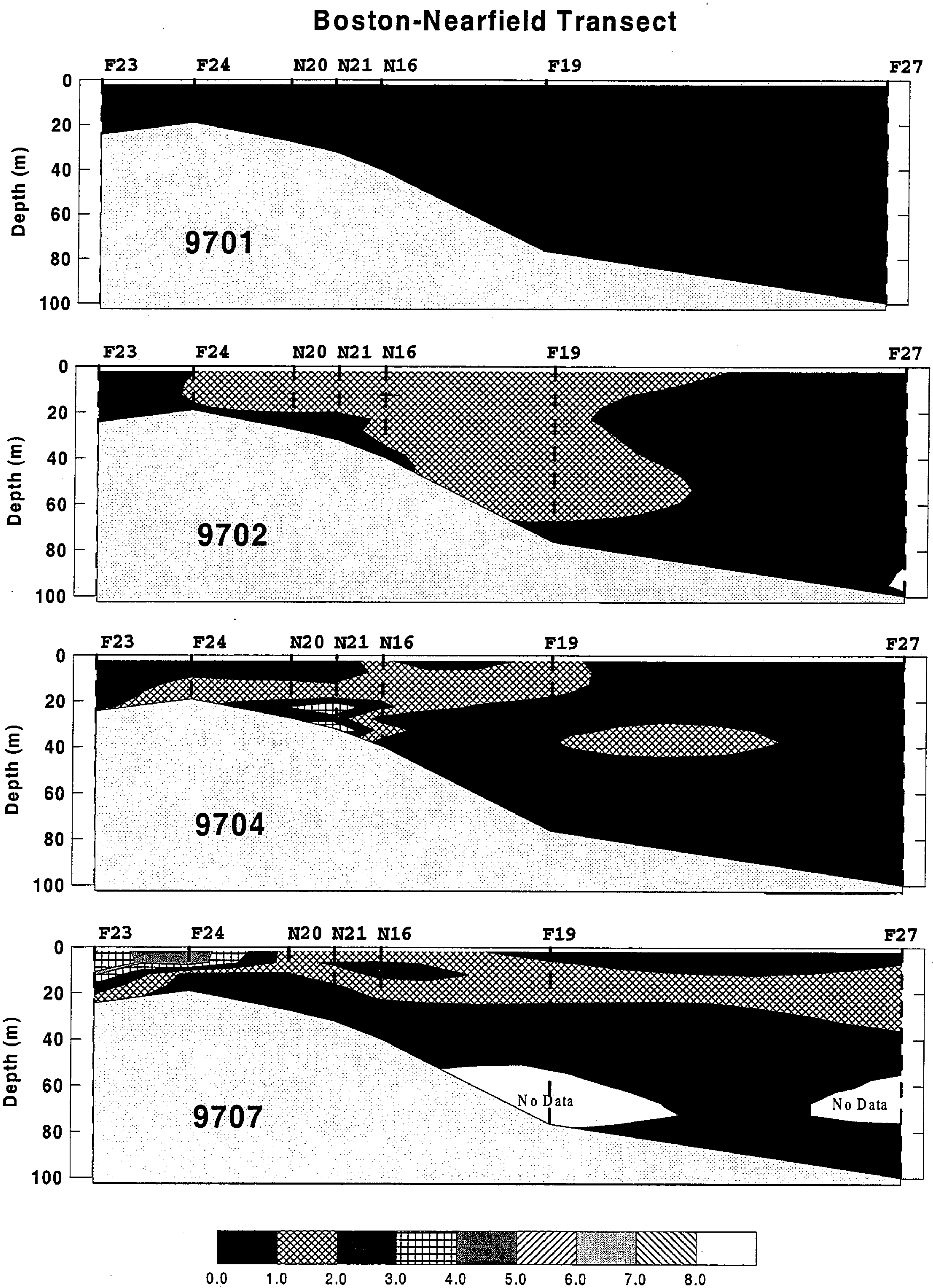


FIGURE 4-25
Chlorophyll *a* (µg/L) Contours Along the Boston-Nearfield Transect
February 1997 to June 1997

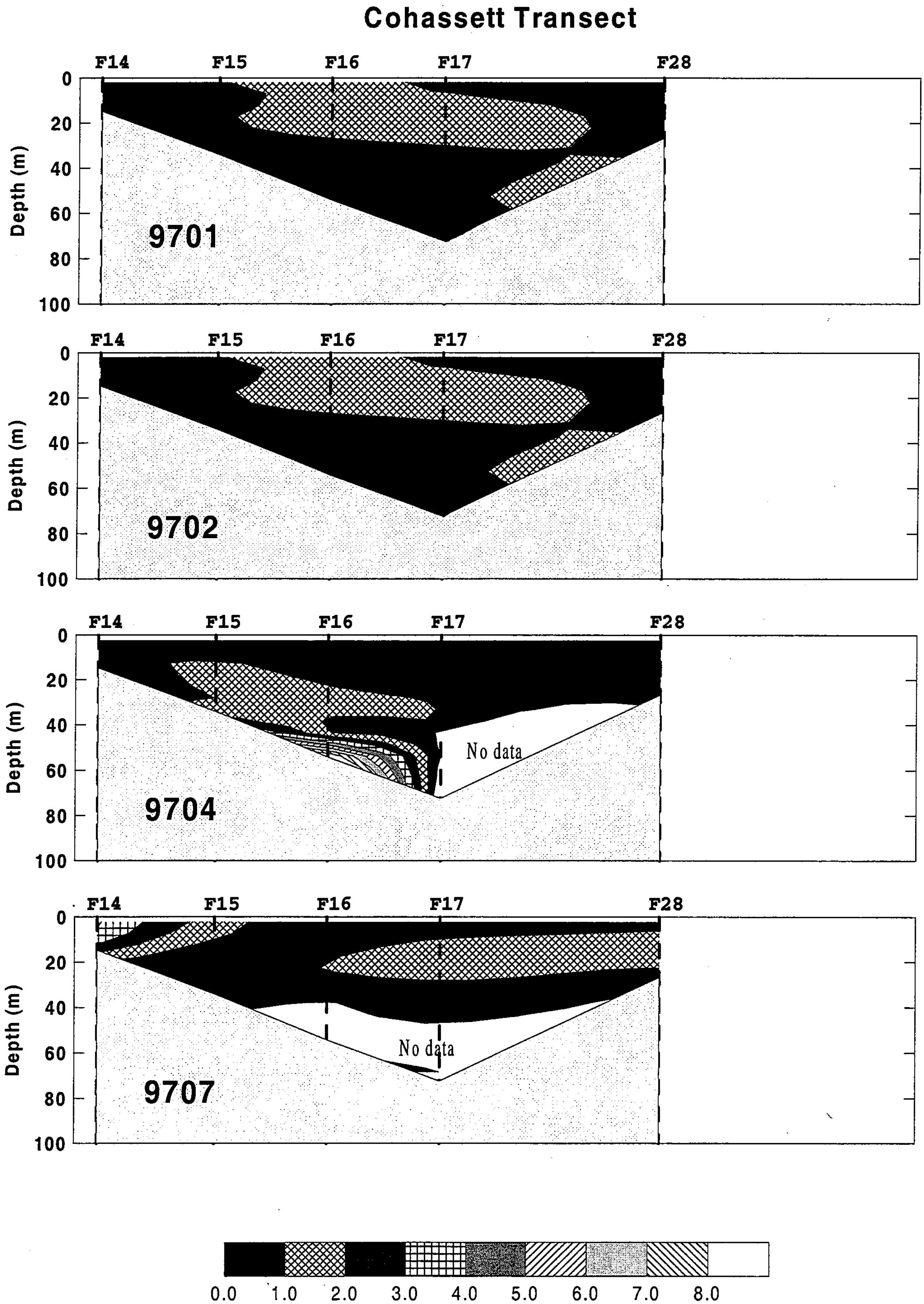


FIGURE 4-26
Chlorophyll *a* (µg/L) Contours Along the Cohasset Transect
February 1997 to June 1997

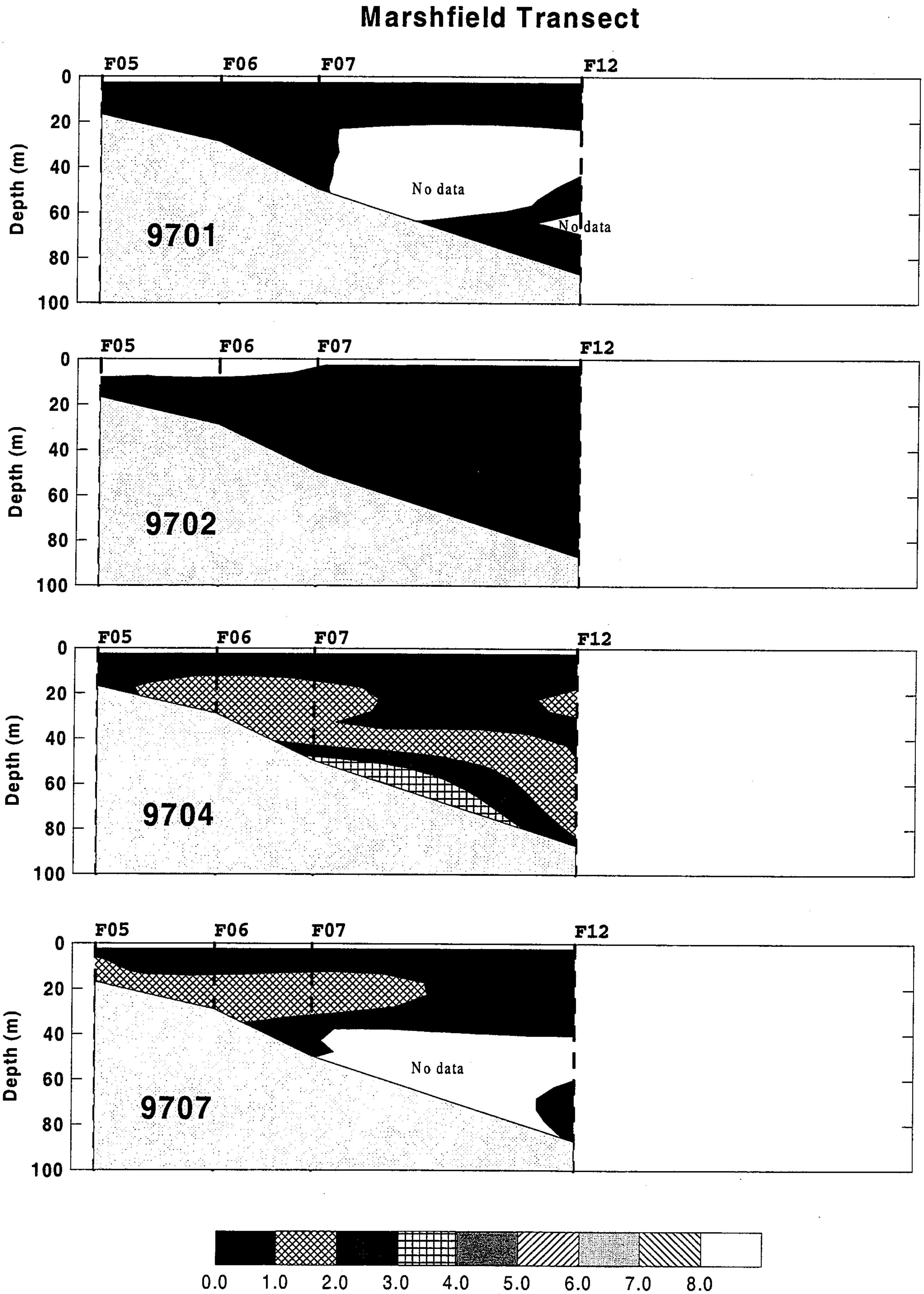


FIGURE 4-27
Chlorophyll *a* (µg/L) Contours Along the Marshfield Transect
February 1997 to June 1997

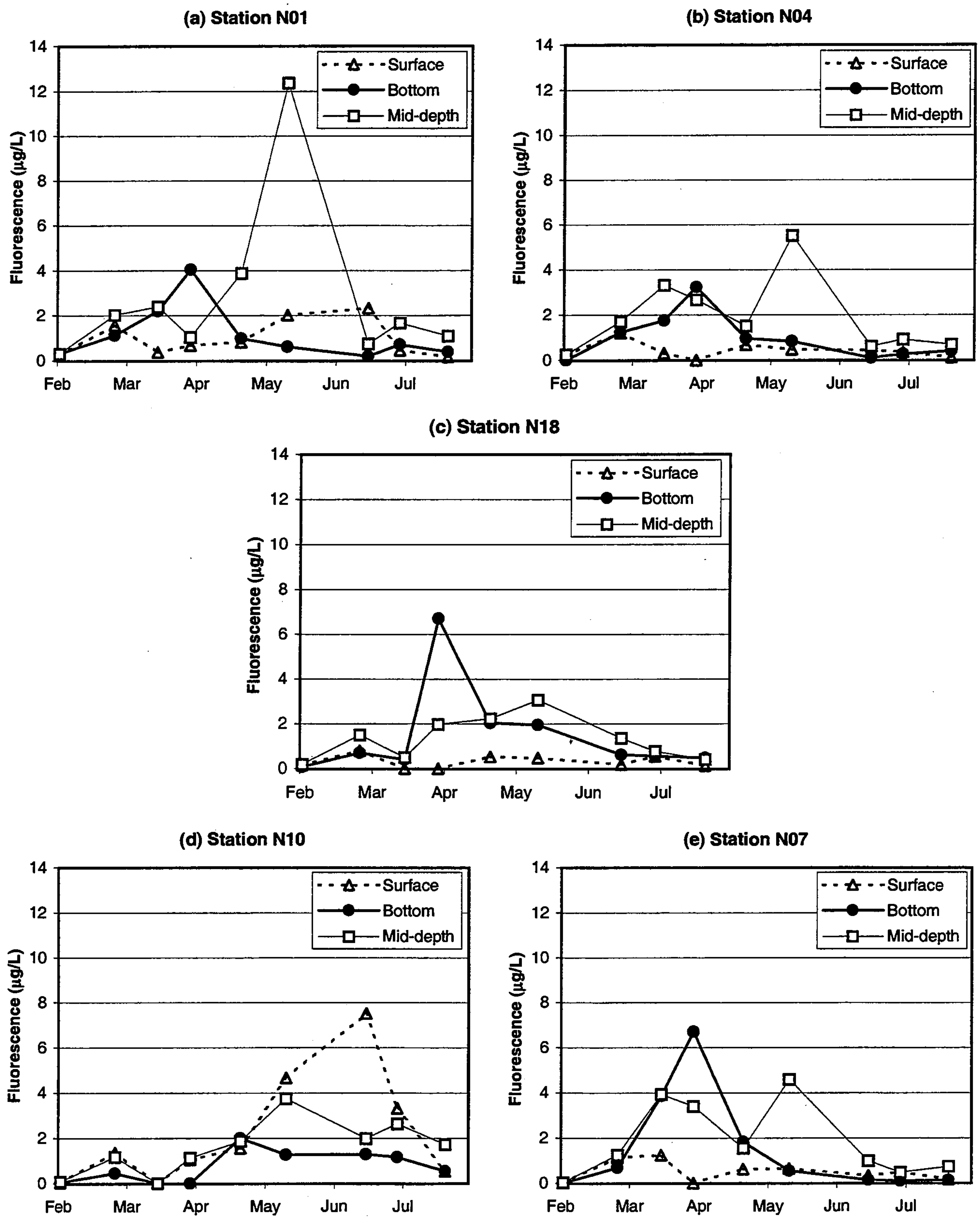


FIGURE 4-28
Time-Series of Surface and Bottom Water Chlorophyll *a* Concentration at Five Nearfield Stations

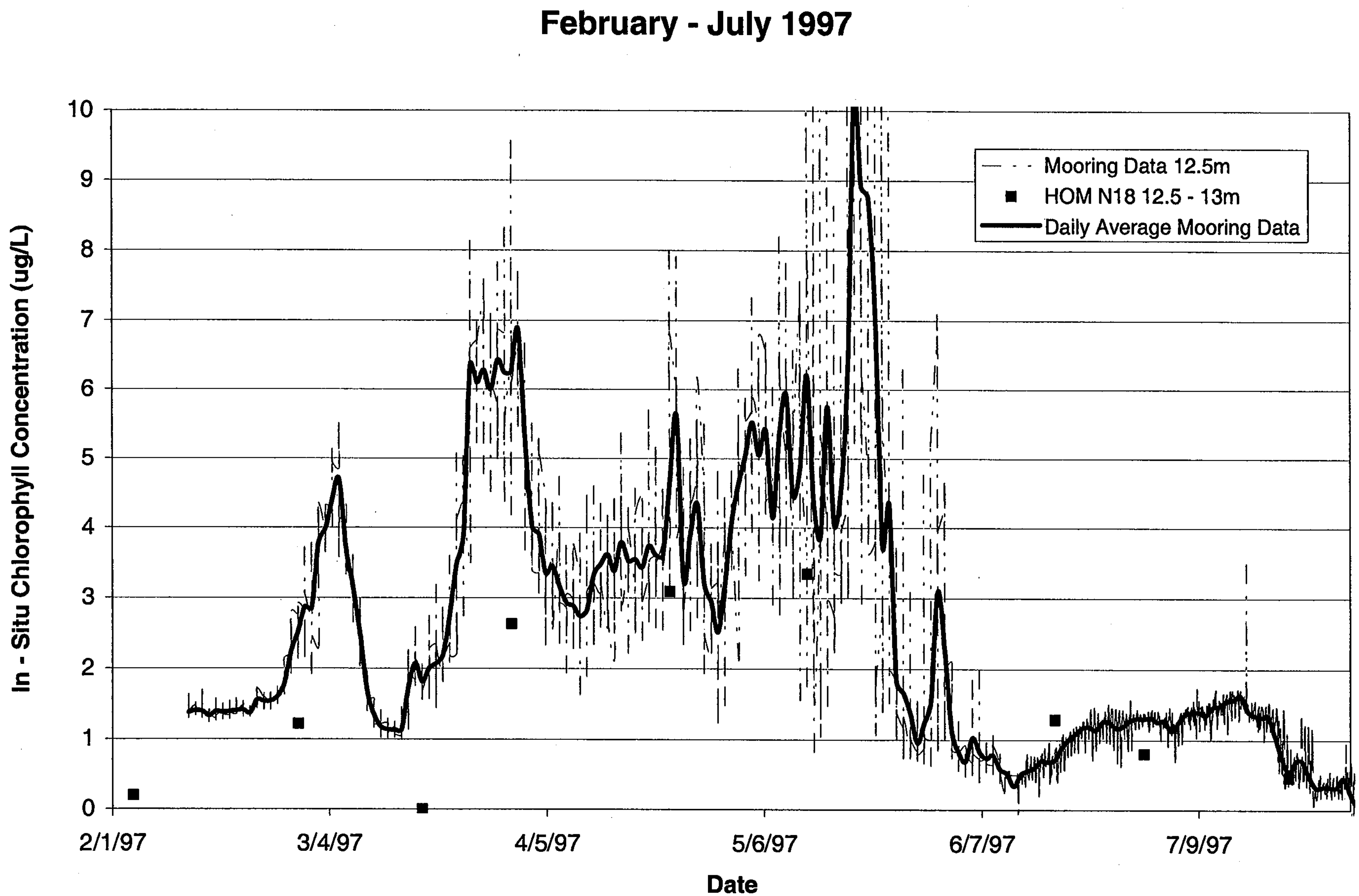


FIGURE 4-29
WETLABS 12.5 Sensor Chlorophyll Results
February 12, 1997 to July 30, 1997

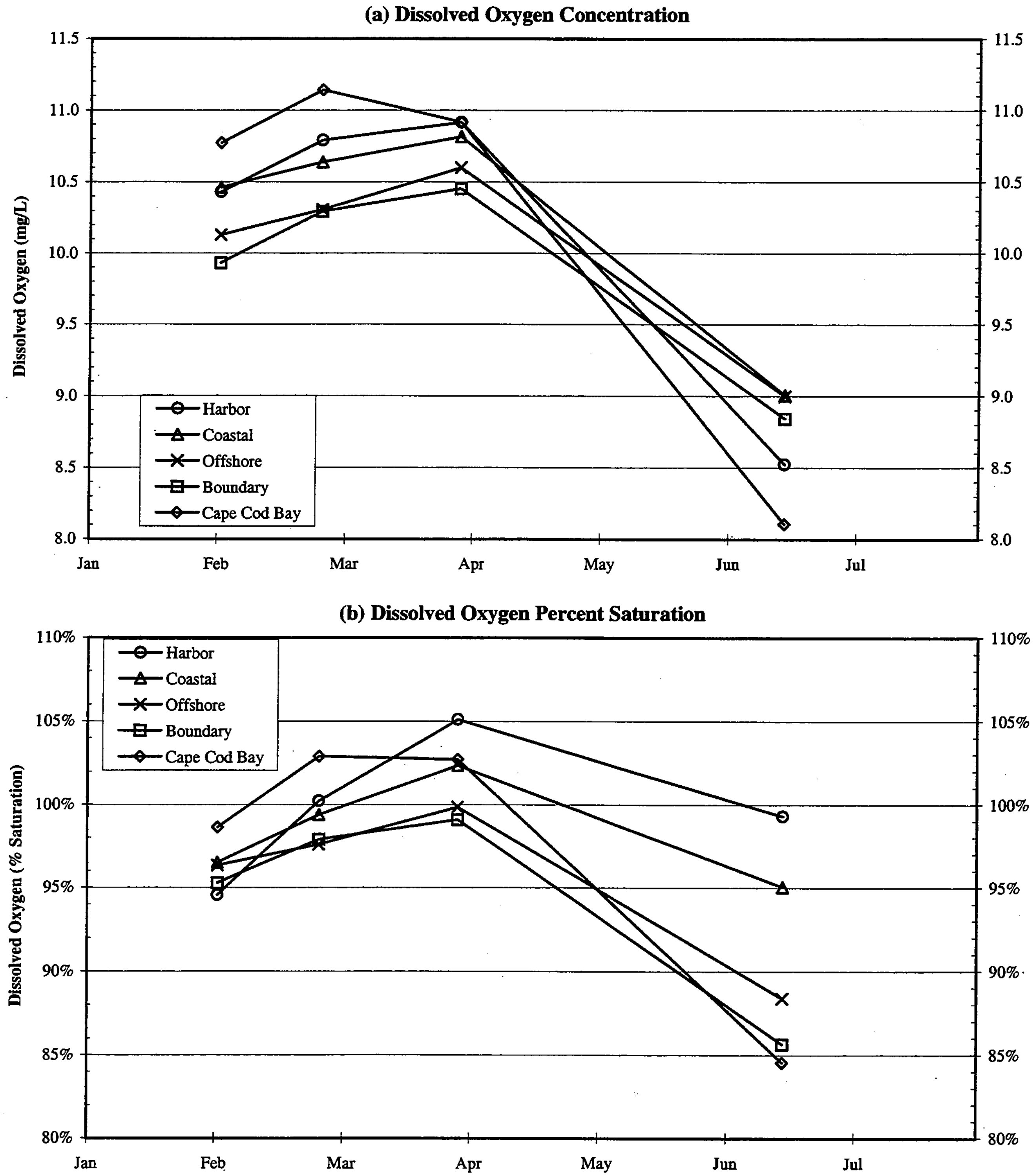


FIGURE 4-30

Time-Series of Average Bottom Water Dissolved Oxygen Concentration (mg/L) and Saturation (%) in the Farfield

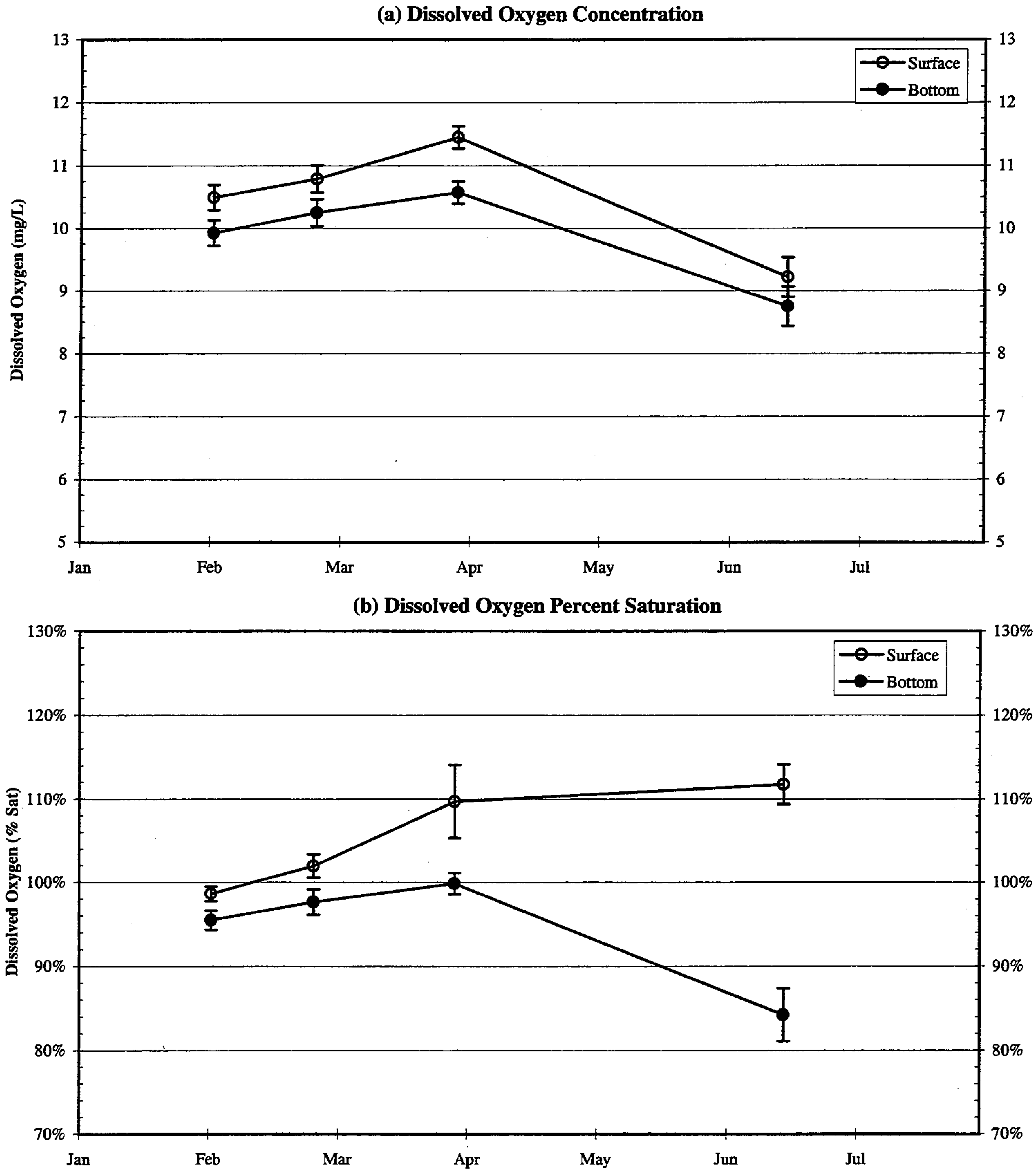


FIGURE 4-31
Time-Series of Average Surface and Bottom Water Dissolved Oxygen Concentration (mg/L) and Saturation (%) Among all Stellwagen Basin Stations

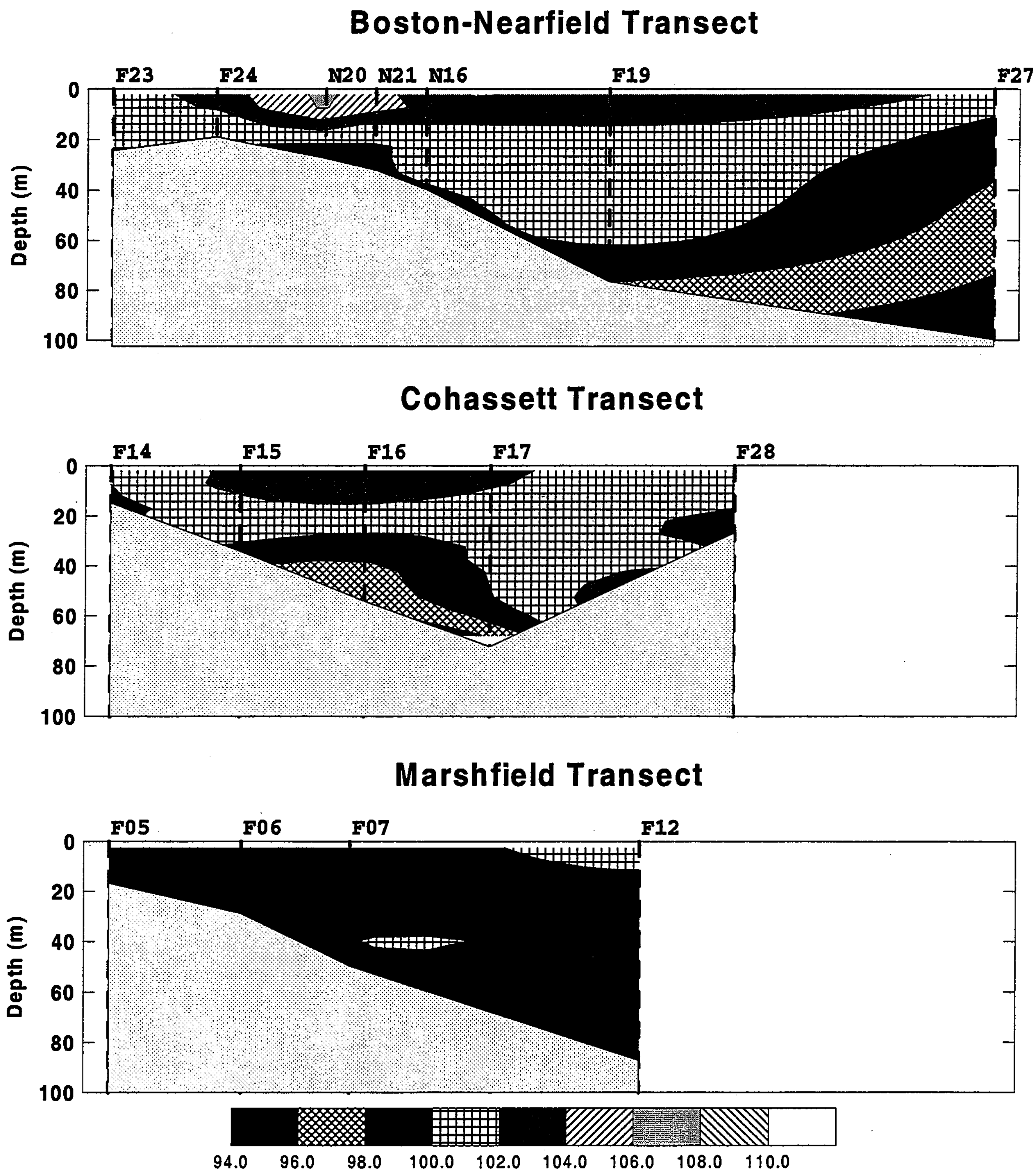


FIGURE 4-32
Dissolved Oxygen Percent Saturation Contours Along Three Farfield Transects in Late February (W9702)

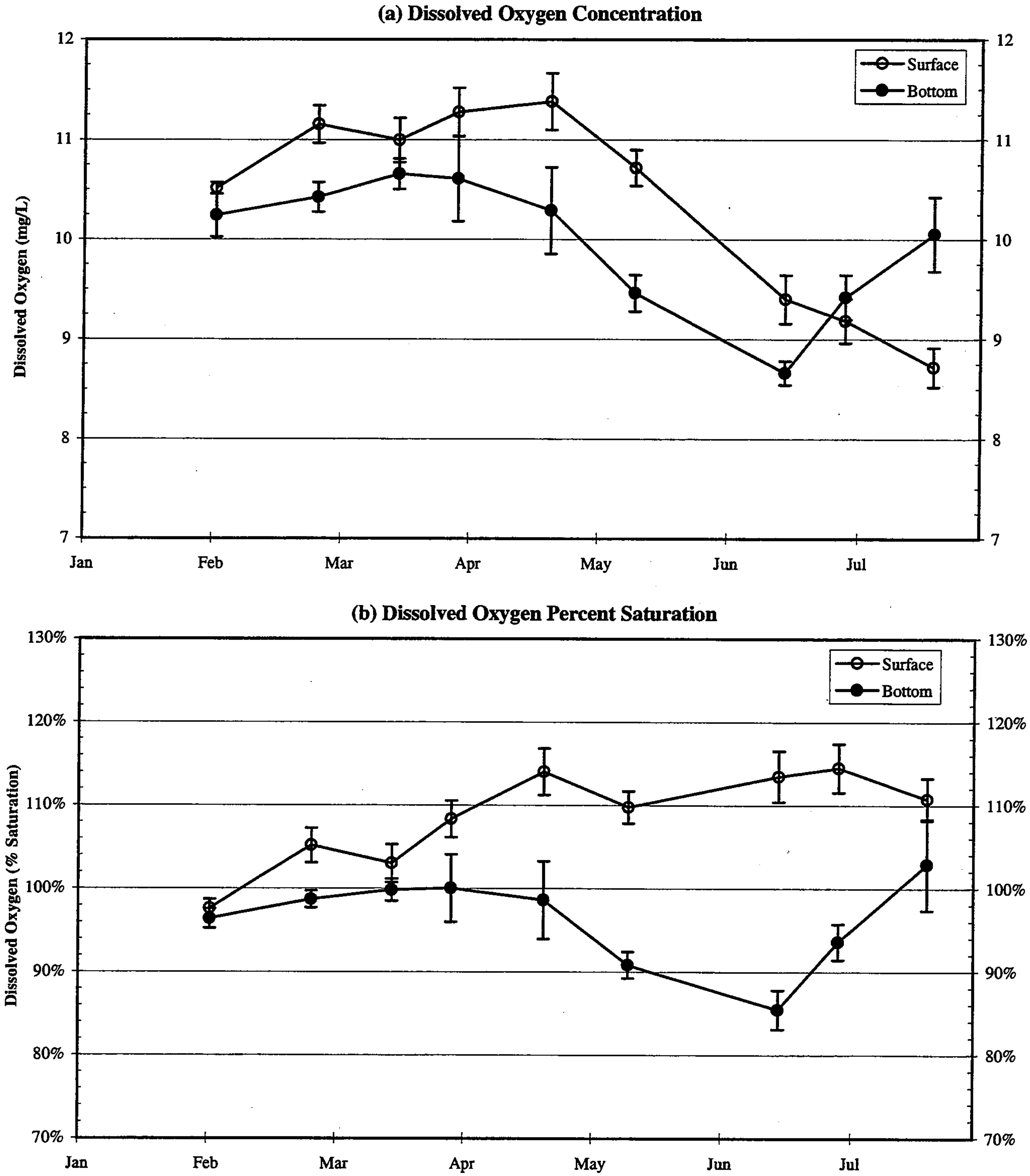


FIGURE 4-33
Time-Series Average of Surface and Bottom Water Dissolved Oxygen Concentration (mg/L) and Saturation (%) Among all Nearfield Stations

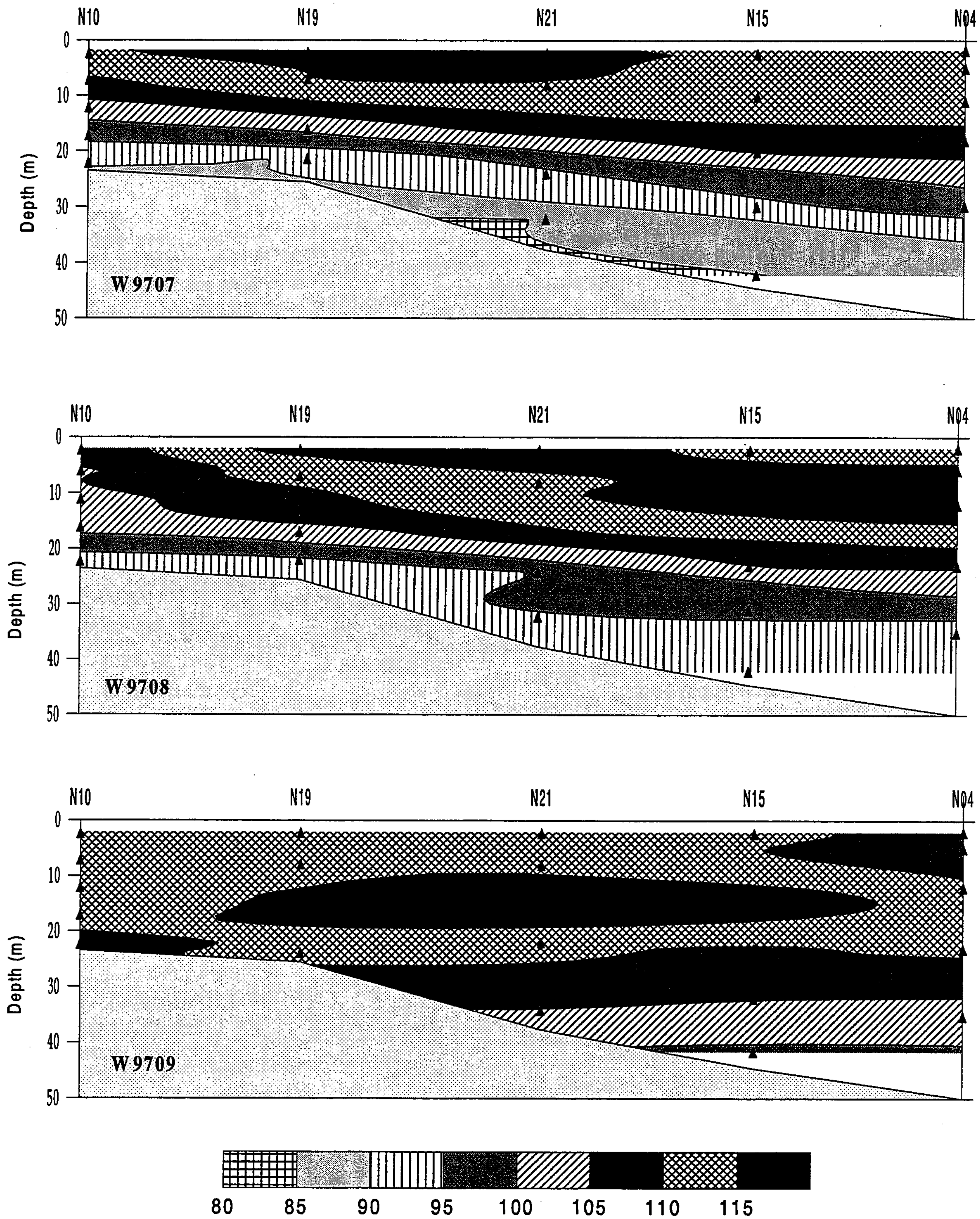


FIGURE 4-34
Dissolved Oxygen Saturation (%) Contours Along
Nearfield Transect During Surveys W9707-W9709

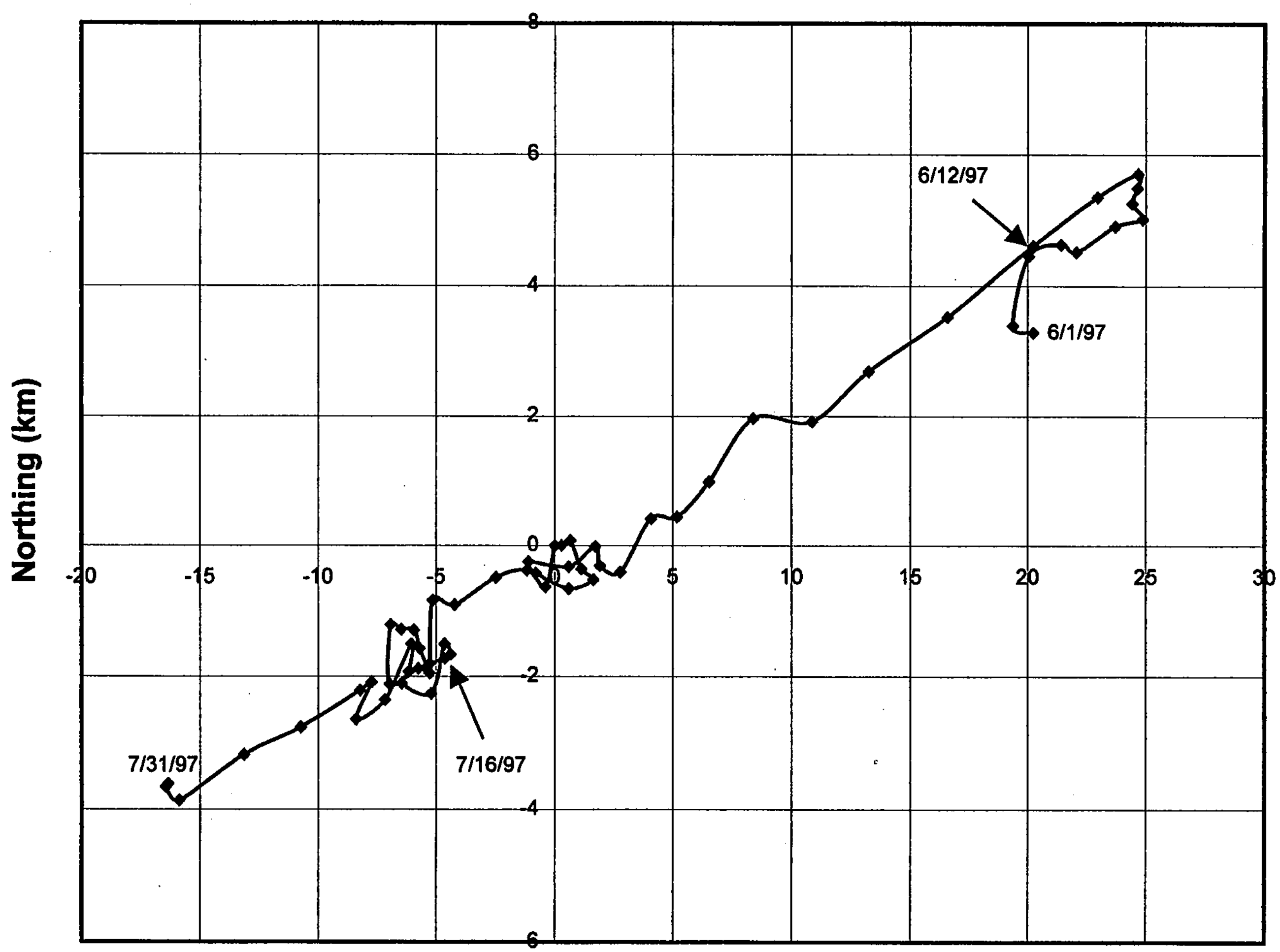


FIGURE 4-35
Progressive Vector Plot: June - July 1997
Depth = 29.2 meters (Bottom)

5.0 PRODUCTIVITY, RESPIRATION, AND PLANKTON RESULTS

This section presents the results of the biological parameters measured in the HOM Program, including primary productivity, microbial respiration, phytoplankton, and zooplankton. They are discussed in the context of the physical and chemical results presented in Section 4.

5.1 Productivity

Production measurements were taken at two nearfield stations (N04, N18) and one farfield station (F23), at the entrance to Boston Harbor. All three stations were sampled during the four combined nearfield/farfield surveys conducted during this semi-annual reporting period. Stations N04 and N18 were also sampled during the additional five nearfield-only surveys conducted during the period. Samples were collected at five depths throughout the euphotic zone. Production was determined by measuring ^{14}C uptake at varying light intensities as summarized below.

In addition to samples collected from the water column, productivity calculations also utilized light attenuation data from a CTD-mounted 4π sensor, and incident light time-series data from an on-deck 2π irradiance sensor. Upon collection of the productivity samples and addition of 14C-bicarbonate, they were incubated in a temperature-controlled incubator. The resulting photosynthesis versus light intensity (P-I) curves (Figure 5-1 and comprehensively in Appendix D), were used, in combination with ambient light attenuation and incident light data, to calculate hourly production for each sampling depth for determination of daily areal rates of phytoplankton productivity.

For this semi-annual report, areal production ($mgCm^{-2}d^{-1}$) is determined by integrating the measured productivity over the sampling depth interval. In addition, calibrated chlorophyll *a* sensor data were used to normalize daily productivity (provided for each of five water depths) for calculation of chlorophyll-specific production, a measurement of the efficiency of production and physiological status of the phytoplankton population.

5.1.1 Areal Production

Measured areal production during the first semi-annual period was indicative of the different conditions affecting productivity between the harbor (station F23) and the nearfield, represented by stations N04 and N18. Following initial rates in the nearfield of less than 500 $mgCm^{-2}$ d^{-1} during early February, areal production peaked at around 2,500 $mgCm^{-2}d^{-1}$ at N04 in late February (W9702; Figure 5-2). The spring bloom appeared to be exhausted by late April (W9705), falling to around 700 $mgCm^{-2}d^{-1}$. Comparably low levels continued to the end of June, when a modest increase (around 1,300 $mgCm^{-2}d^{-1}$) was reported.

The minimum rate at N18 for the semi-annual period (150 $mgCm^{-2}d^{-1}$) was reported in early February (W9701), and was immediately followed by its period maximum (2,100 $mgCm^{-2}d^{-1}$) in late February. Productivity fell to 750 $mgCm^{-2}d^{-1}$ in March, consistent with patterns seen in nutrient uptake and chlorophyll distributions (Section 4), but rebounded to almost 1,500 $mgCm^{-2}d^{-1}$ in early April (W9704). Rates again fell to around 500 $mgCm^{-2}d^{-1}$ in late April (W9705), followed by another rebound by mid-May (W9706; 1,800 $mgCm^{-2}d^{-1}$). Thereafter, productivity rates at N18 remained around 1,500 $mgCm^{-2}d^{-1}$ for the remainder of the sampling period.

Boston Harbor data showed a different pattern of productivity relative to the nearfield. The seasonal increase in productivity began slower than the nearfield and continued to show increasing production rates through the final farfield event in mid-June. Its initial low in early February (13 $mgCm^{-2}d^{-1}$) was well below that seen in the nearfield, as were rates in late February were also well below that measured in the nearfield (Figure 5-2). The reported rate in April (1,090 $mgCm^{-2}d^{-1}$) was comparable to those reported in the nearfield during that period. The Harbor's semi-annual maximum in June (W9707; 1,700 $mgCm^{-2}d^{-1}$) exceeded those from the nearfield, but was of a similar magnitude as rates at N18 measured during W9706 and W9708.

The peak in productivity reported during February was concentrated in the surface water of the nearfield stations N04 and N18 (Figure 5-3). Despite the low surface chlorophyll concentrations prevalent March and April (Section 4.4), productivity remained fairly high at the surface through April. A pronounced subsurface peak in productivity was evident at station N18 but not N04 during May (W9706). Both nearfield stations showed relatively high production throughout the surface mixed layer at the end of June (W9708). Productivity in the Harbor was largely restricted to the upper 10m of the water column.

5.1.2 Chlorophyll-Specific Production

In order to compare production with chlorophyll concentrations, chlorophyll-specific production (daily production normalized to average chlorophyll concentrations over the water column) was calculated. During the late-winter bloom, chlorophyll-specific production rates exceeded 200 $mgCmgChla^{-1}d^{-1}$, and were slightly higher at N18 compared with N04 (Figure 5-4). Throughout the stratified summer period in the nearfield, chlorophyll-specific production rates exceeded 300 $mgCmgChla^{-1}d^{-1}$ in the upper water column, and at N04 reached almost 500 $mgCmgChla^{-1}d^{-1}$ at the surface during late July (W9709). By comparison, chlorophyll-specific rates in the Harbor did not exceed 200 $mgCmgChla^{-1}d^{-1}$, and were highest (and most comparable to the nearfield) during early April (W9704).

Chlorophyll-specific production is an estimate of the efficiency of photosynthesis. Despite the low chlorophyll biomass in the water column during the summer, these results indicate that highly efficient productivity was occurring in the upper water column. Supporting monitoring data also contain evidence for high summer productivity. A surface bloom of the diatom *Rhizosolenia fragilissima* occurred at N18 during late June (W9708; see Section 5.3). Biomass estimates based on phytoplankton biovolume indicated that this diatom bloom rivaled the spring bloom in terms of carbon equivalence. Zooplankton abundance was also at its peak in the nearfield during this period (Section 5.4), which would require a substantial source of primary production for its support.

Interestingly, the subsurface peak in daily production seen at station N18 during May (W9706; Figure 5-3) was not evident in the chlorophyll-specific results. This would indicate a subsurface phytoplankton assemblage exhibiting very low photosynthetic efficiency. Results from discrete phytoplankton samples taken at depth at N18 during the period indicated that species of the diatom genus *Chaetoceros* were present in densities approaching 2 million cells/L (Section 5.3). This same diatom was beginning to bloom in the surface water of Boston Harbor during the period, and the rapid loss of silicate in surface water relative to the previous survey indicated that it may have bloomed in nearfield surface water between surveys W9705 and W9706. The chlorophyll-specific data may have identified a large mat of that bloom sinking in the nearfield.

5.2 Respiration

Respiration was measured at the same two nearfield stations (N04 and N18) and one harbor station (F23) as productivity, and at farfield station F19 in Stellwagen Basin (Figure 1-2). All stations were sampled during the four combined nearfield/farfield surveys, and stations N04 and N18 were additionally sampled during the five other nearfield-only surveys during the semi-annual period. Samples were typically collected at three depths (surface, mid-depth, and bottom), and incubated without light at *in situ* temperatures. Bottom water respiration measurements were also obtained at station F19 during the first three benthic flux surveys (March, May, and July), however, these additional data will be presented in the Annual Water Column Report.

Both respiration (in units of μMO_2hr^{-1}) and carbon-specific respiration ($\mu MO_2\mu MC^{-1}hr^{-1}$) rates at the three sampled depths are presented here. Carbon-specific respiration was calculated by normalizing respiration rates to the total measured particulate organic carbon (POC) at each respiration depth. Carbon-specific respiration provides an indicator of how biologically available (labile) the POC substrate material is for microbial breakdown.

5.2.1 Water Column Respiration

Respiration rates during the winter and spring surveys (W9701 through W9706) in 1997 were <0.2 μMO_2hr^{-1} for all of the stations and depths measured, with the exception of the surface water at station F23 (Figure 5-5). The respiration rate during the first survey at station F23 was almost 0.4 μMO_2hr^{-1}, after which it fell to less than 0.1 μMO_2hr^{-1} through April, comparable with other stations during the sampling period. Respiration rates reached a maximum at station F23 at the end of June (almost 0.5 μMO_2hr^{-1}).

Generally, similar respiration rates are expected throughout a well-mixed water column because respiration is a temperature-dependent reaction, and also the lack of a pycnocline allows unrestricted flux of particulate organic carbon (POC) to the bottom waters. During the winter and spring of 1997, however, some differences were apparent. At station N04, for example, the respiration rate at the surface was twice the bottom rate during the late February survey (W9702), indicating an effect from the late winter bloom on surface water respiration rates (Figure 5-5). Surface and bottom respiration rates were generally similar at all stations during March and early April (W9703 and W9704), with deepwater station F19 being the least similar.

By the following survey in late April (W9705), the difference in surface and bottom water respiration began to be controlled by differential water temperature and the onset of stratification. It should be noted that respiration during the colder mixed periods temporally lags production. Respiration shows less temporal fluctuation than photosynthesis due to the less variable nature of its temperature - dependent rate (as opposed to the more variable light-dependent photosynthesis), and the buffering effect of detrital carbon.

Surface water respiration remained low until the first summer survey in June (W9707), at which point respiration increased by a factor of 2-5 relative to the previous survey, with the greatest increase reported at station F23 (Figure 5-5). The high surface water respiration at all stations indicated a source of respirable carbon, which potentially could have been supported by the observed production despite the relatively low chlorophyll concentrations seen in the samples. The present outfall in Boston Harbor also provides a source of respirable carbon to F23 and N10, however, the bloom that was pervasive throughout the Harbor and coastal stations (Sections 4.4 and 5.3) may well have supported the observed respiration.

Surface respiration rates continued to increase at nearfield station N18 during the next survey in early July (W9708), but fell to the June level during the final semi-annual survey in late July (W9709; Figure 5-5). Surface rates at decreased slightly in early July, but remained fairly constant through the period. By comparison, bottom water respiration in the nearfield and Stellwagen Basin peaked in April after the late winter bloom, and thereafter remained fairly constant around 0.05 μMO_2hr^{-1}. Only station F23 showed a continuous increase through the period.

5.2.2 Carbon-Specific Respiration

Carbon-specific respiration normalizes microbial activity for variations in the size of the carbon pool. Differences in carbon-specific respiration result from variations in the quality of the available organic matter or from environmental conditions such as temperature. Sources of organic carbon which are more easily oxidized (i.e., recently produced phytoplankton) will result in higher carbon-specific respiration. Stratification produces lower carbon-specific respiration in bottom water due the lower water temperature and to the typically lower substrate quality resulting from partial degradation during sinking.

Carbon-specific respiration rates in surface samples generally increased throughout the reporting period, interrupted by a brief downturn at station N18 during early April (W9704) and at N04 during May (W9706; Figure 5-6). Given the fairly constant temperatures through the early season bloom period (Figure 4-11), these results would indicate that the substrate quality at the surface was highest late in the bloom (i.e., April). Both hourly and C-specific respiration rates also seemed to lag peaks in surface productivity (Figure 5-3). This comparison would also suggest that the early February peak at F23 was probably from non-phytoplankton carbon substrate flushed into the Harbor by runoff (see Figure 4-5). Overall, bottom water rates also increased in apparent response to the late winter bloom, but clear relationships between production rates were less obvious.

The highest semi-annual POC concentrations were reported in bottom water during the early April (W9704) survey, suggesting settling of the late-winter bloom (Figure 5-7). Station N04 yielded a bottom concentration of 24 μM, while the bottom POC concentration at station N18 was over 45 μM. Late-period peaks were also seen at these two stations in mid-June (N04) and late July (both stations). Both hourly and C-specific rates showed only a modest response to these subsequent increases, suggesting the carbon was of relatively low quality.

5.3 Plankton Results

The 1997 HOM Program included analysis of the plankton community in Boston Harbor, Massachusetts Bay, and Cape Cod Bay during 11 nearfield and six combined farfield surveys conducted from February to December. Two stations (N04 and N18) were occupied in the nearfield surveys, while an additional ten locations were sampled during the combined events (Figure 5-8). During 1997, station N16 continued to be sampled during the farfield segment of the combined events in lieu of a station revisit at one of the two nearfield stations. In this report, the first half of the 1997 plankton record is presented (surveys W9701 to W9709), including four of the six annual combined sampling events (W9701, W9702, W9704, and W9707). Comprehensive tabulations of results are available in periodic Plankton Data Reports.

Whole water and screened phytoplankton samples were collected at the surface and at mid-depth, with the latter often selected to coincide with the presence of a sub-surface chlorophyll maximum (as determined by in vivo fluorometry). Zooplankton samples were collected at each station by oblique tow. Details regarding sampling and analysis can be found in the Combined Work Plan/QAPP for water column monitoring (Bowen *et al.*, 1997). Quantitative taxonomic analyses and carbon equivalence estimates were made for the plankton communities using species-specific carbon data from the literature.

In this section, the plankton data are presented through an assessment of their seasonal and regional characteristics. Total abundance, relative abundance of major groups, and estimated carbon equivalence are presented for each plankton community. Nuisance algae issues are also addressed. Appendix E-1 tabulates dominant phytoplankton species (>5% of total abundance) for whole water surface samples, along with the associated cell densities and percent abundance. Appendix E-2 provides similar information for the mid-depth samples. Appendix F-1 tabulates dominant phytoplankton species (>5% of total abundance) for screened surface samples, along with the associated cell densities and percent abundance. Appendix F-2 provides similar information for the mid-depth samples. Appendix G presents zooplankton results. Appendix H-1 tabulates dominant phytoplankton carbon contributors (>5% of total carbon) for whole water surface samples, along with the associated carbon densities and percent carbon contribution. Appendix H-2 provides similar information for the mid-depth samples. Appendix I-1 and I-2 includes similar information for screened phytoplankton results

5.3.1 Phytoplankton

5.3.1.1 Seasonal Trends in Total Phytoplankton Abundance

Total phytoplankton abundance in the nearfield for both whole water surface and mid-depth samples (average of nearfield samples) increased through late March and peaked early April (survey W9704), with peak densities around 6 million (6M) cells L^{-1} at mid-depth and 3M cellsL^{-1} at the surface (Figure 5-9). A general decline in abundance followed during late April and May, although a slight increase was noted in the mid-depth sample in May (W9706; Figure 5-9a). After the onset of stratification, averaged nearfield densities remained below 1M cellsL^{-1} except for a brief surface bloom to 2M cellsL^{-1} in late June (W9708).

Regionally, Cape Cod Bay had the highest densities during the first three combined events, both at the surface and mid-depth (Figure 5-9). Cape Cod Bay densities reached over 10M cellsL^{-1} during W9704. Samples from the harbor and coastal areas had the highest densities during the fourth combined event in mid-June (W9707), with a similar pattern in the mid-depth samples. June Harbor densities were highest in surface samples, reaching over 6M cellsL^{-1}.

5.3.1.2 Nearfield Phytoplankton Community Structure

Phytoplankton abundance and community composition at the three nearfield stations (N04, N16, and N18) were plotted for surface (Figure 5-10) and mid-depth (Figure 5-11). Note that station N16 was only sampled during the second, third and fourth farfield surveys conducted during the reporting period. A striking feature of these plots is the small contribution by centric diatoms that typically dominate late winter bloom. For example, *Thalassiosira* spp., which typically exceed 1M cellsL^{-1} , only reached densities of around 0.2M cellsL^{-1} during 1997. The dominant phytoplankton groups during the bloom were haptophytes (*Phaeocystis pouchetii*) and unidentified microflagellates.

Phaeocystis pouchetii numerically dominated the nearfield during the bloom, comprising 27 to 78 percent of total abundance in surveys in March and April (W9703 through survey W9705; Appendix E-1). Peak densities of 7.7M cellsL^{-1} were reported in mid-depth samples at station N16 during W9704 (Figure 5-11). Following the late April survey, microflagellate taxa dominated most samples. Peak densities reached around 1.5M cellsL^{-1} at the surface at station N18 during April (W9708), comprising 61 percent of total abundance (Figure 5-10; Appendix E-1). Cryptomonads were co-dominant throughout the stratified period.

Centric diatom blooms did develop sporadically throughout the period. During late March (W9704) centric diatoms *Chaetoceros* spp. reached 0.5M cells/L^{-1}, though they typically exceed 1M cellsL^{-1} during this period. During May (W9706), *Chaetoceros* exceeded 2M cellsL^{-1} at mid-depth in the nearfield. Finally, *Rhizosolenia fragilissima* achieved densities of 0.5M cellsL^{-1} at the surface of station N18 during late June (W9708).

Despite the unusually low densities of centric diatoms, they were significant contributors of carbon to the Massachusetts Bay system during the late winter bloom. Carbon equivalence estimates based on biovolume indicate centric diatoms were biomass dominants during the bloom (Figures 5-12 and 5-13). Dinoflagellates also were notable contributors of phytoplankton carbon. The centric diatom genus *Chaetoceros* and the dinoflagellate *Ceratium longipes* together were the dominant carbon producers during the late winter/spring bloom (appendix H-1 and H-2).

Phytoplankton carbon equivalence maxima occurred at N16 and N18 in late March (W9704), N04 and N18 in early May (W9706), and late June at N18. Note the also the significant mid-depth carbon contribution from *Phaeocystis pouchetii* at N16 during late March (Figure 5-13b), the carbon dominance at N18 by dinoflagellates during late April (W9705) at the surface (Figure 5-12c), and the total carbon dominance of mid-depth late-period samples at N04 by dinoflagellates (Figure 5-13a). In the latter case, the dominant dinoflagellate was *Ceratium longipes*, which reached densities of over 6,000 cellsL^{-1} (Appendix F-2).

5.3.1.3 Regional Phytoplankton Assemblages

Abundance plots from farfield station (whole water samples) were used to demonstrate the differences in regional successional patterns (Figures 5-14 through 5-17). Nearfield results were included to facilitate regional comparisons. During early February (W9701), the microflagellate component of the phytoplankton assemblage dominated throughout Massachusetts Bay and Cape Cod Bay (Figure 5-14; Appendix E-1). Note the high relative distribution of centric diatoms (*Thalassiosira gravida* and *Rhizosolenia delicatula*) in southern Massachusetts Bay and Cape Cod Bay stations.

By late February, Cape Cod Bay had a fully developed *Phaeocystis pouchetii* bloom, with densities exceeding 5M cellsL^{-1} in eastern Cape Cod Bay (station F02; Figure 5-15). Microflagellates and *Thalassiosira gravida* were co-dominants there and dominant at all other stations. By early April (W9704), *P. pouchetii* dominated many other stations, including Boston Harbor and the nearfield (Figure 5-16). In eastern Cape Cod Bay, densities of *P. pouchetii* had risen to 15M cellsL^{-1} in mid-depth samples (Figure 5-16b).

Based on nearfield-only surveys in late April and May (W9705 and W9706), the *Phaeocystis* bloom persisted through April but had disappeared from samples by early May (Figures 5-10 and 5-11). As stated in the previous section, flagellates then became dominant in surface water, and the centric diatom *Chaetoceros* was the numerical dominant at mid-depth.

By the final farfield survey in mid-June (W9707), microflagellates dominated most regions and had greatest densities in Boston Harbor (Figure 5-17). The centric diatoms *Chaetoceros* sp. and *Rhizosolenia fragilissima*, as well as cryptomonads, were producing a strong bloom in Boston Harbor and adjacent coastal stations (Section 4.4). Microflagellates and cryptomonads were also dominant in Cape Cod Bay.

5.3.1.4 Nuisance Algae

Three nuisance algae species have been targeted in the HOM Program: *Alexandrium tamarense*, *Phaeocystis pouchetii*, and *Pseudo-nitzschia multiseries*. The seasonal distribution for each of these species includes the late winter and spring periods covered by this semi-annual report. With the possible exception of *Phaeocystis*, nuisance species did not reach densities that would be of concern in the first half of 1997. As described in the previous section, the spring of 1997 included a system-wide bloom of the *P. pouchetii*, with densities in Cape Cod Bay ranging from 4 to 14.9 million cellsL^{-1}. Densities at several other stations often ranged from 2 to 7 million cellsL^{-1}.

A. tamarense was not reported in any samples from the period. Results from monitoring activities conducted by Dr. Don Anderson of Woods Hole Oceanographic Institution which target this species confirmed that very low densities were found for *A. tamarense* in Massachusetts Bay during 1997.

Due to the difficulty in taxonomically separating the toxic diatom *P. multiseries* from the morphologically similar taxon *P. pungens* using light microscopy, the HOM Program conservatively reports their combined abundance as an indicator species. The maximum density of this indicator species (0.034 million cellsL^{-1}) was reported during survey W9706 in the surface sample at nearfield station N18 (Table 3-1). These results are well below the 100,000 cellsL^{-1} threshold tentatively being used by the HOM Program based on domoic acid toxicity levels observed in Canadian waters (S. Bates, pers. comm.).

5.3.2 Zooplankton

5.3.2.1 Seasonal Trends in Total Zooplankton Abundance

Zooplankton densities in the nearfield generally increased through early April (W9704), with peak densities often coinciding with increases in total phytoplankton abundance at station N18 and N04 (Figure 5-18).

Initial total abundance during the first survey ranged from around 23,000 m^{-3} (station N18) to close to 58,000 m^{-3} (station N04; Figure 5-18). Peak densities by W9704 reached just over 70,000 m^{-3} (station N18). Total densities decreased slightly by the next survey during late April. A second peak in total zooplankton abundance occurred at stations N16 and N18 in mid-June (W9707), with maximum densities of around 104,000 m^{-3} to 110,000 m^{-3}, respectively. Peak abundance at station N04 (105,000 m^{-3}) was not reached until the late June survey (W9708).

5.3.2.2 Nearfield Zooplankton Community Structure

Zooplankton community composition during the early surveys predominately consisted of copepod adults and copepod nauplii (Figure 5-19), although the more inshore stations (N16 and N18) had a larger contribution from barnacle nauplii during the second survey (W9702; Figure 5-19b and c). Copepods and their nauplii continued to dominate the zooplankton assemblage as the season progressed and throughout the reporting period.

The numerically dominant taxonomic groups among the copepods during the reporting period were copepod nauplii and *Oithona similis*. *O. similis* peaked in July at around 16,800 m^{-3} (Appendix G). Other dominant copepods included cirripede species (W9702), gastropoda at N18 (W9704) and bivalvia at all nearfield stations during W9707. In terms of estimated biomass, *Calanus finmarchicus* was by far the dominant species, followed by *Pseudocalanus newmani*.

5.3.2.3 Regional Zooplankton Assemblages

Regional data for the first combined nearfield/farfield survey (W9701) showed highest zooplankton densities (around 58,000 m^{-3}) reported at nearfield station N04, followed by Offshore station F06 and western Cape Cod Bay station F01 (Figure 5-20). Copepod adults and nauplii numerically dominated all regional assemblages. Copepod nauplii, *Oithona similis* and *Pseudocalanus newmani* numerically dominated the copepod component.

By the late February survey W9702, highest densities reported from farfield stations were found at the coastal station F25, the harbor station F30, and Boundary station F27 (Figure 5-21). Densities ranged from 24,000 m^{-3} to 35,000 m^{-3}. The notable difference between assemblages was the relatively high fraction of barnacle nauplii in the Harbor and adjacent coastal stations (particularly station F25). Cape Cod Bay also differed in the relative absence of "other" zooplankton, specifically molluscan larvae at boundary station F27 and polychaete larvae at the more inshore stations.

Nearfield station N18 and Boundary station F27 had the highest zooplankton densities during the April (W9704) combined survey, with reported densities of 72,000 m^{-3} and 70,000 m^{-3}, respectively (Figure 5-22). In addition to copepod adults and nauplii, dominant taxa included molluscan larvae offshore and polychaete larvae inshore.

During the mid-June combined survey (W9707), copepods and copepod nauplii continued to dominate the zooplankton assemblage, along with bivalve larvae (Figure 5-23). Maximum densities were reported at the coastal station F13 and at Boston Harbor station F30. Densities ranged from 118,000 m^{-3} to 138,000 m^{-3}. Nearfield station densities yielded the next most abundant results, ranging from 90,000 m^{-3} to 110,000 m^{-3}.

5.4 Summary of Water Column Biological Events

Productivity

- Nearfield productivity increased from its seasonal low of <500 in early February to its seasonal peak of >2,000 in late February during the height of the late winter bloom.

- High productivity continued in the nearfield through early April, although diminished activity was evident during March (particularly at N18). The late winter bloom in the nearfield appeared to be over by late April, however, productivity in Boston Harbor continued to increase throughout the reporting period.

- A second seasonal peak in productivity was evident in the nearfield during May, particularly at mid-depth. The data suggest that this peak was caused a sinking bloom of the diatom Chaetoceros.

- A late period peak in surface productivity appeared to be caused by a bloom of the diatom Rhizosolenia fragilissima.

Respiration

- Surface water respiration in the nearfield and Stellwagen Basin showed maxima in late February and late April, and then a substantial increase in late June (particularly at N18).

- Surface respiration rates in Boston Harbor were high in early February, but more similar to the nearfield during the next two combined surveys. During the final sampling in June, both surface and bottom respiration rates in Boston Harbor were the highest of all samples taken during the period.

- Bottom water respiration rates in the nearfield reached their period maxima in early April, coinciding with the peak in the late winter bloom and maximum bottom water POC concentrations. Bottom rates fell to around half their peak levels for the remainder of the period.

Plankton

- Phytoplankton abundance was low in all regions during early February. By the end of February, the late-winter bloom was well developed in eastern Cape Cod Bay, with evidence that it was beginning in earnest throughout most of Massachusetts Bay.

- Peak phytoplankton densities occurred during early April, with Phaeocystis pouchetii the numerically dominant taxon, reaching almost 8M cellsL at mid-depth in the nearfield and almost 15 M cellsL at mid-depth in Cape Cod Bay. The Phaeocystis bloom was over by mid-May.

- Centric diatoms of the genus Chaetoceros bloomed in April and May, reaching 2M cellsL in mid-depth samples from N18 during mid-May. It may have also been responsible for the rapid loss of silicate in the surface water between late April and early May.

- A late June bloom of the centric diatom Rhizolsolenia fragilissima occurred in the nearfield, and along with the dionoflagellate Ceratium longipes, fueled substantial increases in production, respiration, and POC in surface water.

- Zooplankton densities often tracked phytoplankton blooms, with maxima evident during early April and in June. Zooplankton reached peak densities at the end of the reporting period.

- The zooplankton assemblage was dominated by copepod adults and nauplii, along with barnacle and polychaete larvae inshore, and molluscan and bivalve larvae offshore.

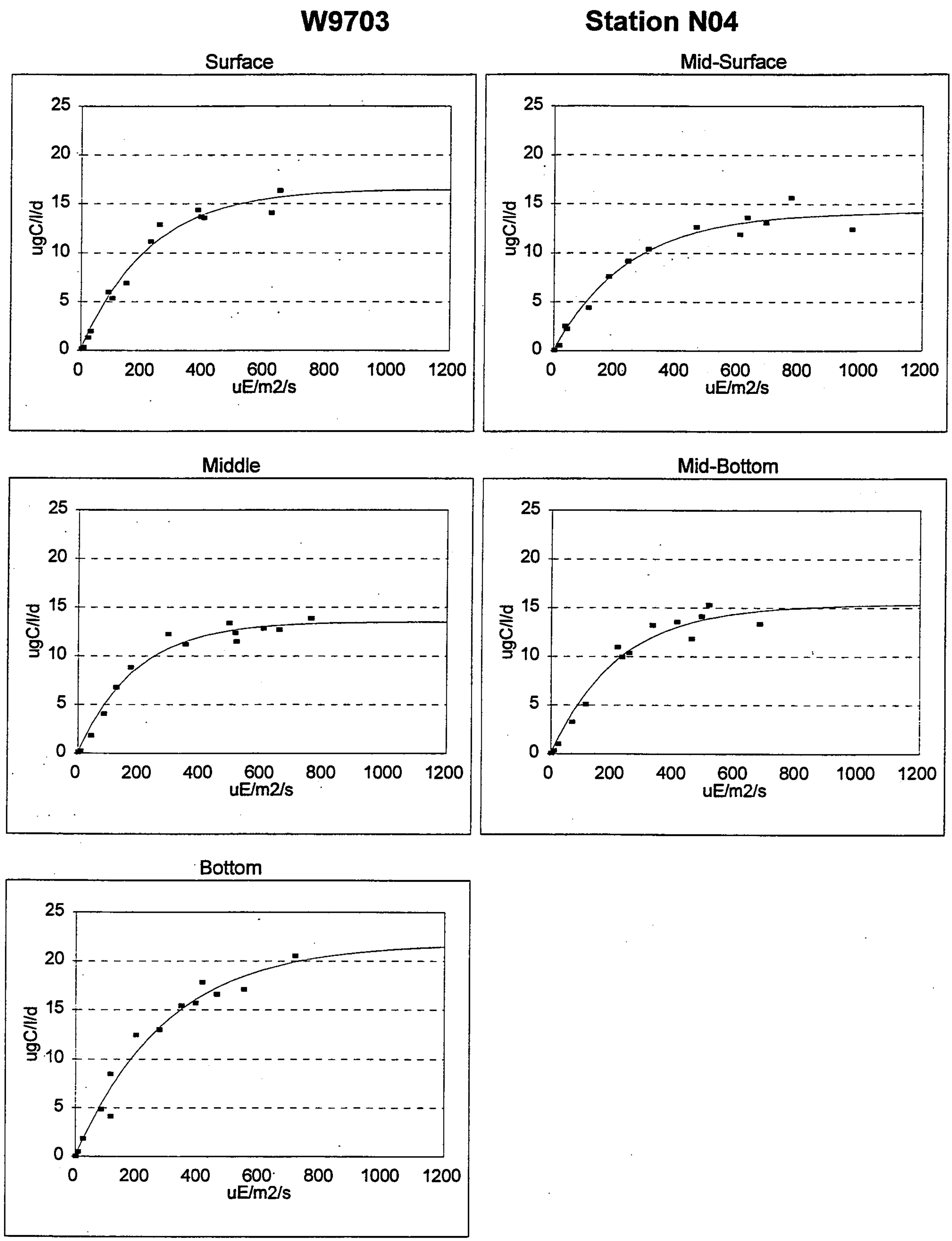


FIGURE 5-1
An example Photosynthesis-Irradiance Curve from Station N10 Collected in March 1997

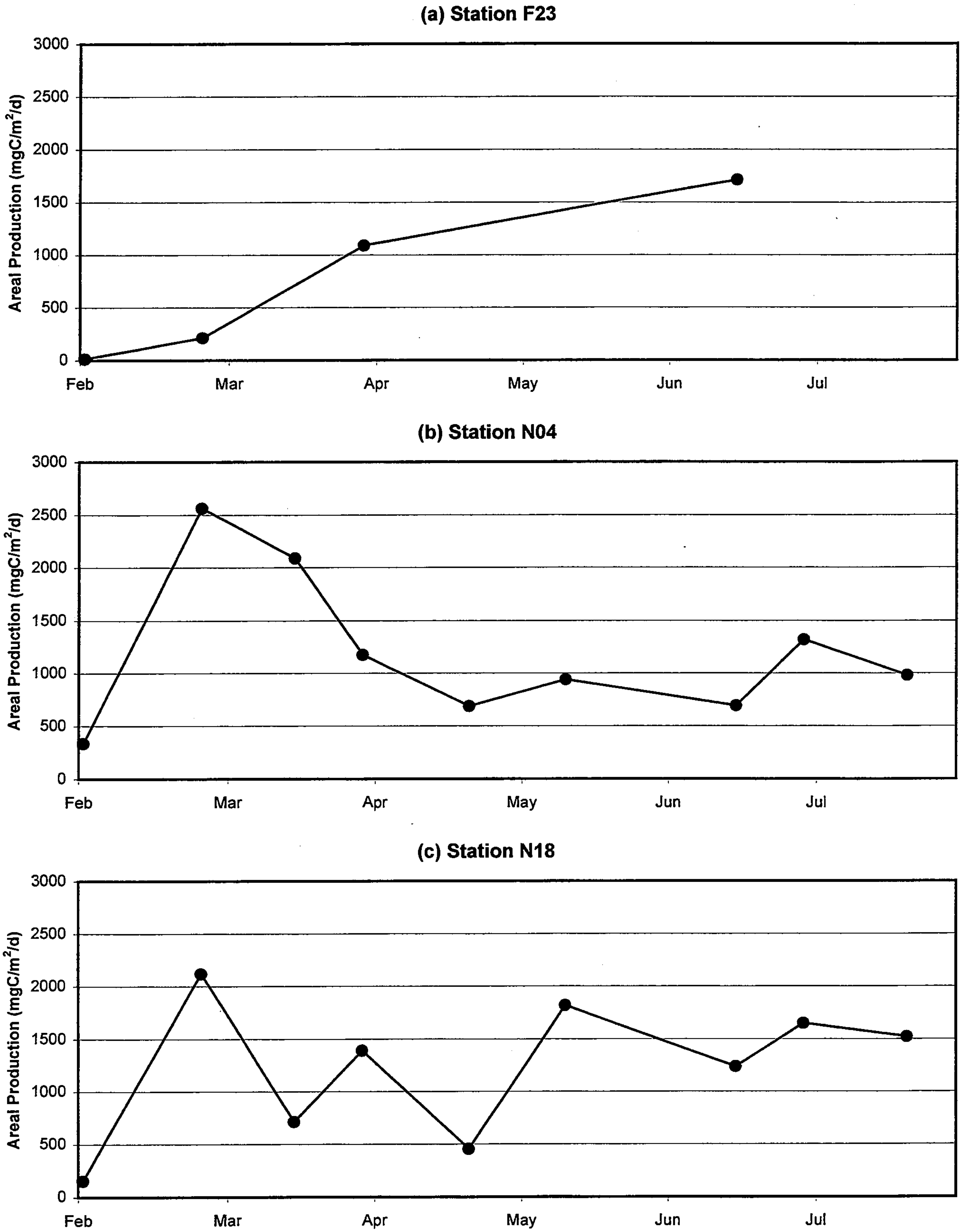


FIGURE 5-2
Time-Series of Areal Production for Productivity/Respiration Stations

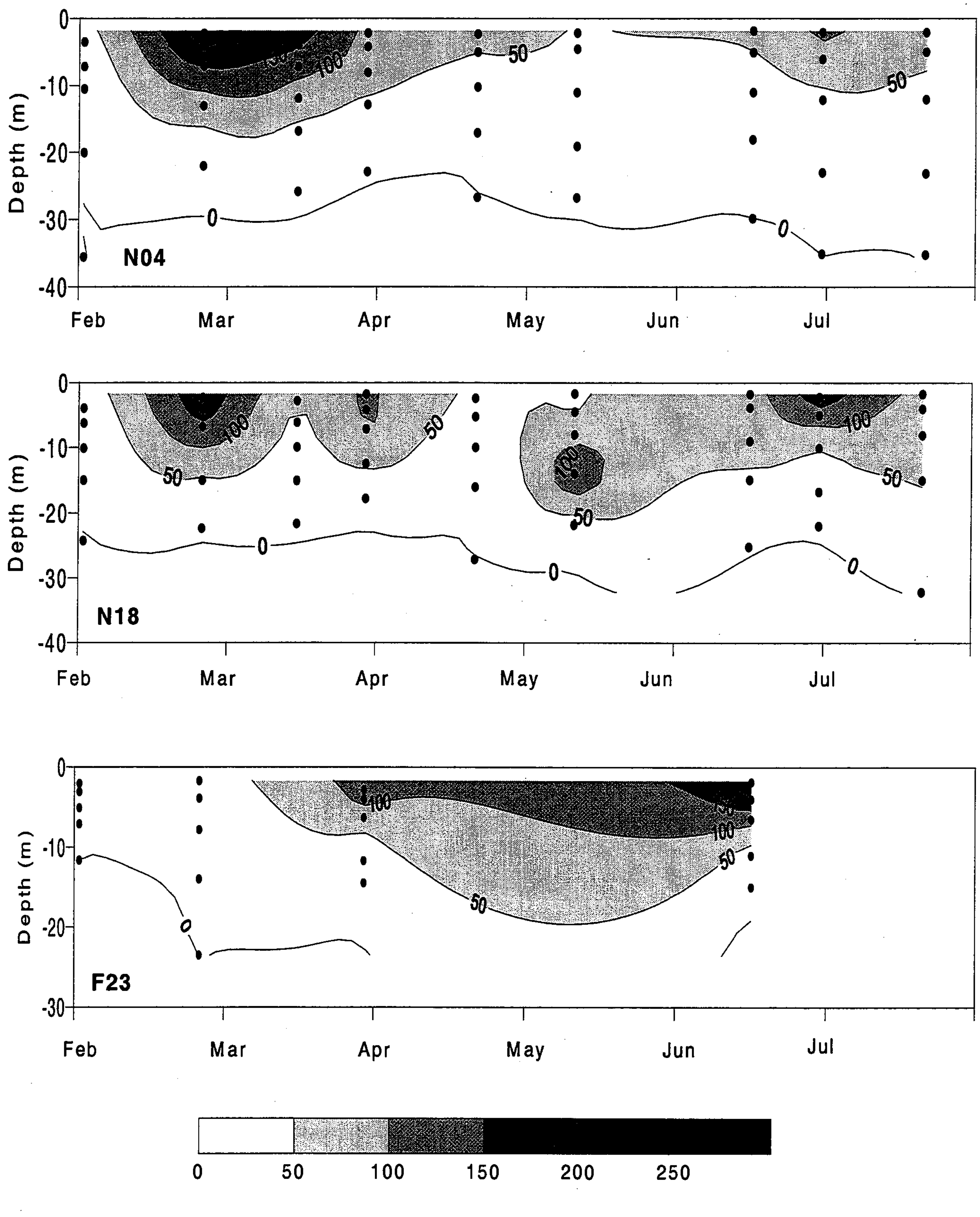


FIGURE 5-3
Time-Series of Contoured Daily Production (mgC/m3/d)
at Productivity/Respiration Stations

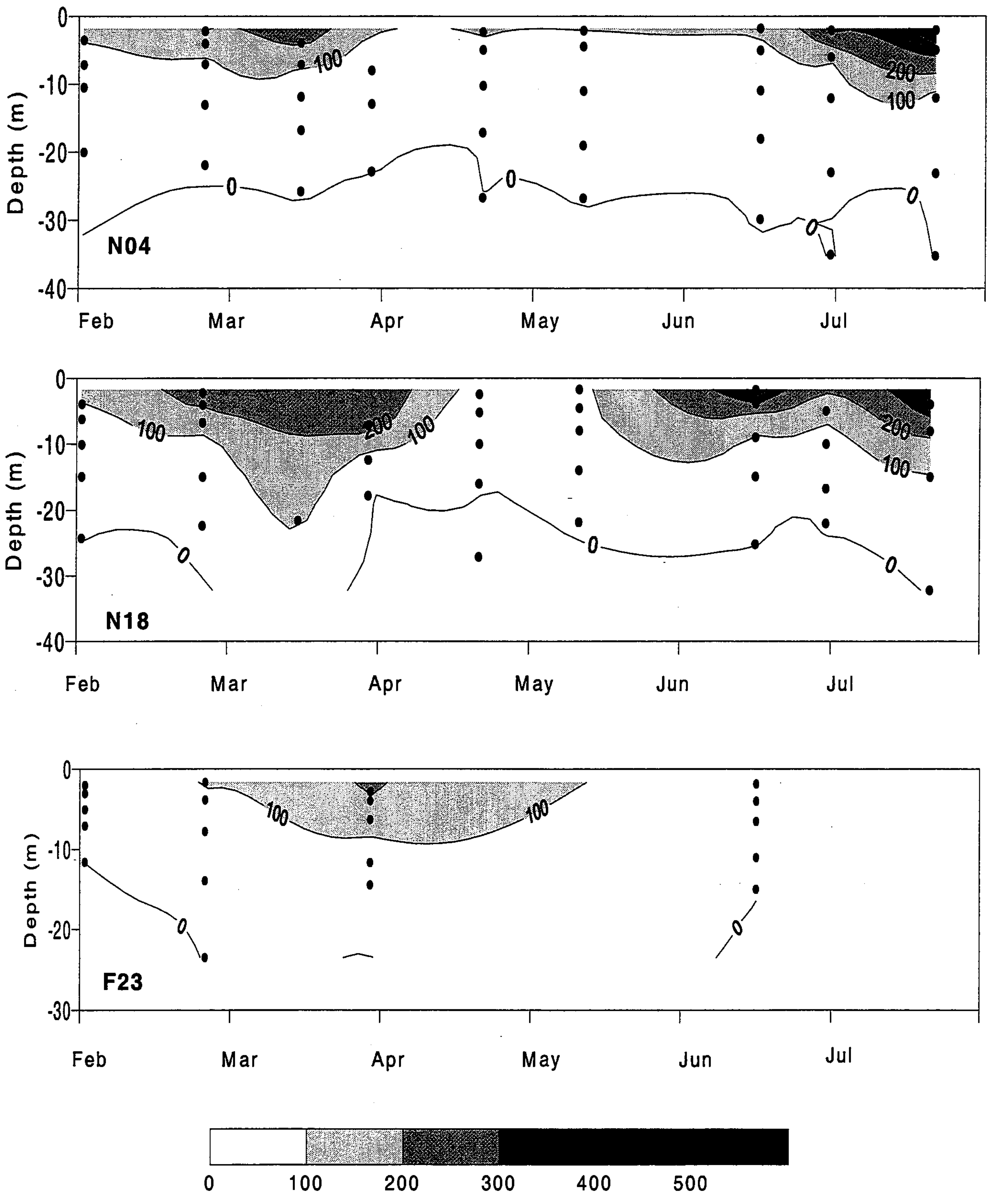


FIGURE 5-4
Time-Series of Contoured Chlorophyll-Specific Production (mgC/mgChl/d)
at Production/Respiration Stations

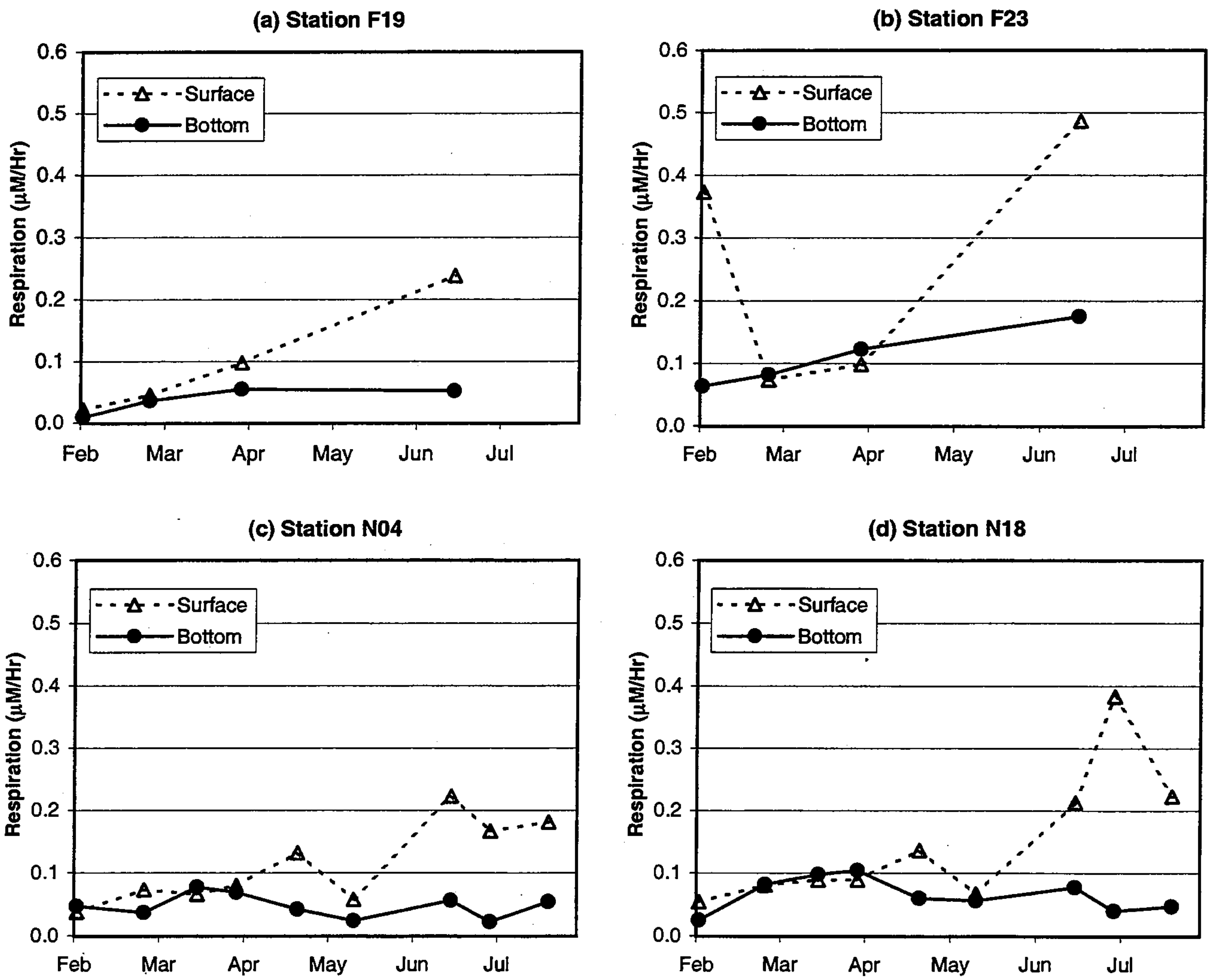


FIGURE 5-5
Time-Series of Water Column Respiration at Productivity/Respiration Stations

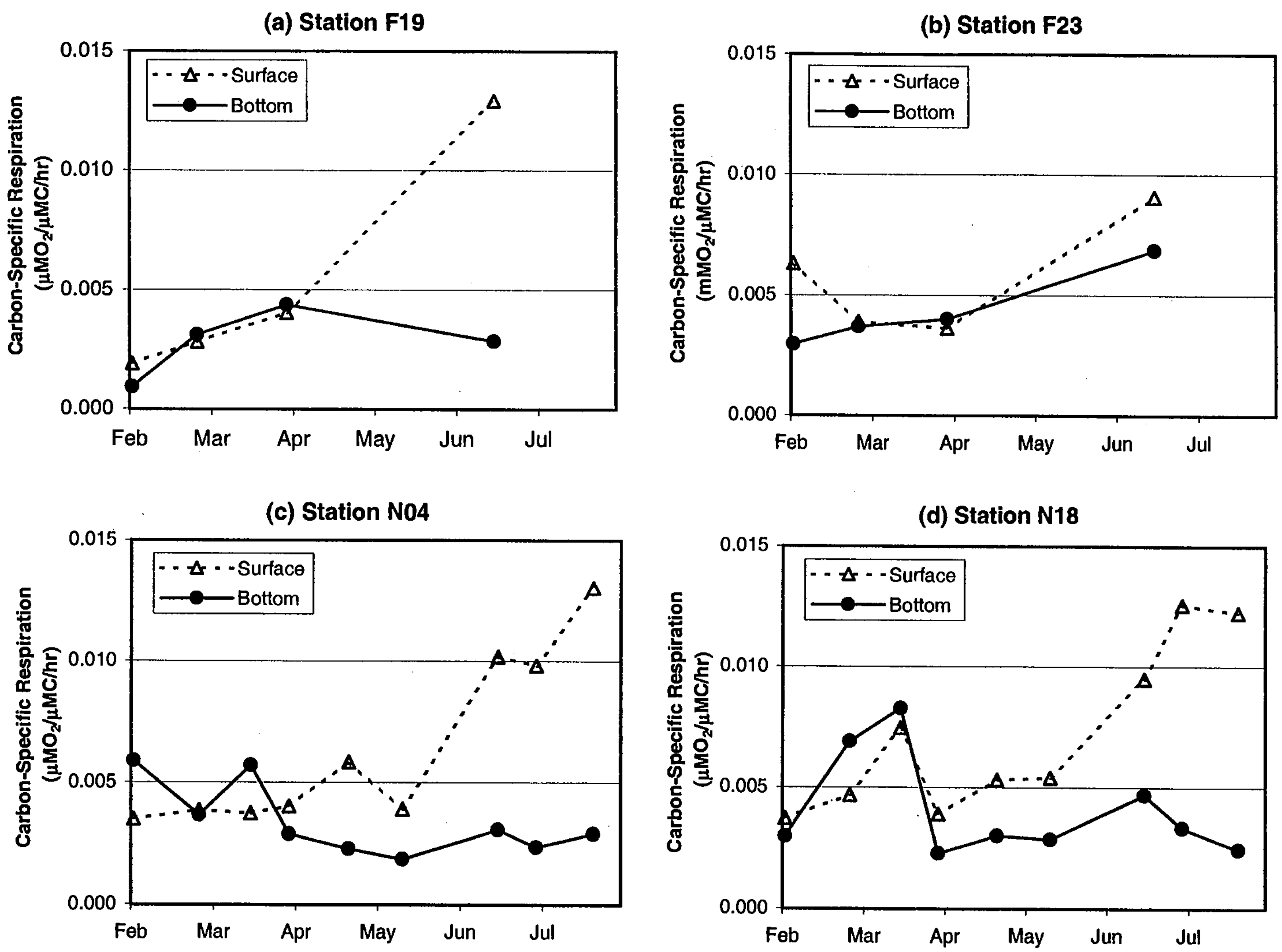


FIGURE 5-6
Time-Series of Carbon-Specific Respiration at Productivity/Respiration Stations

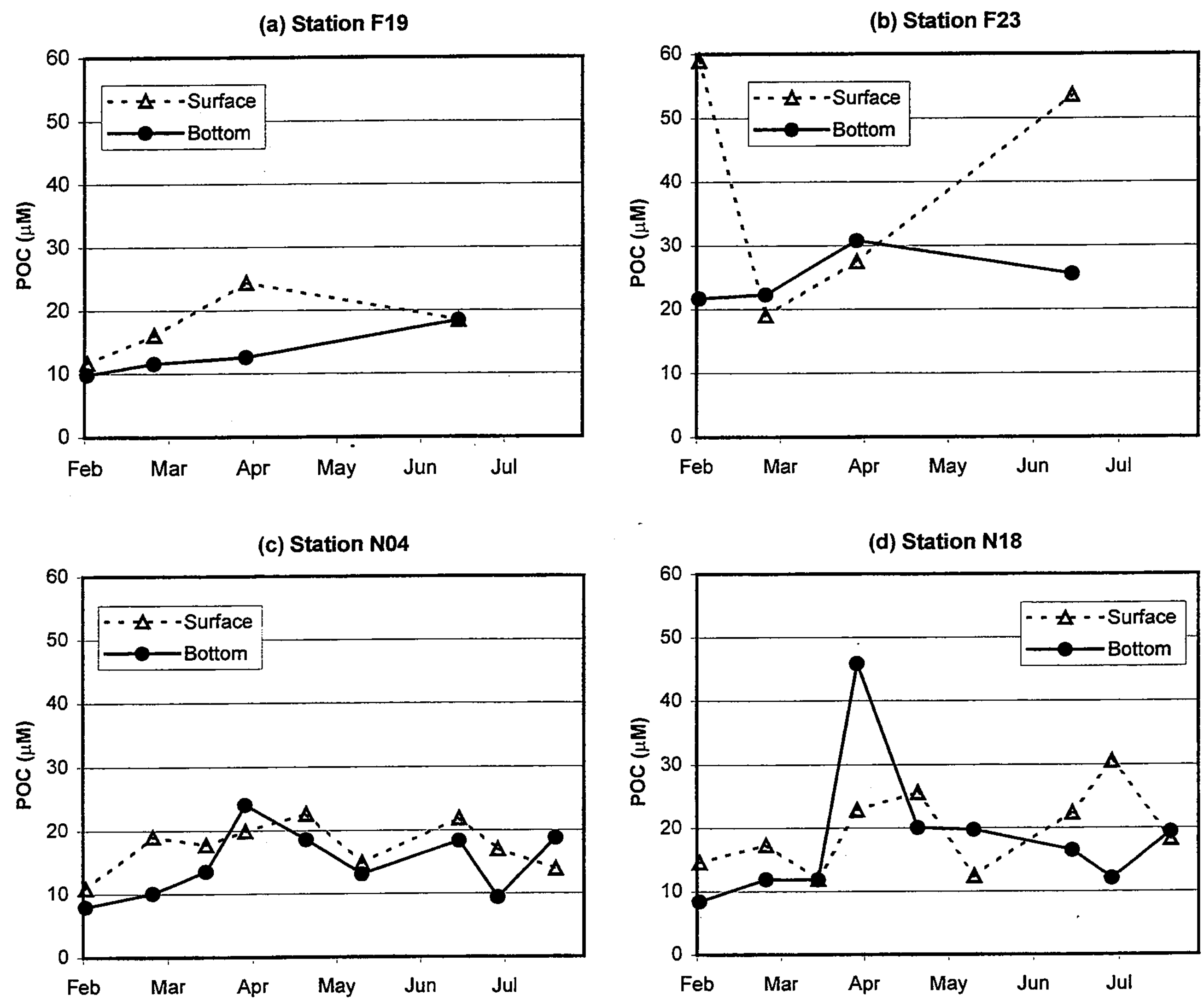


FIGURE 5-7
Time-Series of Particulate Organic Carbon at Productivity/Respiration Stations

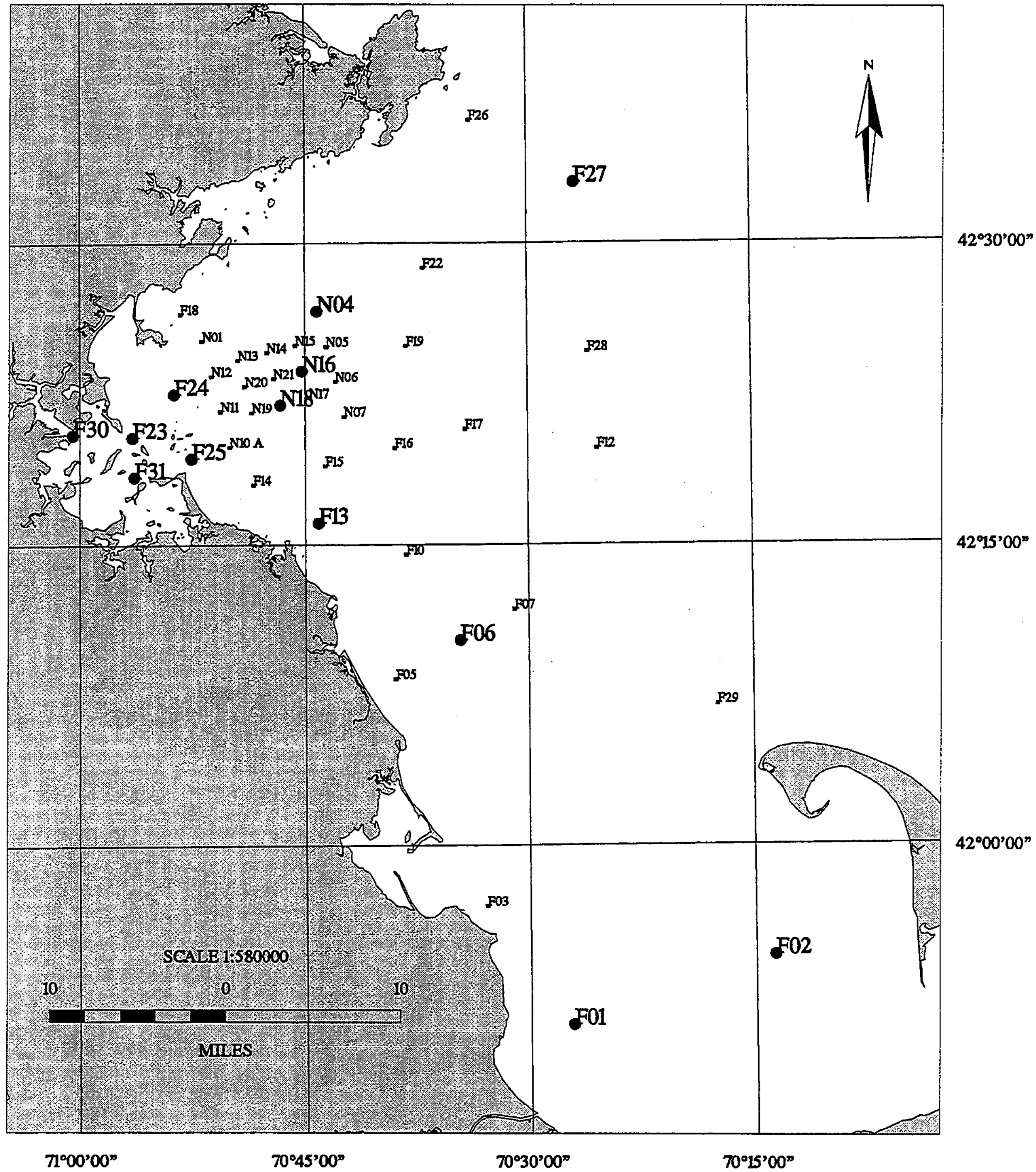
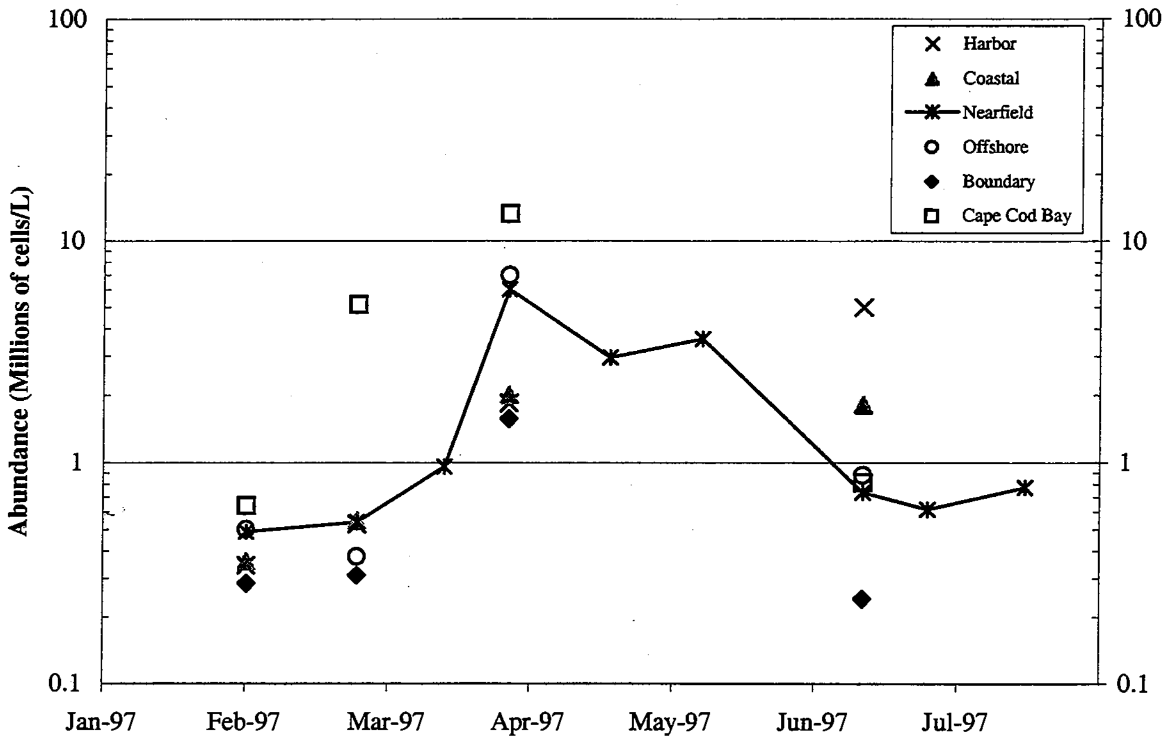


FIGURE 5-8
1997 Plankton Station Locations (Enlarged Text)



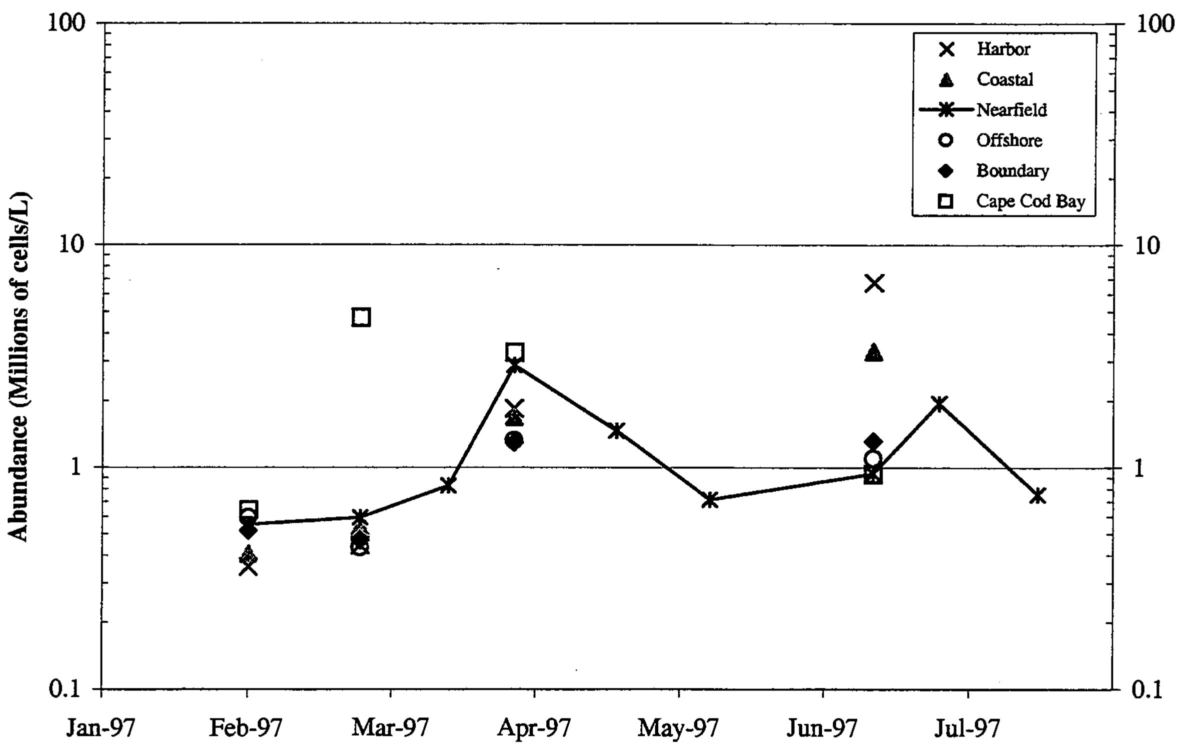


FIGURE 5 -9
Regional Phytoplankton Abundance, Surveys W9701 - W9709
Top: Chlorophyll a Maximum Data, Bottom: Surface Data

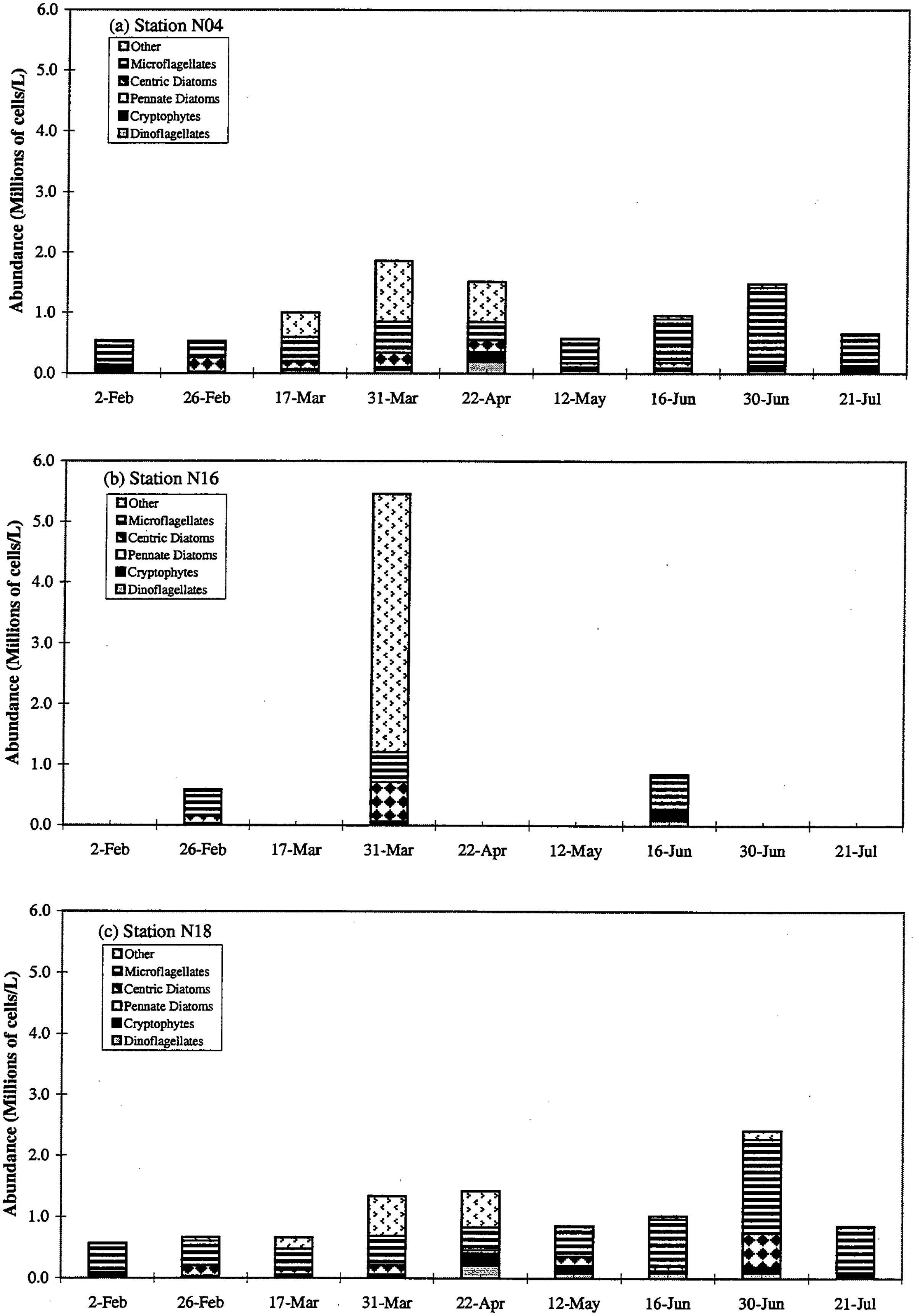


FIGURE 5 -10

Phytoplankton Abundance by Major Taxonomic Group, Nearfield Surface Samples

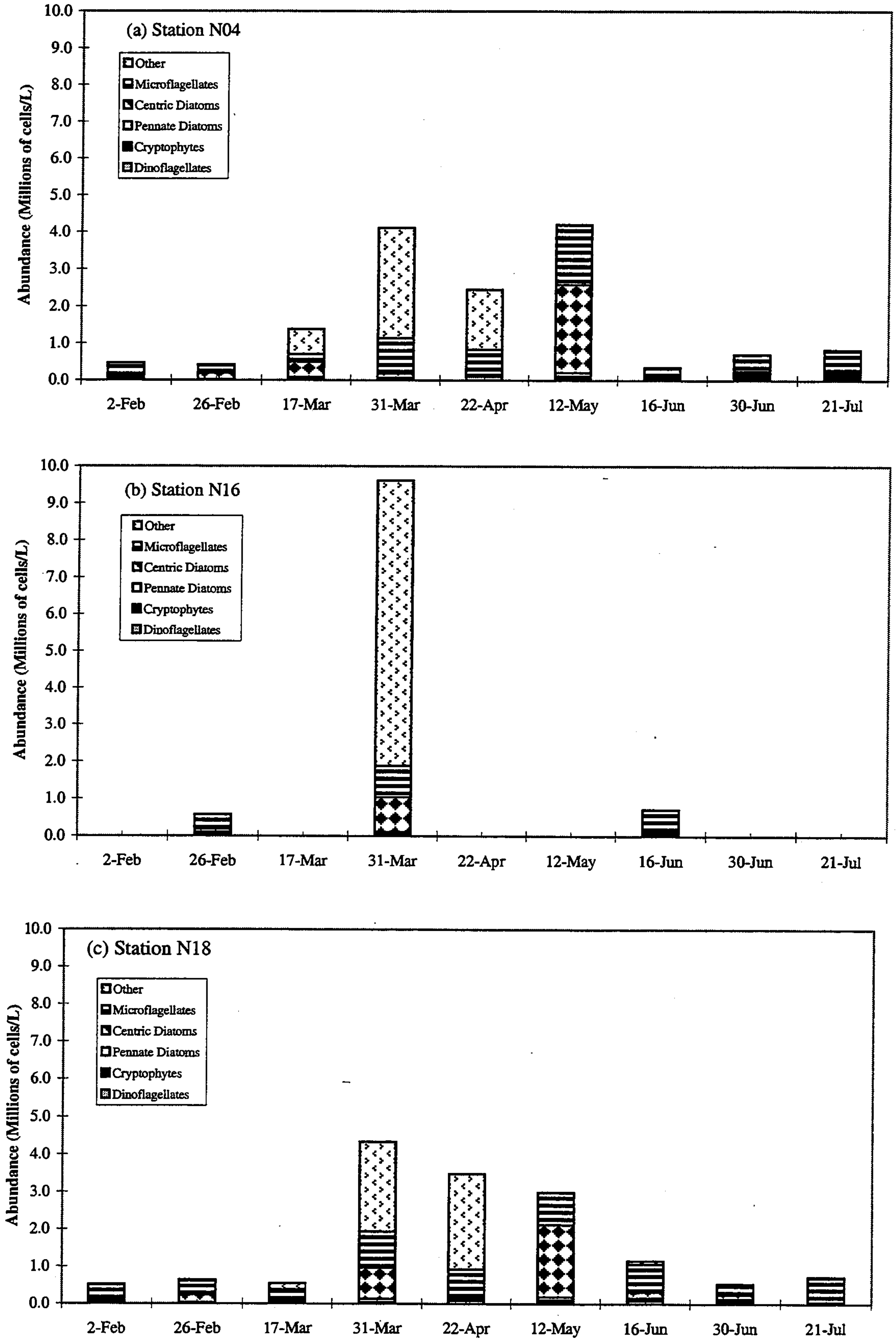


FIGURE 5 -11
Phytoplankton Abundance by Major Taxonomic Group, Nearfield Chlorophyll a Maximum Samples

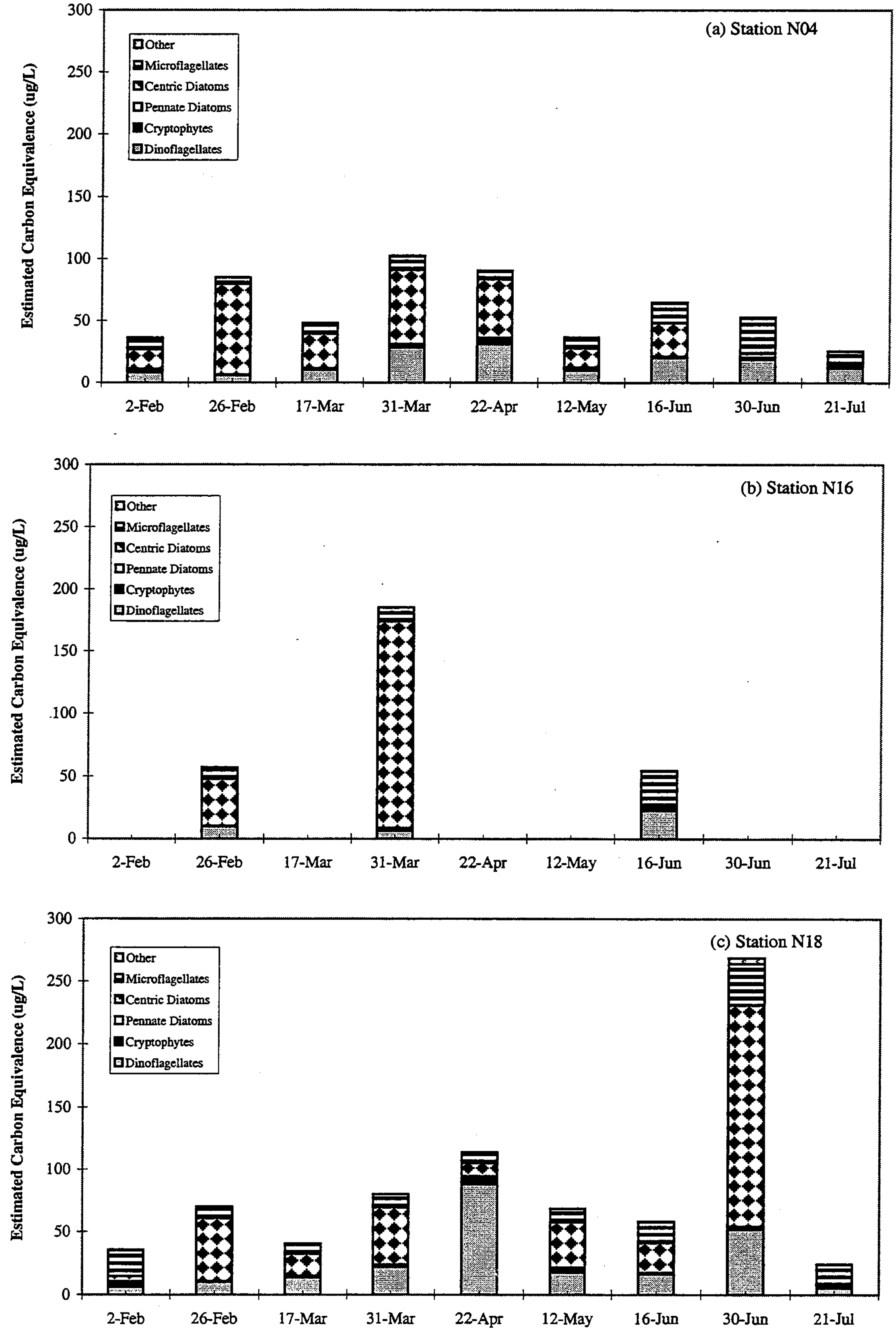


FIGURE 5 - 12
Phytoplankton Carbon by Major Taxonomic Group, Nearfield Surface Water Samples

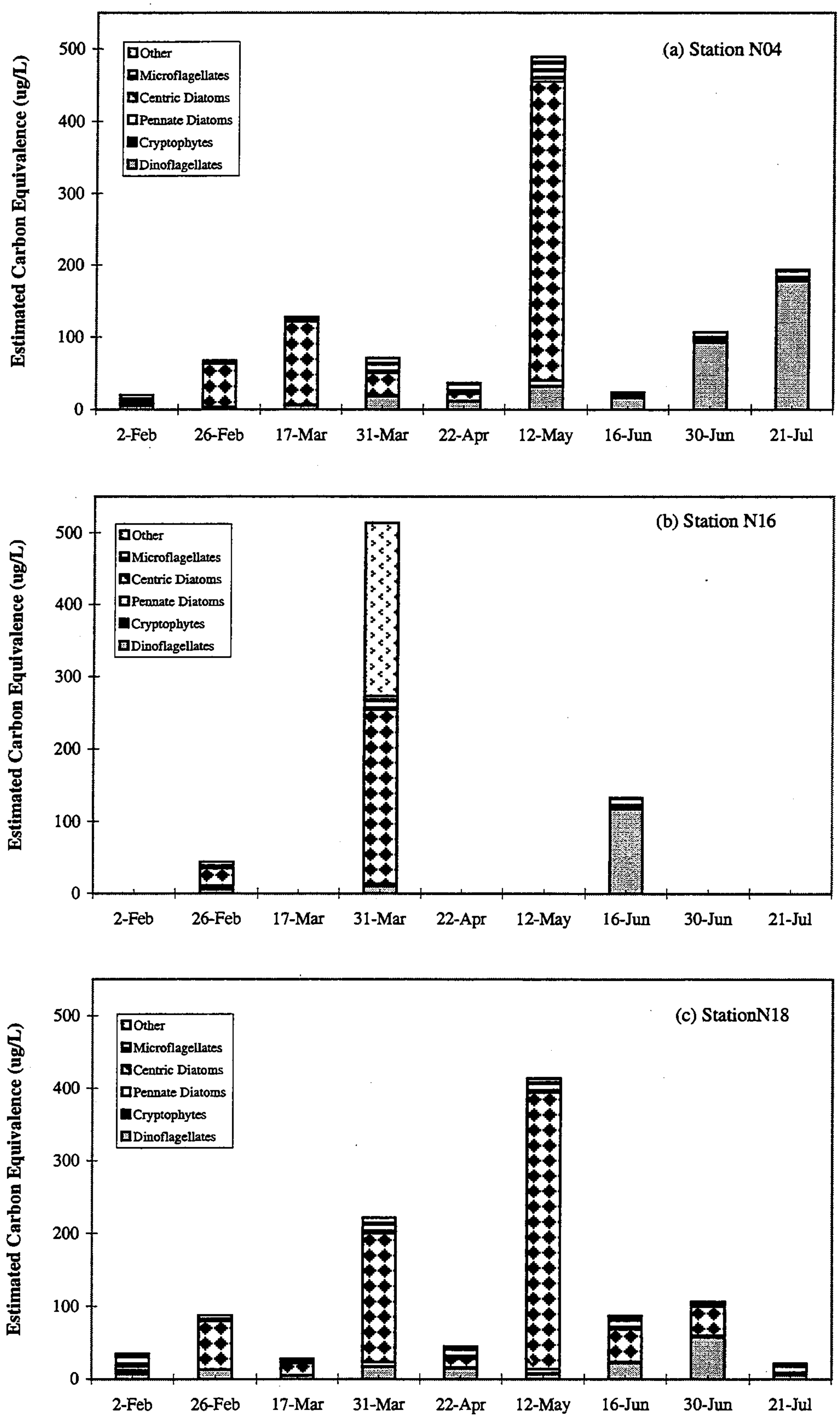


FIGURE 5 -13
Phytoplankton Carbon by Major Taxonomic Group, Nearfield Mid-Depth Samples

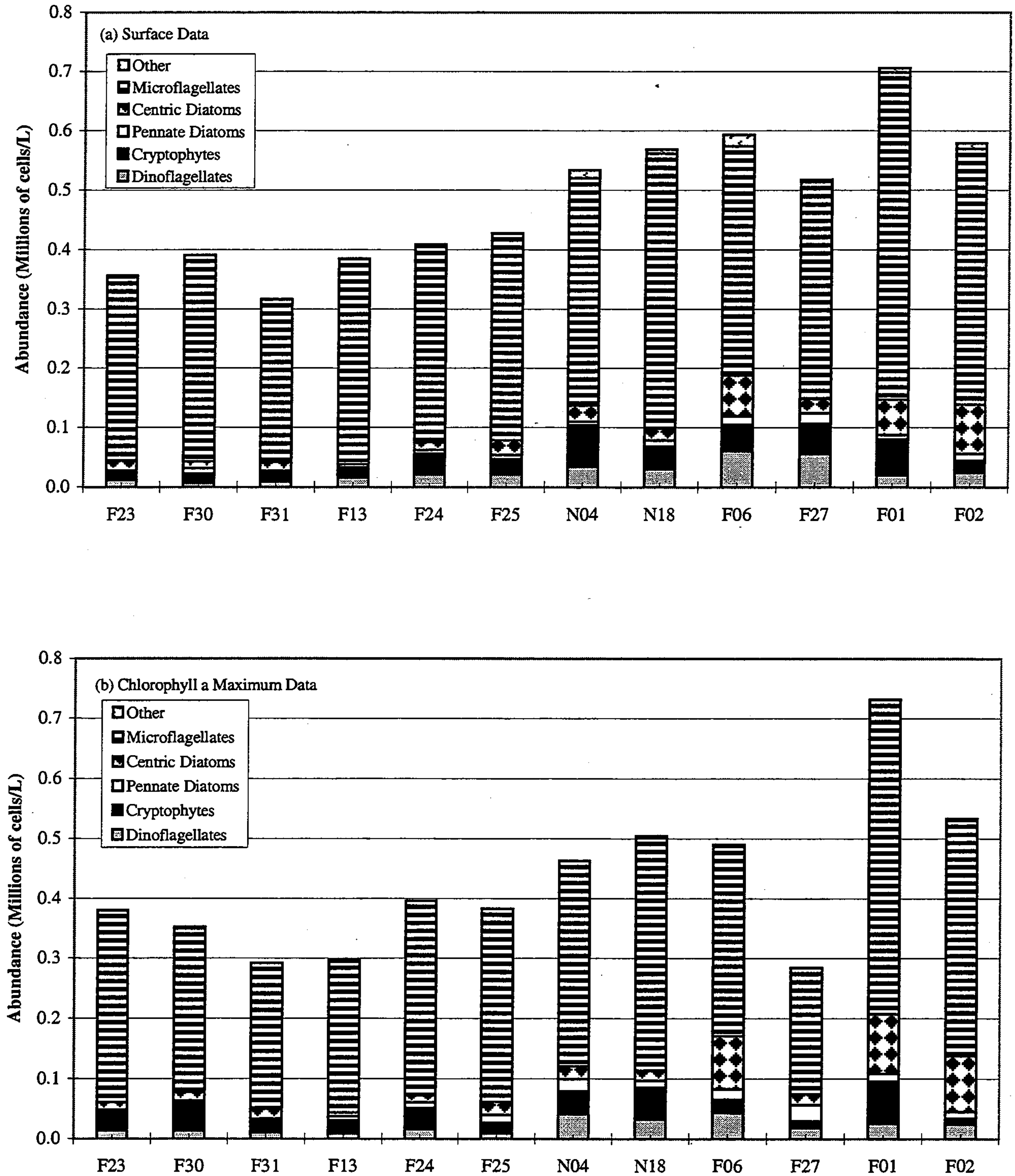
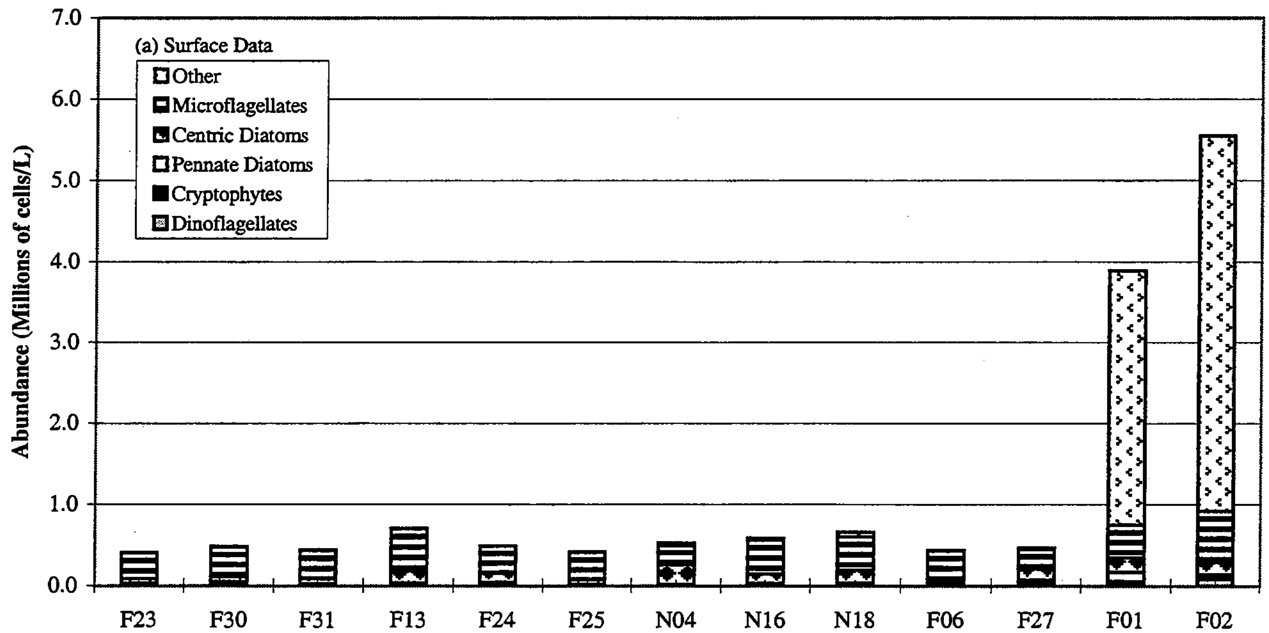


FIGURE 5-14
Phytoplankton Abundance by Major Taxonomic Group - W9701 Farfield Survey Results
February 4 - 7, 1997



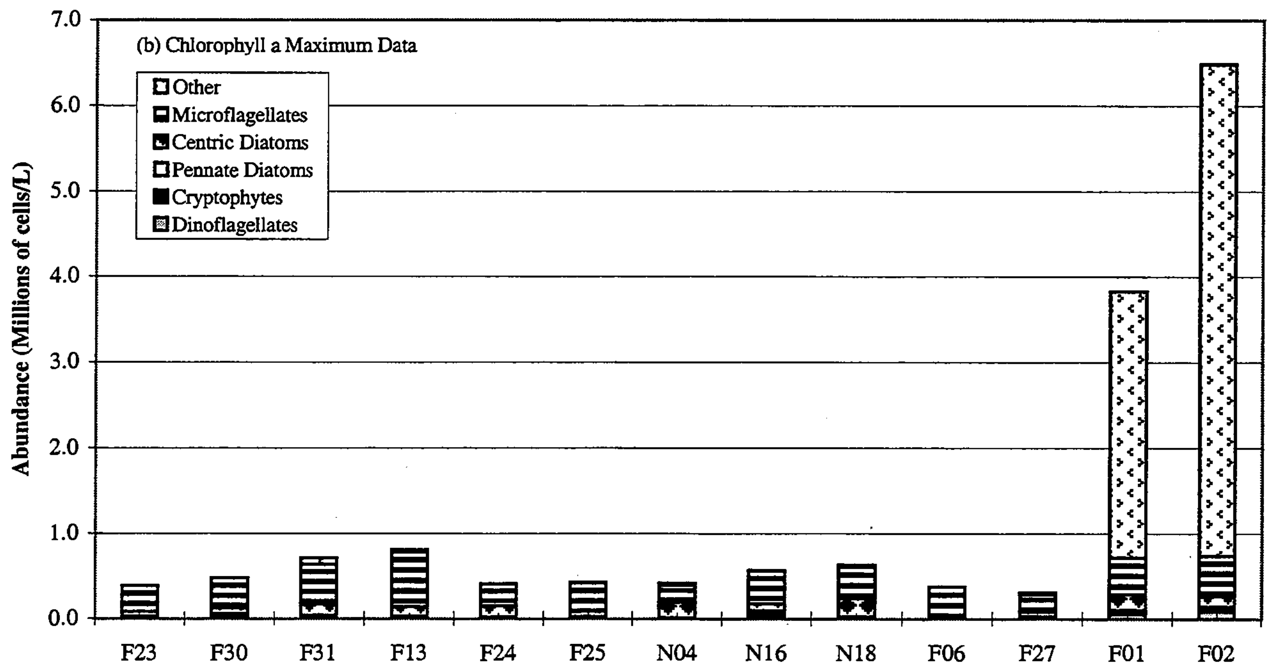
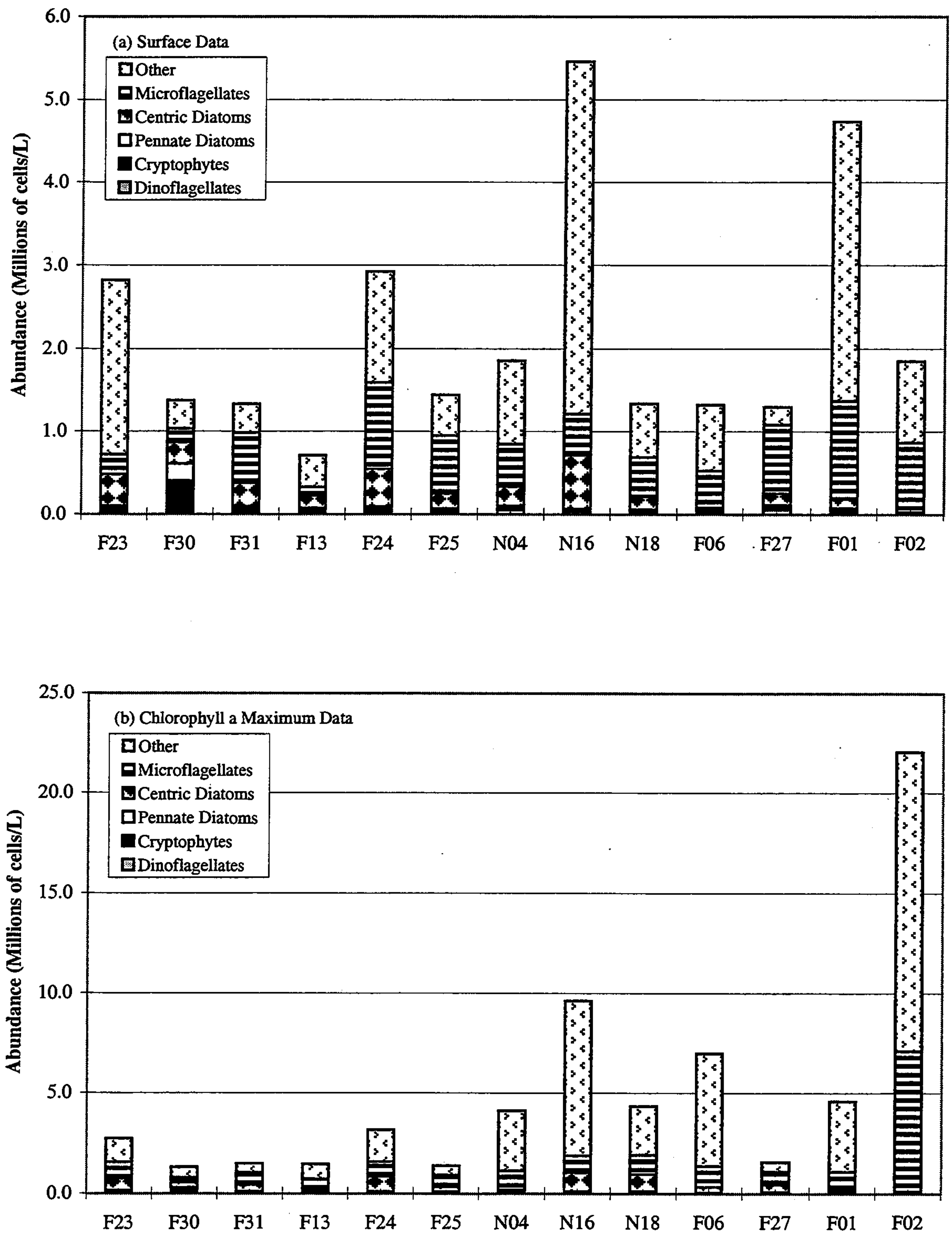
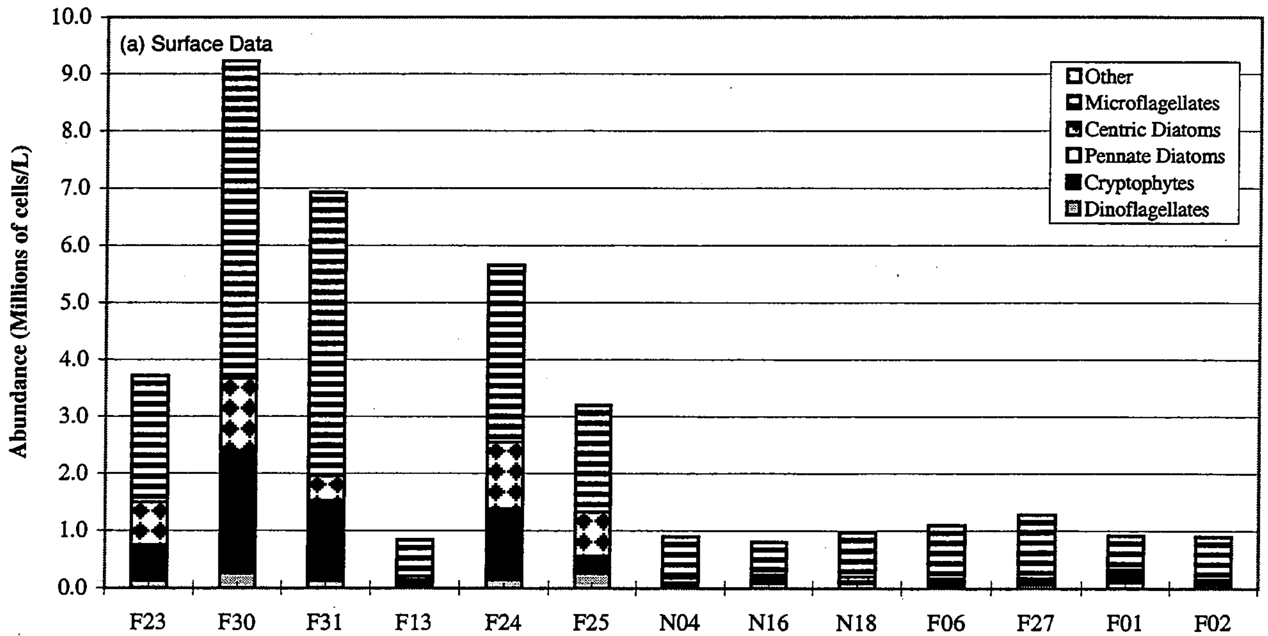


FIGURE 5-15
Phytoplankton Abundance by Major Taxonomic Group - W9702 Farfield Survey Results
February 25 - 28, 1997



*Note difference in y-scale axis

FIGURE 5-16
Phytoplankton Abundance by Major Taxonomic Group - W9704 Farfield Survey Results
April 1 -6, 1997



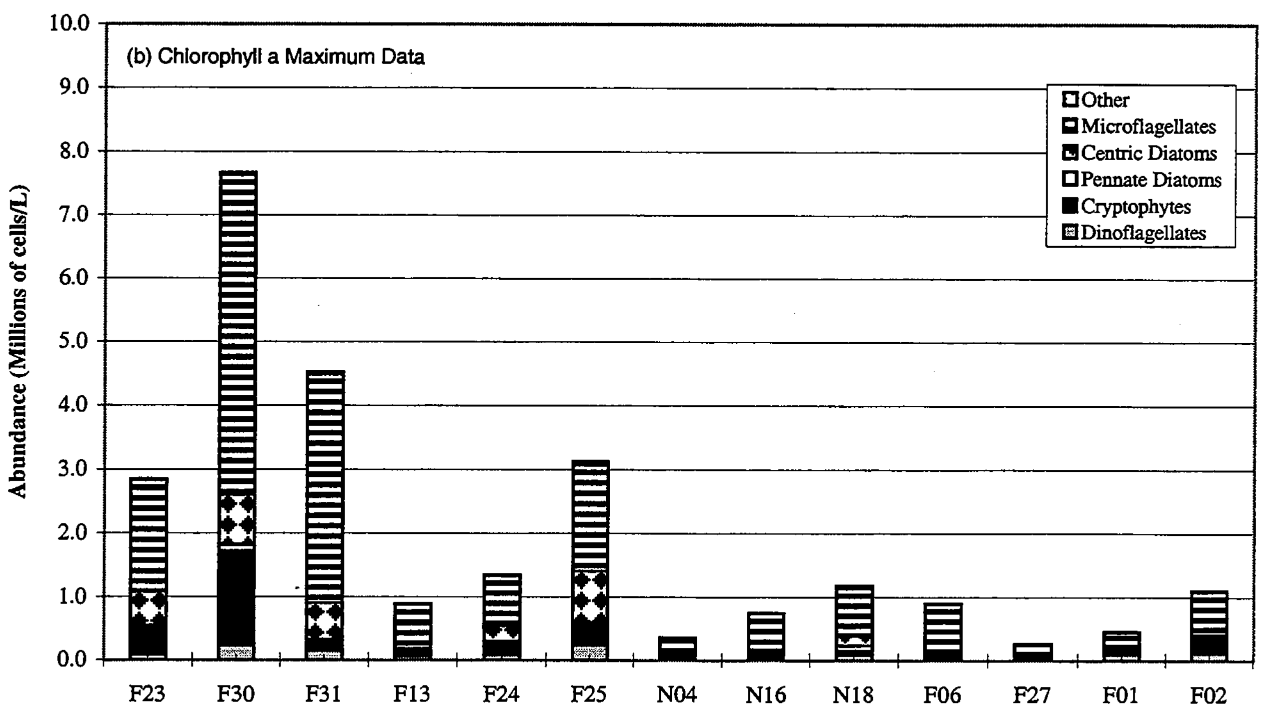


FIGURE 5-17
Phytoplankton Abundance by Major Taxonomic Group - W9707 Farfield Survey Results
June 17 - 20, 1997

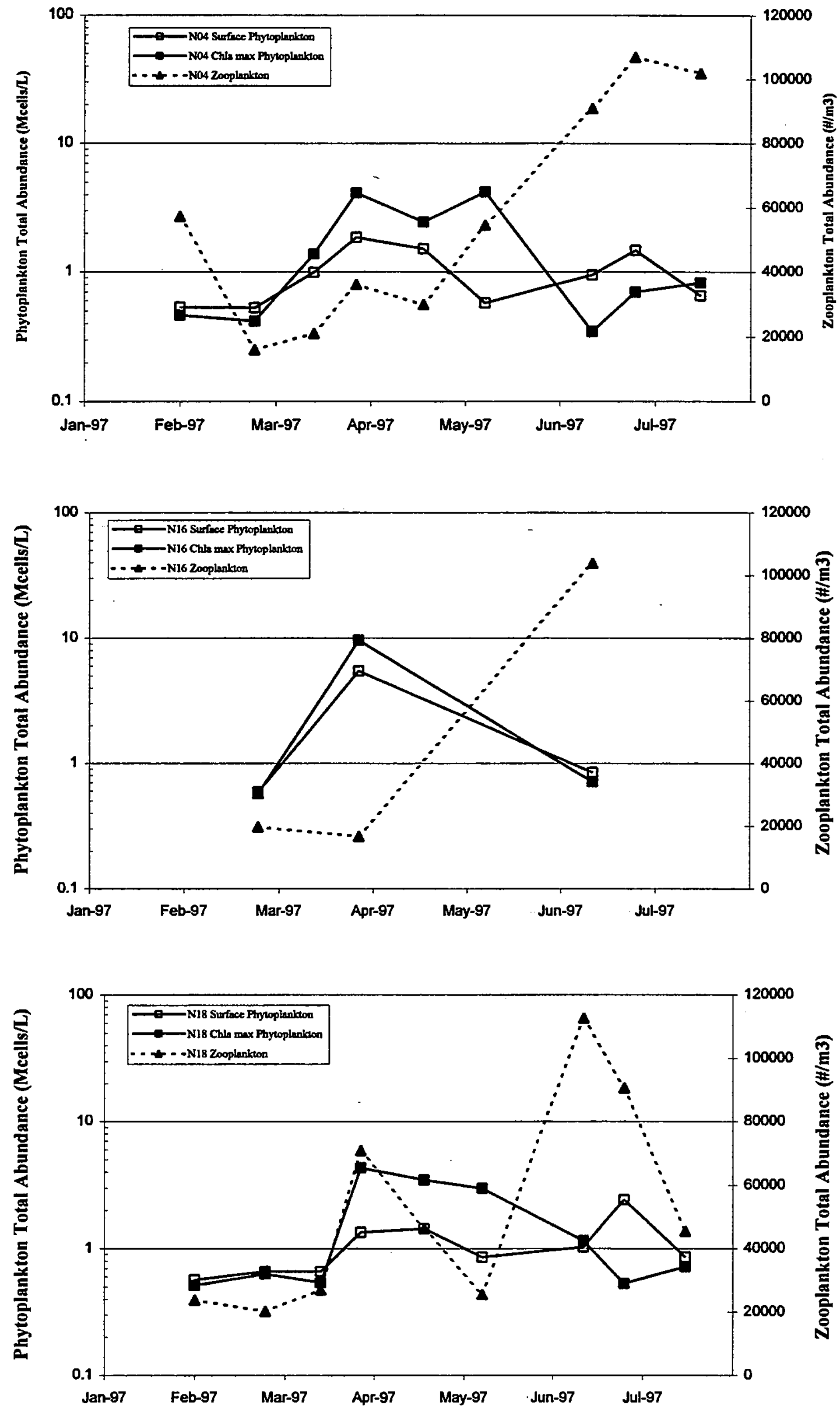


FIGURE 5 -18
Nearfield Phytoplankton and Zooplankton Abundance, Surveys W9701 - W9709
Top: N04, Middle:N16, and Bottom: N18

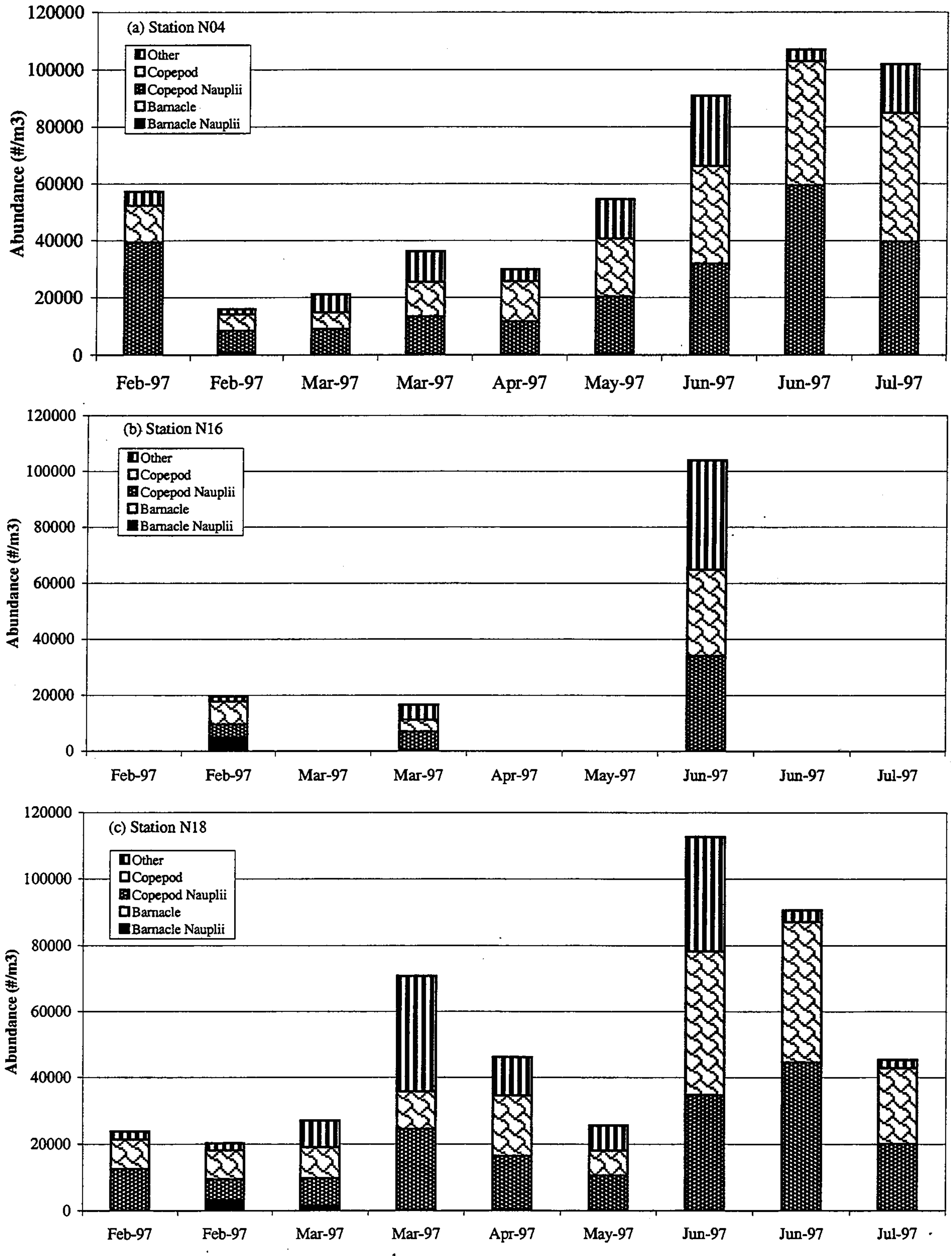


FIGURE 5 - 19
Nearfield Zooplankton Abundance by Major Taxonomic Group

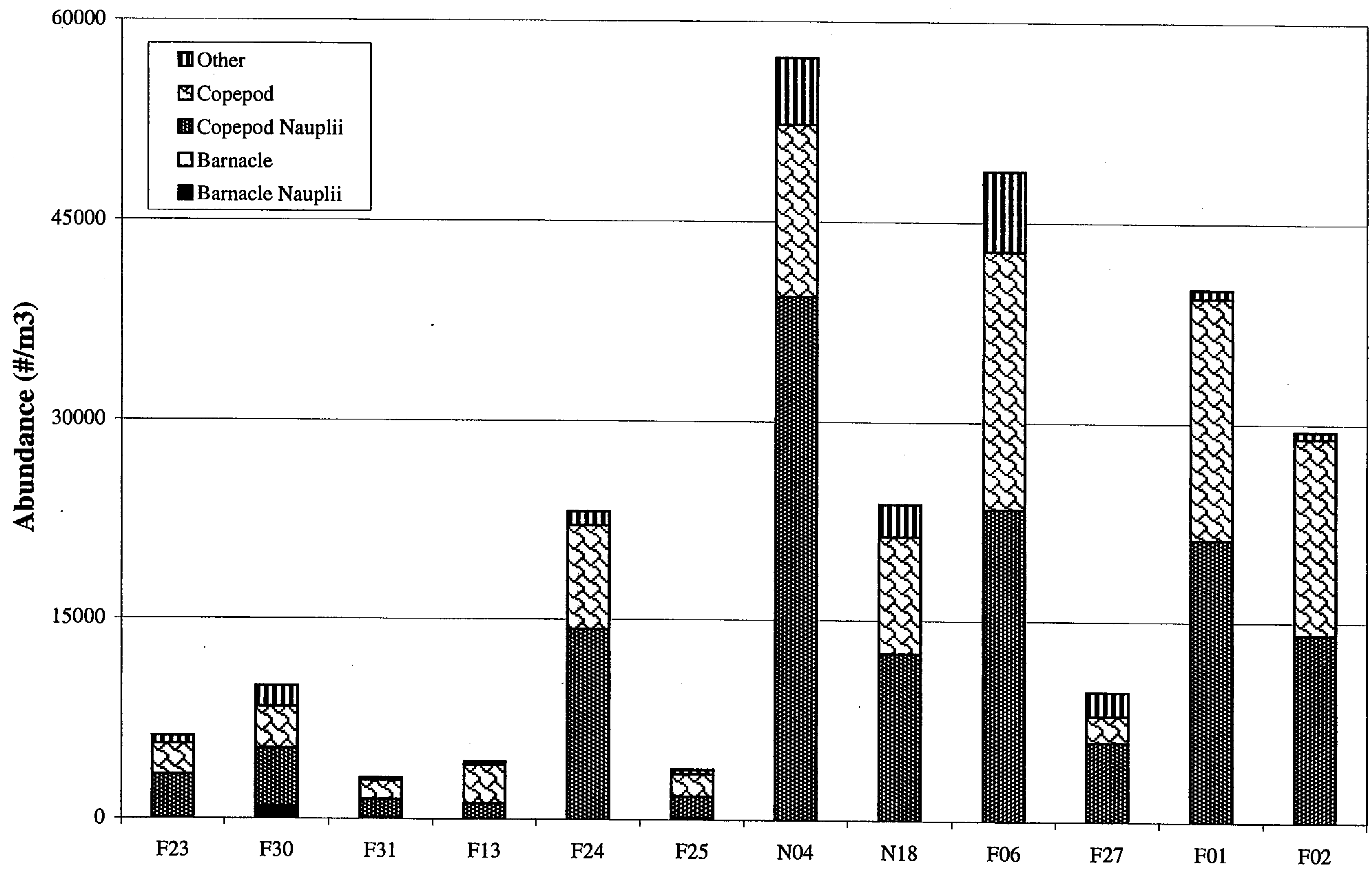


FIGURE 5-20
Zooplankton Abundance by Major Taxonomic Group - W9701 Farfield Survey Results
February 4 - 7, 1997

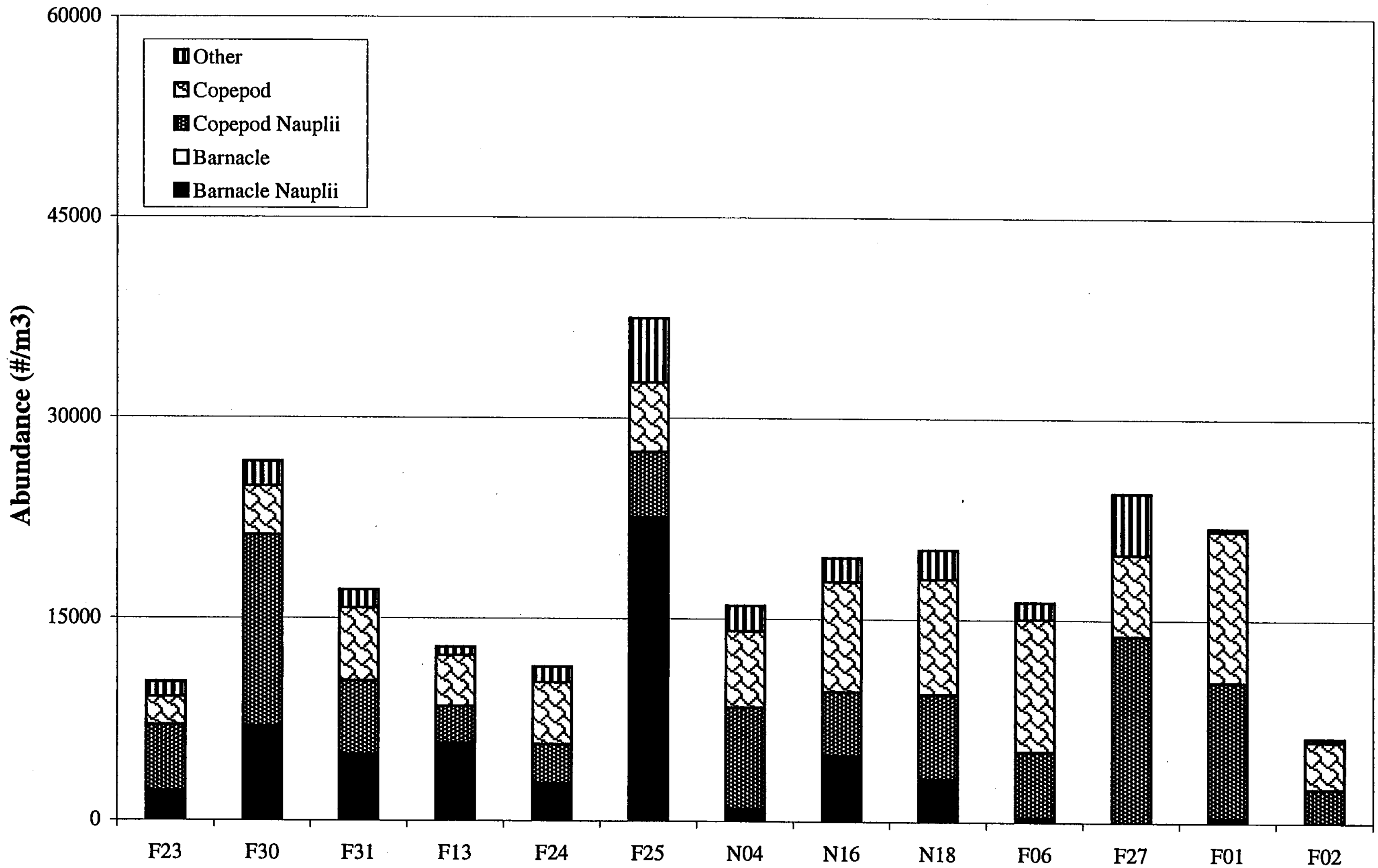


FIGURE 5-21
Zooplankton Abundance by Major Taxonomic Group - W9702 Farfield Survey Results
February 25 - 28, 1997

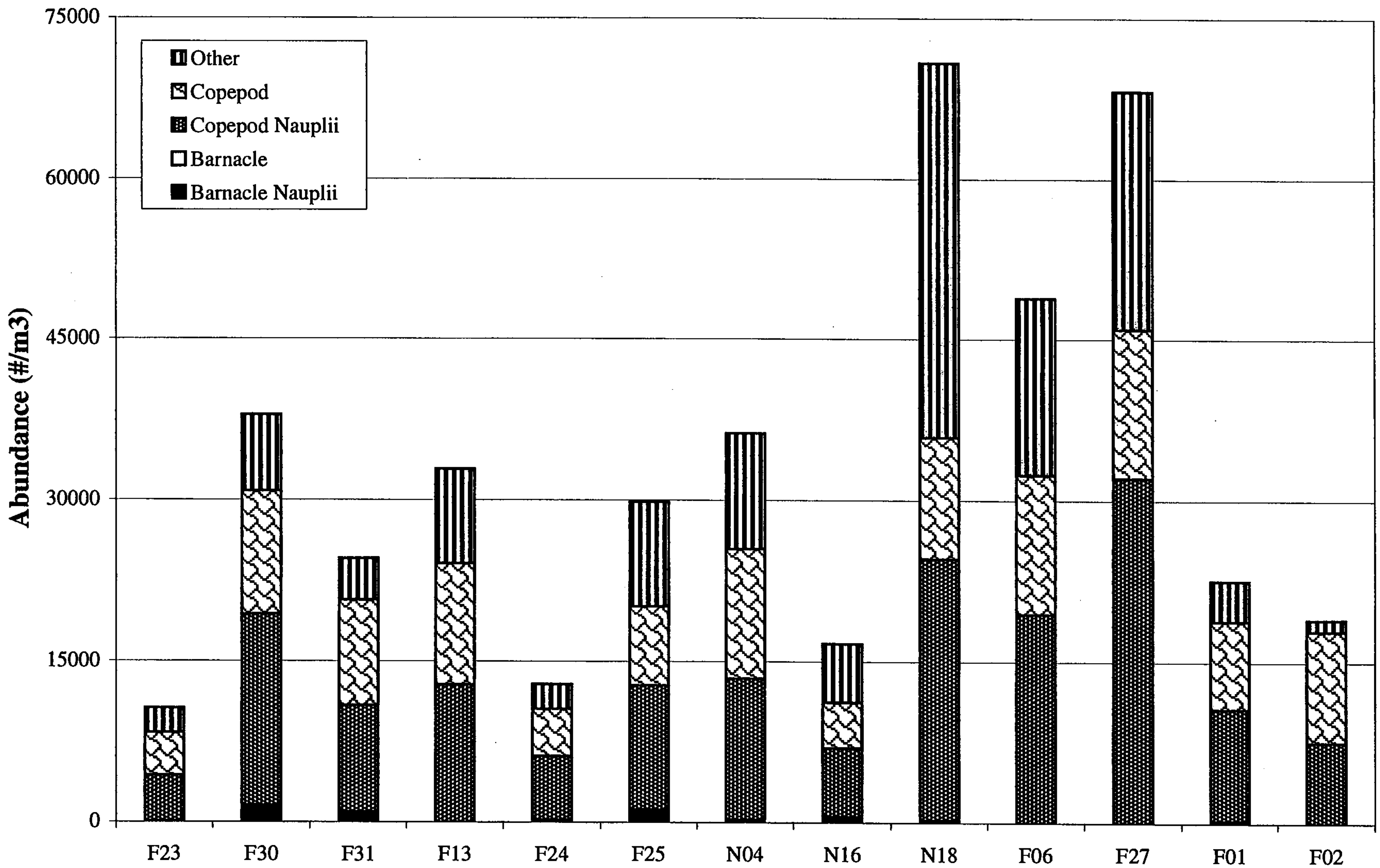


FIGURE 5-22
Zooplankton Abundance by Major Taxonomic Group - W9704 Farfield Survey Results
April 1 - 6, 1997

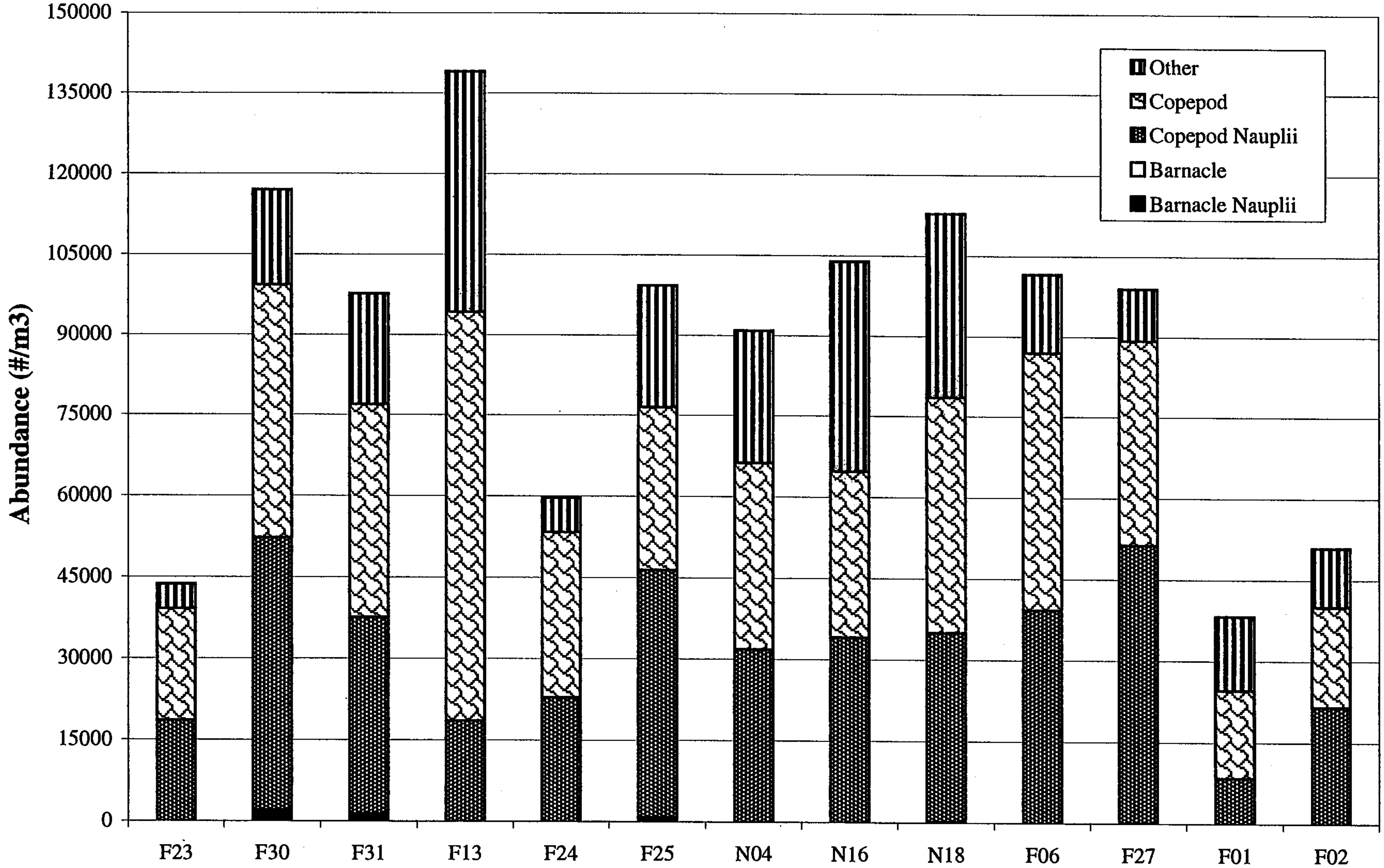


FIGURE 5-23
Zooplankton Abundance by Major Taxonomic Group - W9707 Farfield Survey Results
June 17 - 20, 1997

6.0 A SUMMARY OF MAJOR WATER COLUMN EVENTS

This section provides an overview and synthesis of significant events that occurred in Massachusetts Bay, Cape Cod Bay and Boston Harbor during the reporting period. During the first half of 1997, these included the late winter bloom, a secondary bloom associated with a strong spring freshet, an early summer bloom in the Harbor and adjacent coastal stations, and a reversal in the seasonal decline in bottom water dissolved oxygen. These events were demonstrated in the physical, chemical, and biological measurements taken during the period.

The late winter bloom appeared to develop in Cape Cod Bay in mid-February (between surveys W9701 and W9702). Both chlorophyll and nutrient data indicate that the bloom was beginning to develop at most stations in Massachusetts Bay by late February, a time when maximum rates in primary productivity were measured in the nearfield. However, the bloom in Massachusetts Bay appeared to be "interrupted" during March, indicated by diminished chlorophyll concentrations (particularly at the surface) and reduced nutrient uptake and productivity rates. The typical centric diatom successional pattern (initial dominance by *Thalassiosira* followed by *Chaetoceros*) was evident, but there appeared to be a lag in the development of the latter.

The bloom resumed activity in early April, dominated by *Chaetoceros* and *Phaeocystis pouchetii.* However, chlorophyll, phytoplankton, and POC results indicated that the majority of the bloom was found at mid-depth, although highest densities of *Phaeocystis* were reported in surface samples. Silicate concentrations reached their lowest concentration of the pre-stratified period, and along with nitrogen may have limited continued high productivity. Further pressure on activity may have come from zooplankton grazing, as early April had the highest zooplankton abundance of the pre-stratified period.

By the end of April, a large influx of fresher water entered Massachusetts Bay associated with high river discharge rates. Increased concentrations of major nutrients, particularly silicate, indicated nutrient resupply to surface water in Massachusetts Bay had occurred. Based on rapid depletion of silicate in surface water and evidence of a large accumulation of *Chaetoceros* at mid-depth by the May survey, it appears that a substantial resumption in productivity occurred in response to the freshet.

The Harbor and adjacent coastal stations yielded little photosynthetic activity through April, however, a strong bloom developed in the Harbor and adjacent coastal stations during May and June. *Chaetoceros* and another centric diatom, *Rhizosolenia fragilissima* dominated this bloom. The extent of this coastal bloom appeared to include the inner nearfield stations N01 and N10, and based on nearfield-only sampling at these stations during late June and July, the Harbor bloom ended in late June.

Stratification had developed throughout Massachusetts Bay by mid-May, perhaps reinforced by the spring freshet. Peak bottom water DO concentrations were documented in late March, after which the seasonal decline of DO began. Following the mid-June survey, the steady decline in DO concentration reversed itself, and for the remaining two surveys in the period Bottom water DO increased in both concentration and saturation. While localized primary productivity which was evident at mid-depth may have contributed to the observed increase, evidence from the USGS mooring suggests that a large-scale advection of oxygenated bottom water occurred in the nearfield during the period. This reversal in DO decline resulted in an increase in bottom water DO concentration of 1.5 mg/L. This phenomenon will be more fully examined in the 1997 Annual Water Column Report.

7.0 REFERENCES

Bowen, J., K. Hickey, B. Zavistoski, T. Loder, B. Howes, C. Tayor, E. Butler, and S. Cibik. 1997. Combined Work/Quality Assurance Project Plan for Water Quality Monitoring: 1996-1997. Prepared for the Massachusetts Water Resources Authority, Boston, MA, under Contract S186. 73pp.

Bates, S.S. 1997. Personal Communication with Steve Cibik of ENSR.

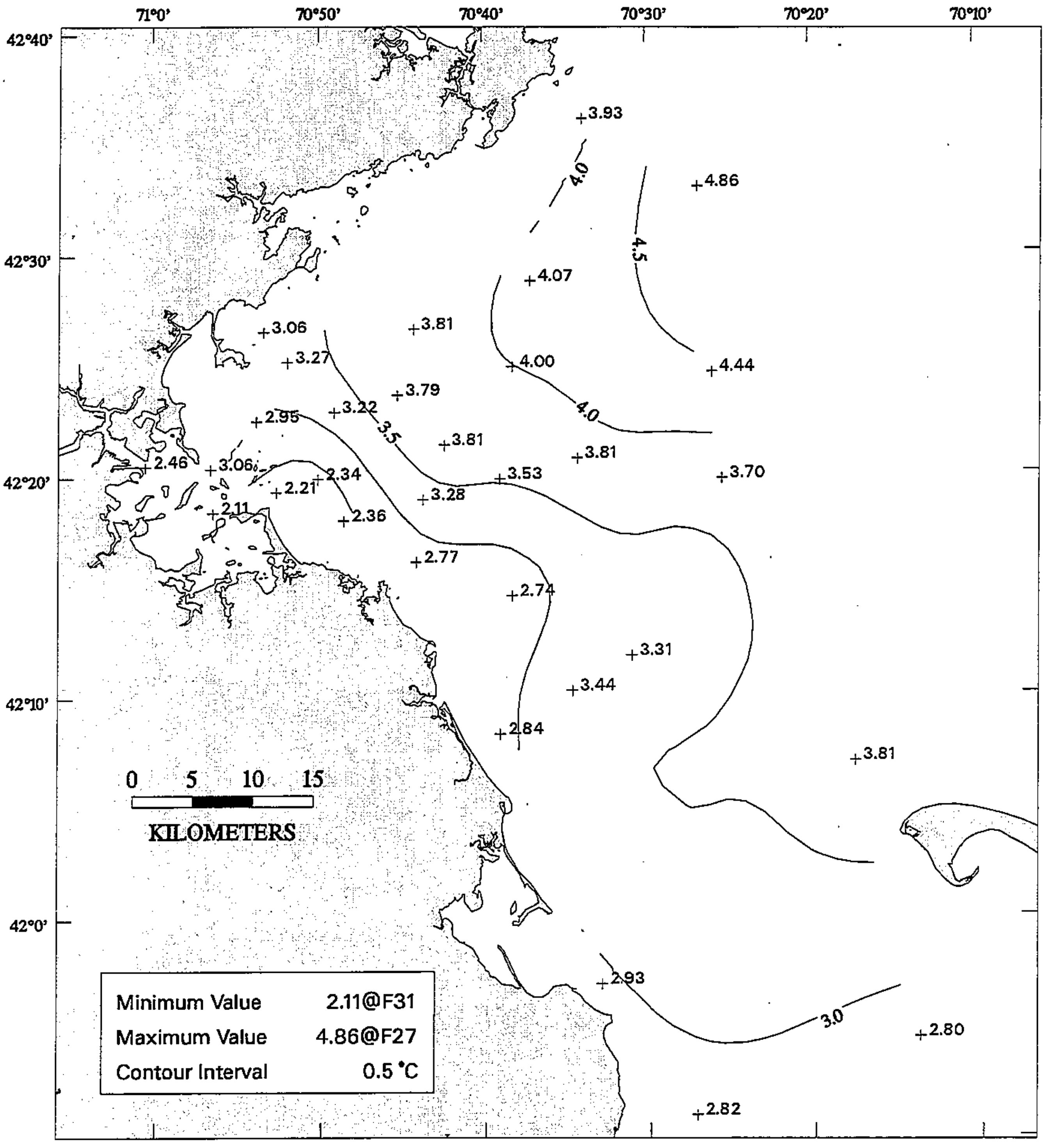
APPENDIX A
Surface Contour Plots - Farfield Surveys

All contour plots were created using data from the surface bottle sample (A). Each plot is labeled on the bottom right with the survey number ("9601"), and parameter as listed below. The minimum and maximum value, and the station where the value was measured, is provided for each plot, as well as the contour interval and parameter units.

Appendix A: Table of Contents

Parameter Name	Map Parameter Name	Units
Temperature	temp_lin	°C
Salinity	sal_lin	PSU
Transmissivity (beam attenuation)	tran_lin	/m
Nitrate (NO_3)	no3_lin	μM
Phosphate (PO_4)	po4_lin	μM
Silicate (SiO_4)	sio4_lin	μM
Dissolved Inorganic Nitrogen (DIN*)	din_lin	μM
Chlorophyll *a*	fluo_lin	μg/L

*$NO_3 + NO_2 + NH_4$



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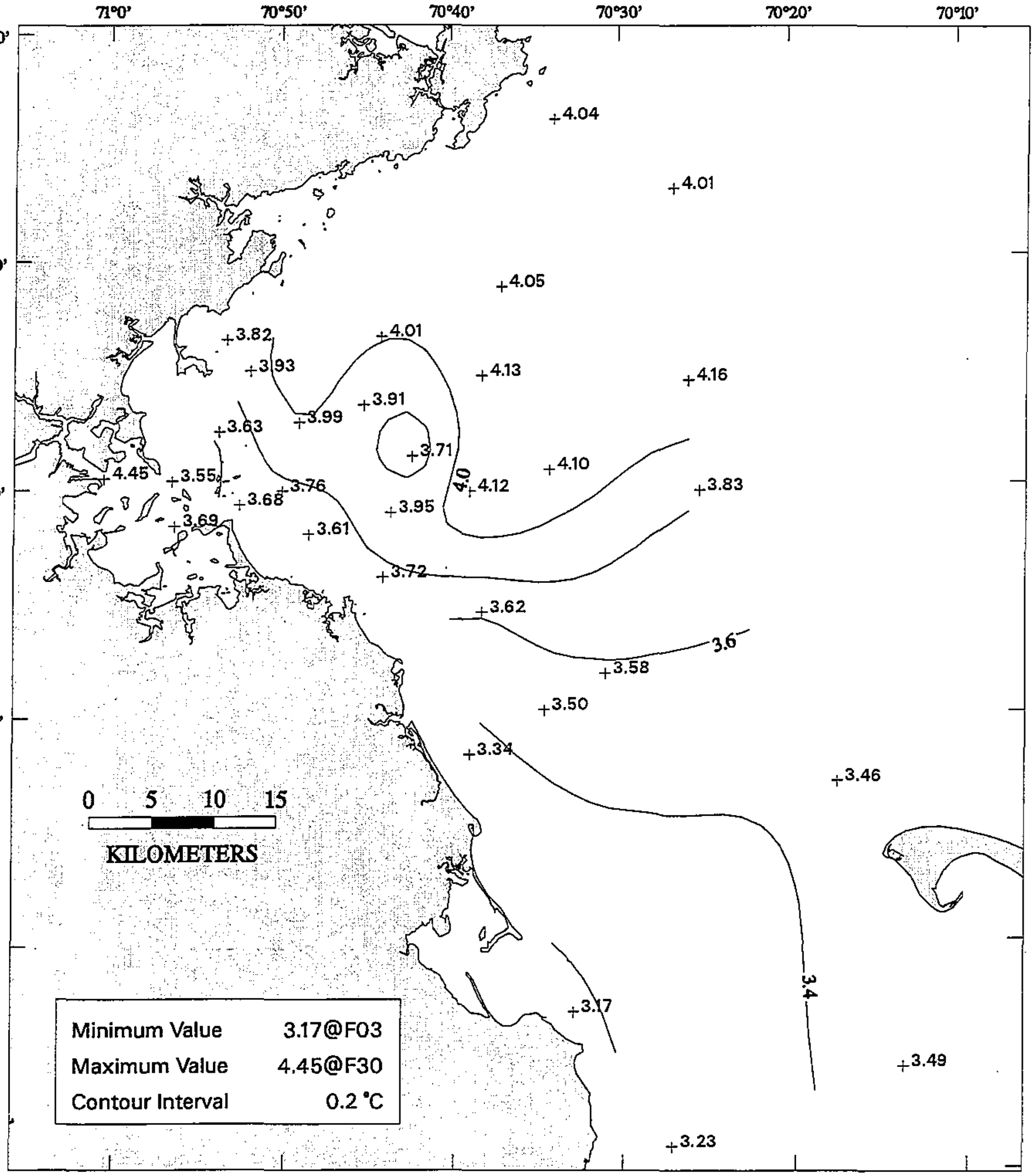
TEMP



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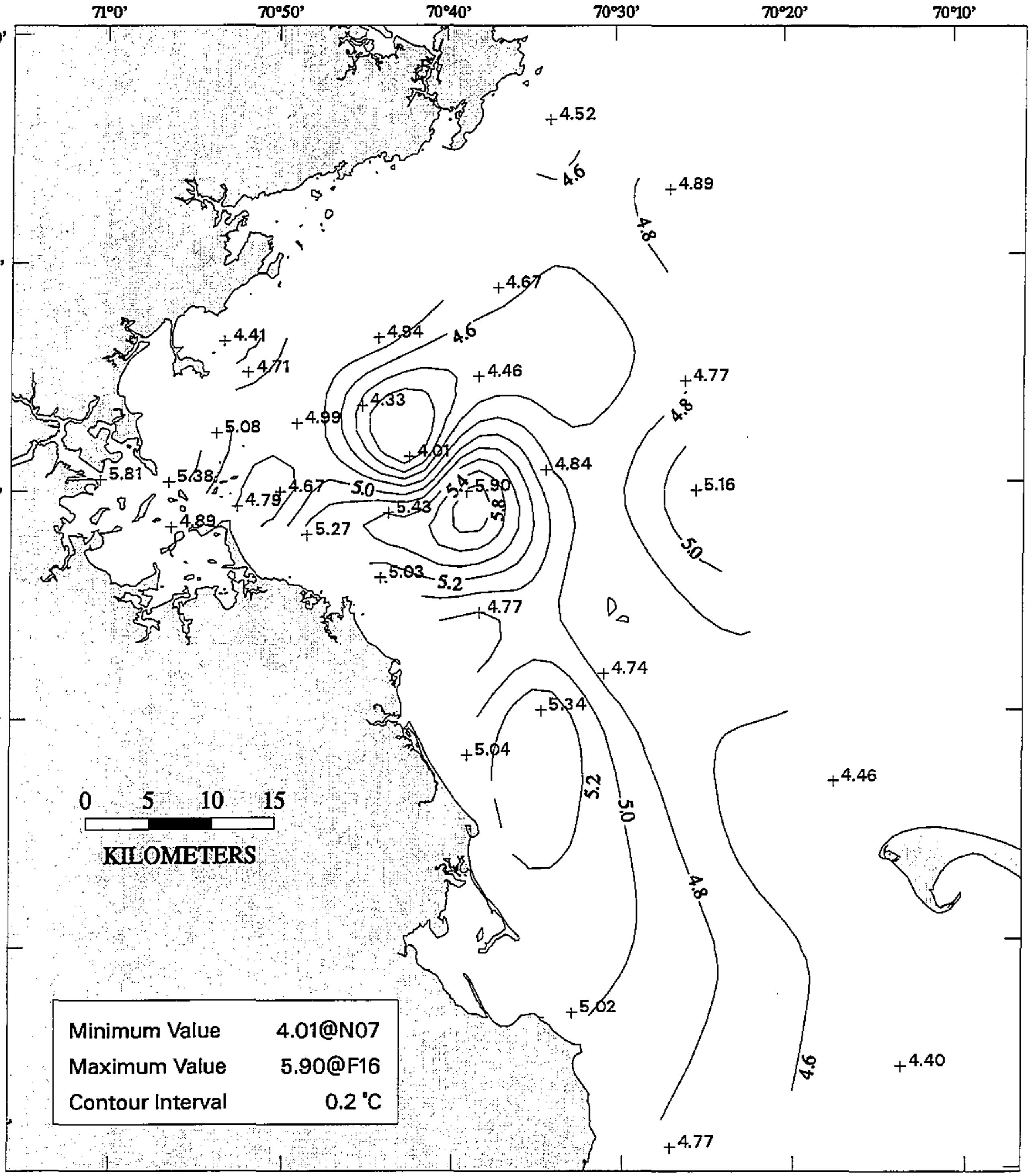
TEMP



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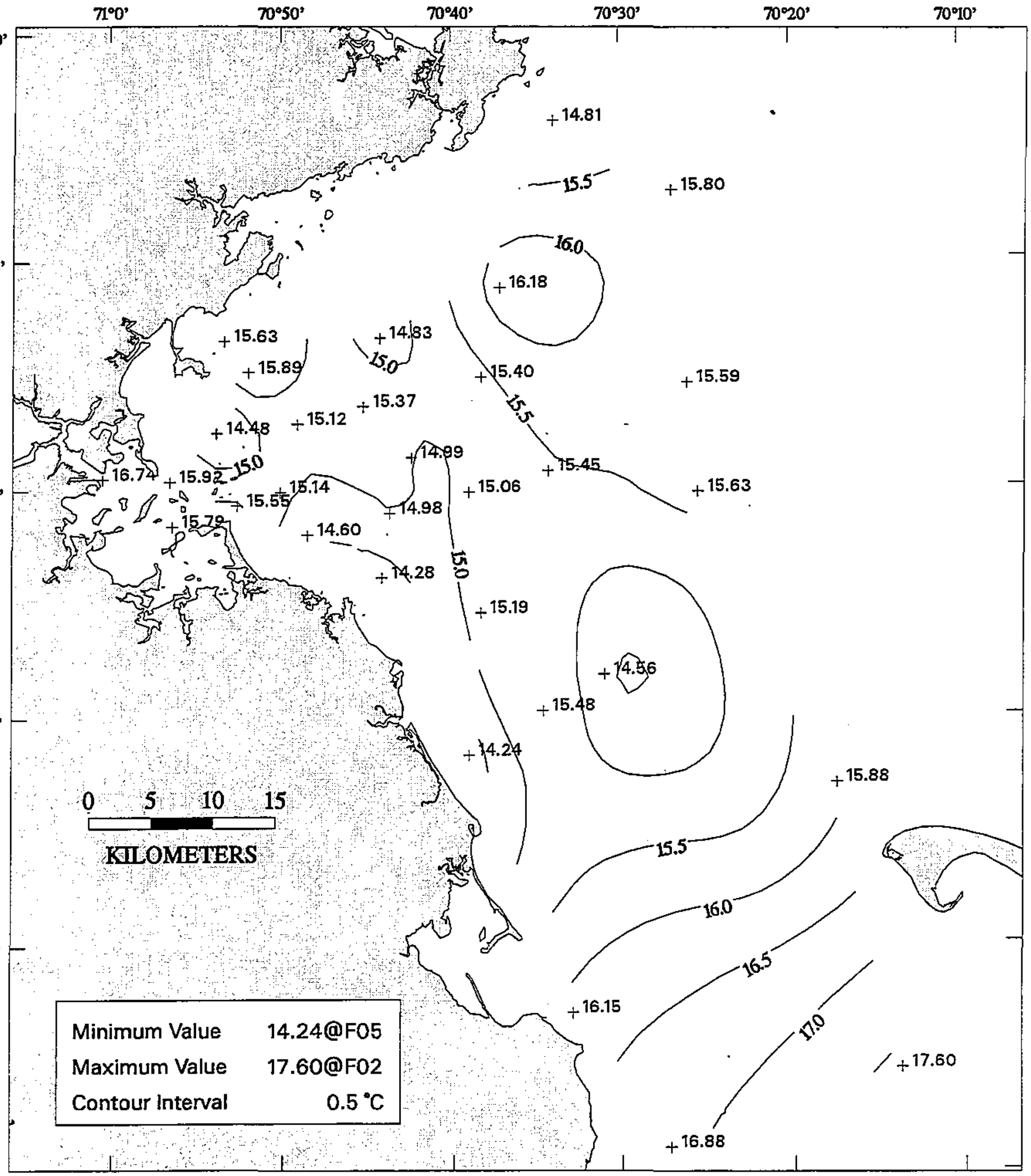
TEMP



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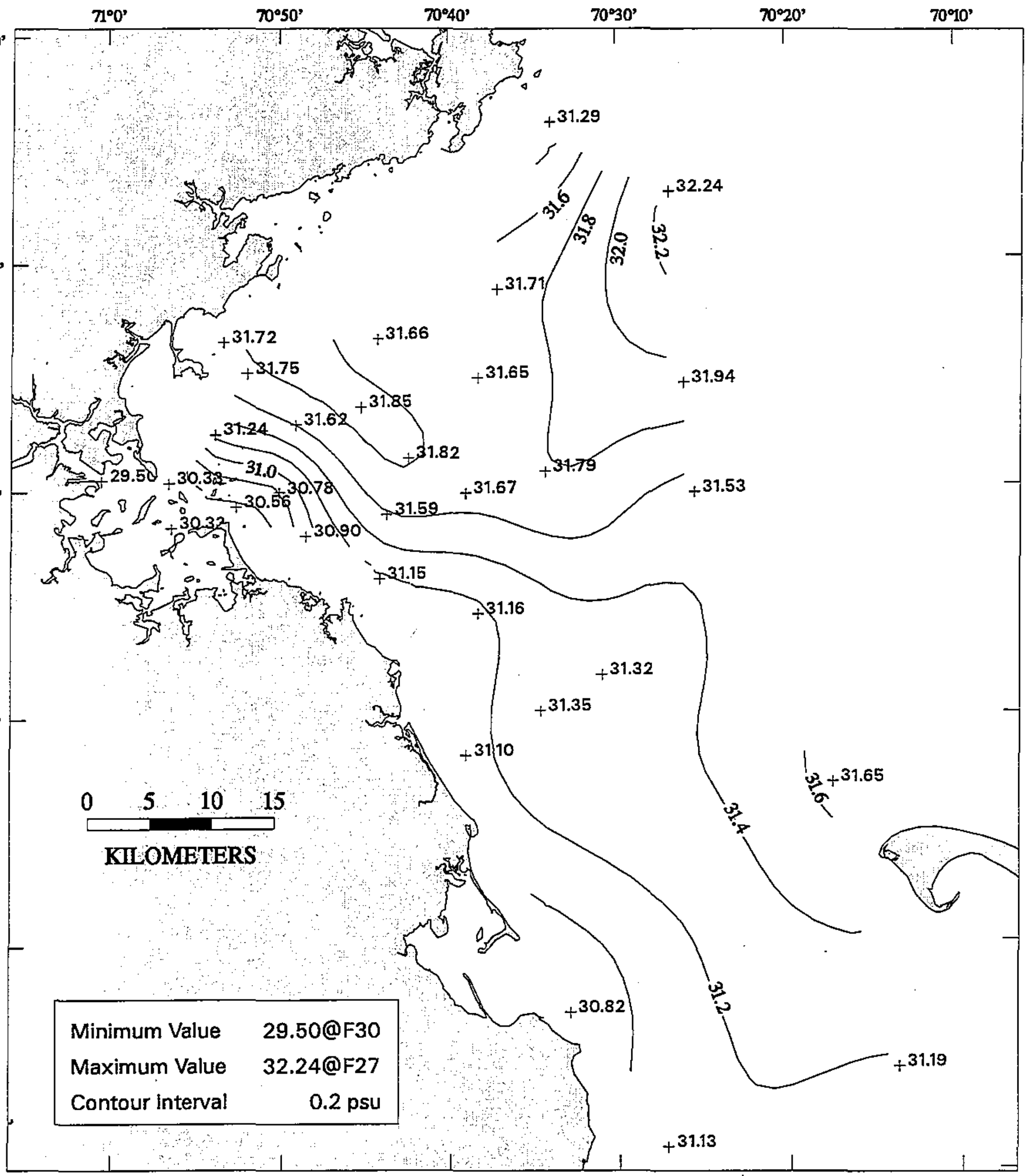
TEMP



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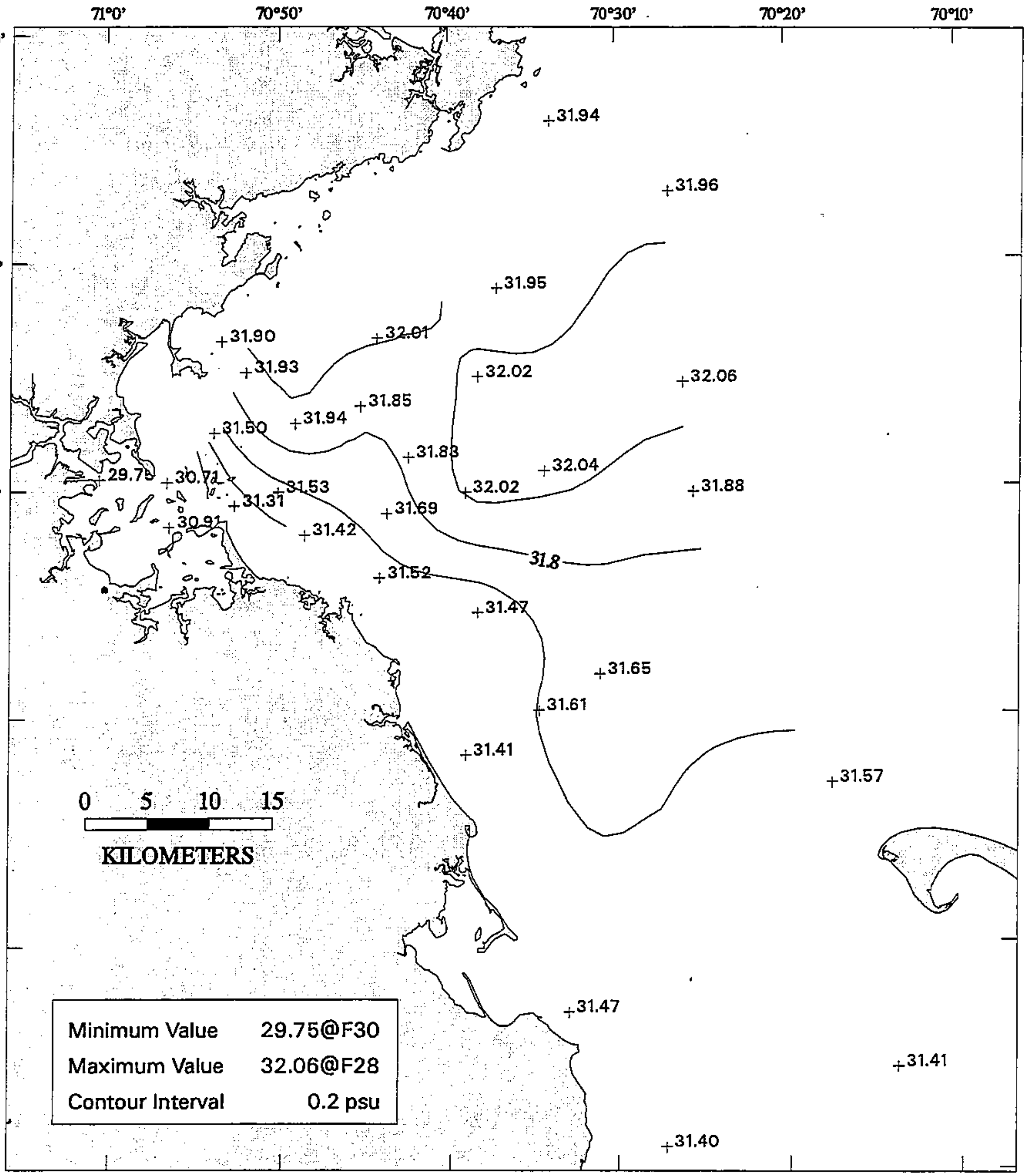
SAL



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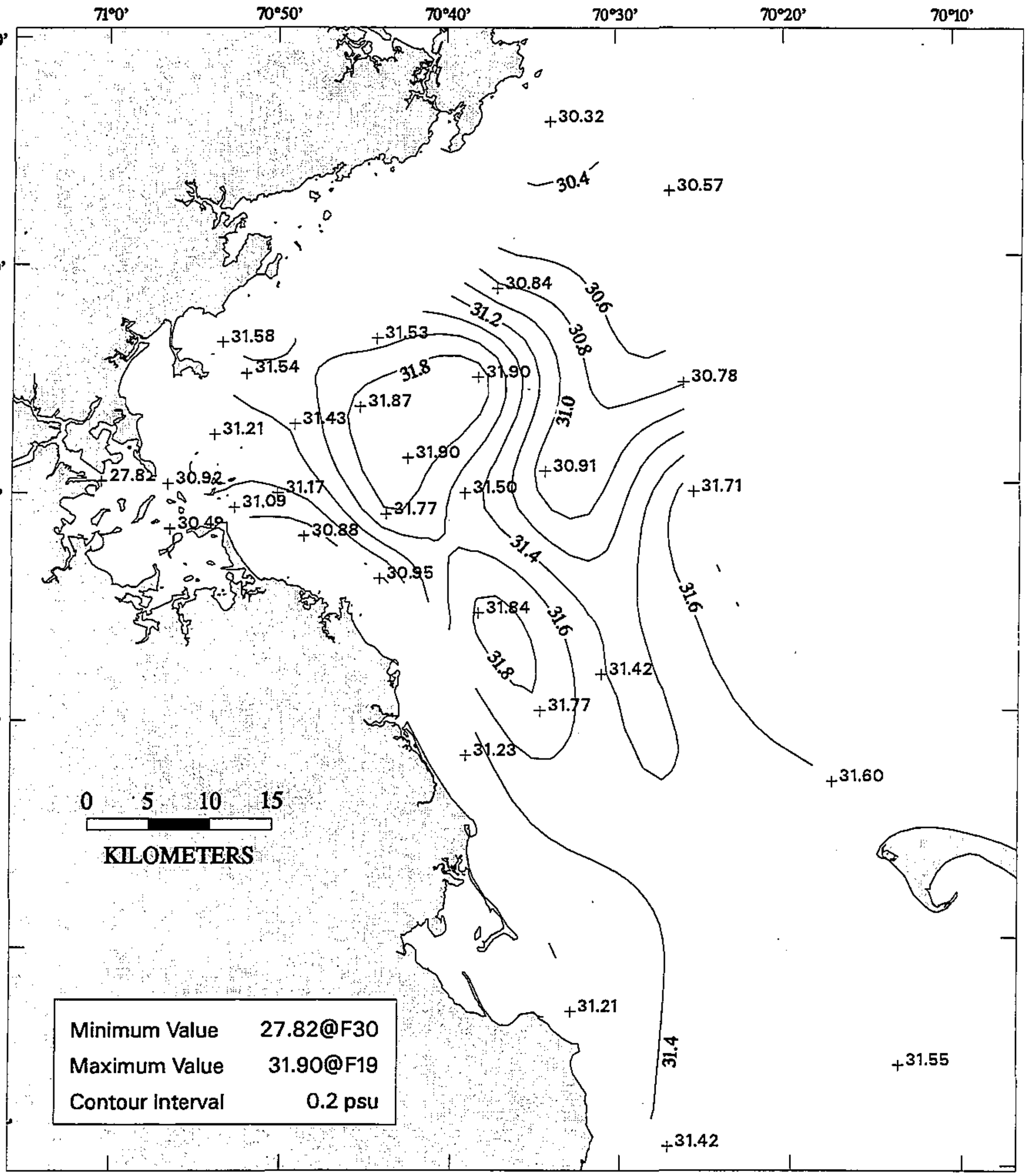
SAL



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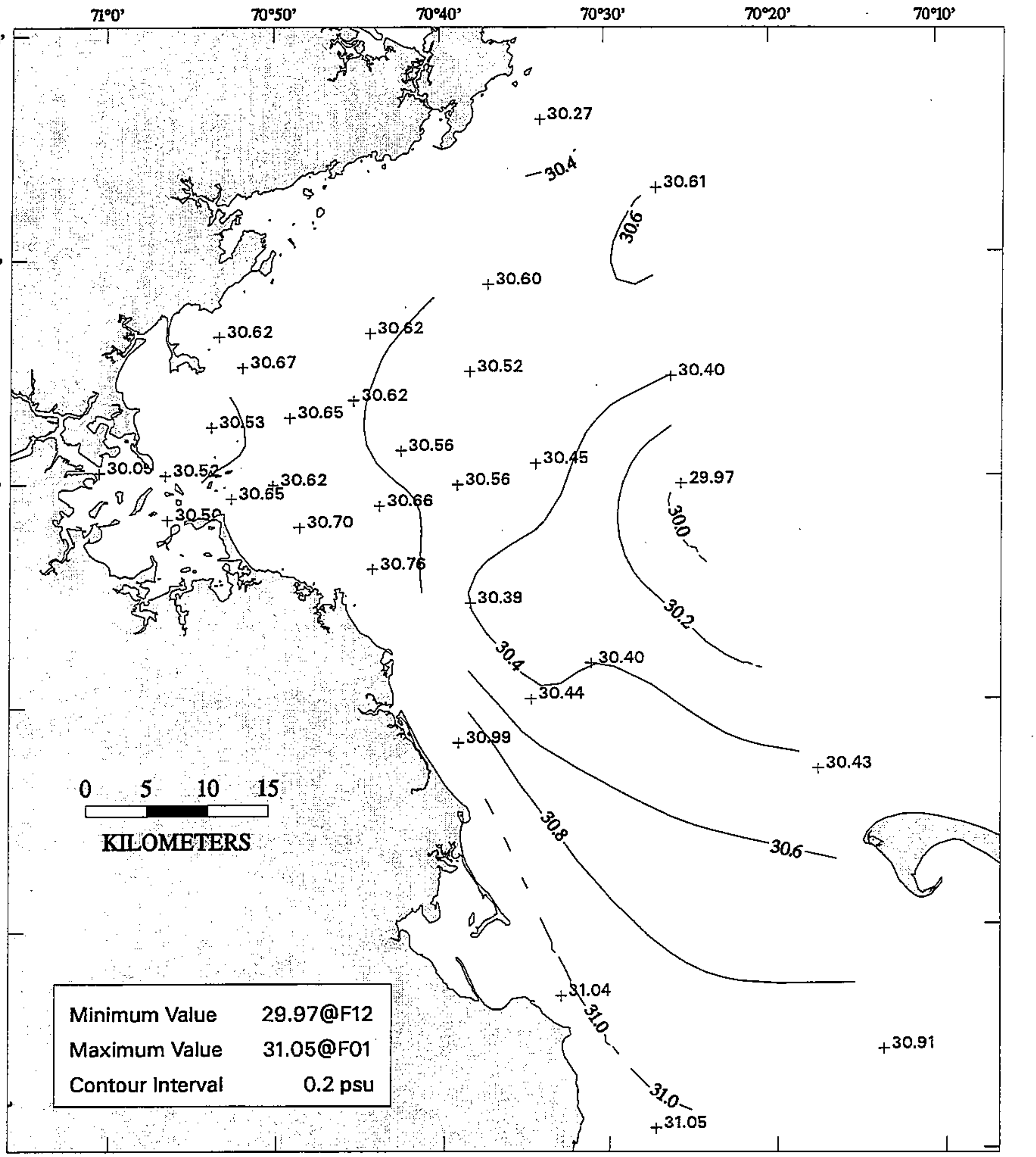
SAL



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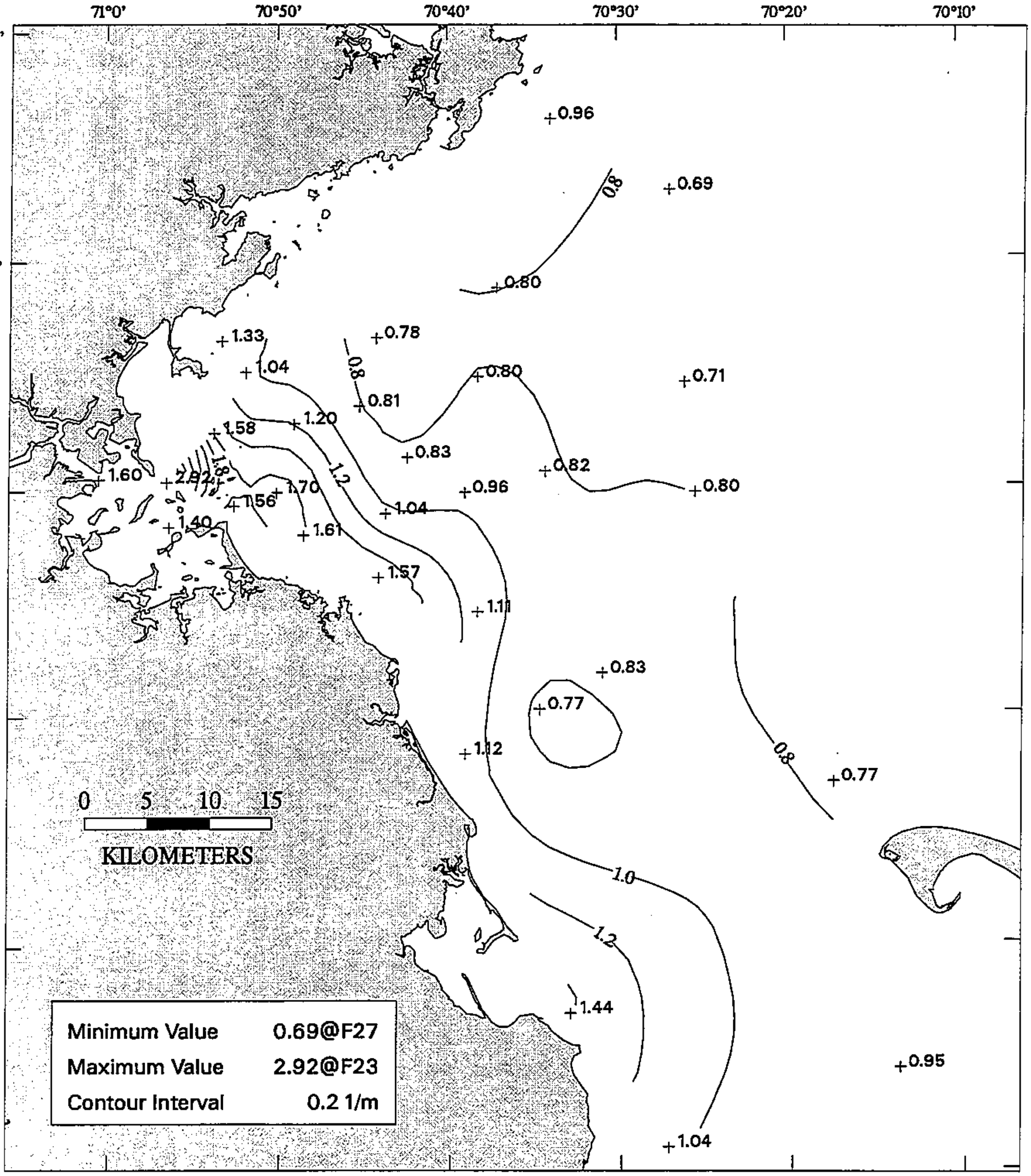
SAL



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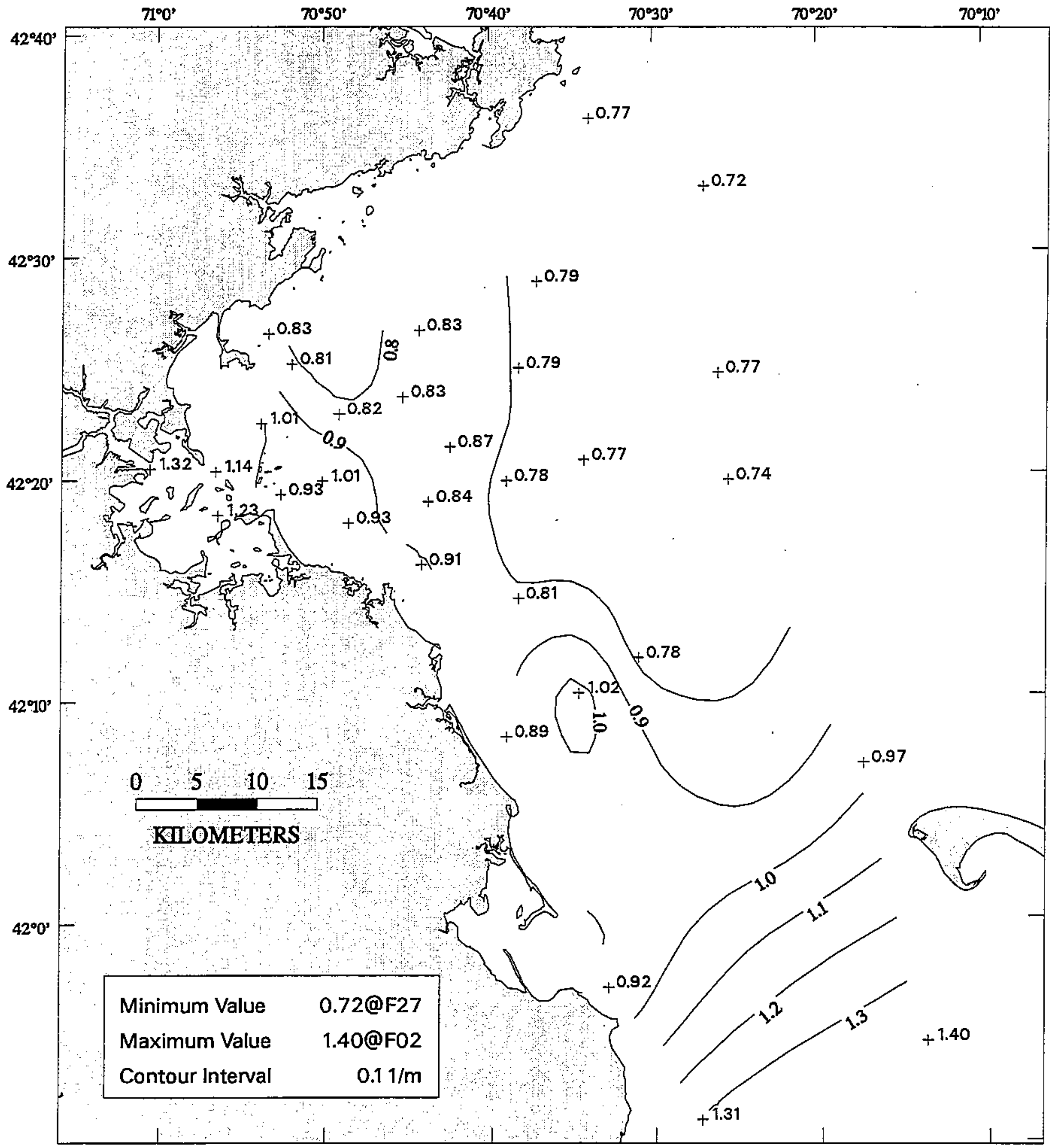
TRAN



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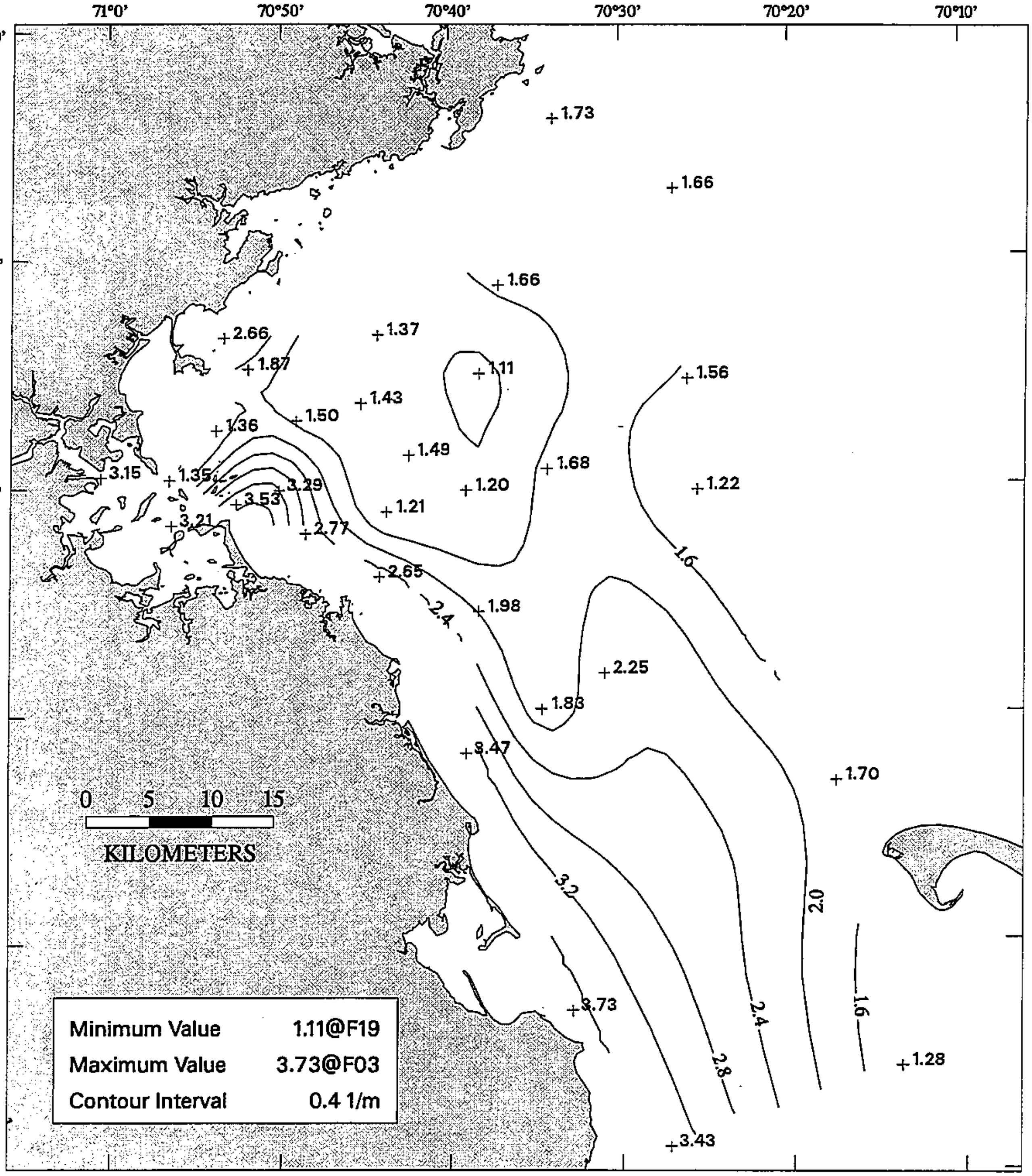
TRAN



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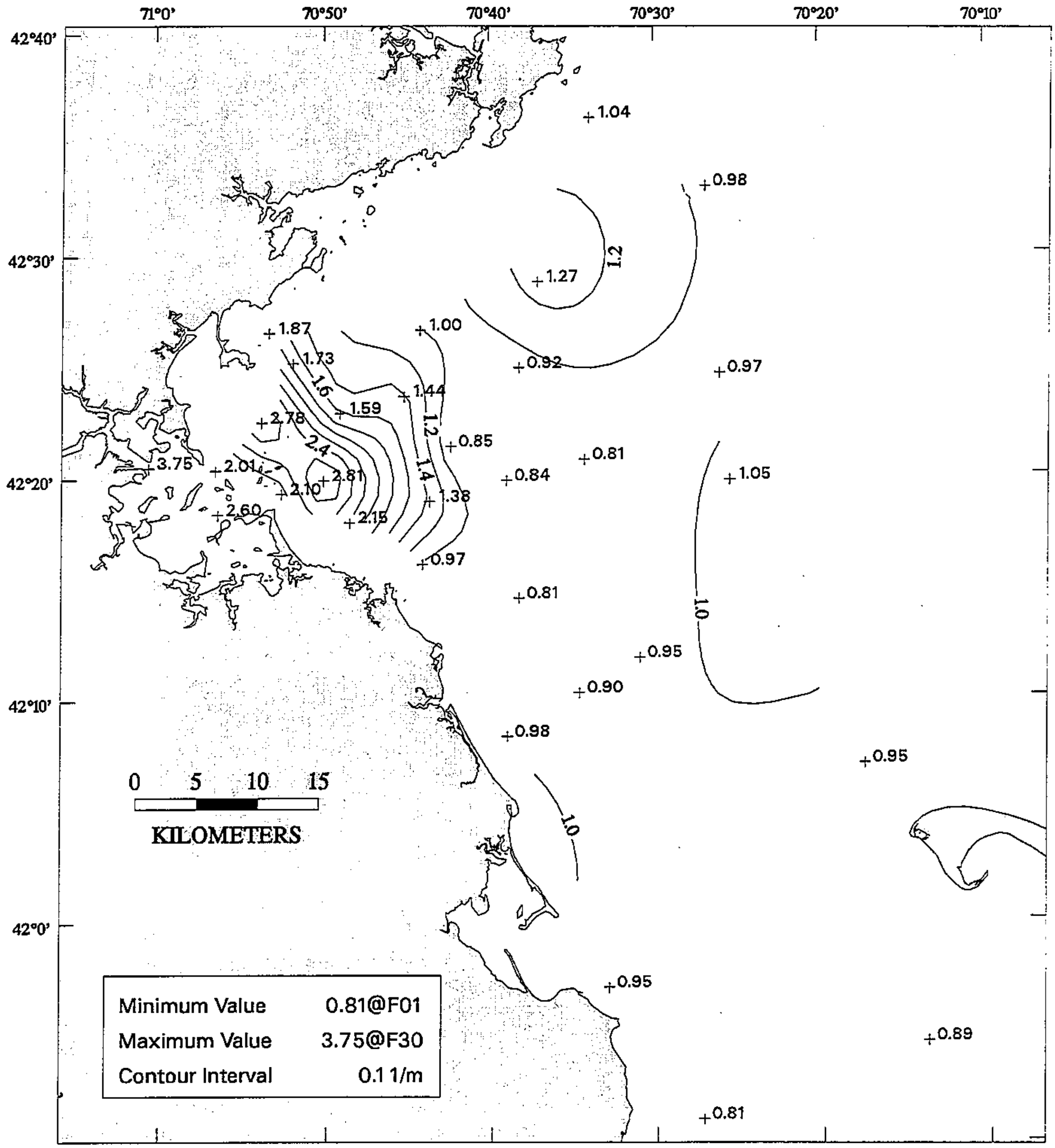
TRAN



Minimum Value	0.81@F01
Maximum Value	3.75@F30
Contour Interval	0.1 1/m

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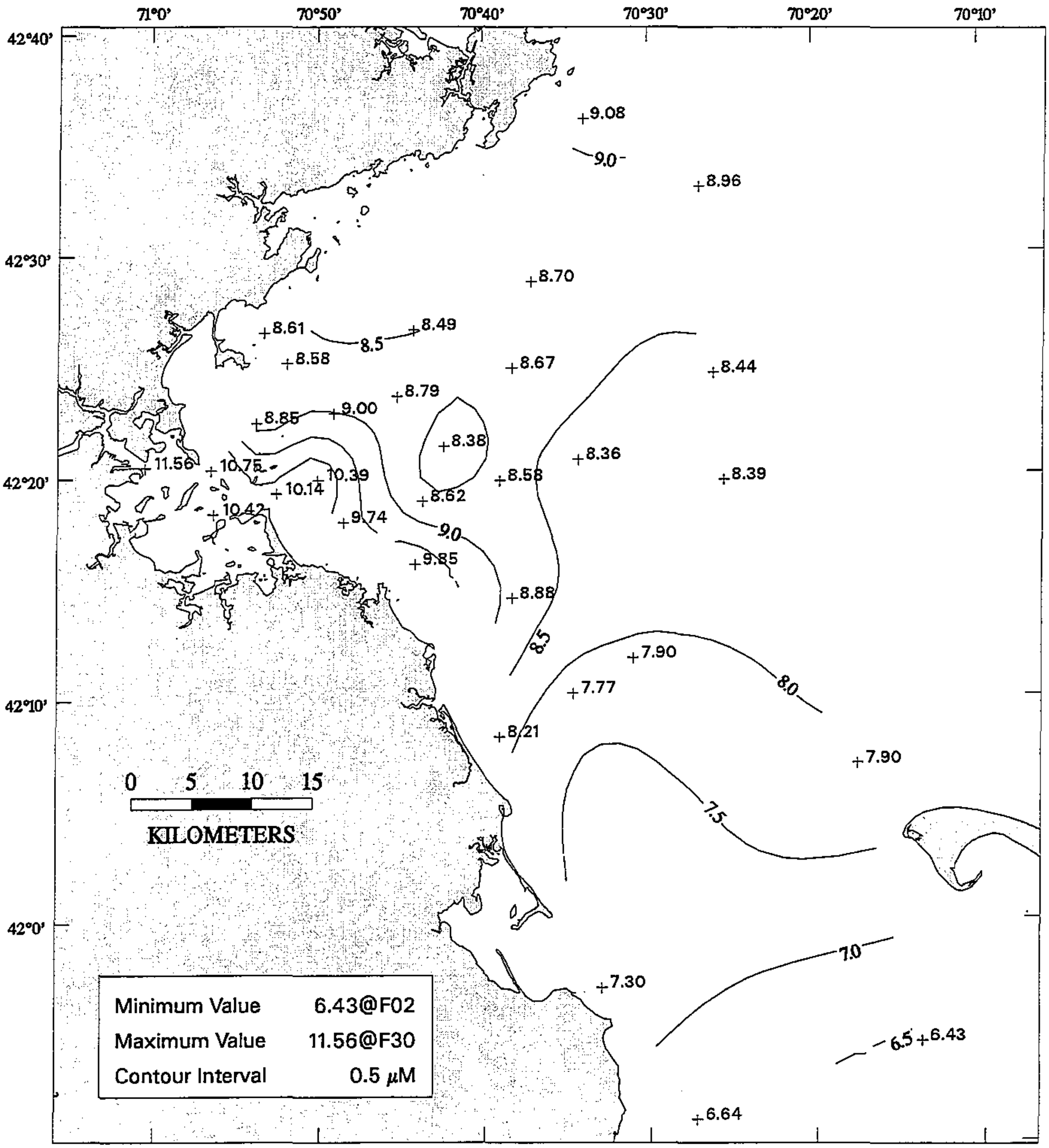
TRAN



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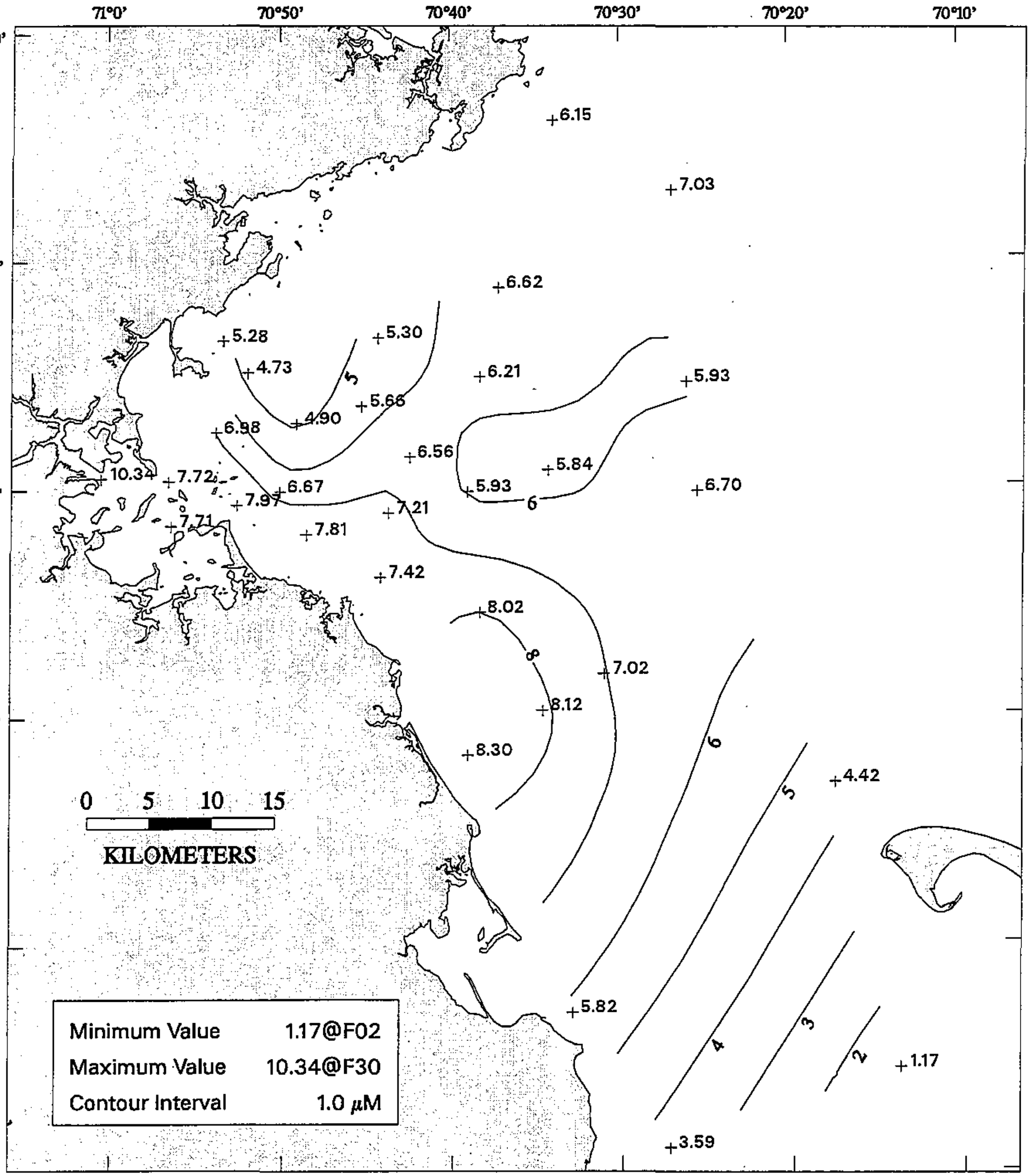
NO3



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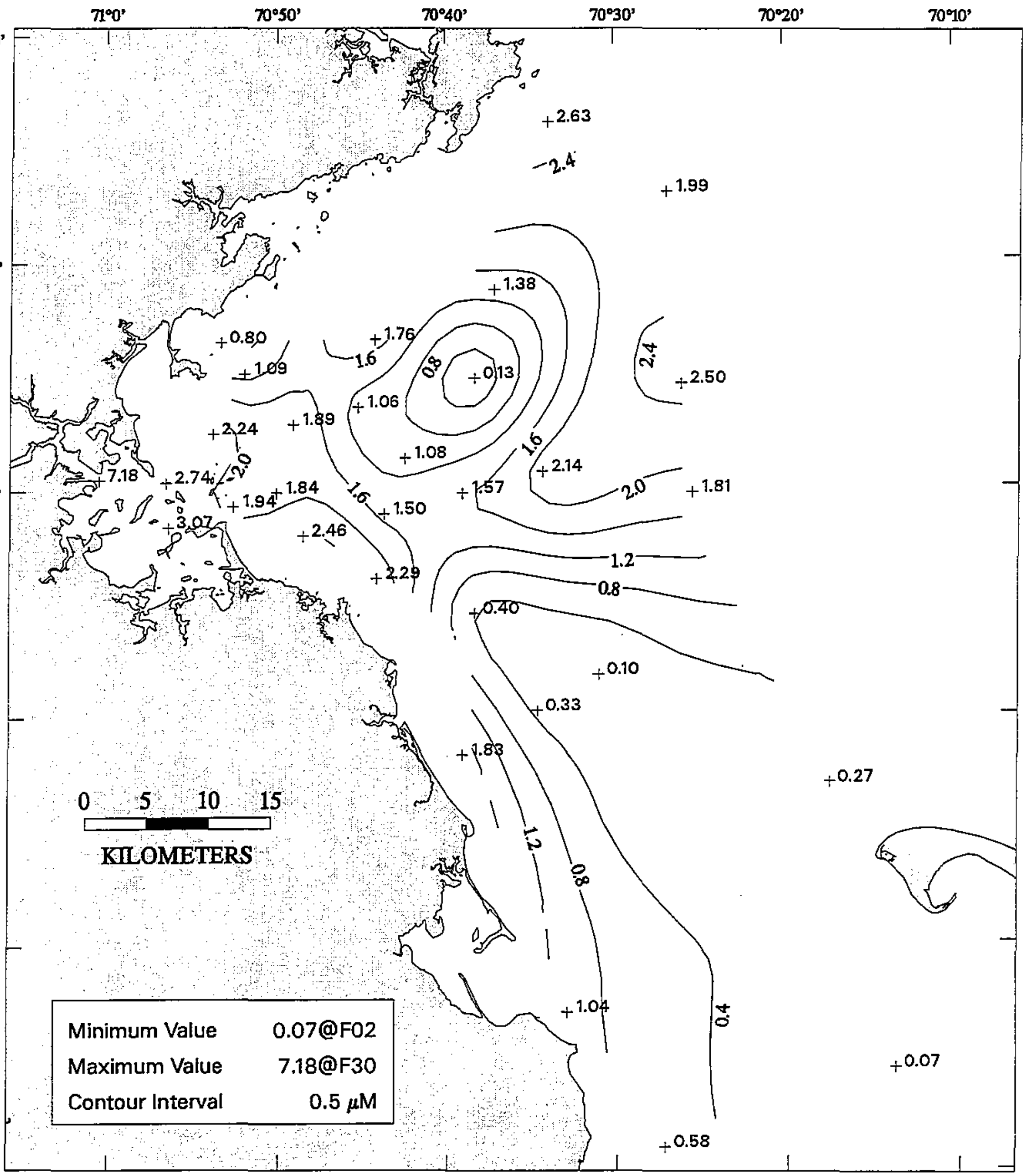
NO3



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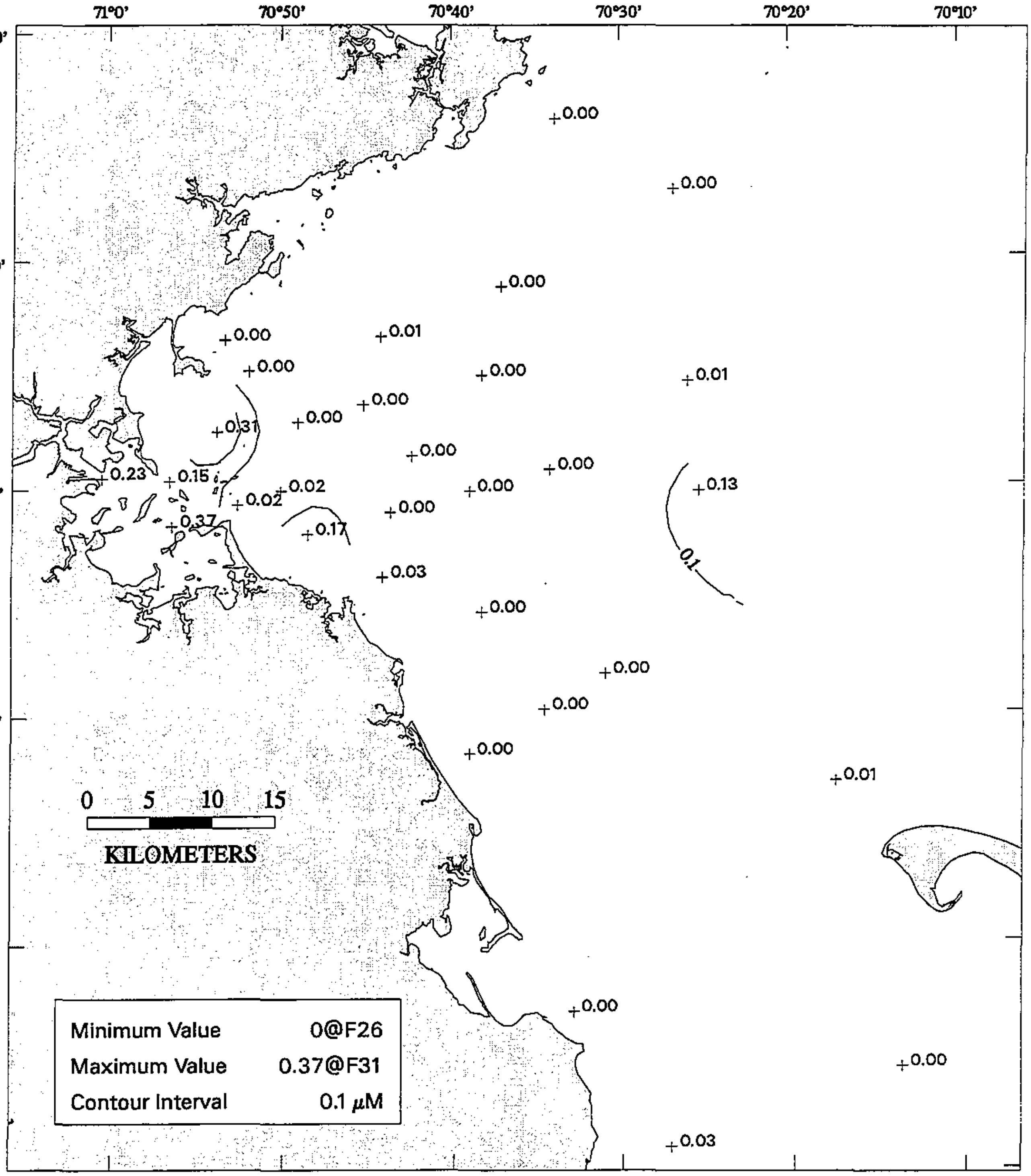
NO3



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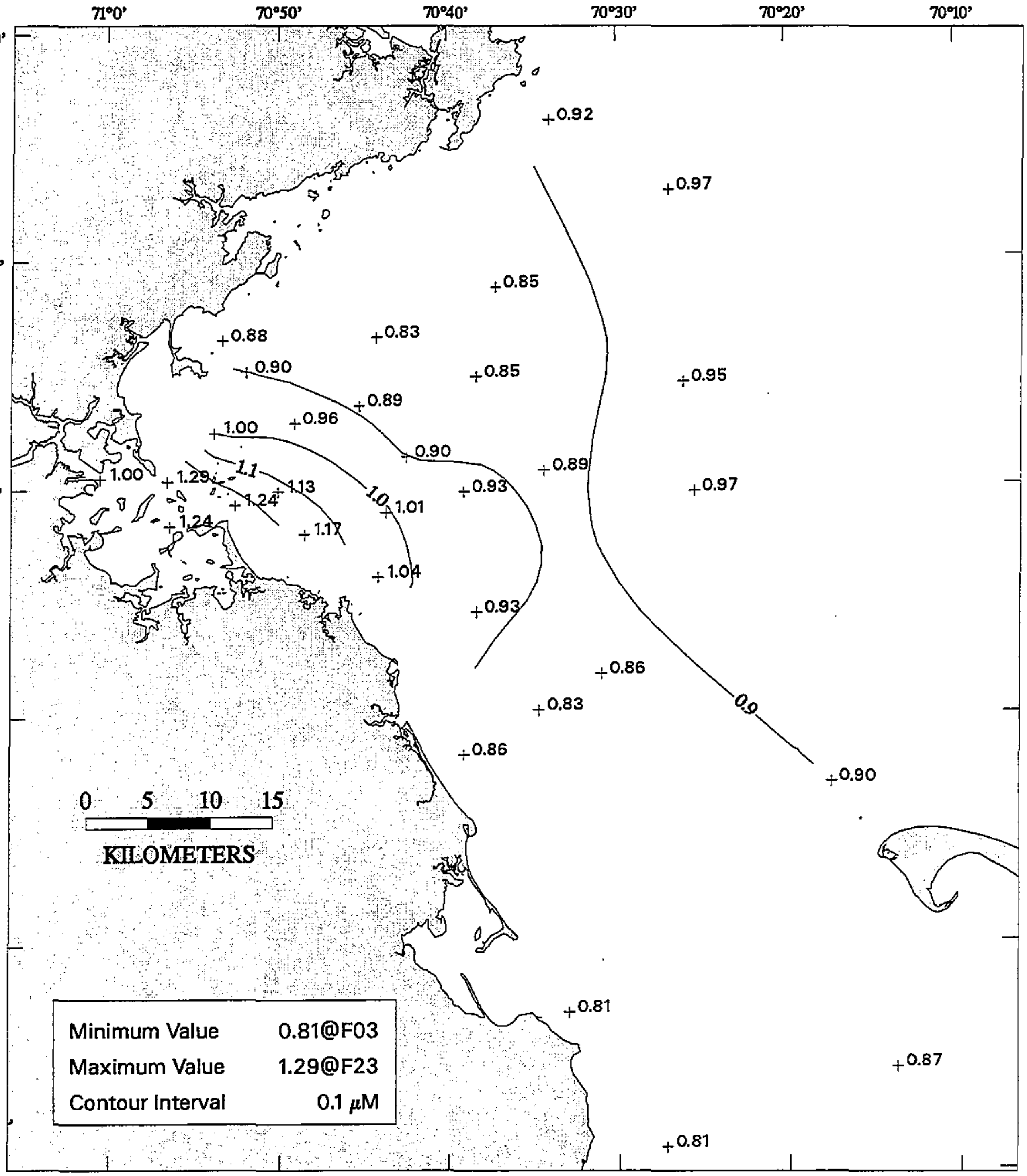
NO3



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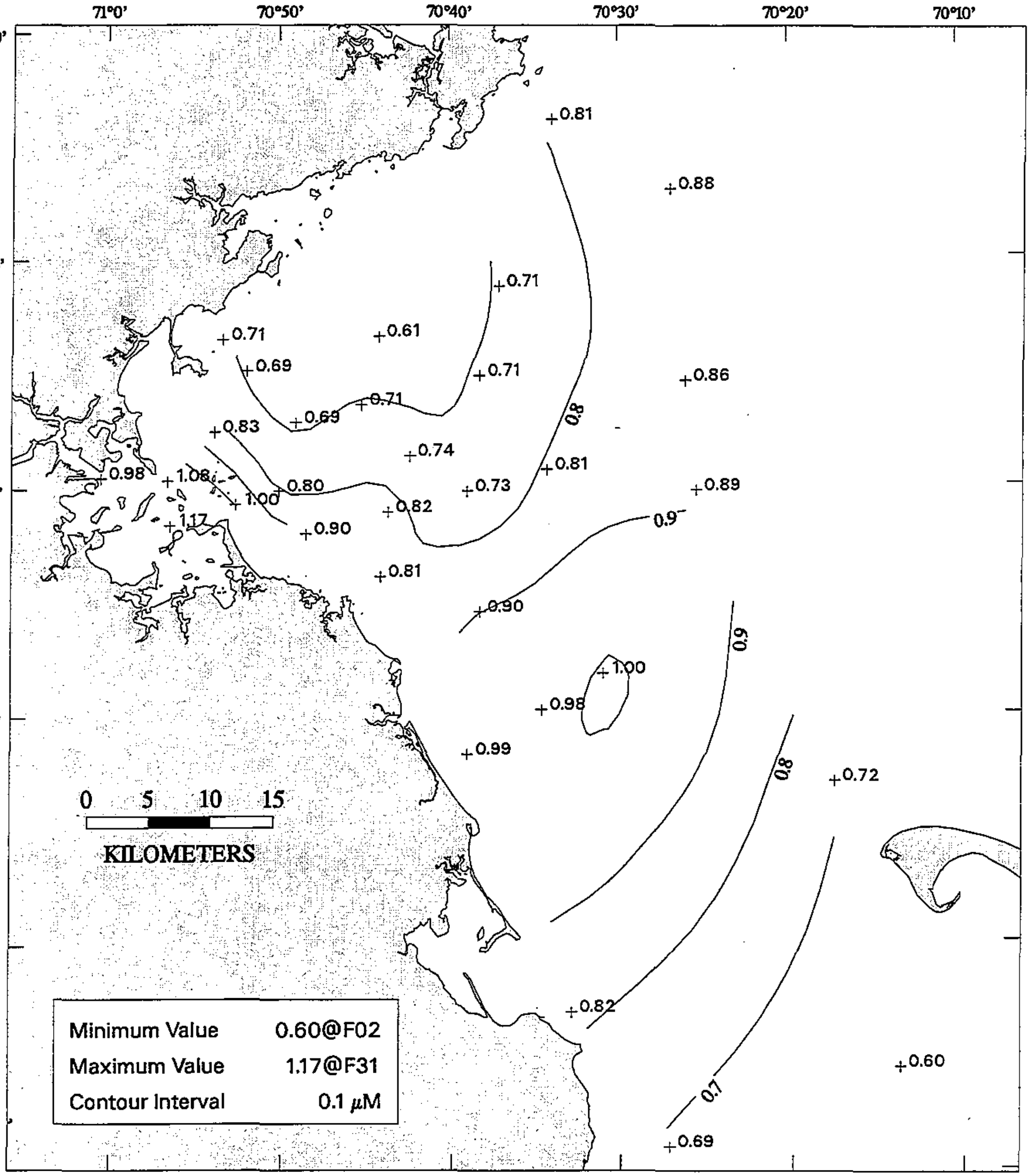
PO4



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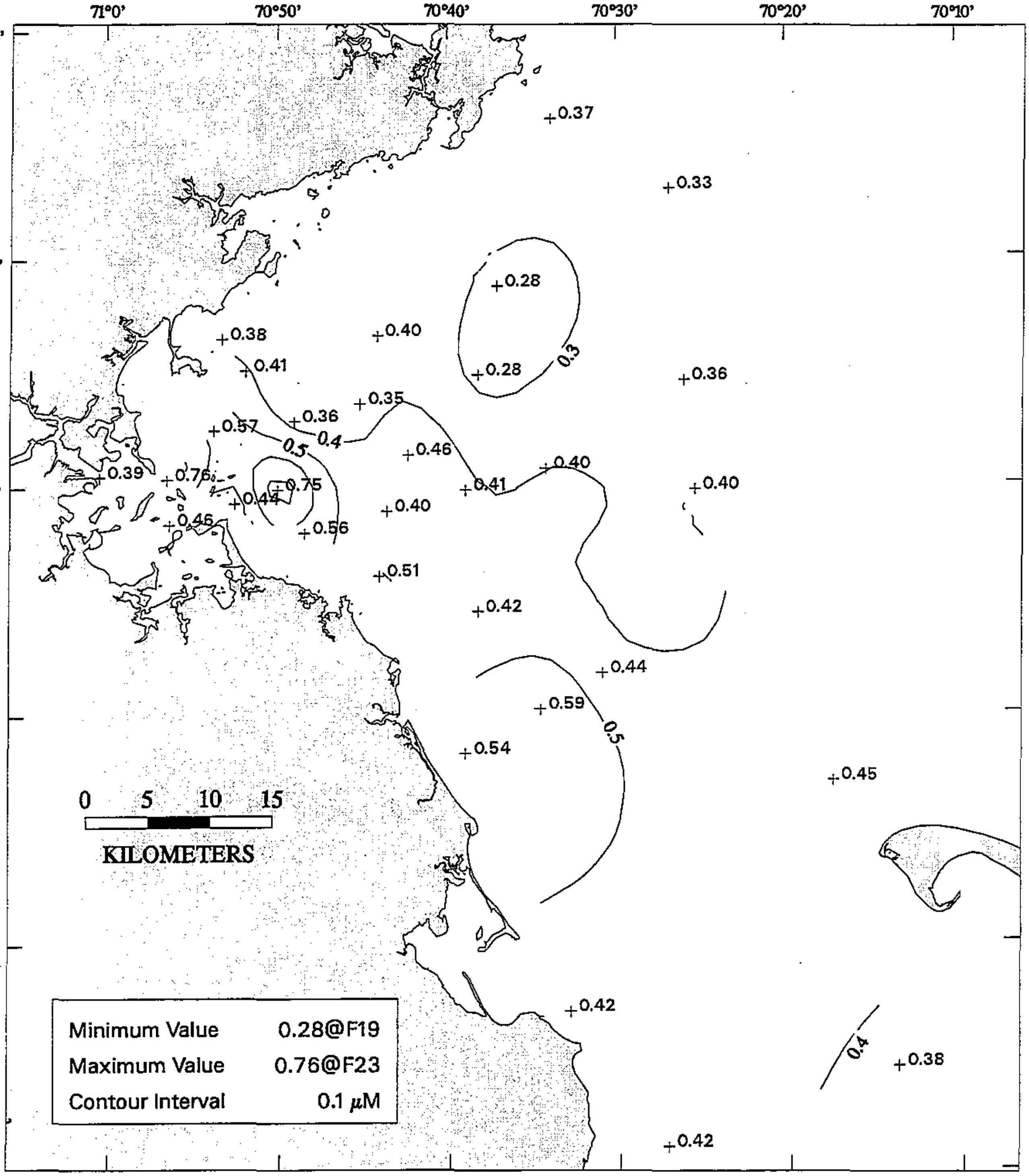
PO4



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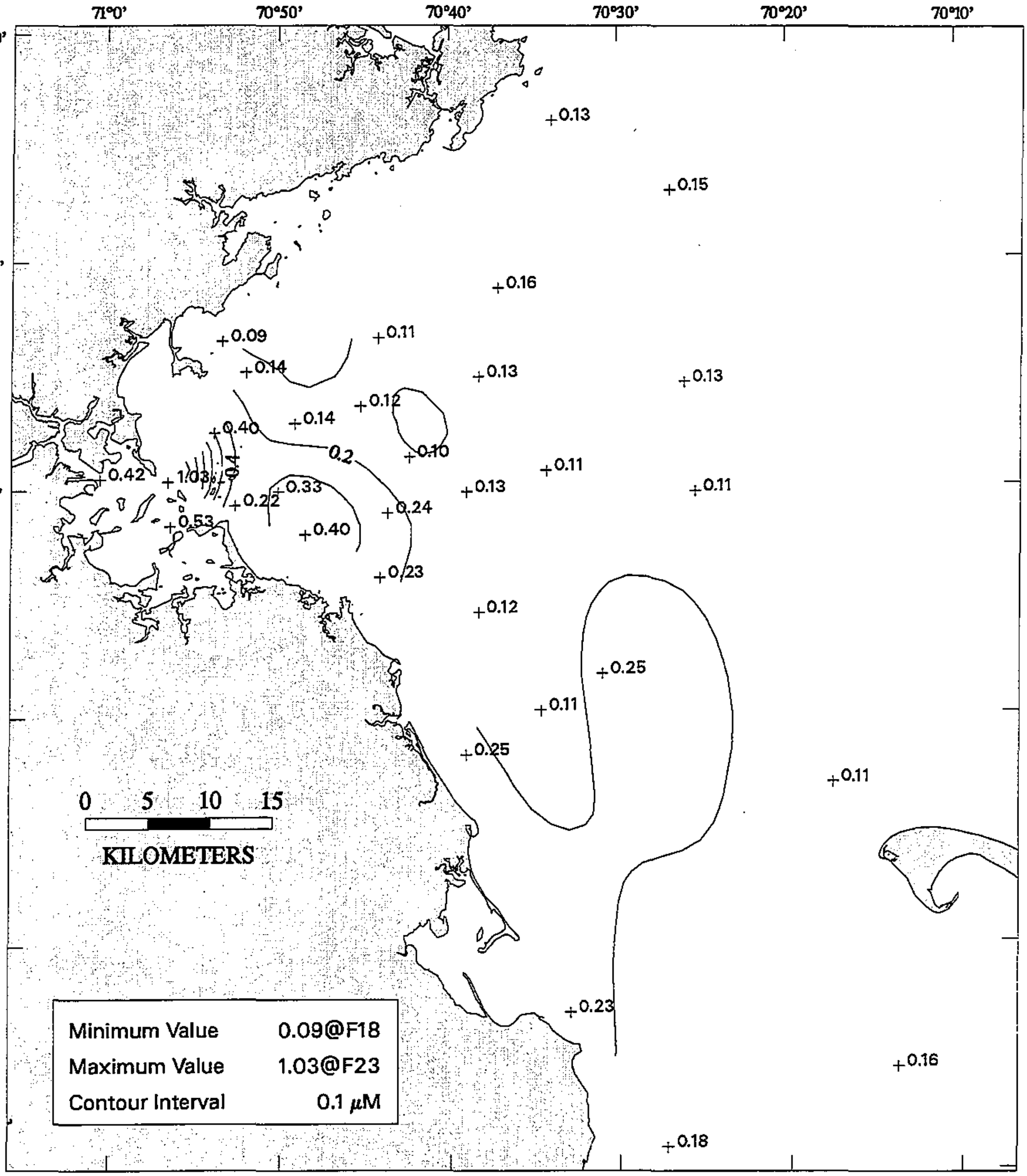
PO4



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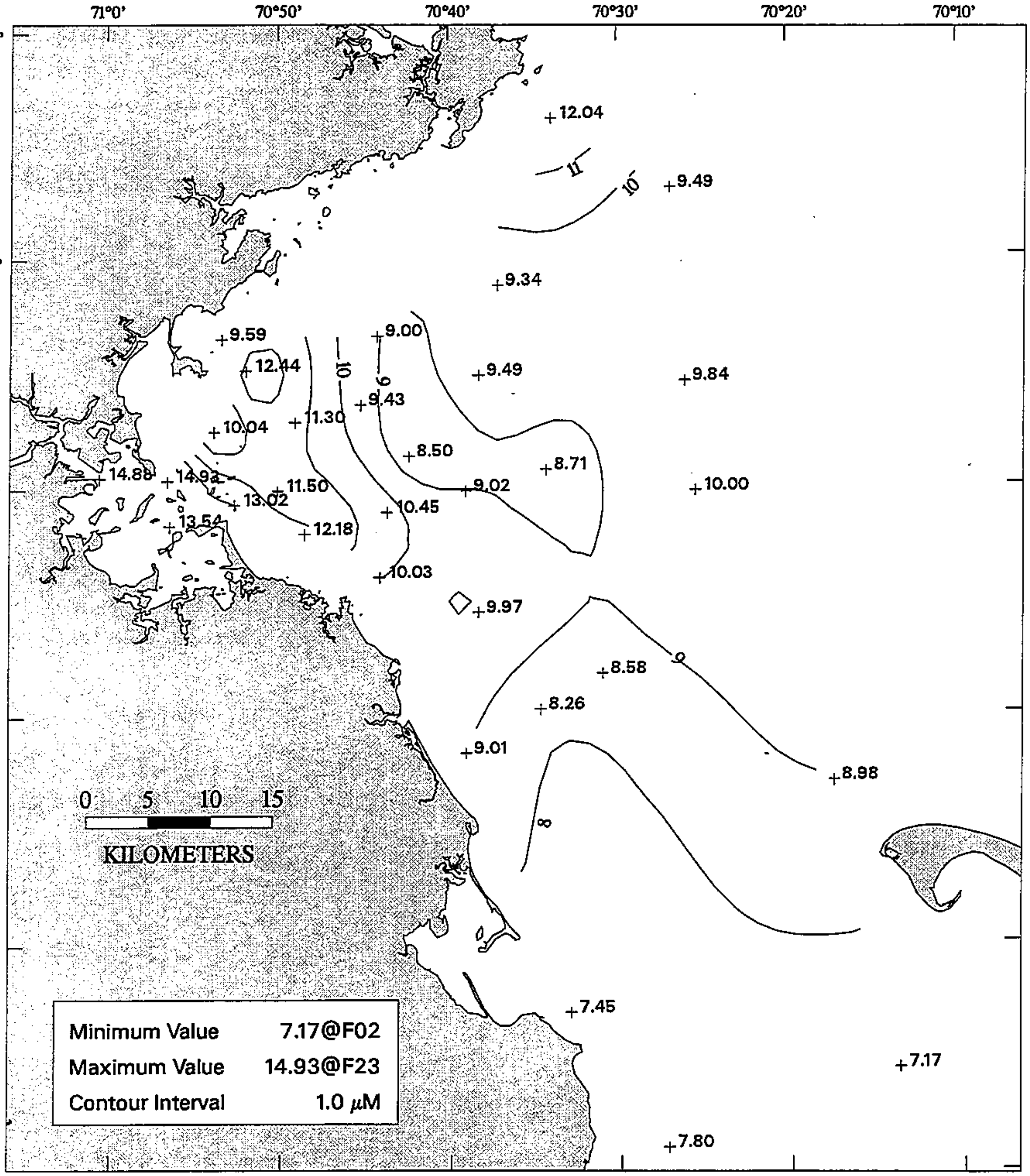
PO4



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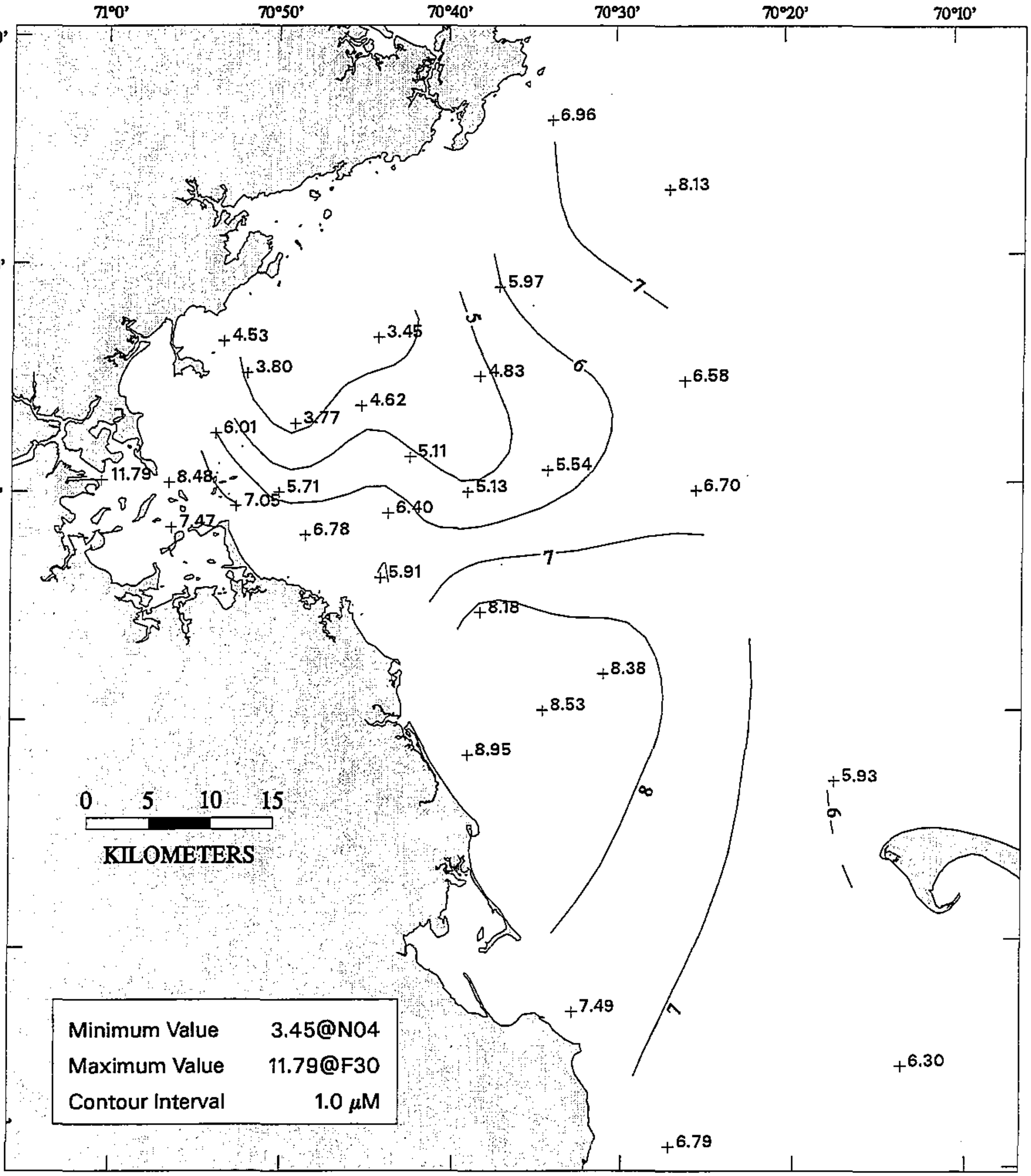
SIO4



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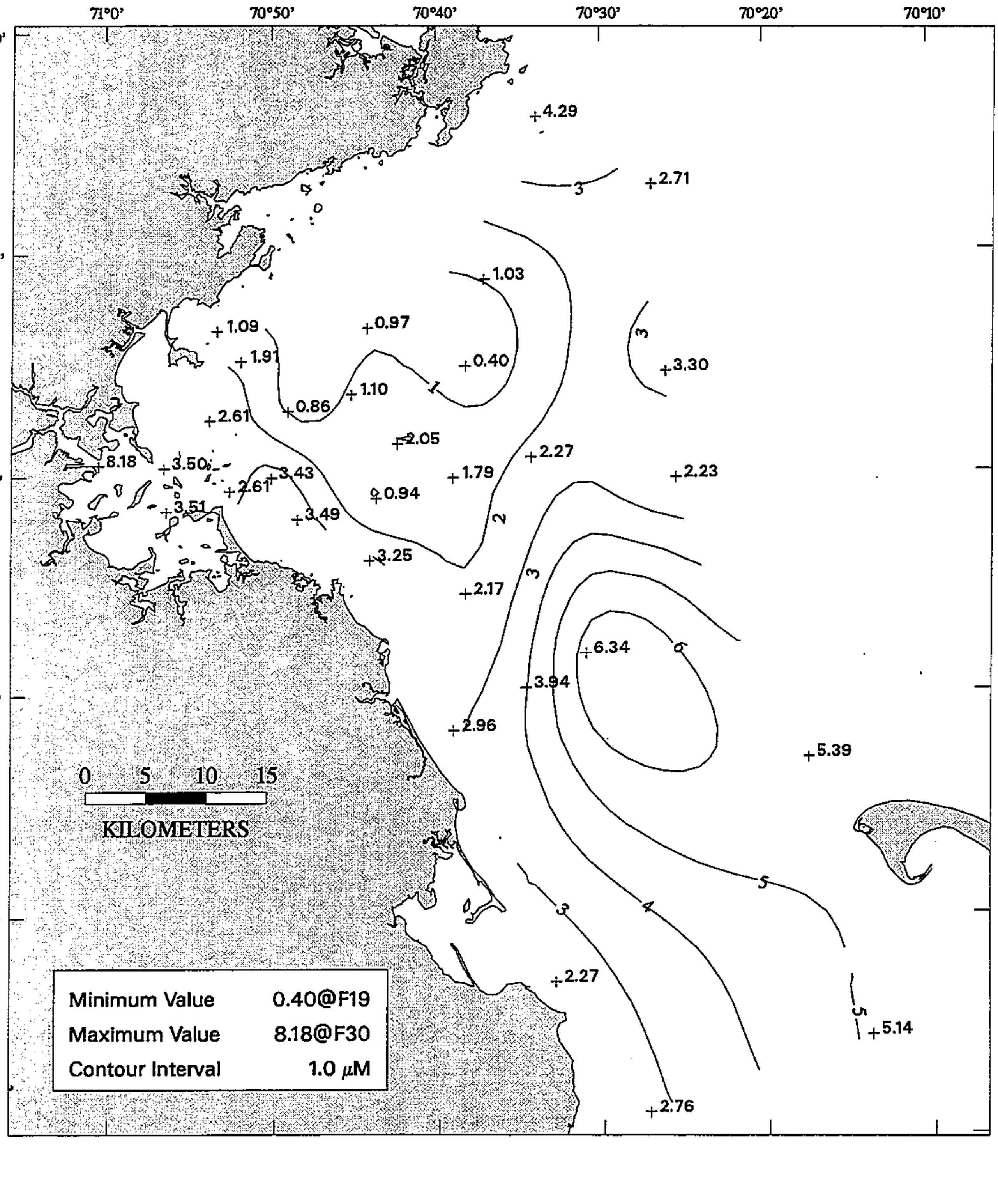
SIO4



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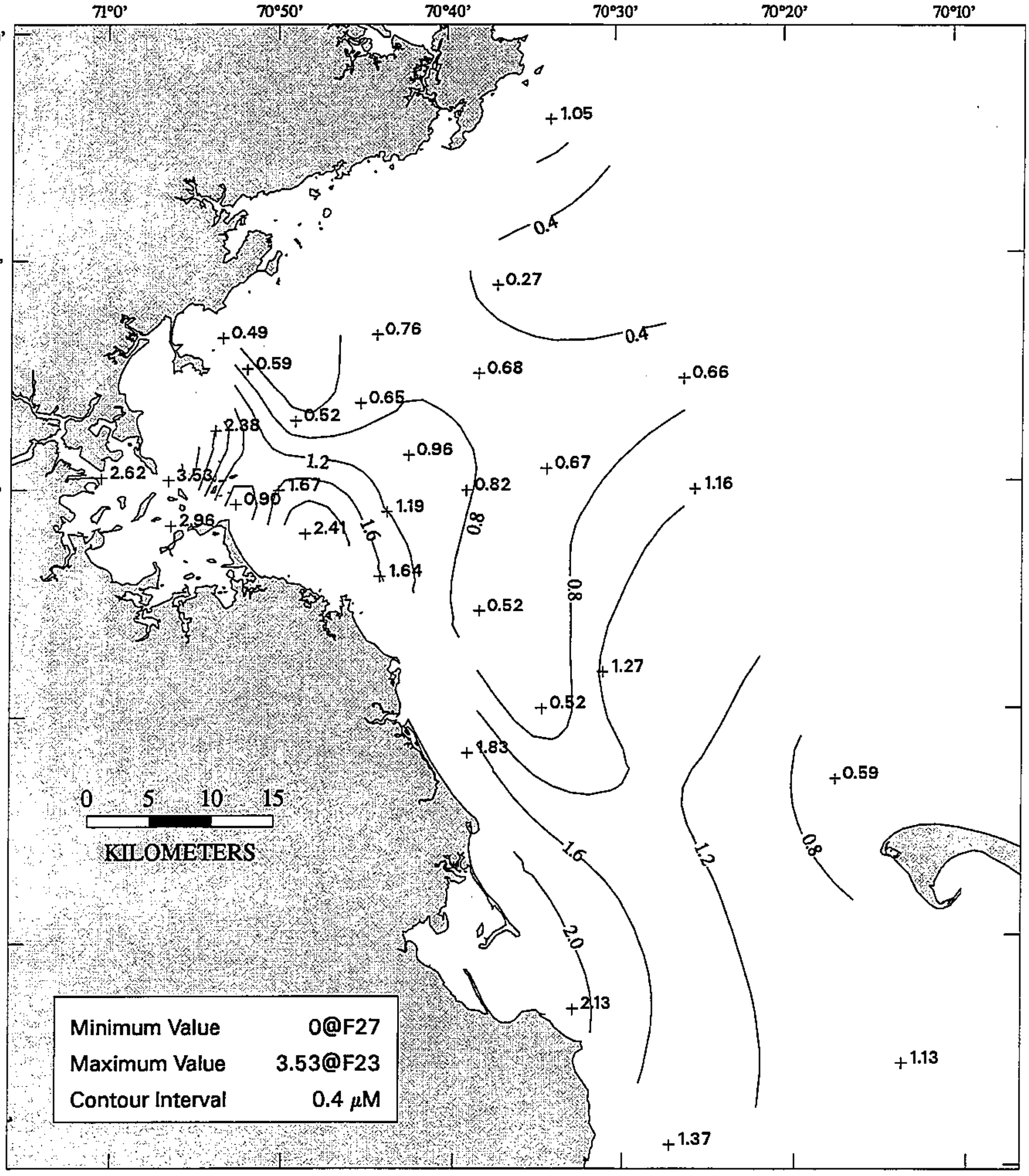

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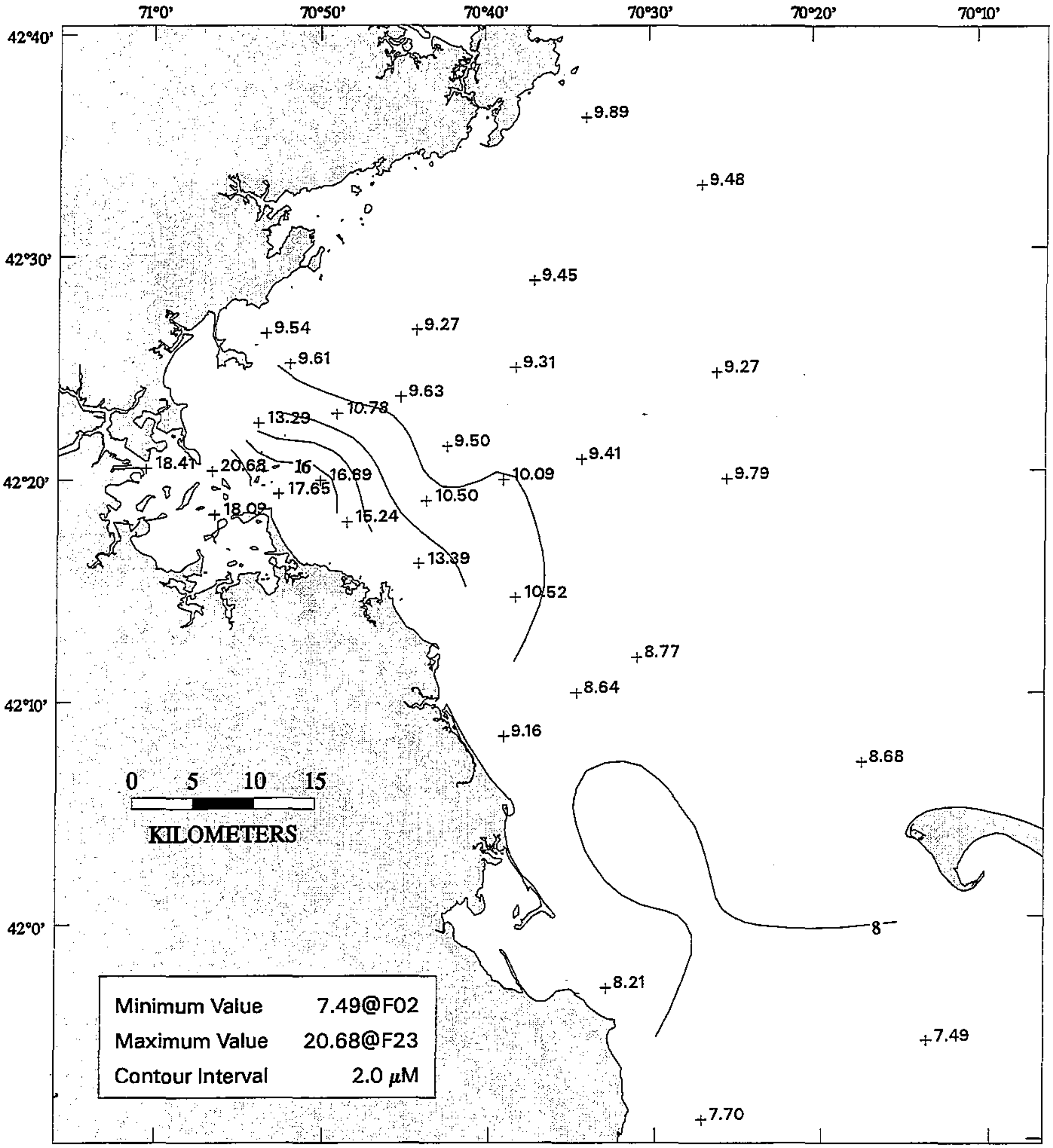

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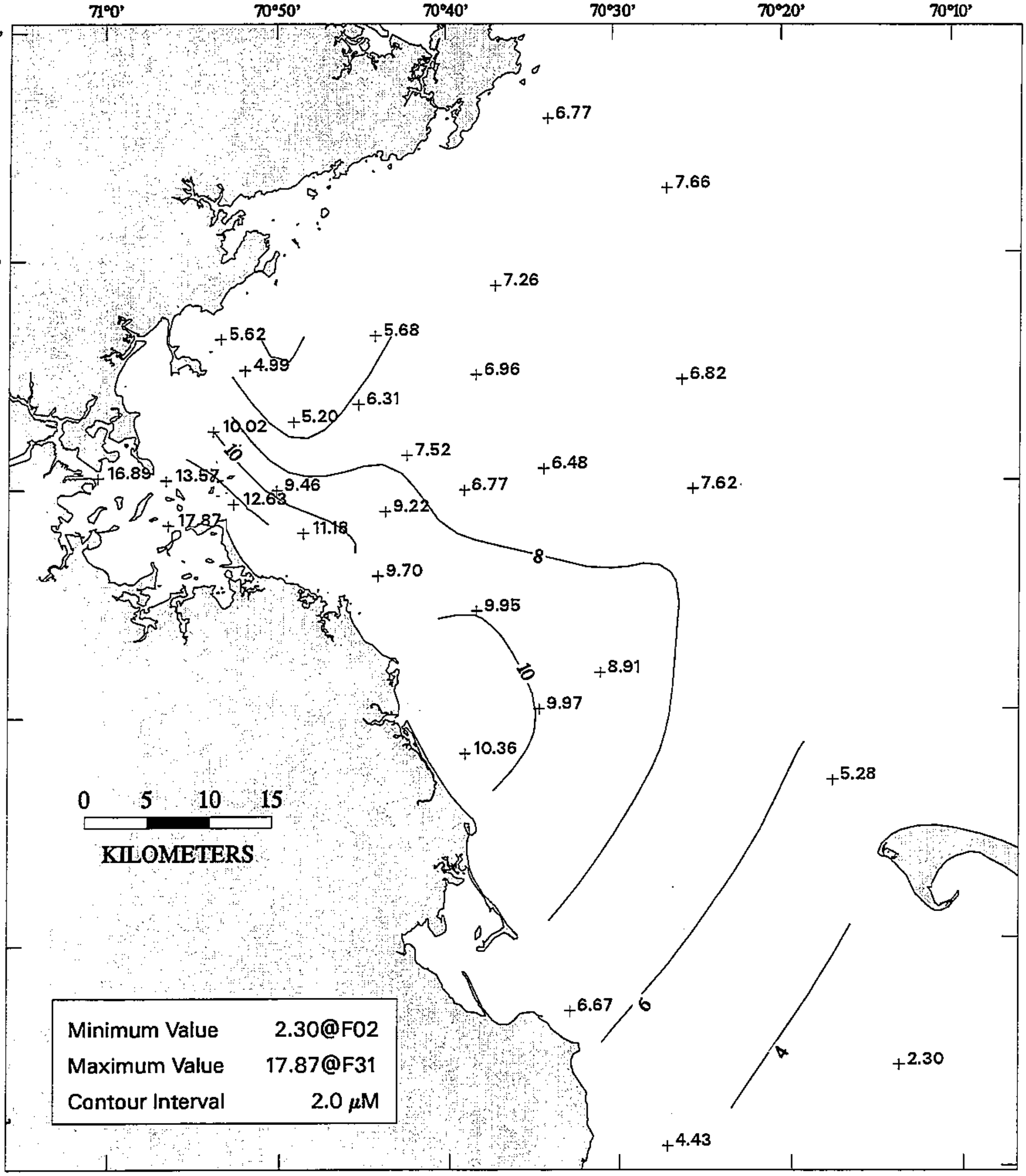
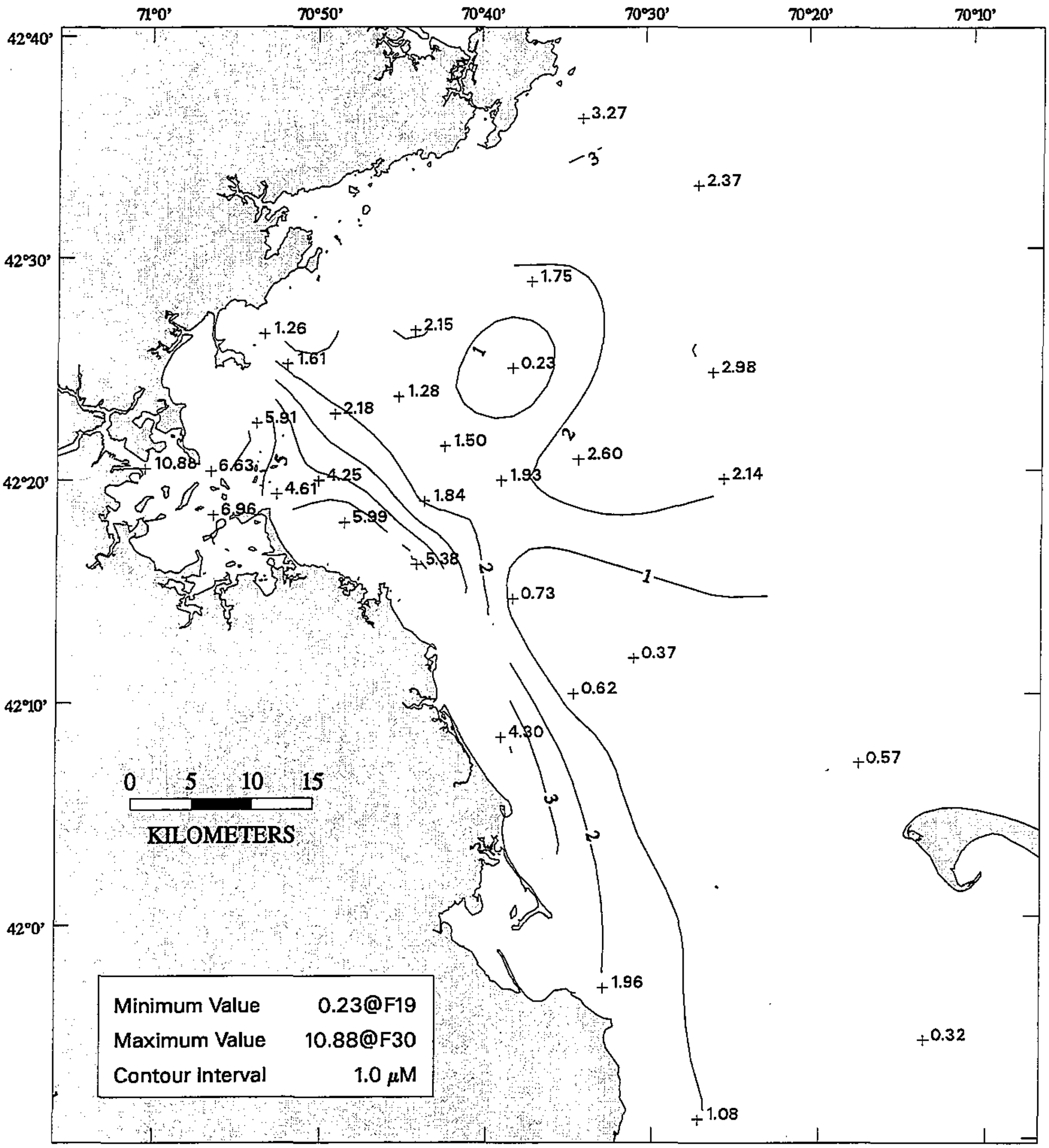
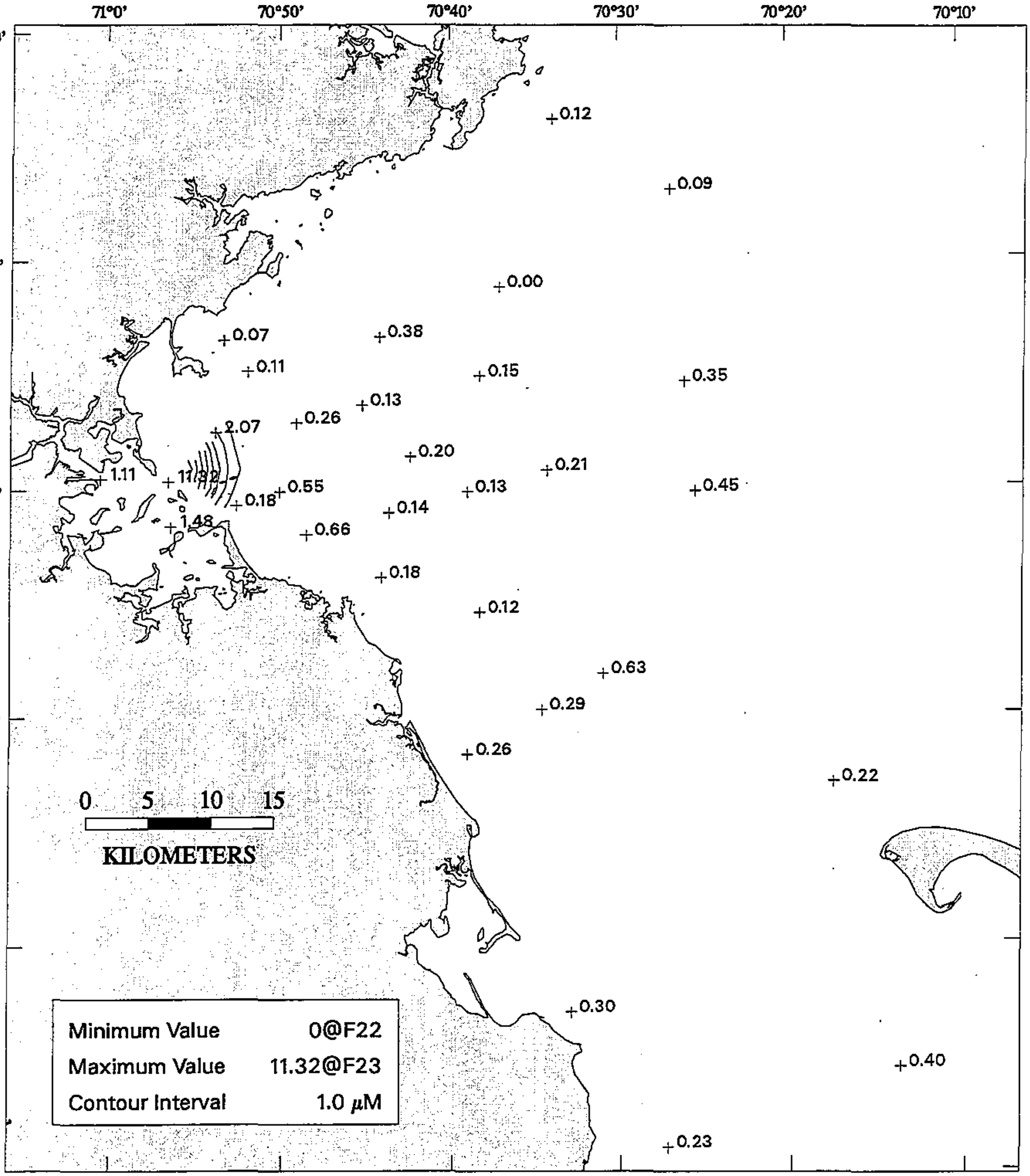
DIN



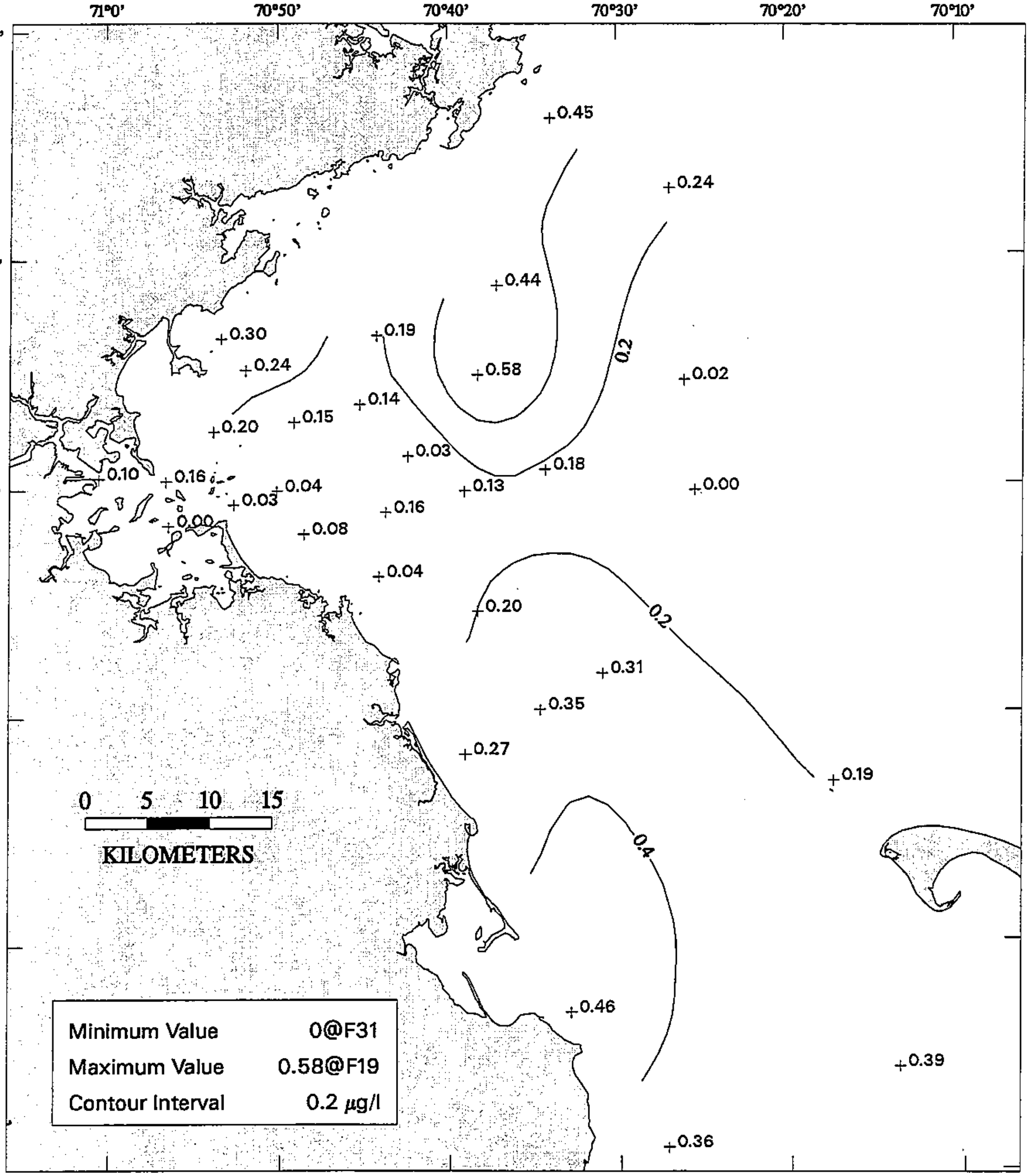
9702din_lin
DIN



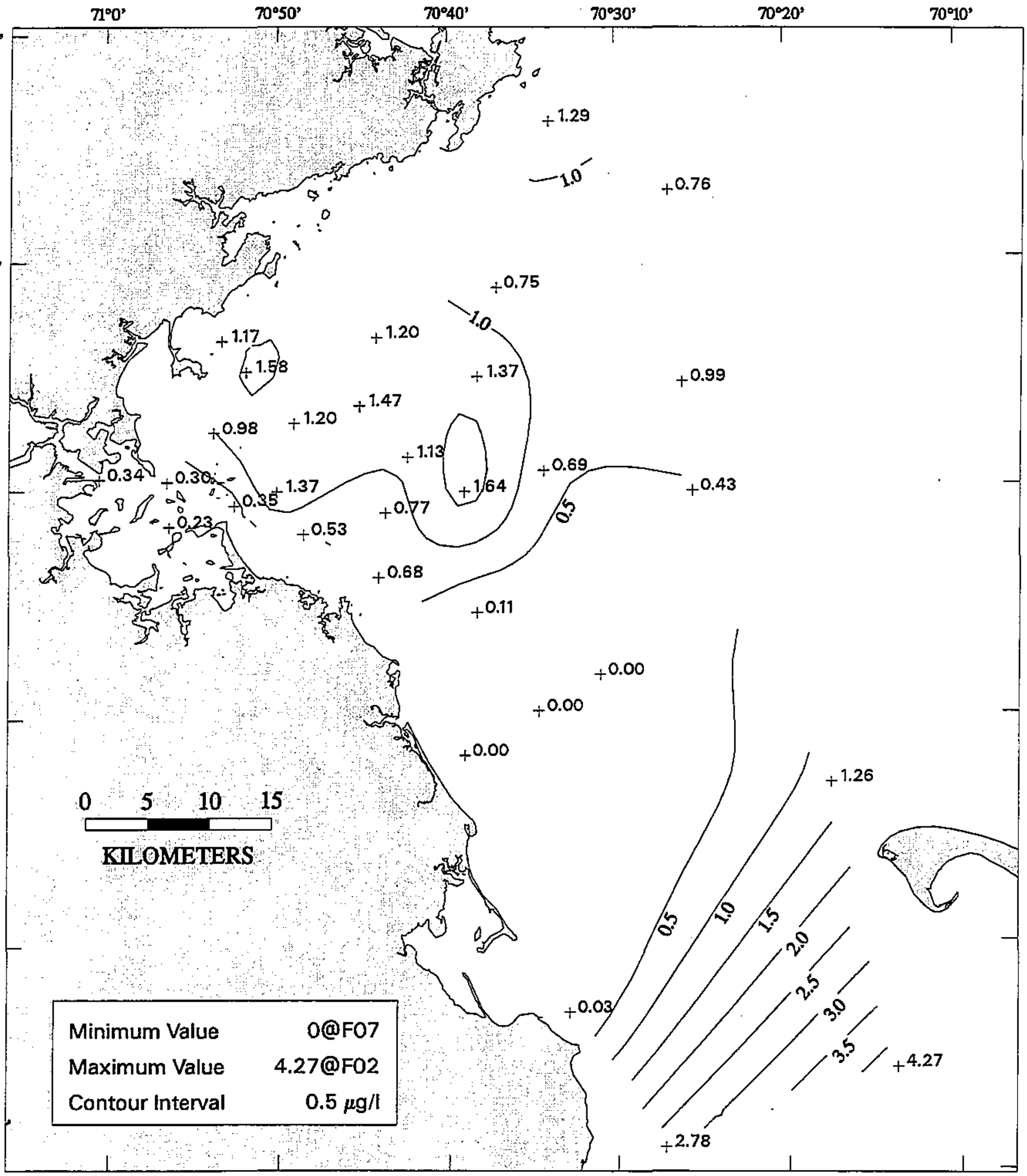
9704din_lin
DIN



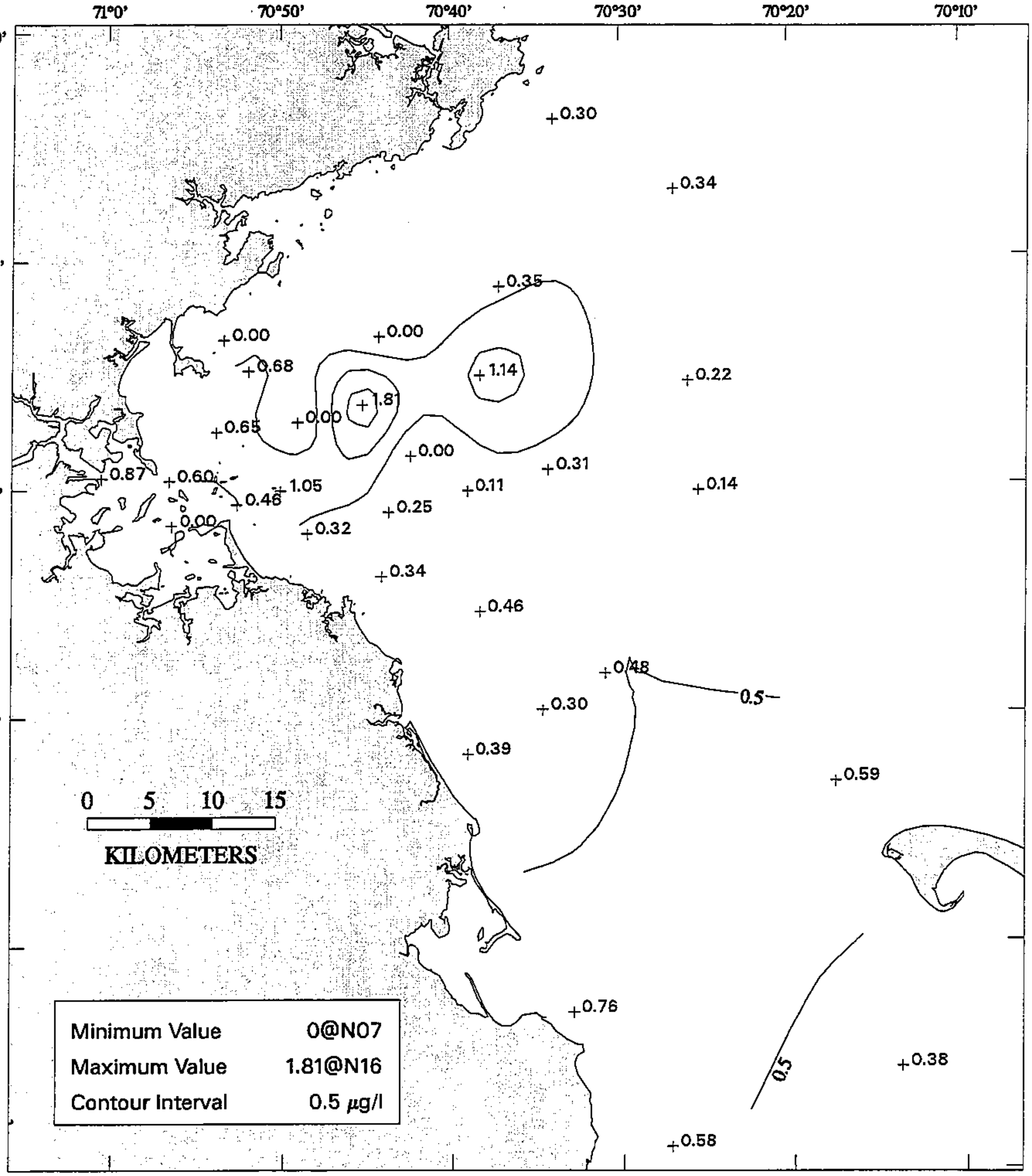
9707din_lin
DIN



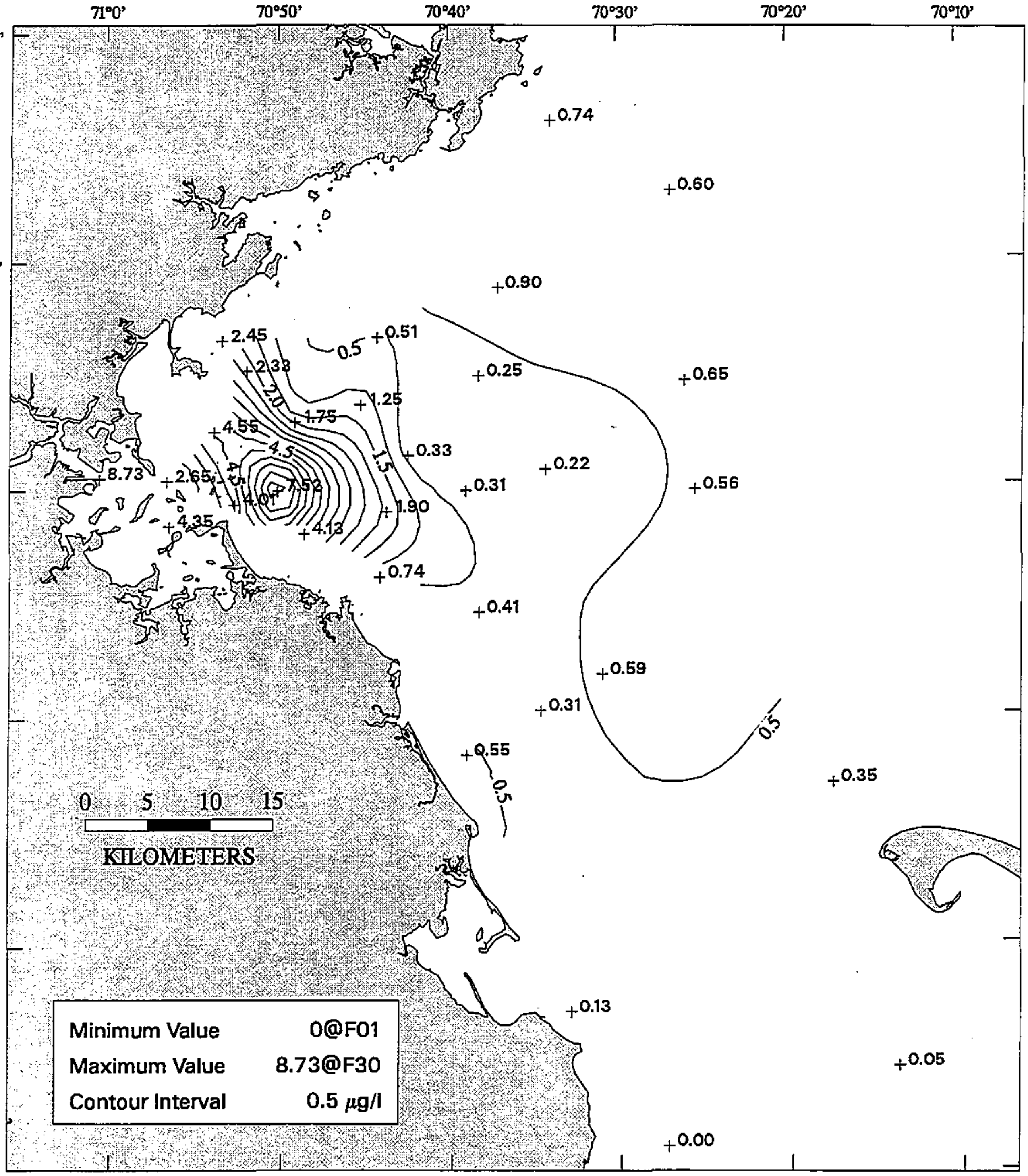
9701fluo_lin
FLUO



9702fluo_lin
FLUO



9704fluo_lin
FLUO



9707fluo_lin
FLUO

APPENDIX B

Transect Plots

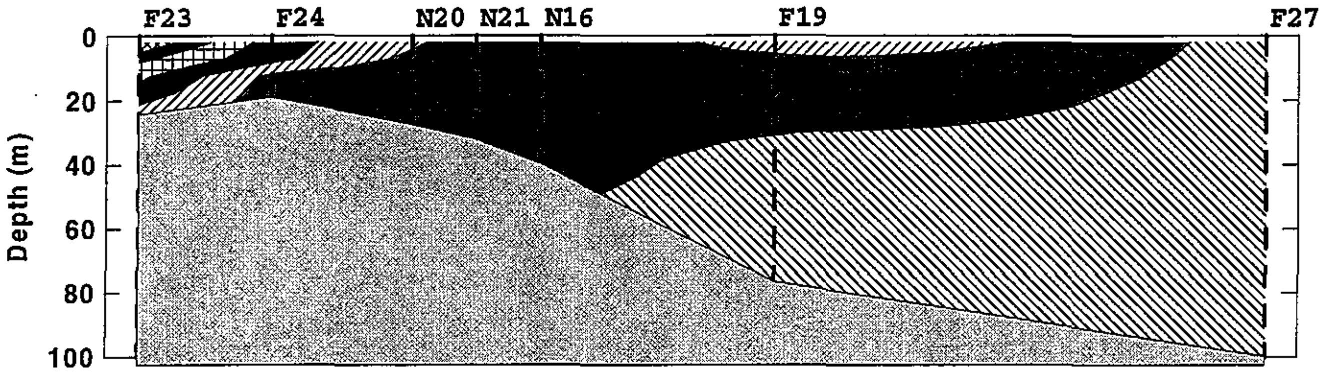
Data were contoured relative to water depth and distance between stations as shown on the transects (Figure 1-3, text). Relative distances between stations and water depth at each station is shown on the transect. Water depth is labelled with negative values in meters, with zero depth at the sea surface, and shaded. Three transects (Boston-Nearfield, Cohasset, and Marshfield) are provided on each plot, as well as shaded contour levels on the scale bar at the bottom of the plot. Contour units are as noted on the table below. Each plot is labelled on the bottom right with the parameter as listed below, and the survey number ("9601").

Appendix B: Table of Contents

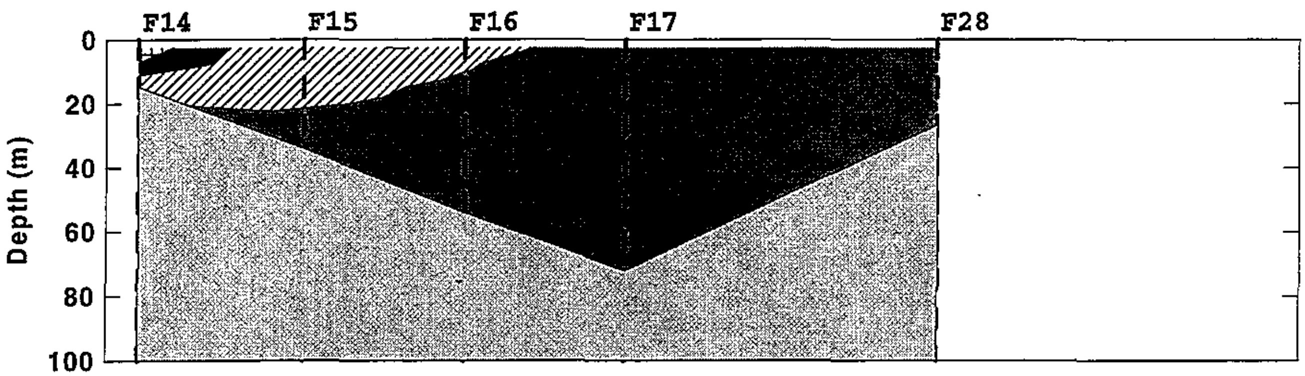
Parameter Name	Units
Sigma-T (σ_t)	n/a
Temperature	°C
Salinity	PSU
Beam Attenuation	/m
Nitrate + Nitrite	µM
Phosphate (PO_4)	µM
Silicate (SiO_4)	µM
Ammonium (NH_4)	µM
Fluorescence (clophylla)	µg/L
Dissolved Oxygen	mg/L

*$NO_3 + NO_2 + NH_4$

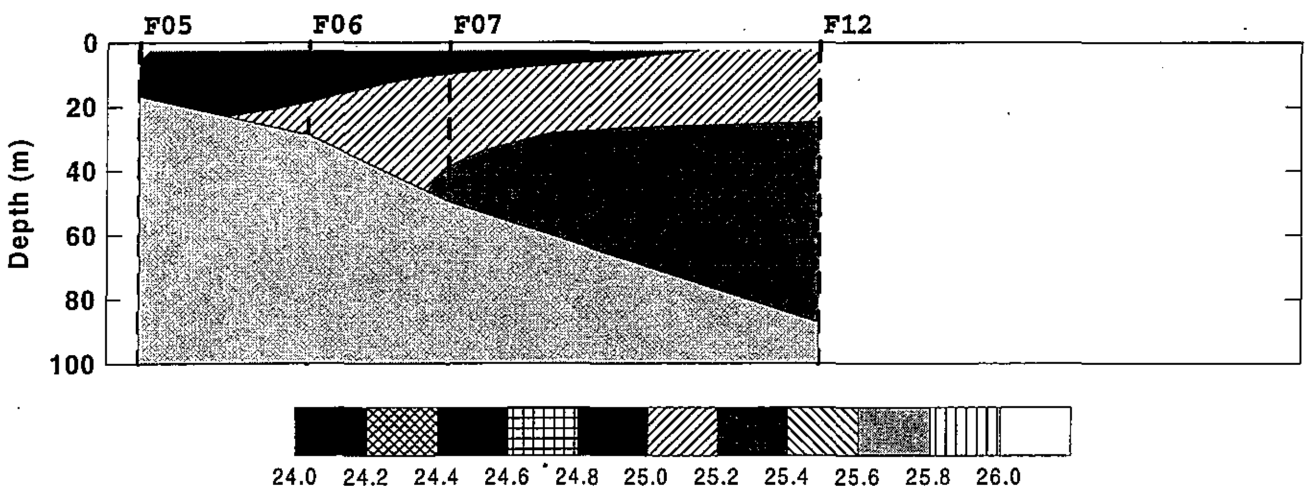
Boston-Nearfield Transect

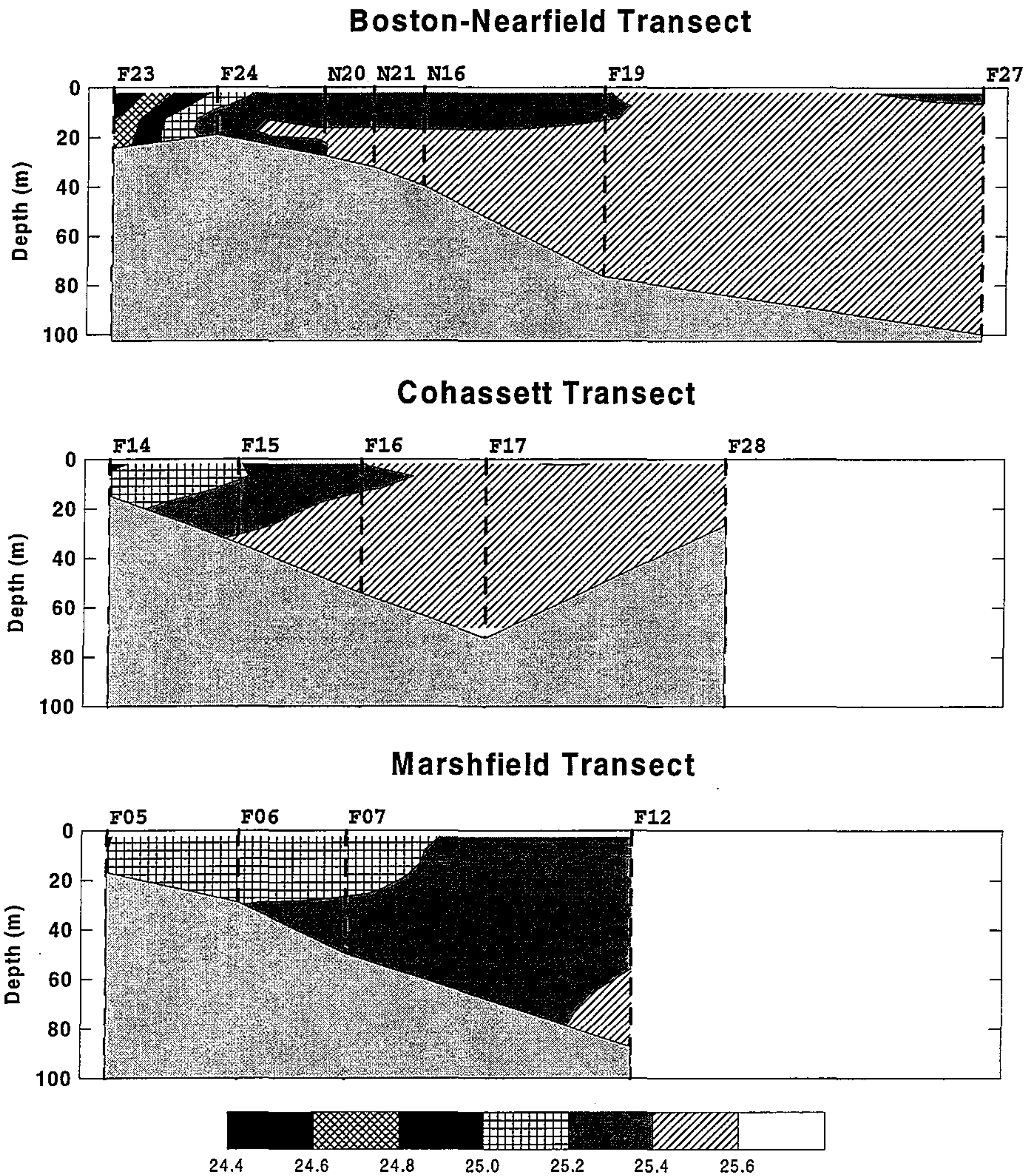


Cohassett Transect

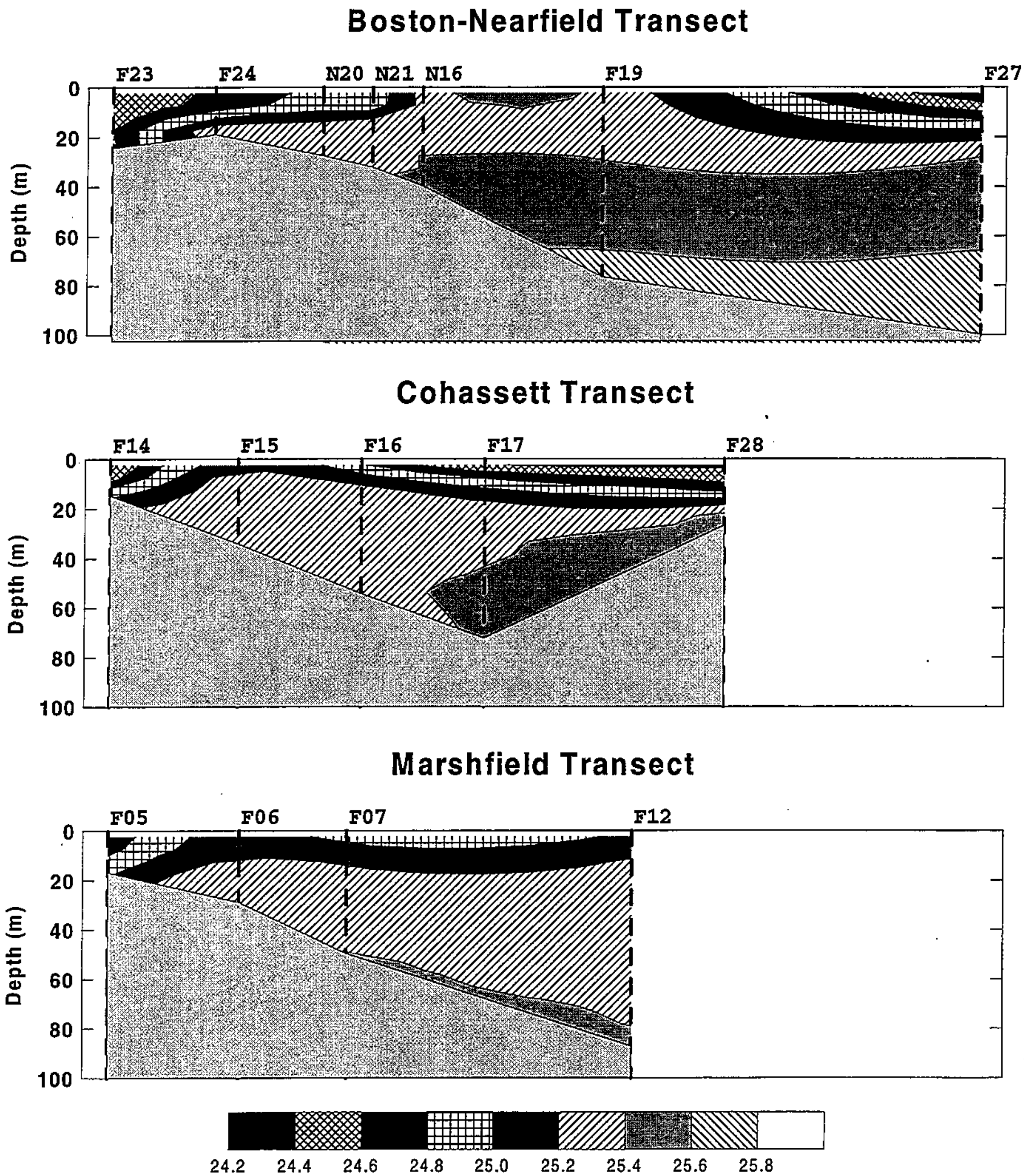


Marshfield Transect




Boston-Nearfield Transect
F23
F24
N20
N21
N16
F19
F27
Depth (m)
0
20
40
60
80
100
Cohassett Transect
F14
F15
F16
F17
F28
Marshfield Transect
F05
F06
F07
F12
24.4
24.6
24.8
25.0
25.2
25.4
25.6

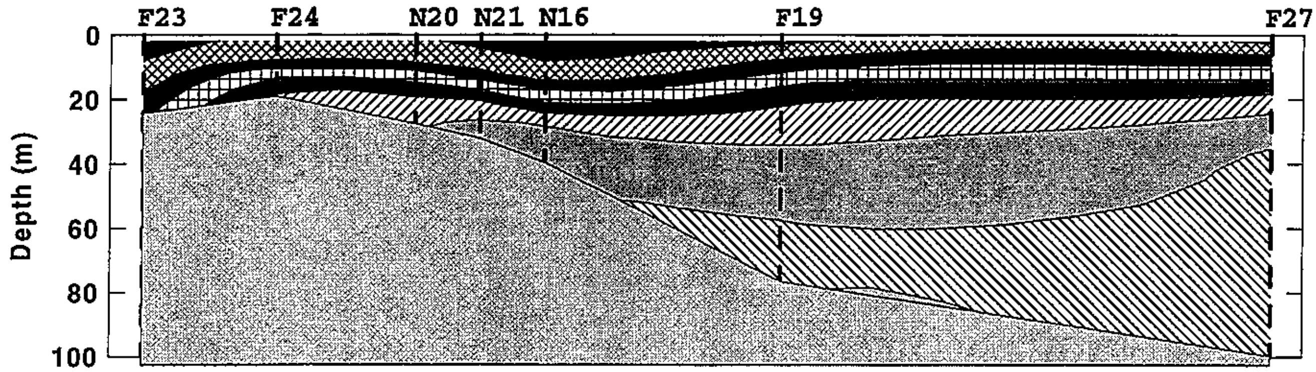
Sigma-T 9702



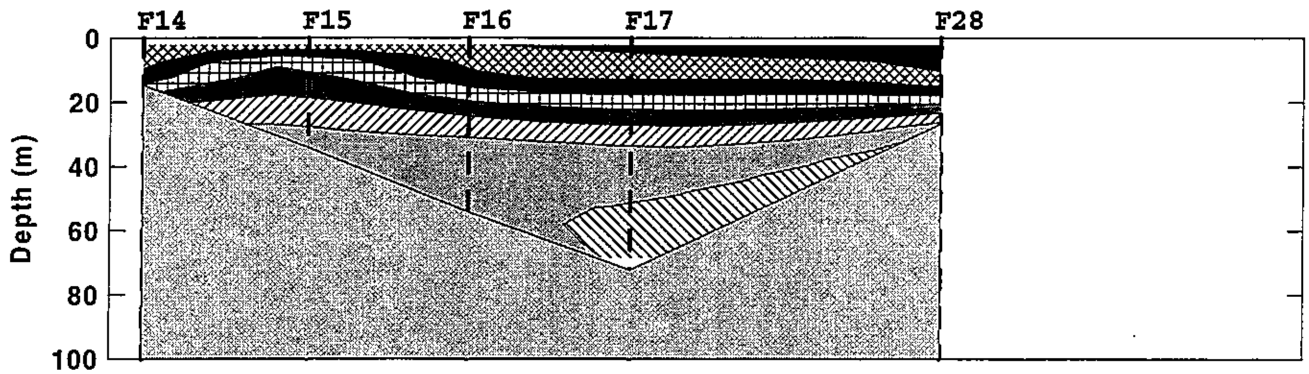
Boston-Nearfield Transect
F23
F24
N20
N21
N16
F19
F27
Depth (m)
0
20
40
60
80
100
Cohassett Transect
F14
F15
F16
F17
F28
Depth (m)
0
20
40
60
80
100
Marshfield Transect
F05
F06
F07
F12
Depth (m)
0
20
40
60
80
100
24.2
24.4
24.6
24.8
25.0
25.2
25.4
25.6
25.8

Sigma-T 9704

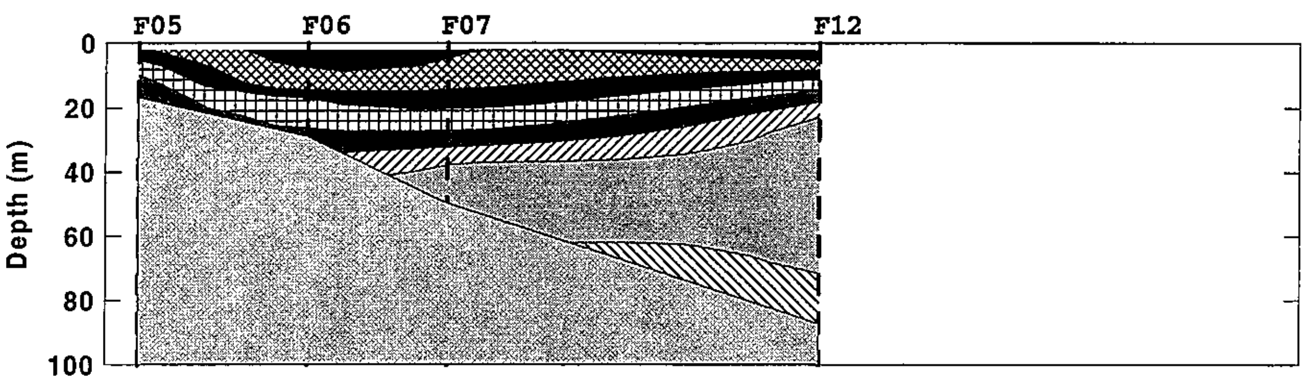
Boston-Nearfield Transect



Cohassett Transect

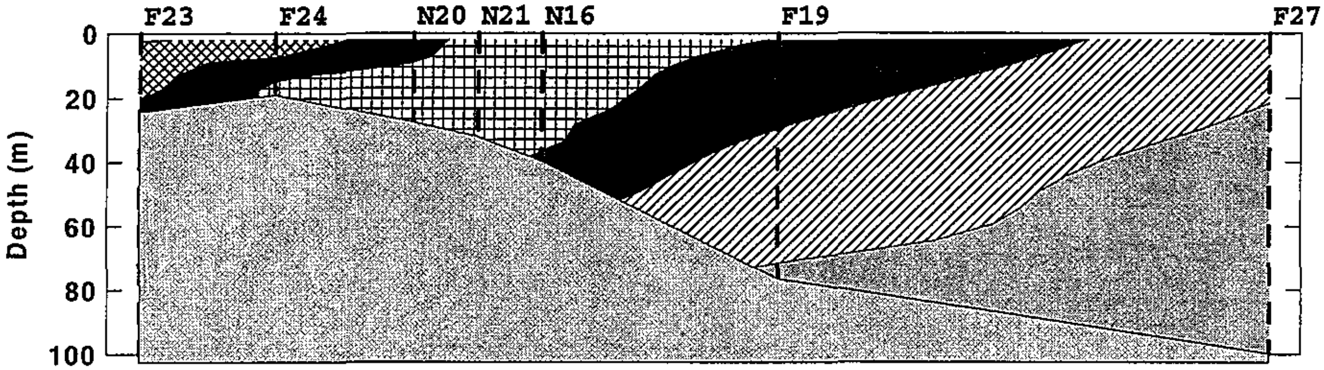


Marshfield Transect

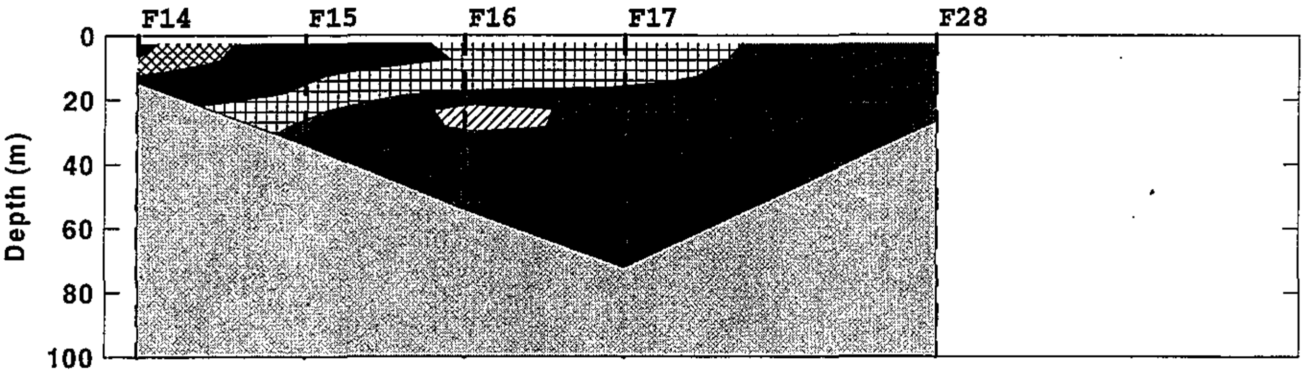


Sigma-T 9707

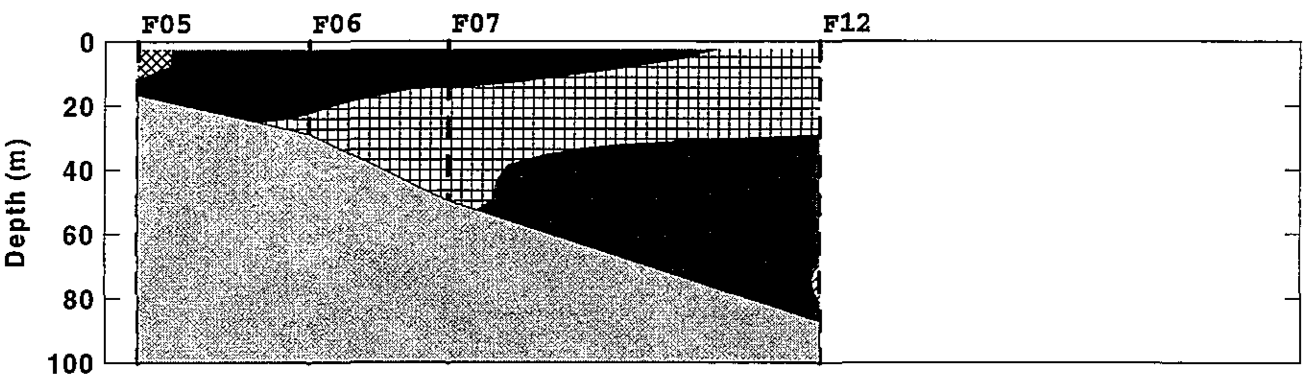
Boston-Nearfield Transect



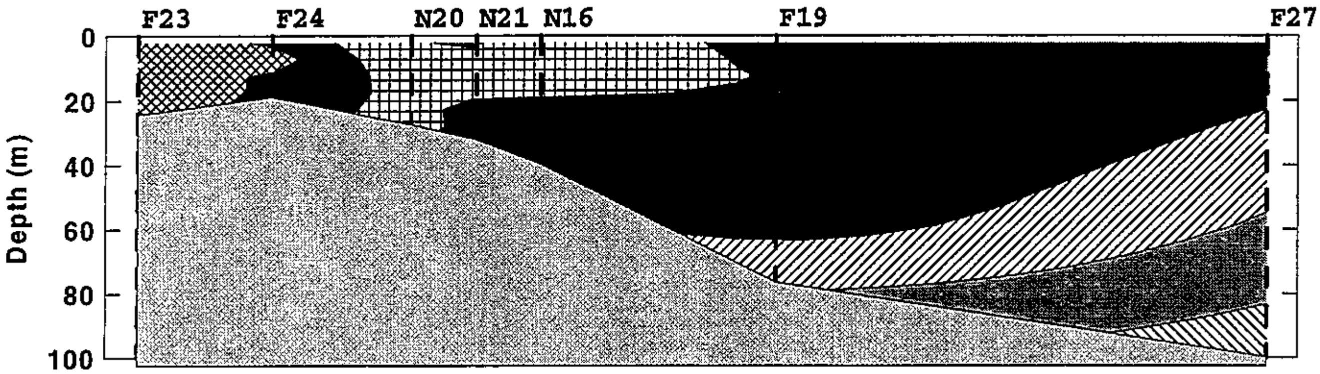
Cohassett Transect



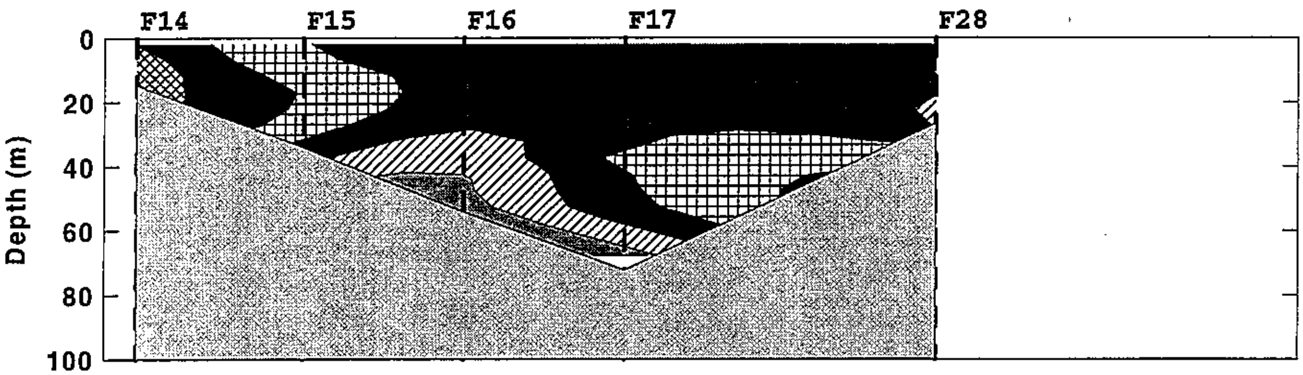
Marshfield Transect



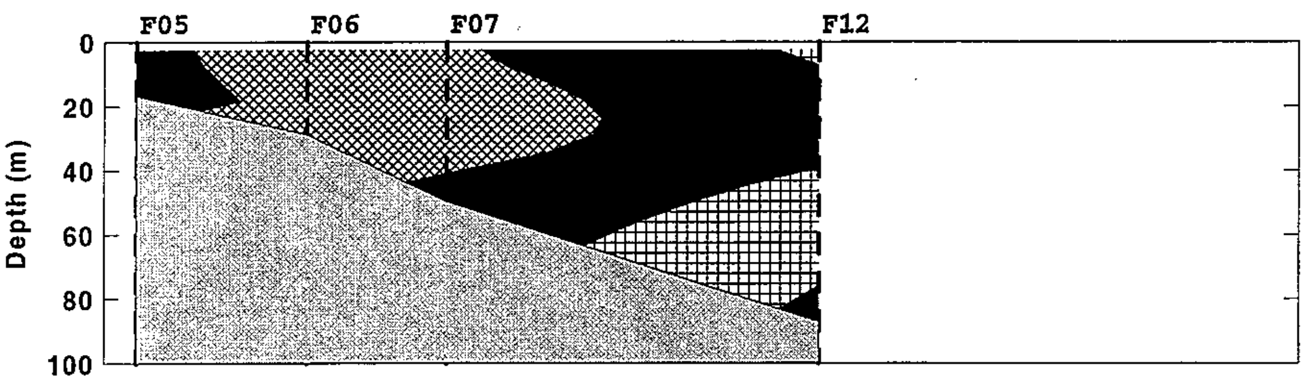
Boston-Nearfield Transect



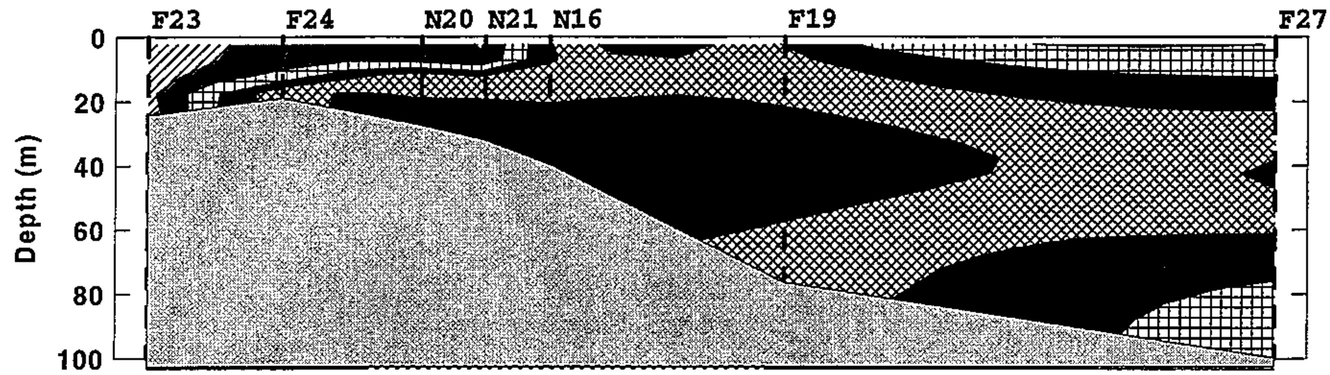
Cohassett Transect



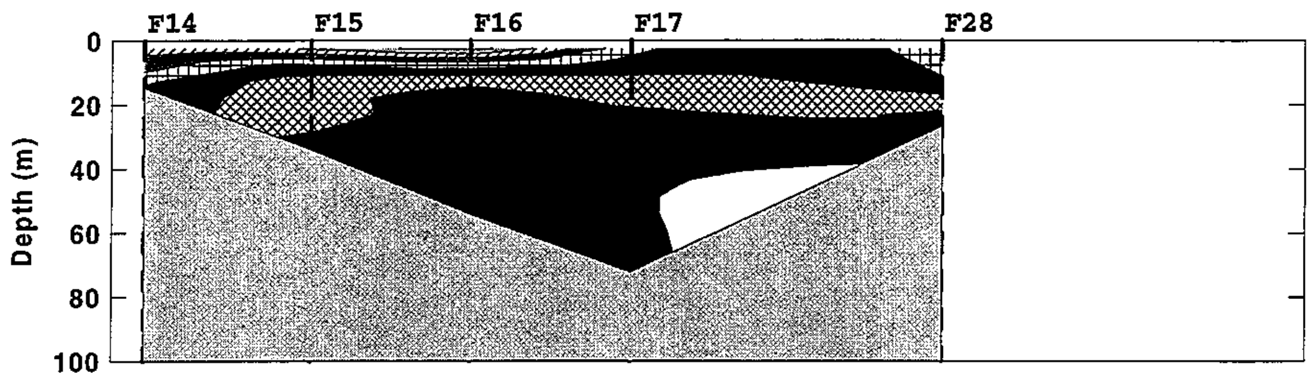
Marshfield Transect



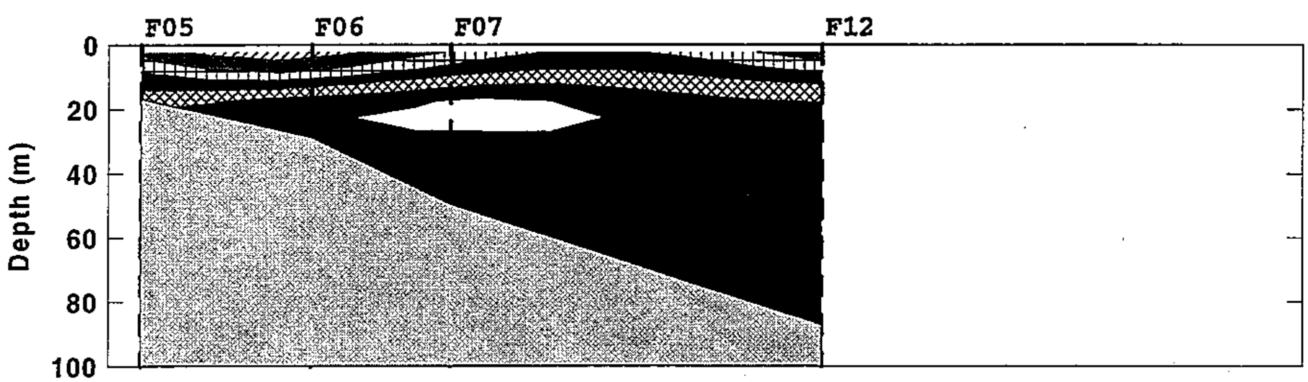
Boston-Nearfield Transect

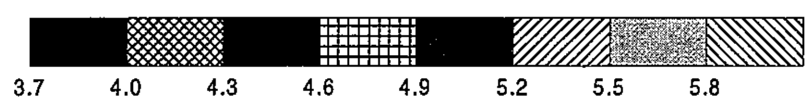


Cohassett Transect



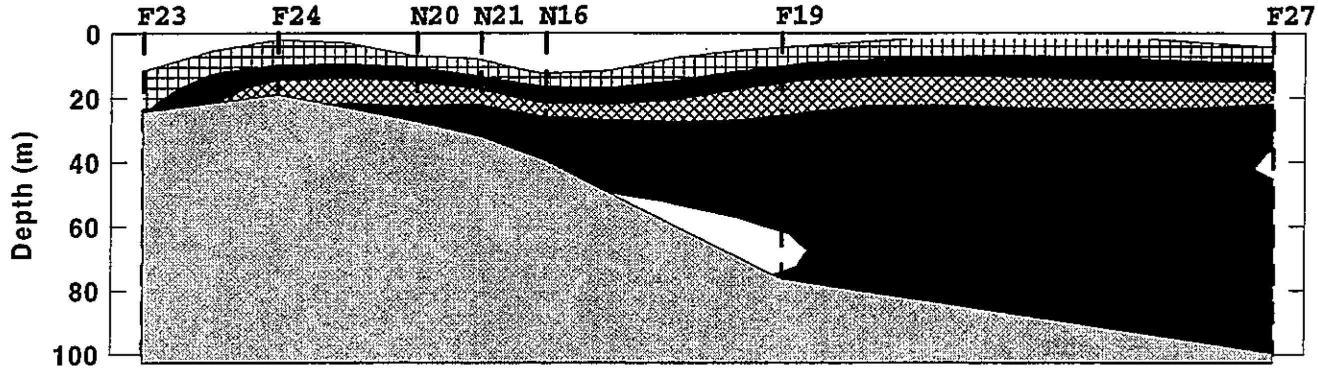
Marshfield Transect



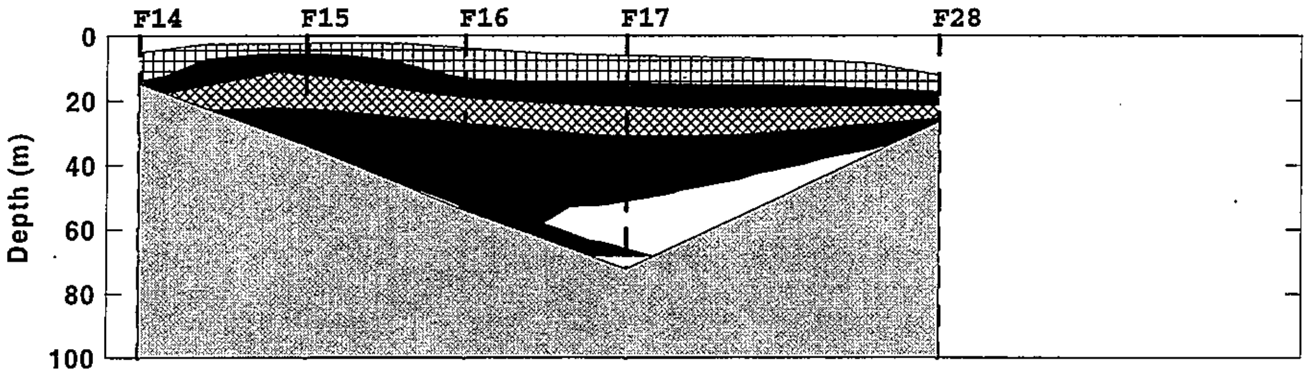


Temperature 9704

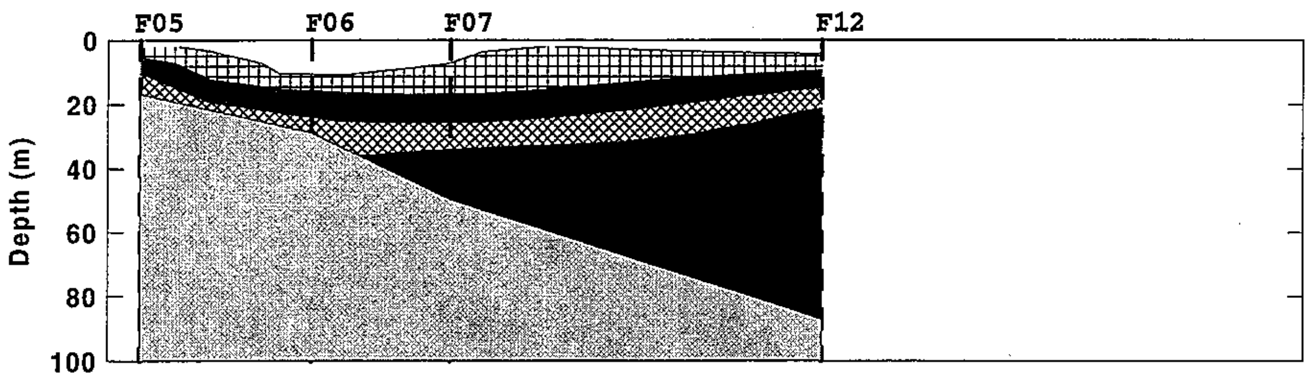
Boston-Nearfield Transect

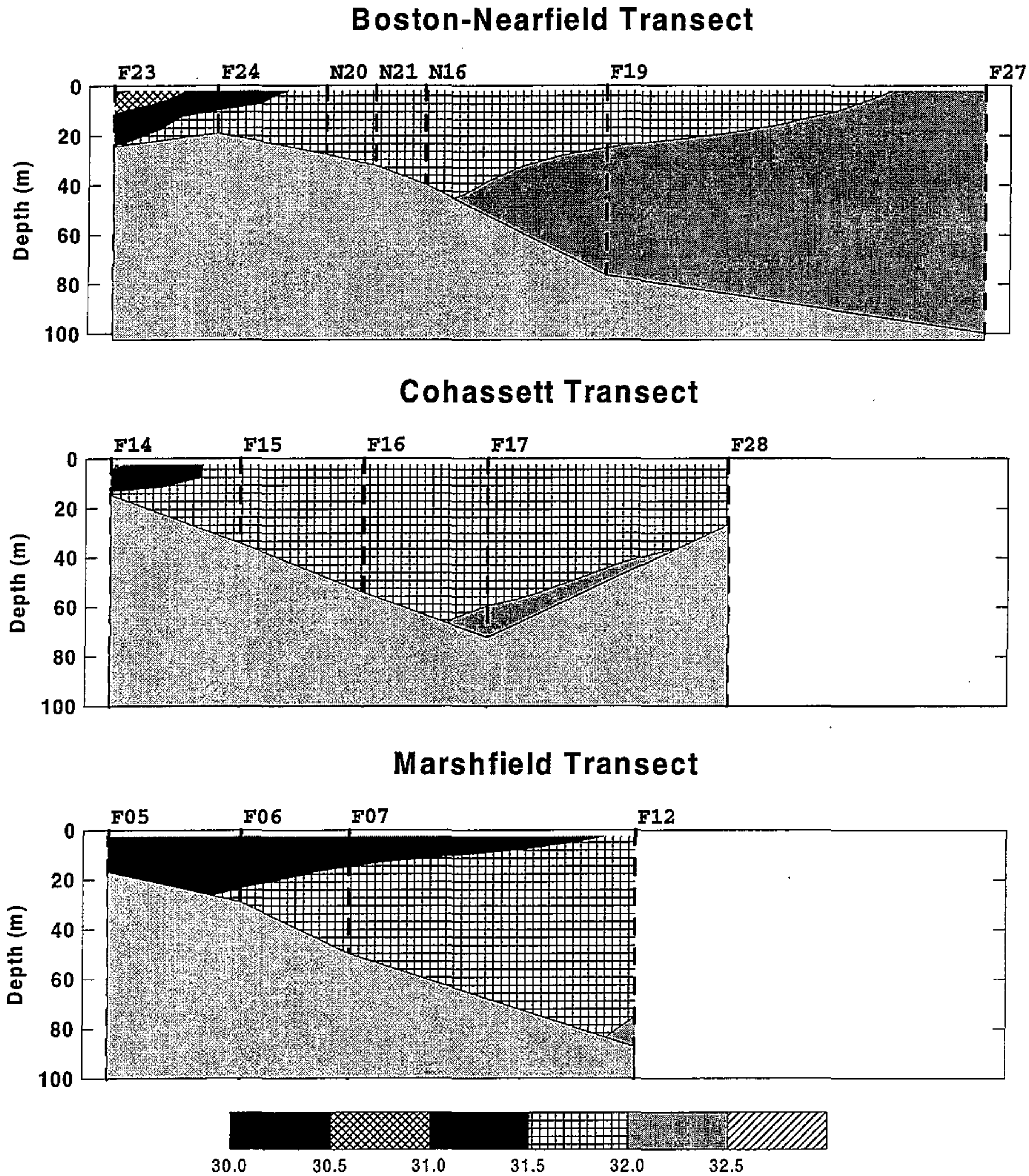


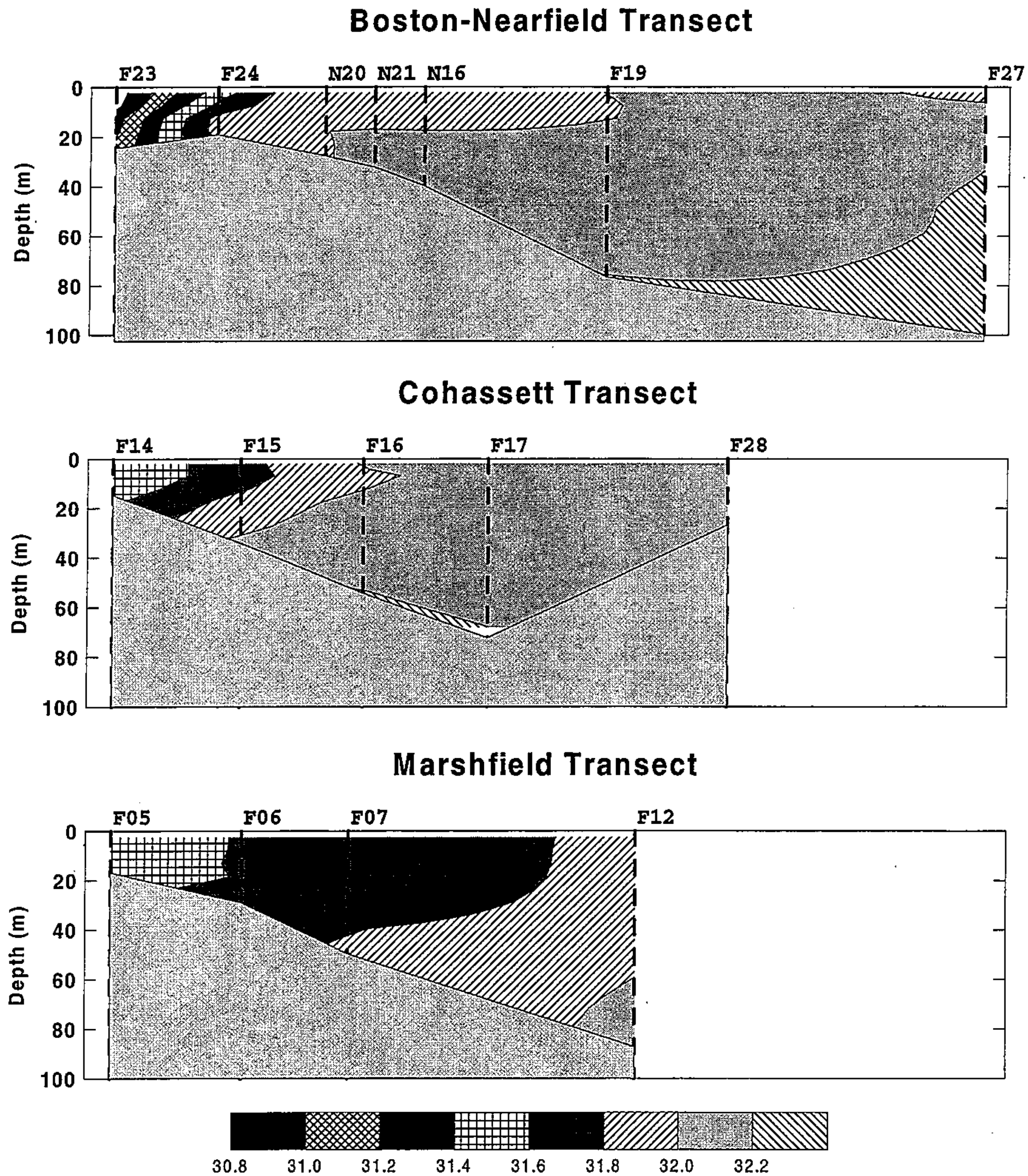
Cohassett Transect



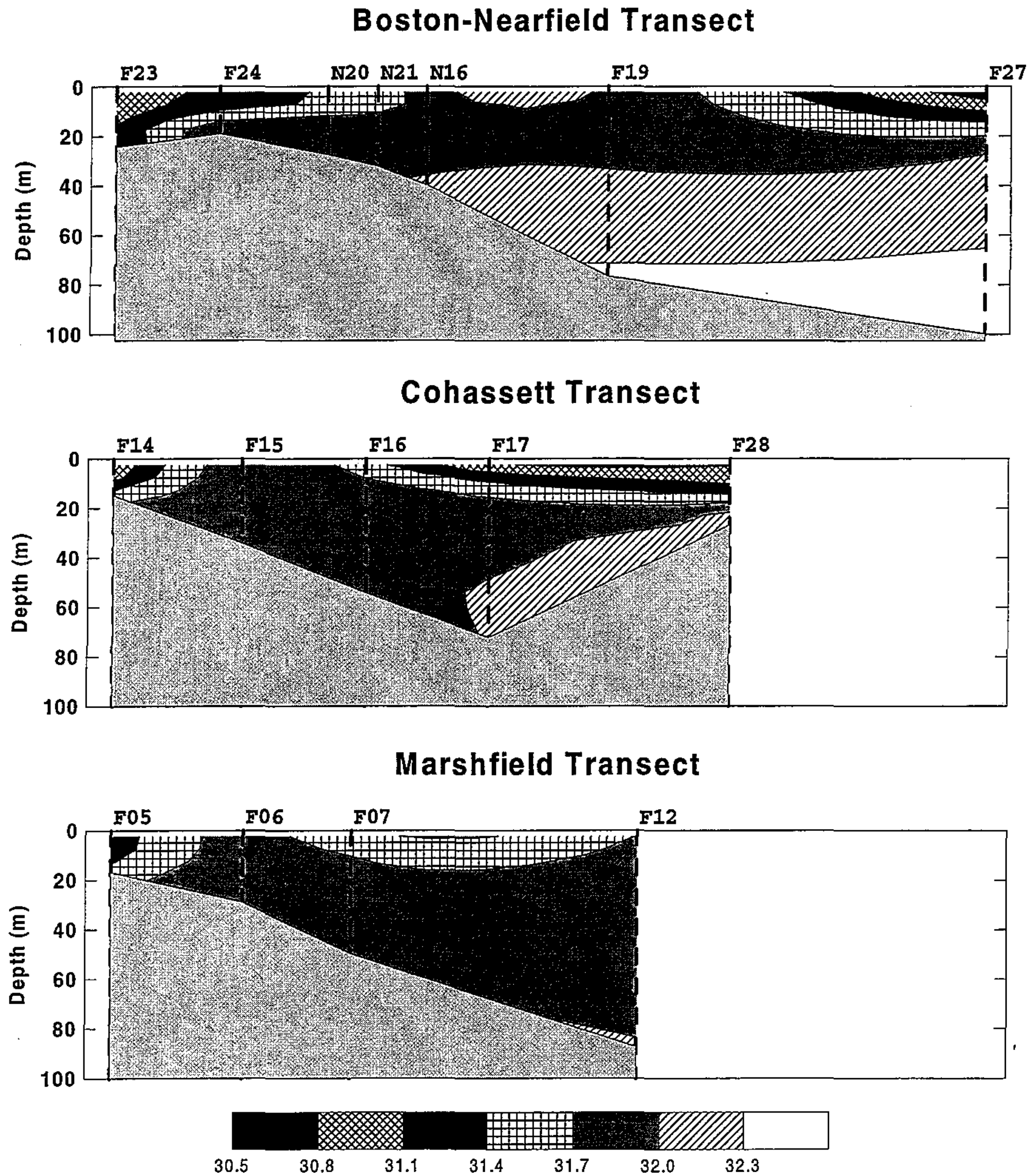
Marshfield Transect



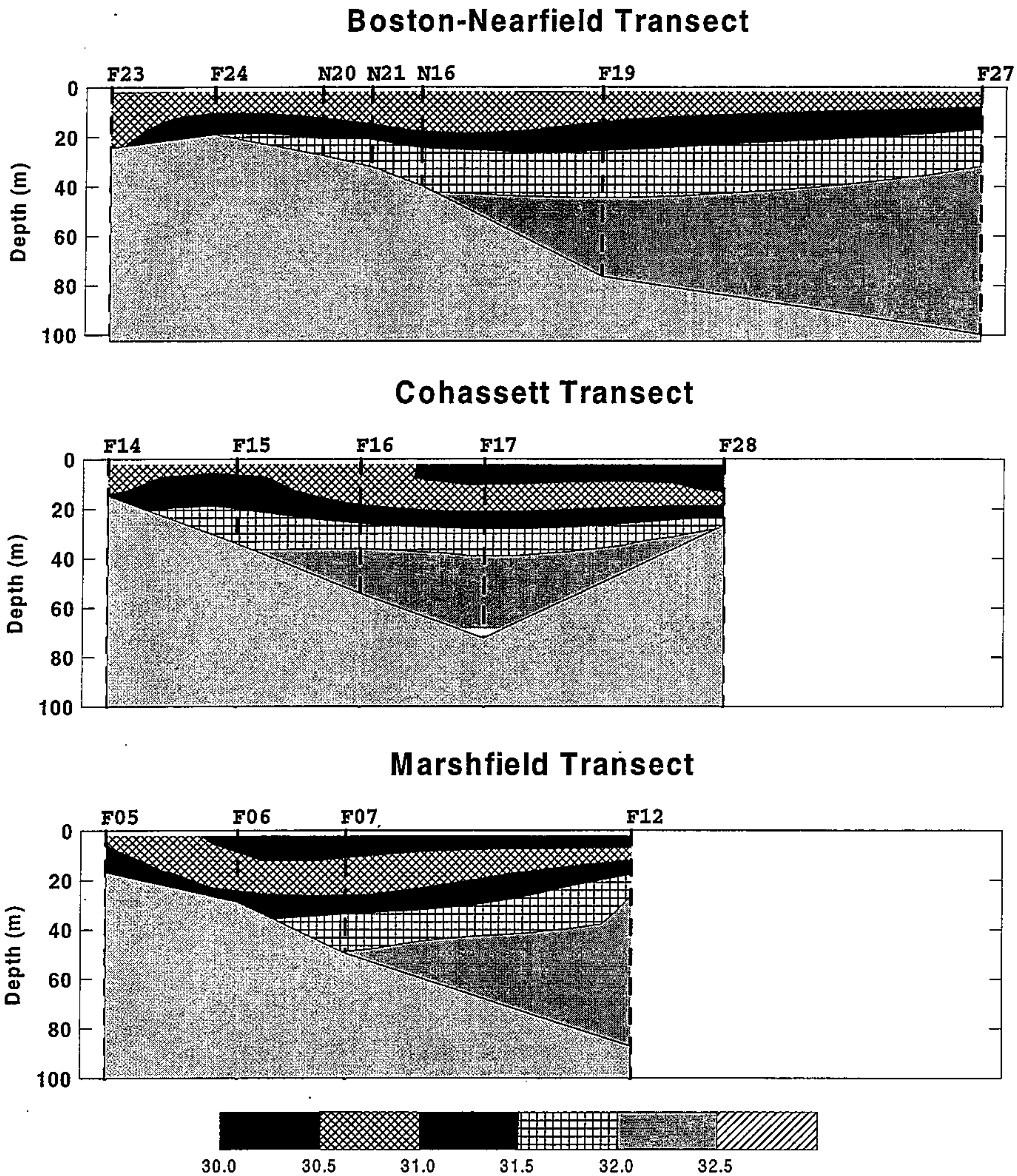

Boston-Nearfield Transect
F23
F24
N20
N21
N16
F19
F27
Depth (m)
0
20
40
60
80
100
Cohassett Transect
F14
F15
F16
F17
F28
Depth (m)
0
20
40
60
80
100
Marshfield Transect
F05
F06
F07
F12
Depth (m)
0
20
40
60
80
100
30.0
30.5
31.0
31.5
32.0
32.5

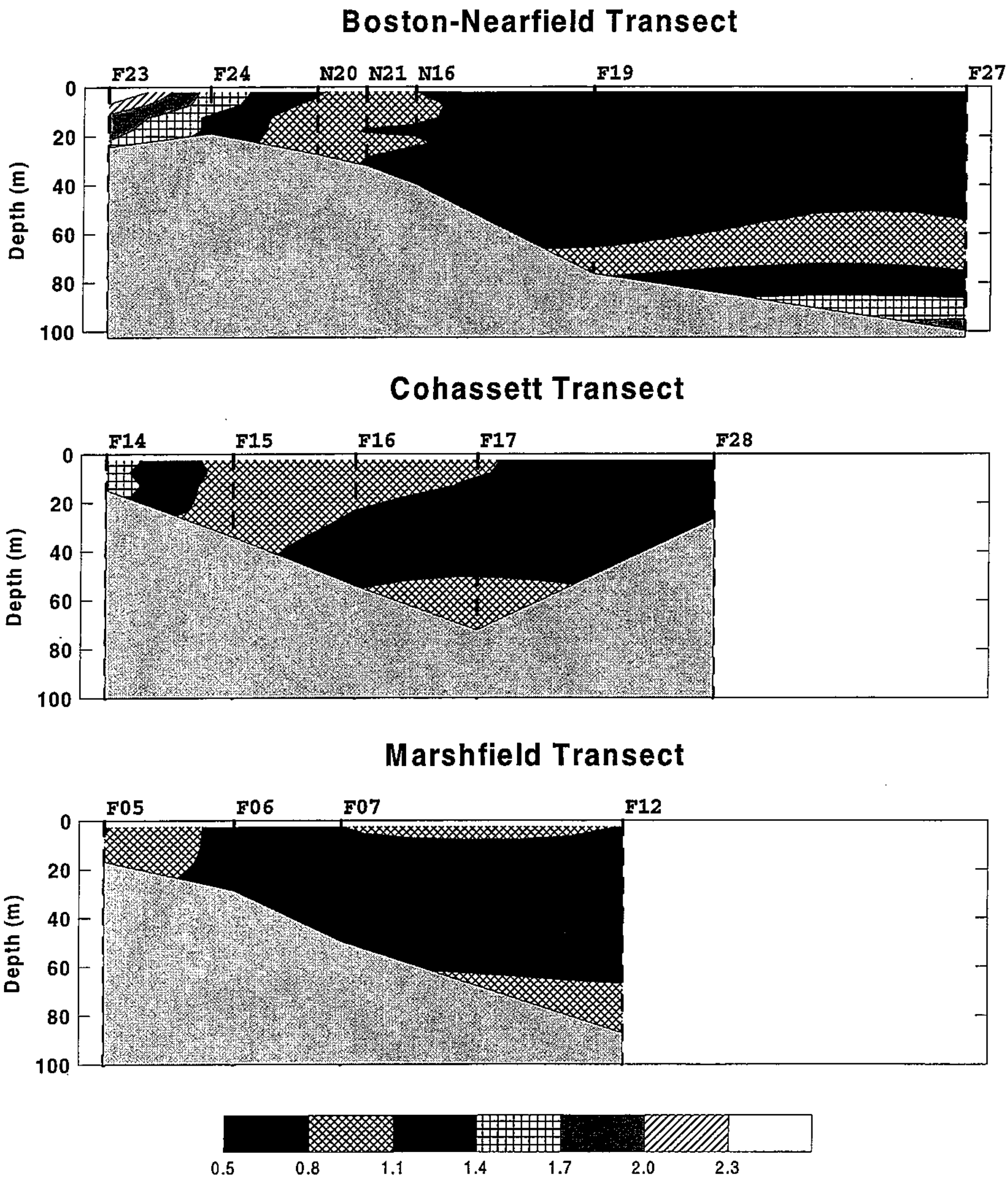


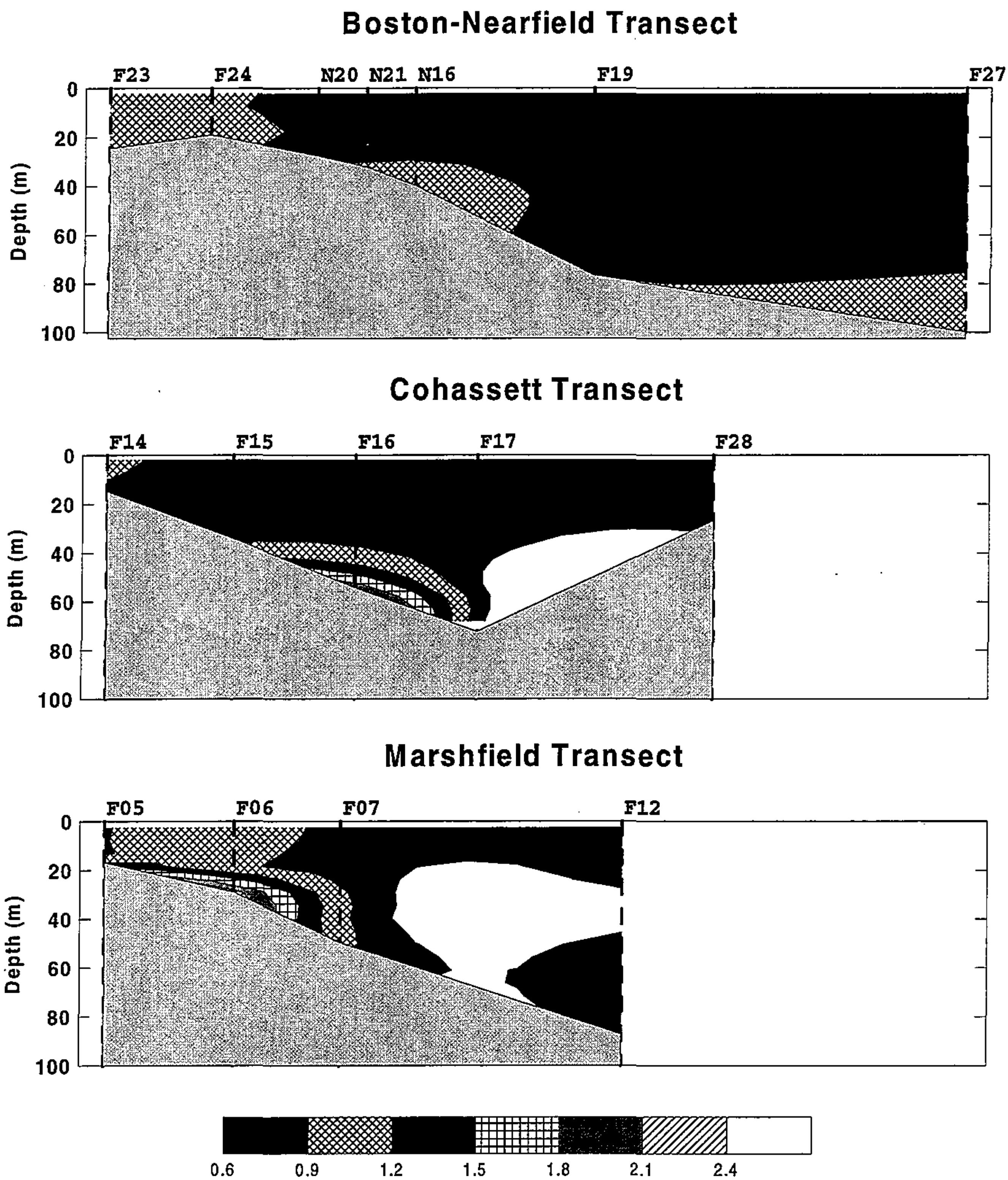
Salinity 9702



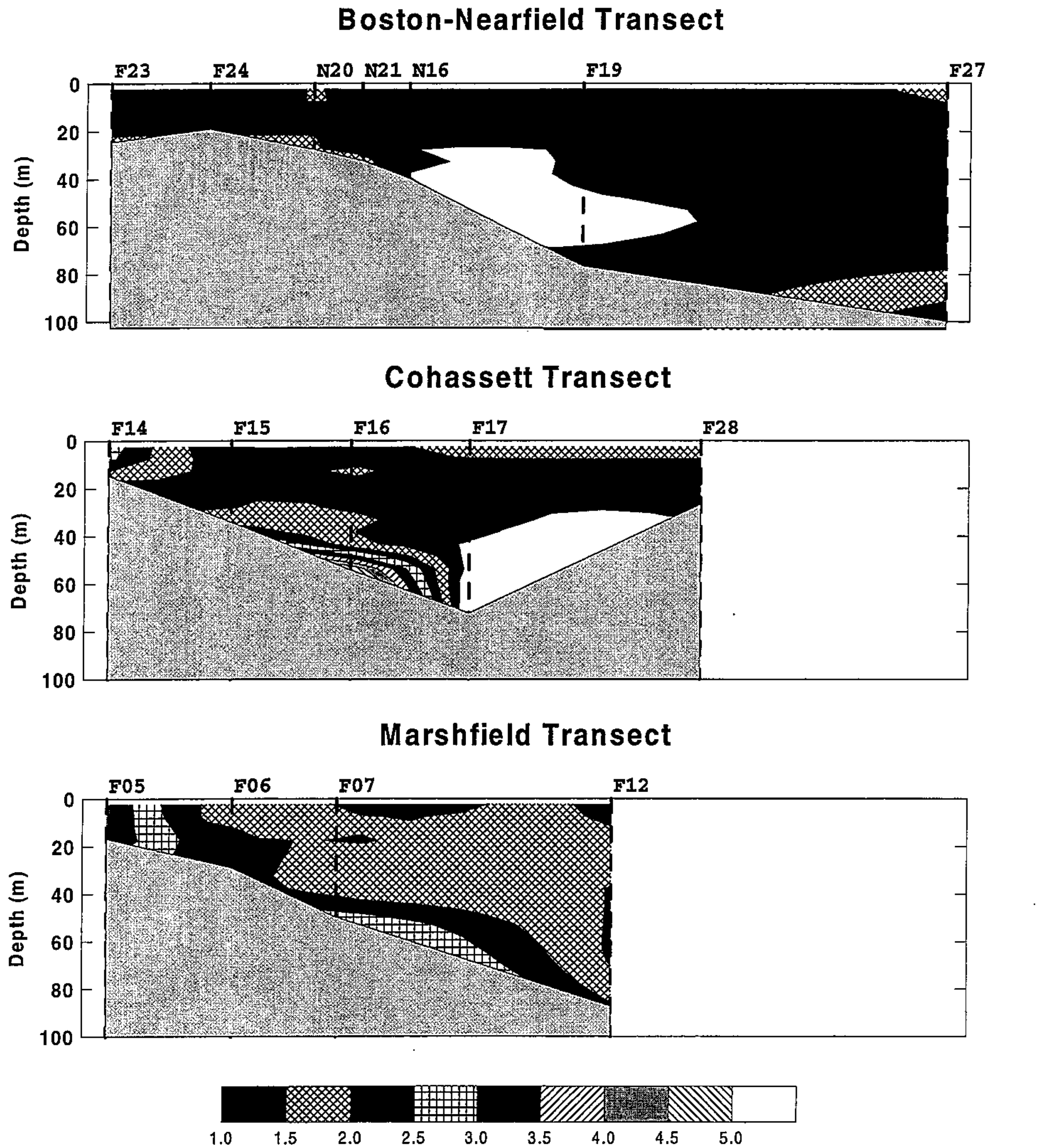
Salinity 9704


Boston-Nearfield Transect
F23
F24
N20
N21
N16
F19
F27
Depth (m)
0
20
40
60
80
100
Cohassett Transect
F14
F15
F16
F17
F28
Marshfield Transect
F05
F06
F07
F12
30.0
30.5
31.0
31.5
32.0
32.5


Boston-Nearfield Transect
F23
F24
N20
N21
N16
F19
F27
Depth (m)
0
20
40
60
80
100
Cohassett Transect
F14
F15
F16
F17
F28
Depth (m)
0
20
40
60
80
100
Marshfield Transect
F05
F06
F07
F12
Depth (m)
0
20
40
60
80
100
0.5
0.8
1.1
1.4
1.7
2.0
2.3

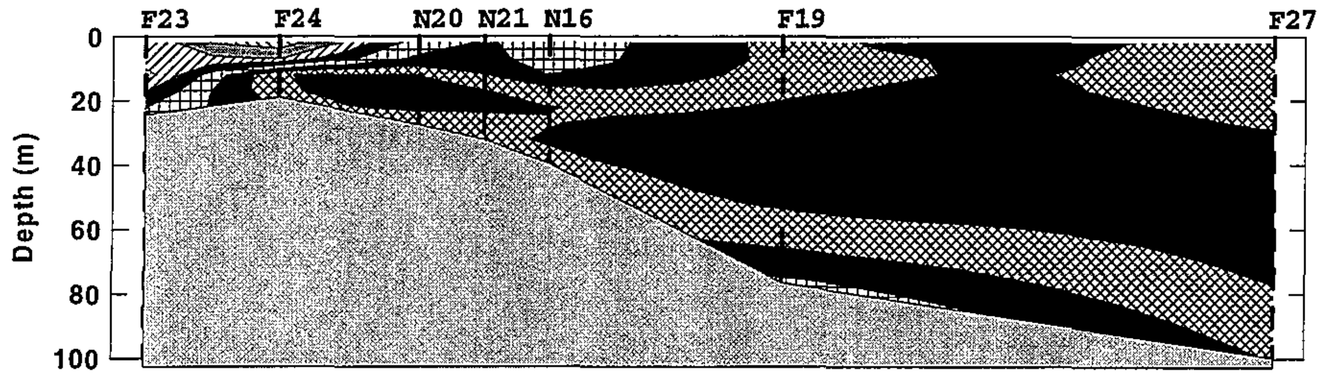


Beam Attenuation 9702

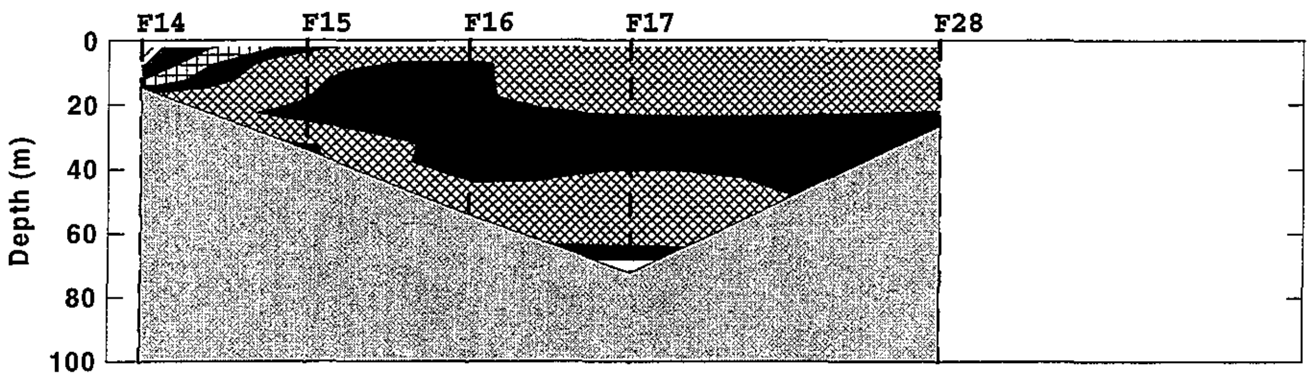


Beam Attenuation 9704

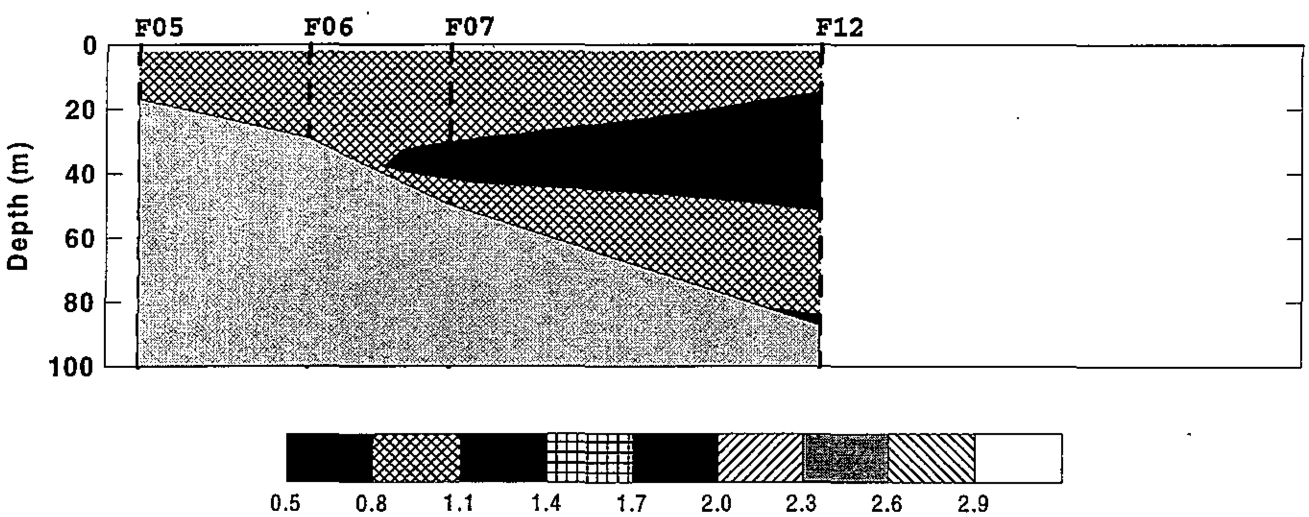
Boston-Nearfield Transect

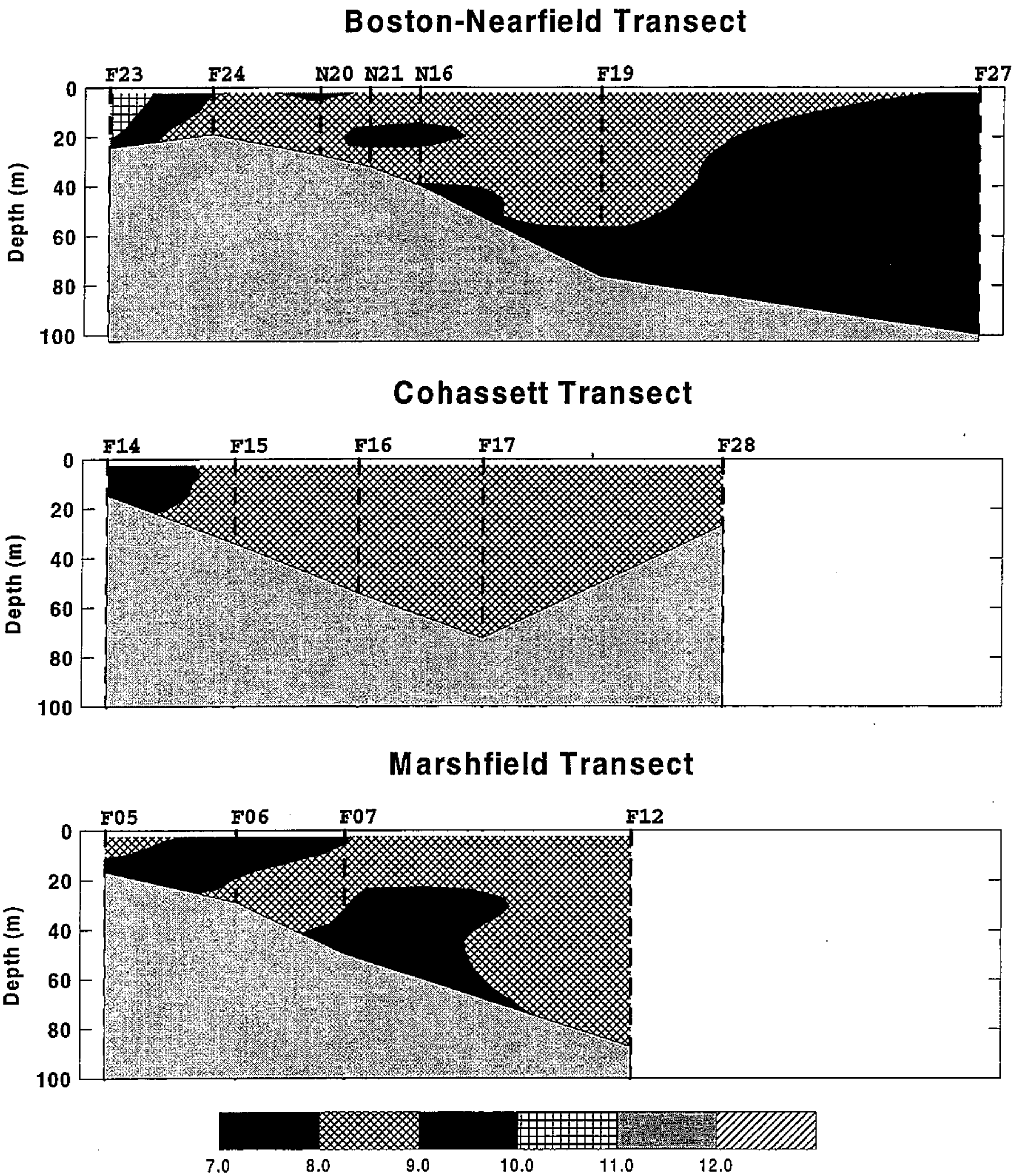


Cohassett Transect

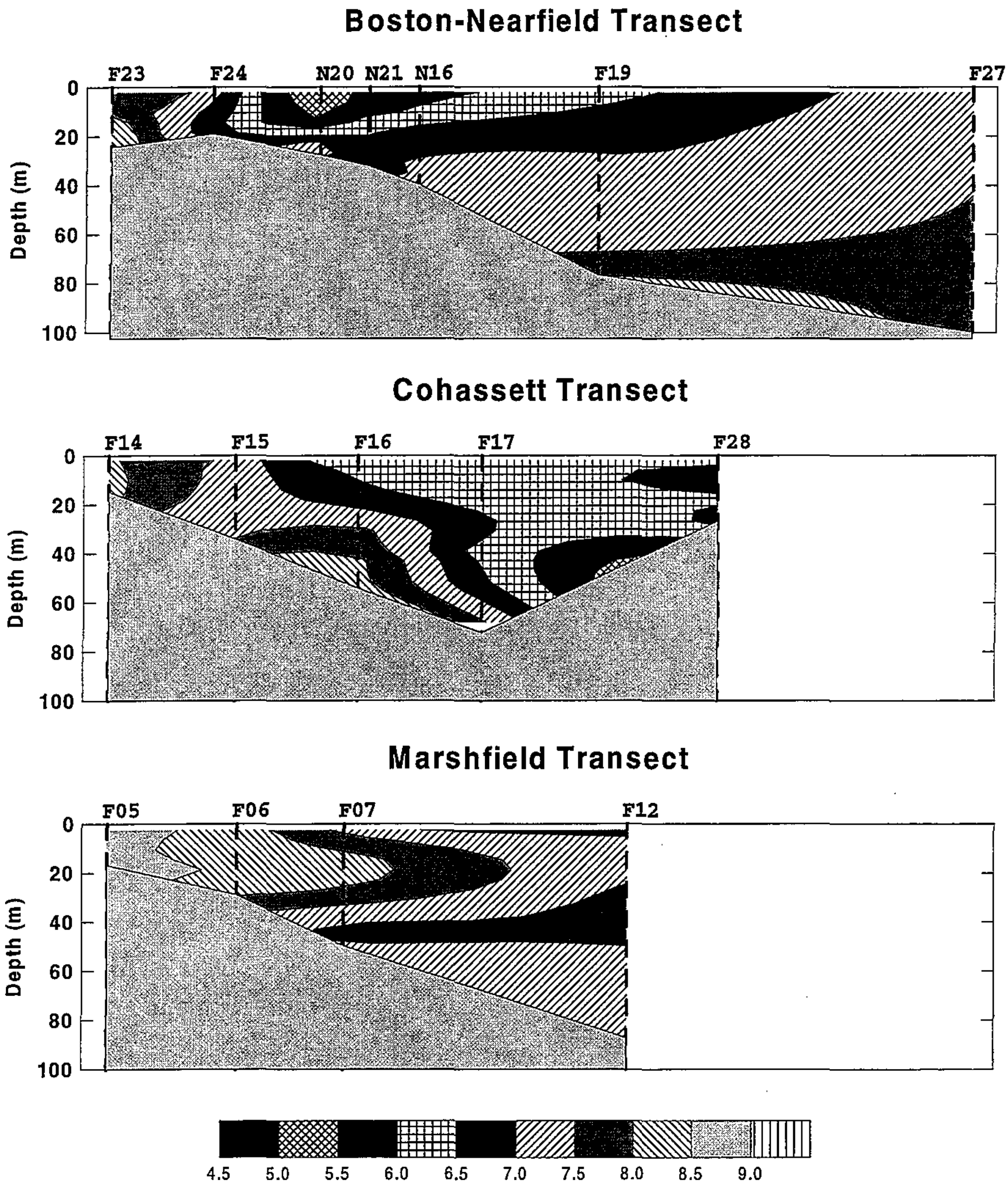


Marshfield Transect

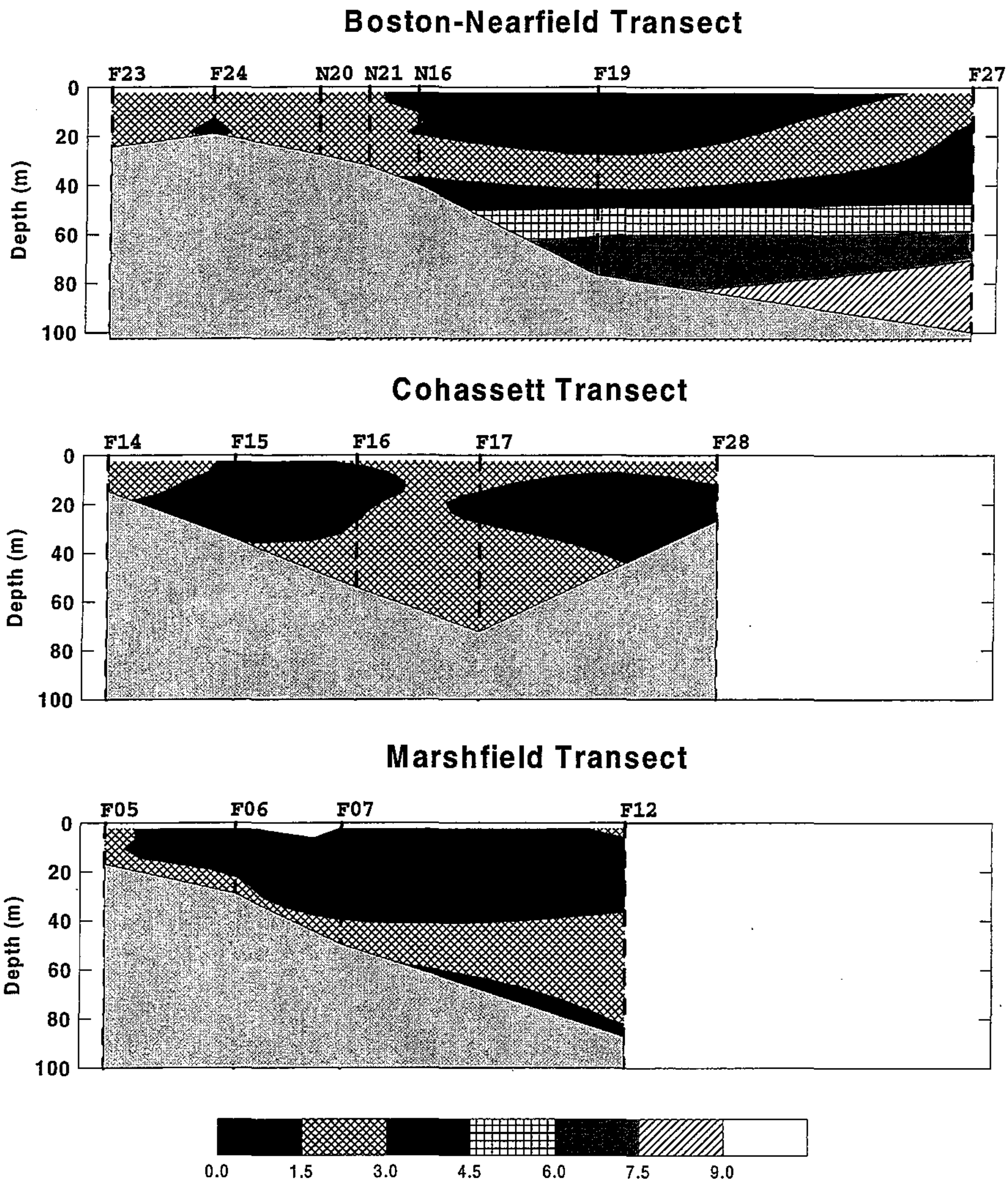




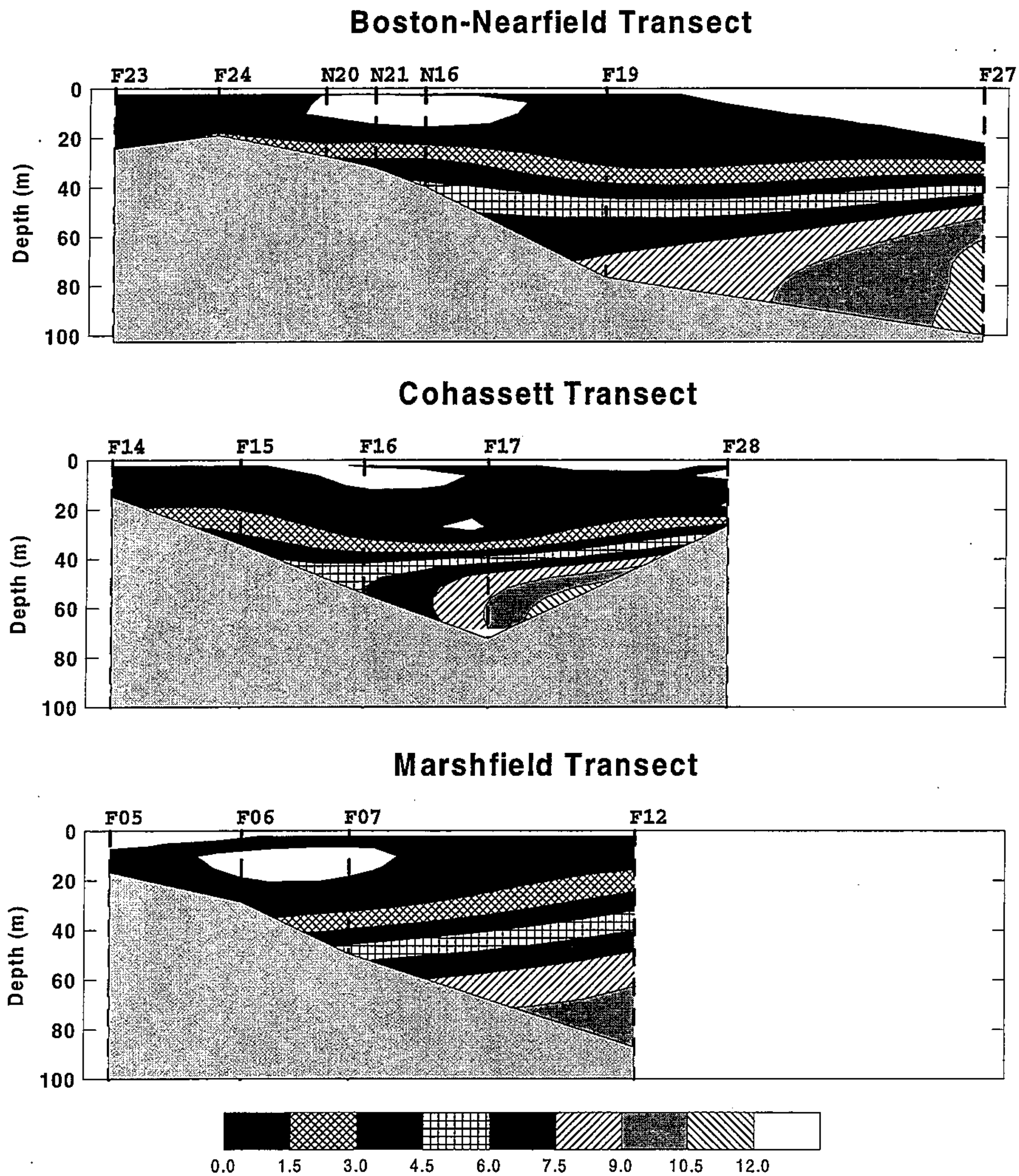
Nitrate + Nitrite 9701



Nitrate + Nitrite 9702

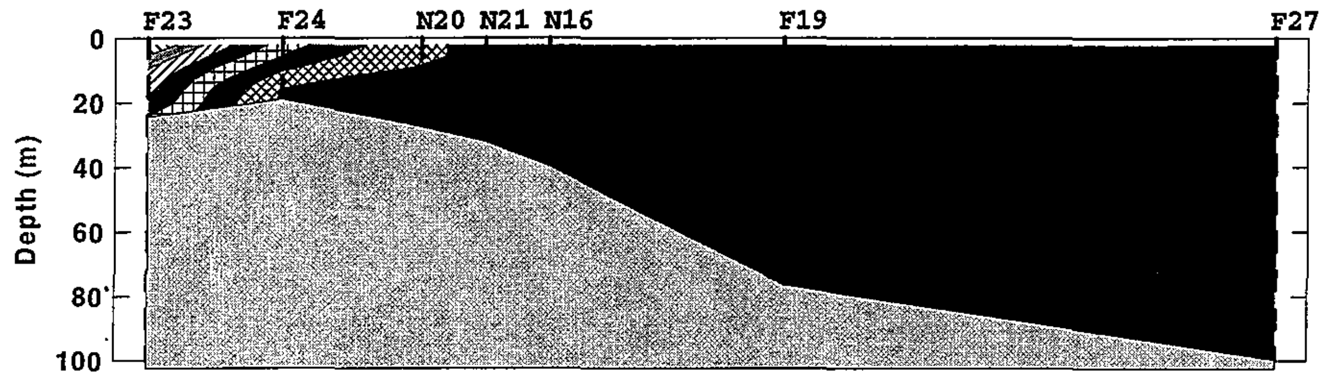


Nitrate + Nitrite 9704

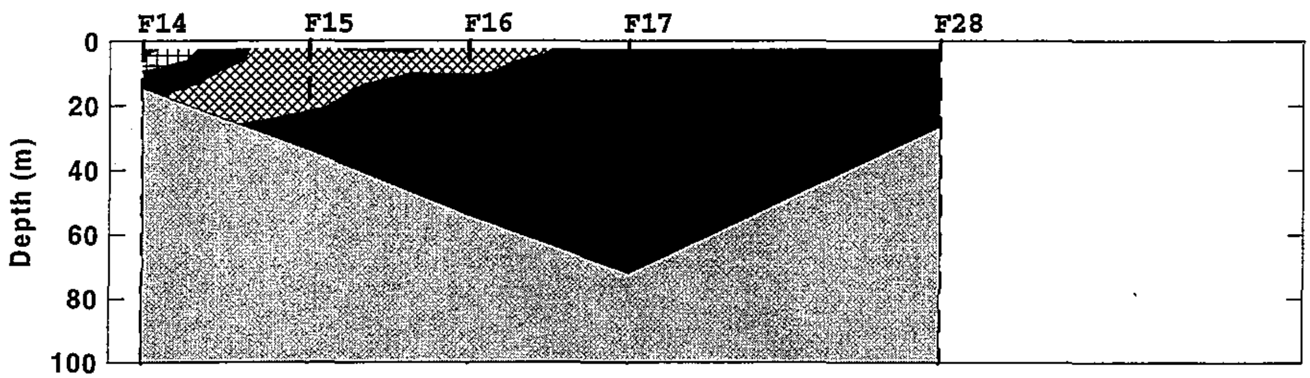


Nitrate + Nitrite 9707

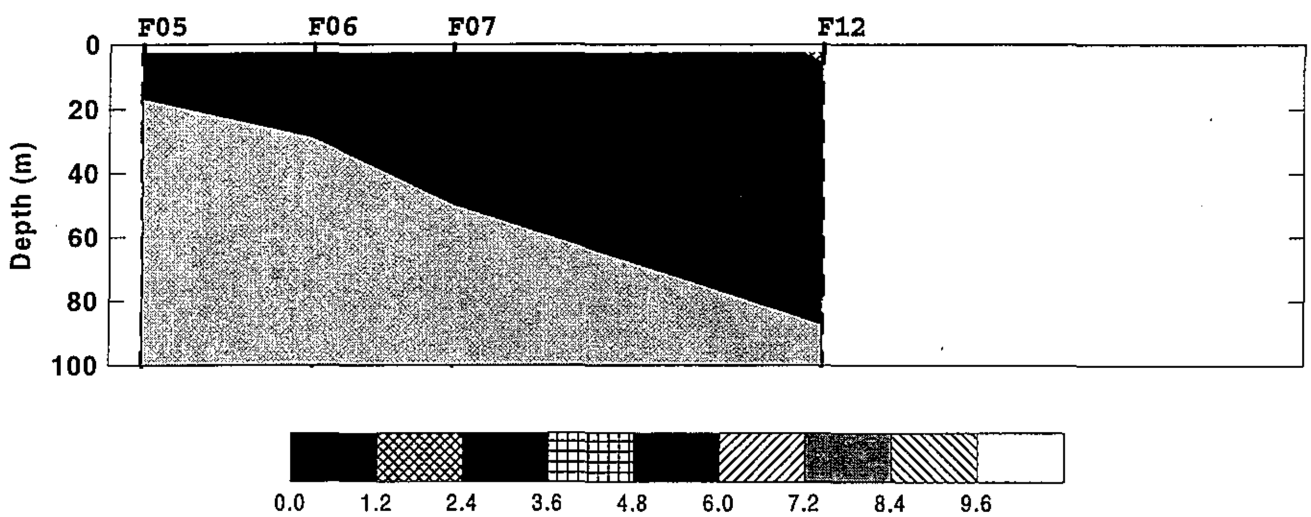
Boston-Nearfield Transect



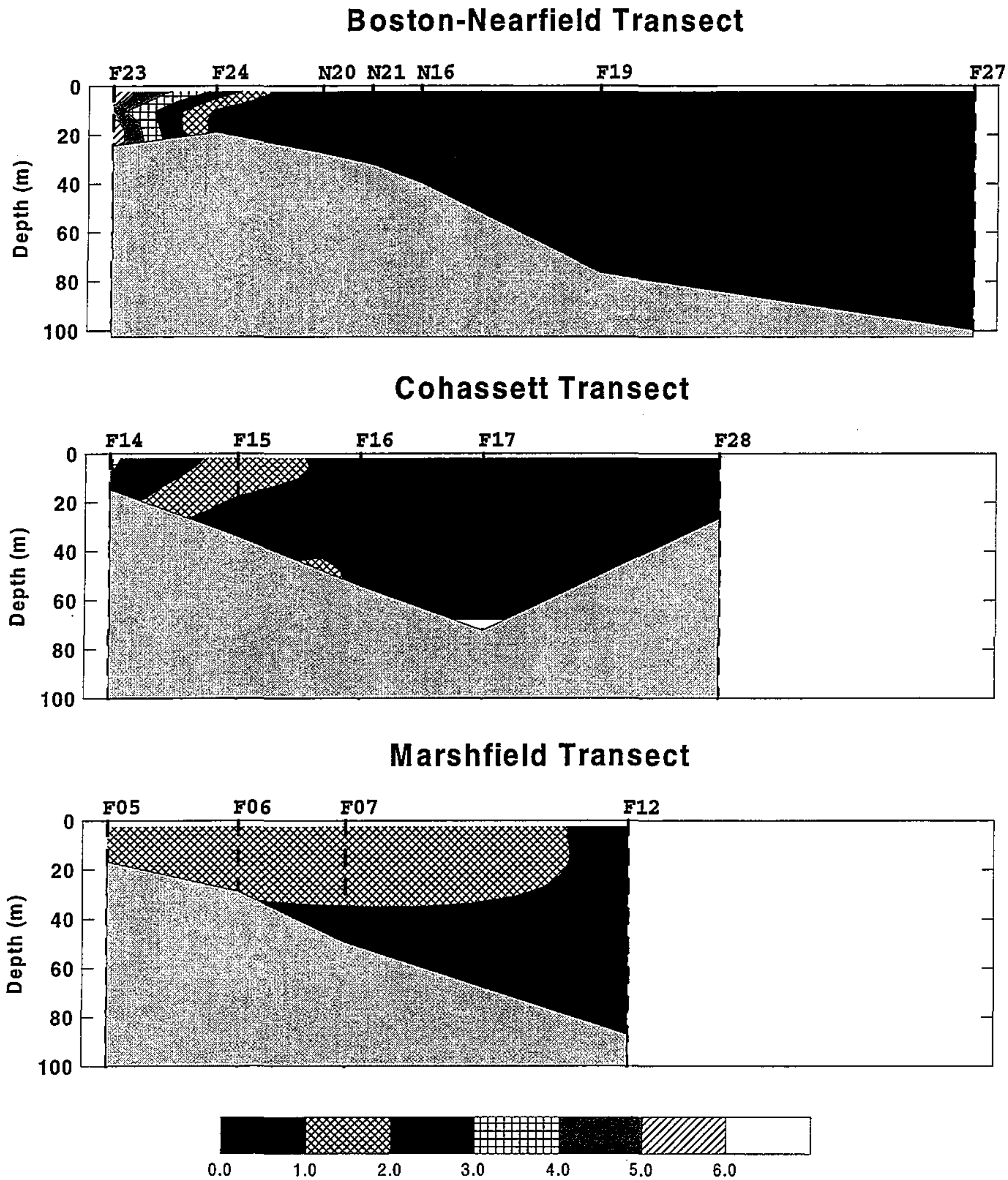
Cohassett Transect



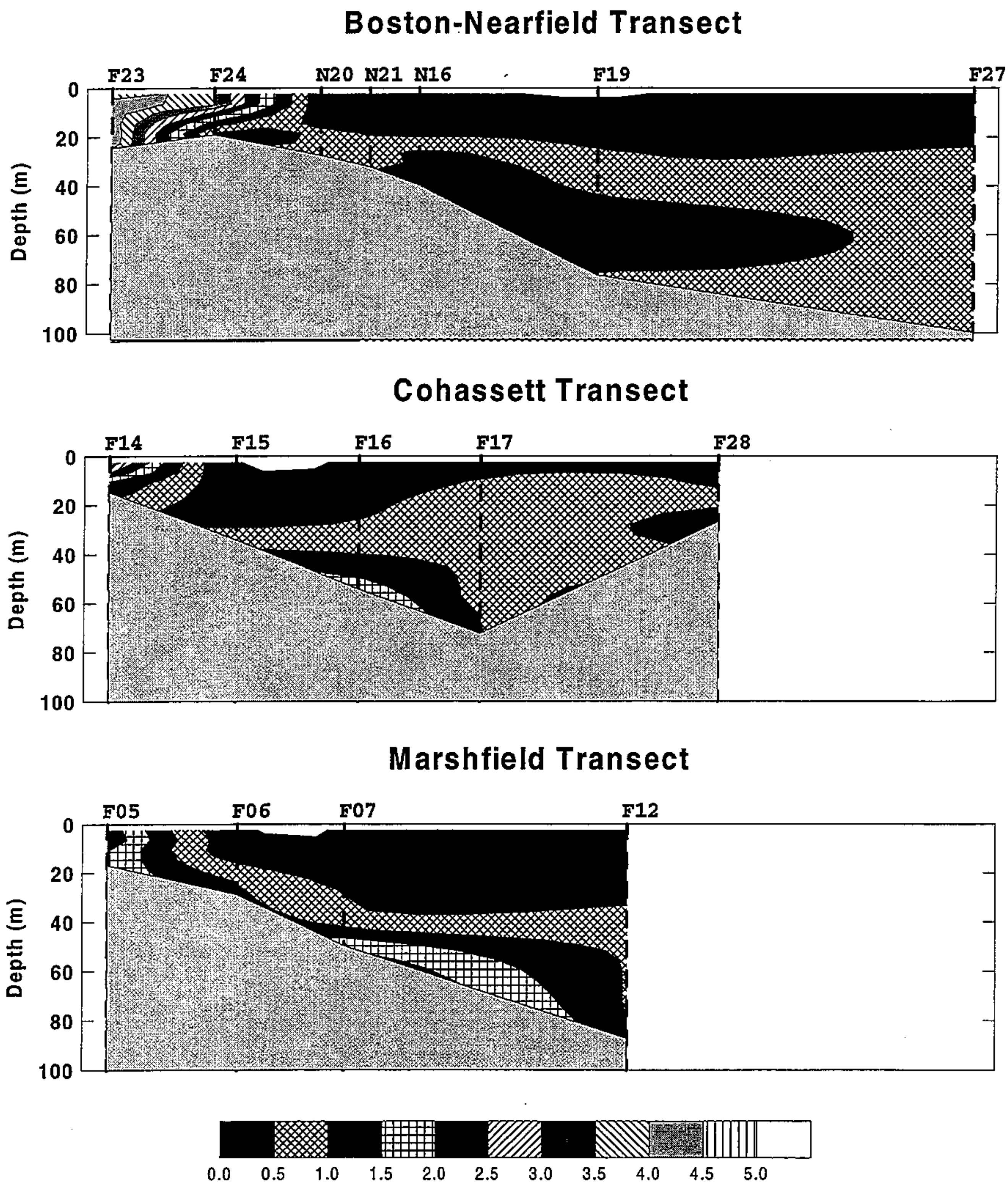
Marshfield Transect



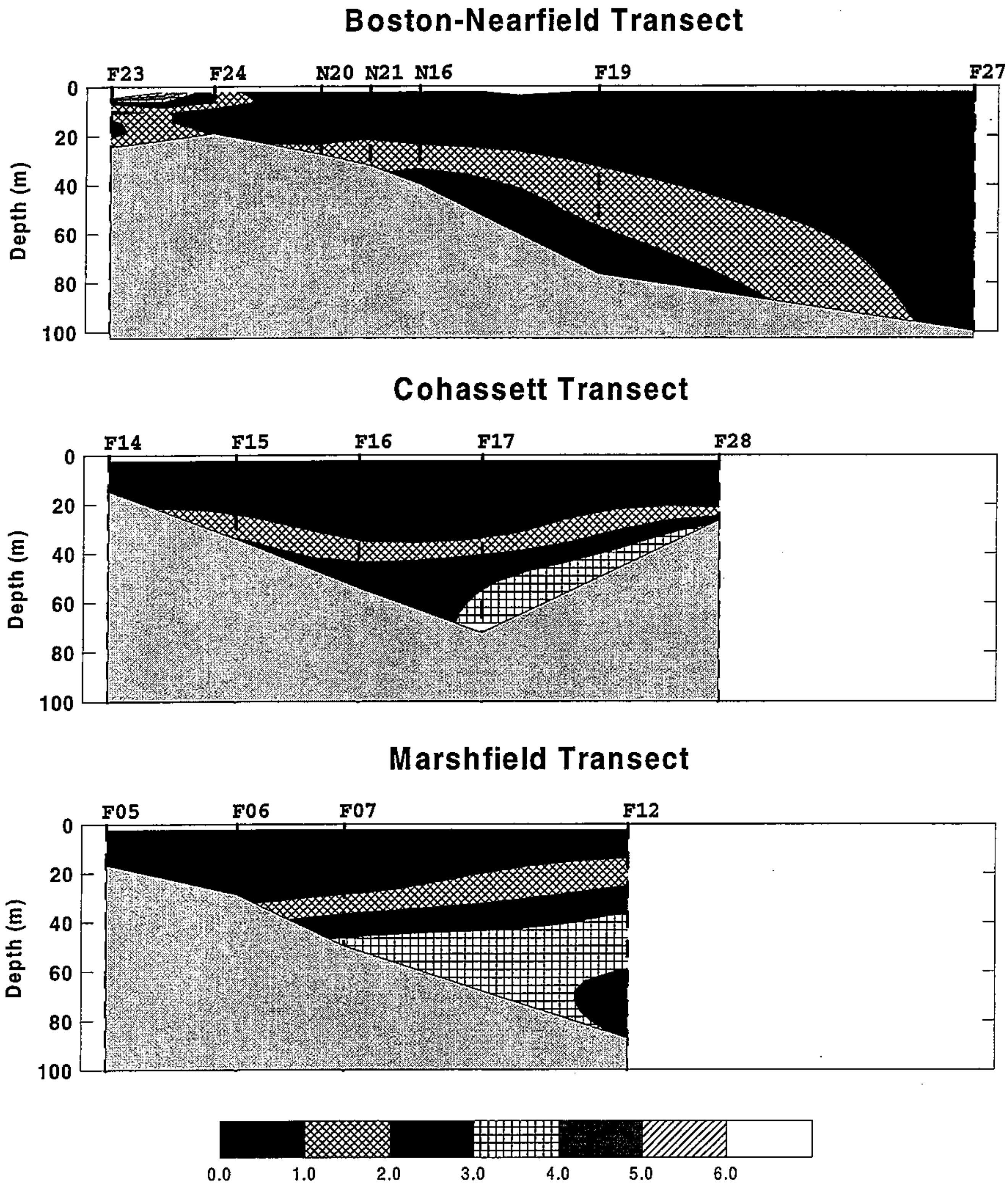
Ammonium 9701



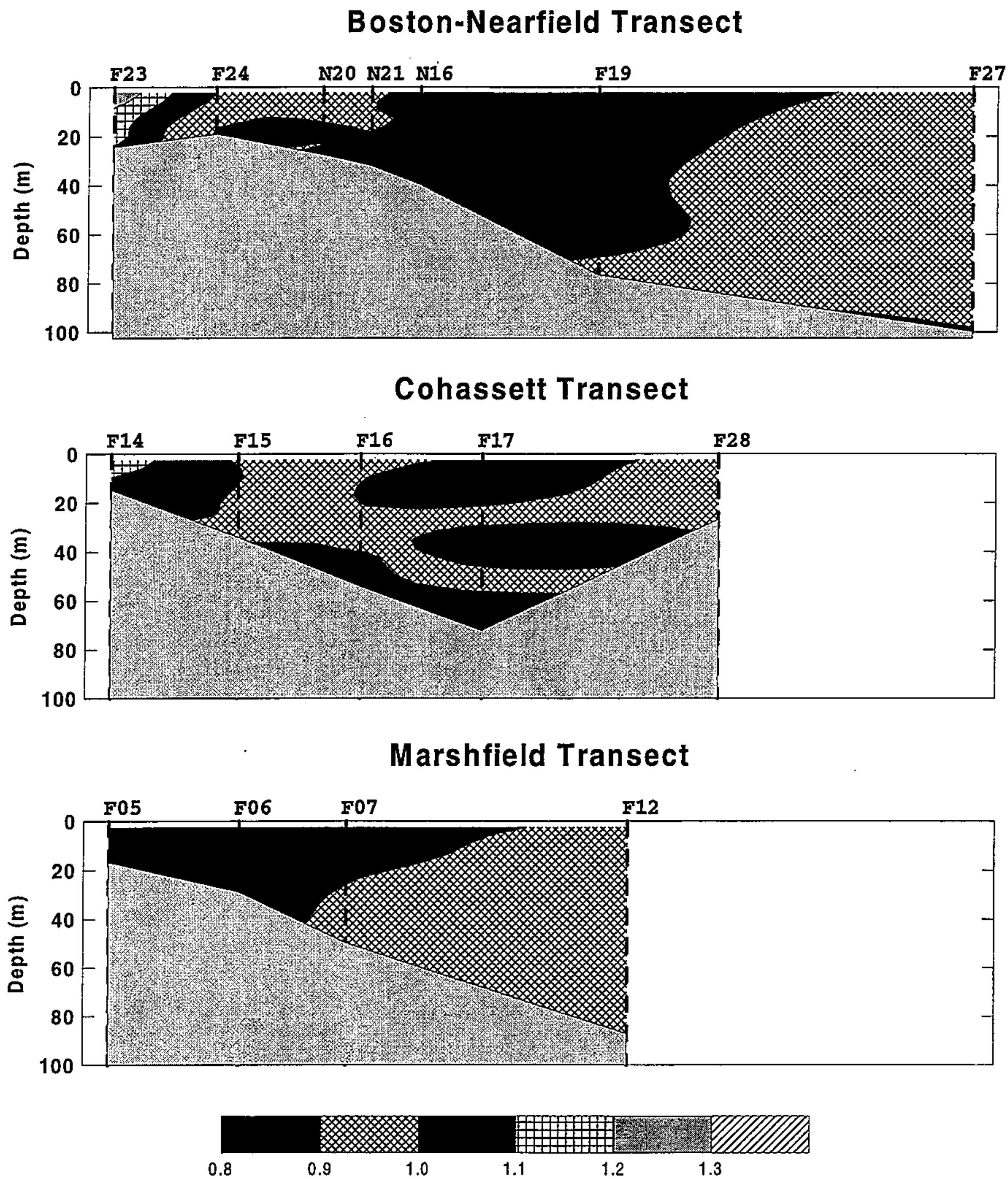
Ammonium 9702



Ammonium 9704

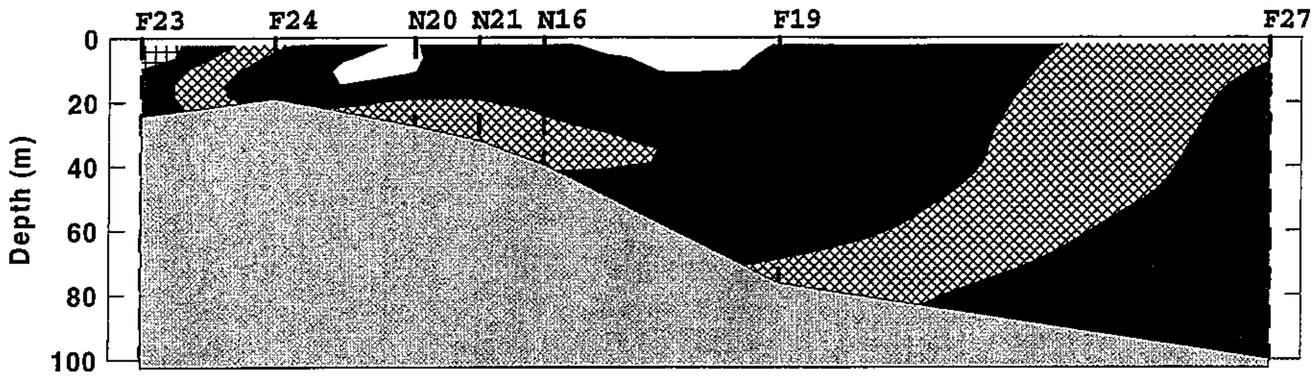


Ammonium 9707

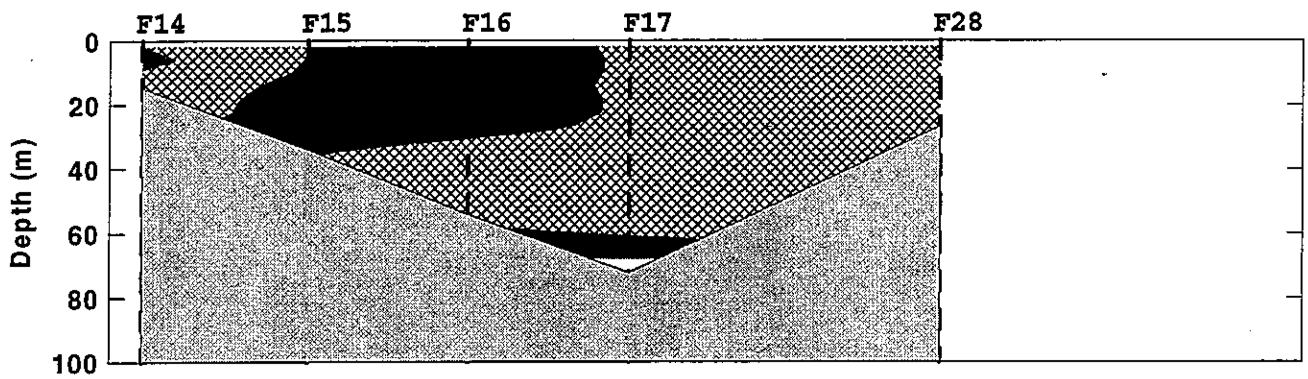


Phosphate 9701

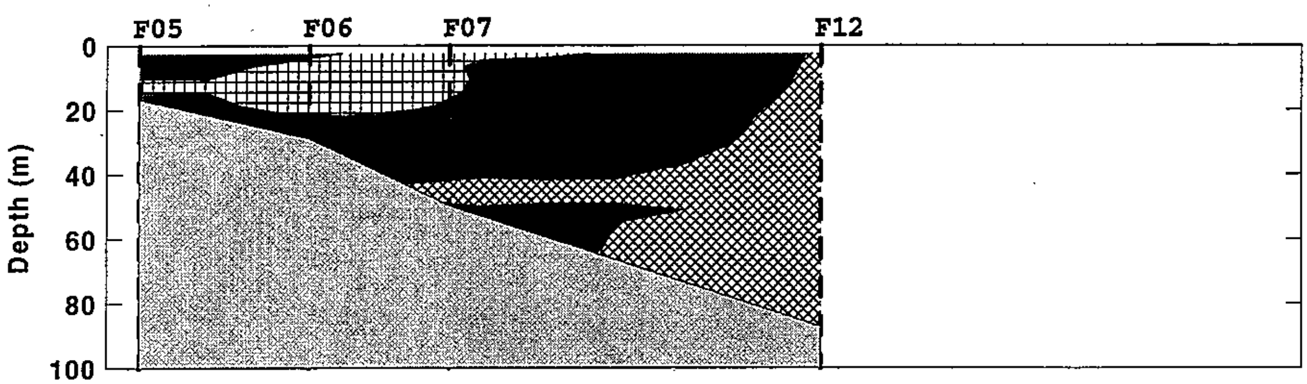
Boston-Nearfield Transect



Cohassett Transect

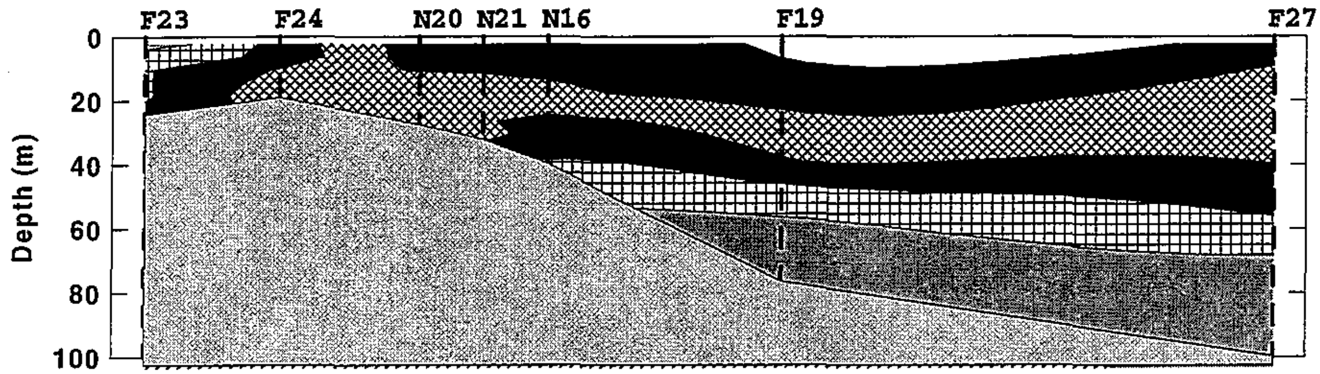


Marshfield Transect

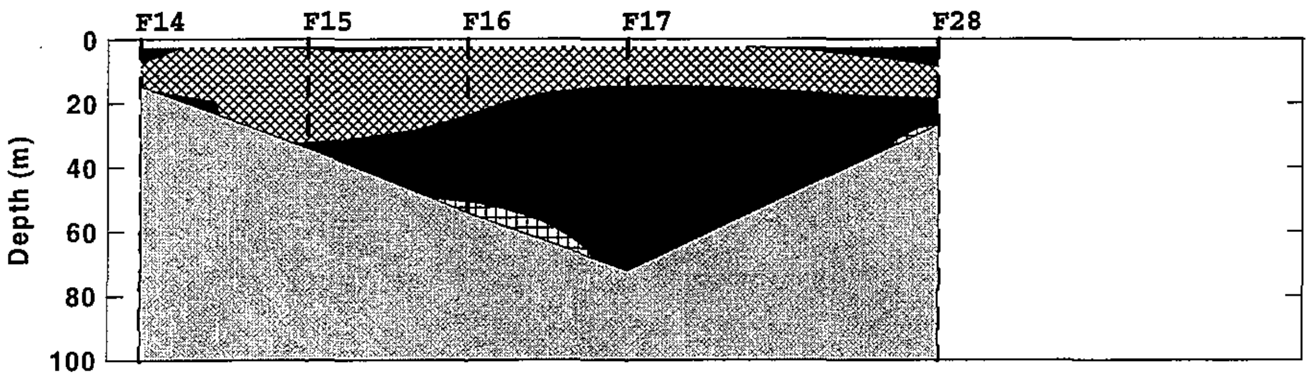


Phosphate 9702

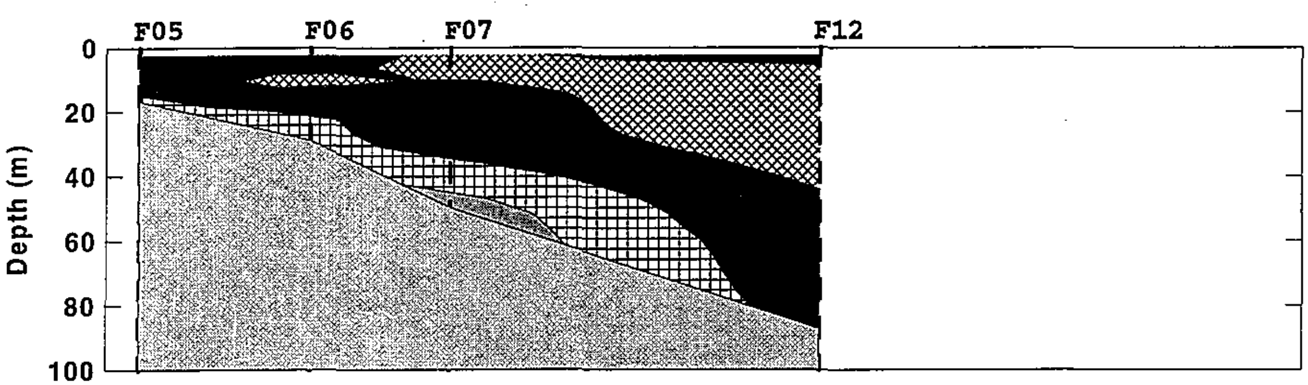
Boston-Nearfield Transect



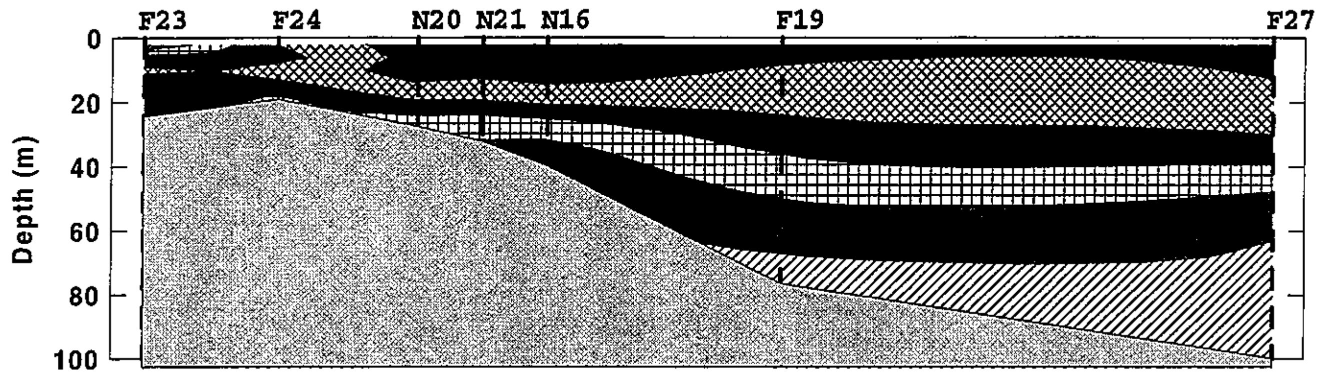
Cohassett Transect



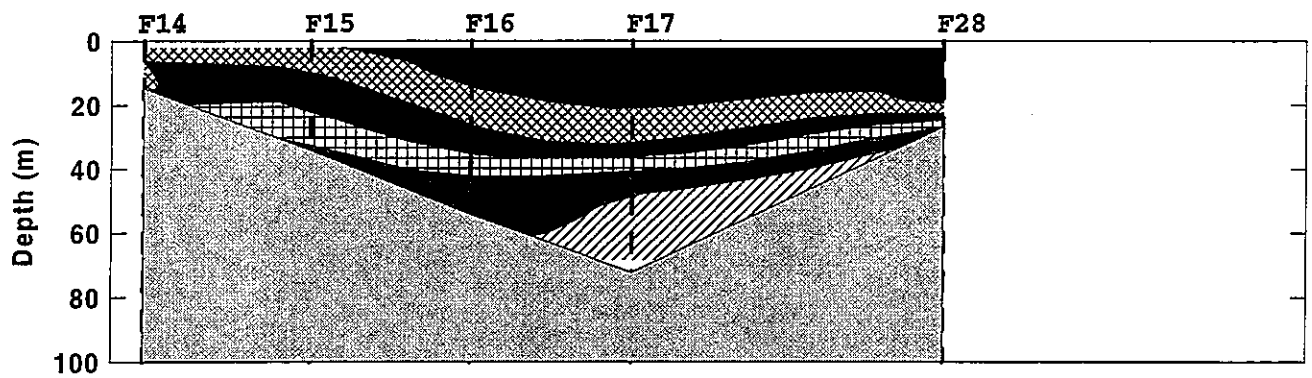
Marshfield Transect



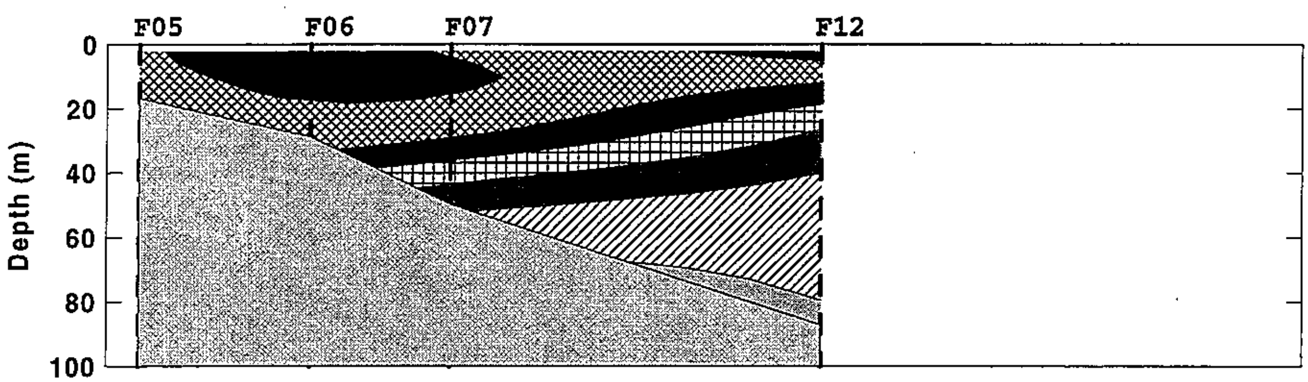
Boston-Nearfield Transect

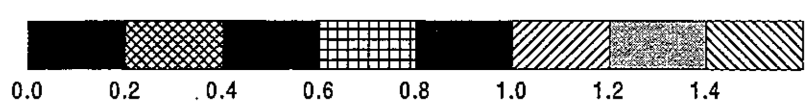


Cohassett Transect

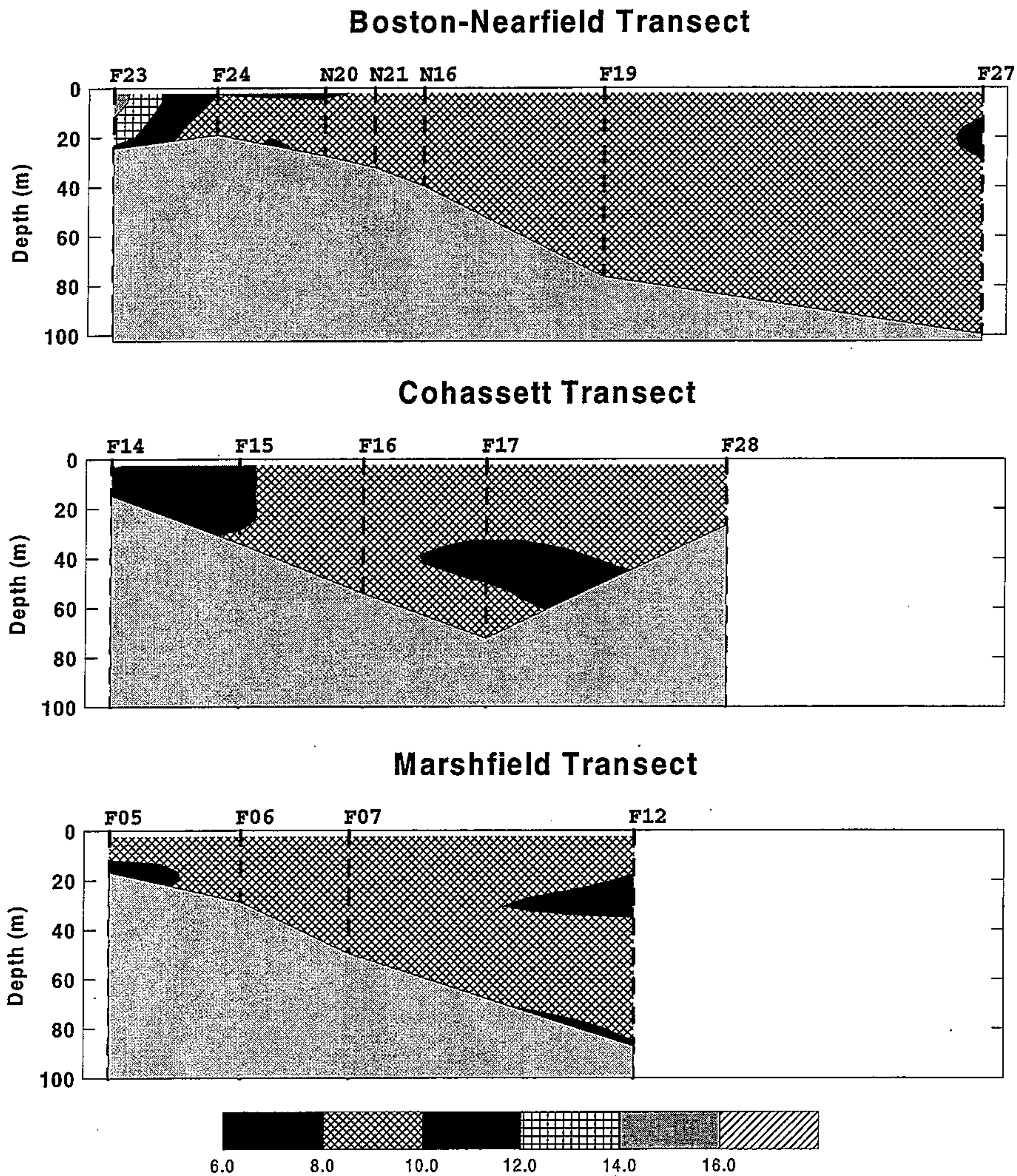


Marshfield Transect

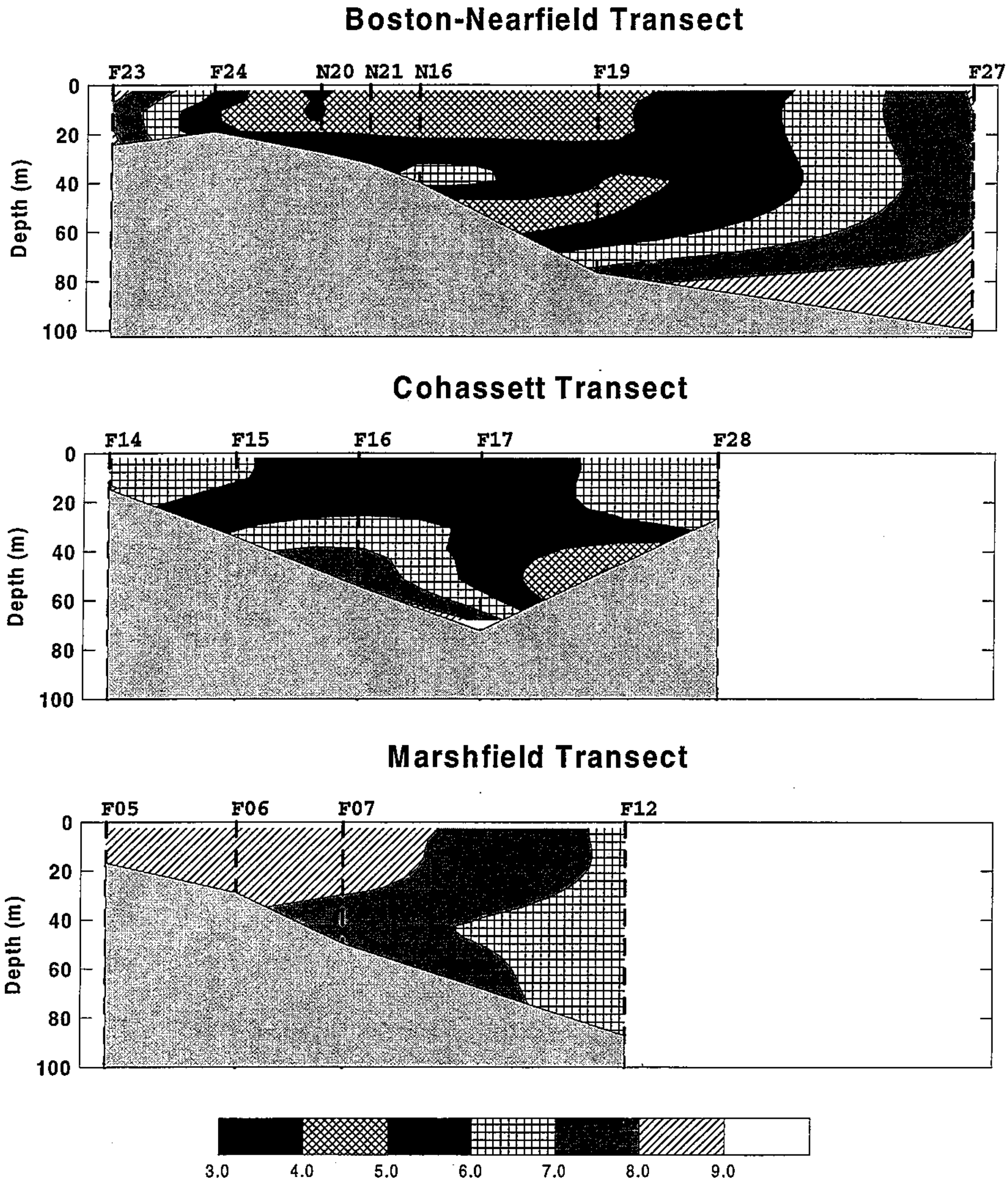




Phosphate 9707

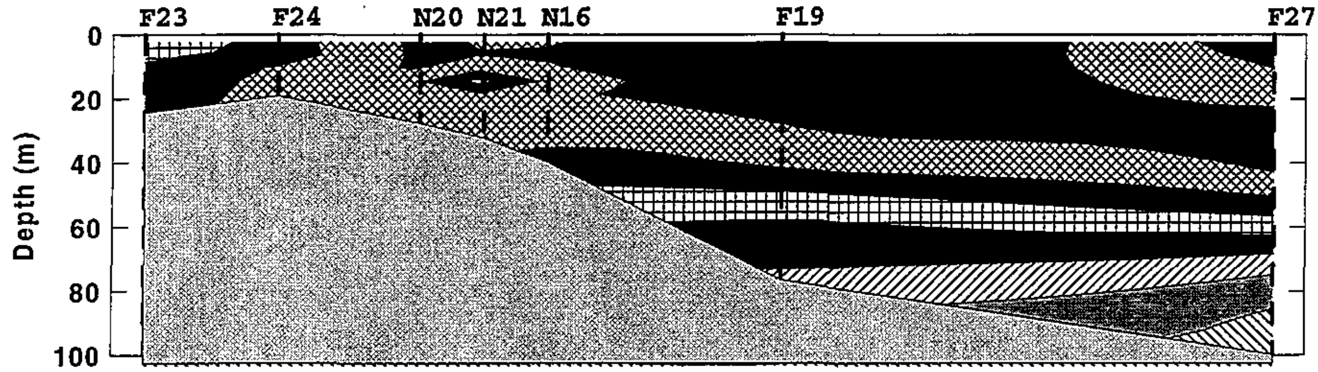


Silicate 9701

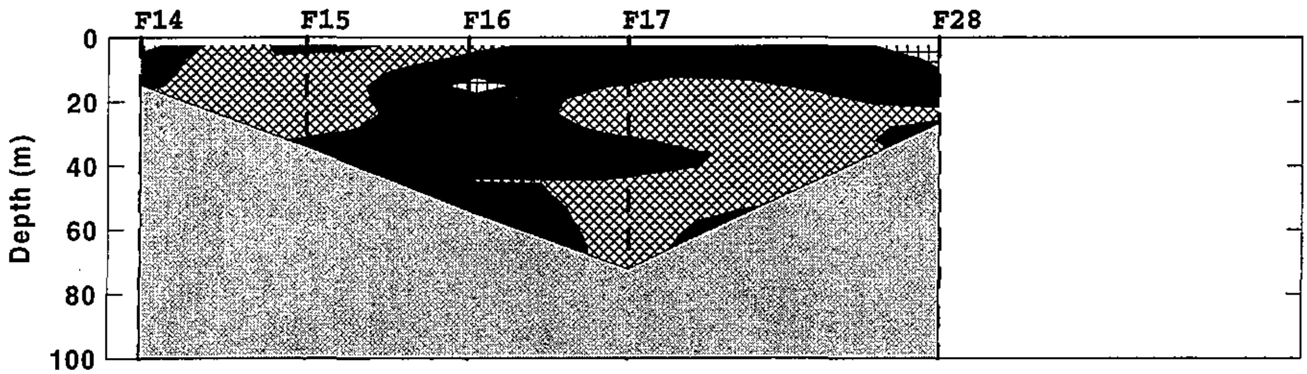


Silicate 9702

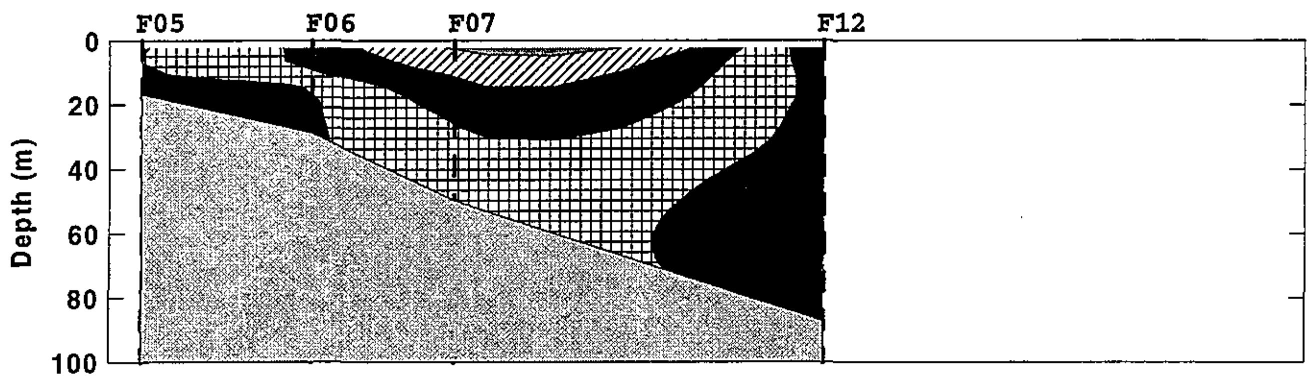
Boston-Nearfield Transect

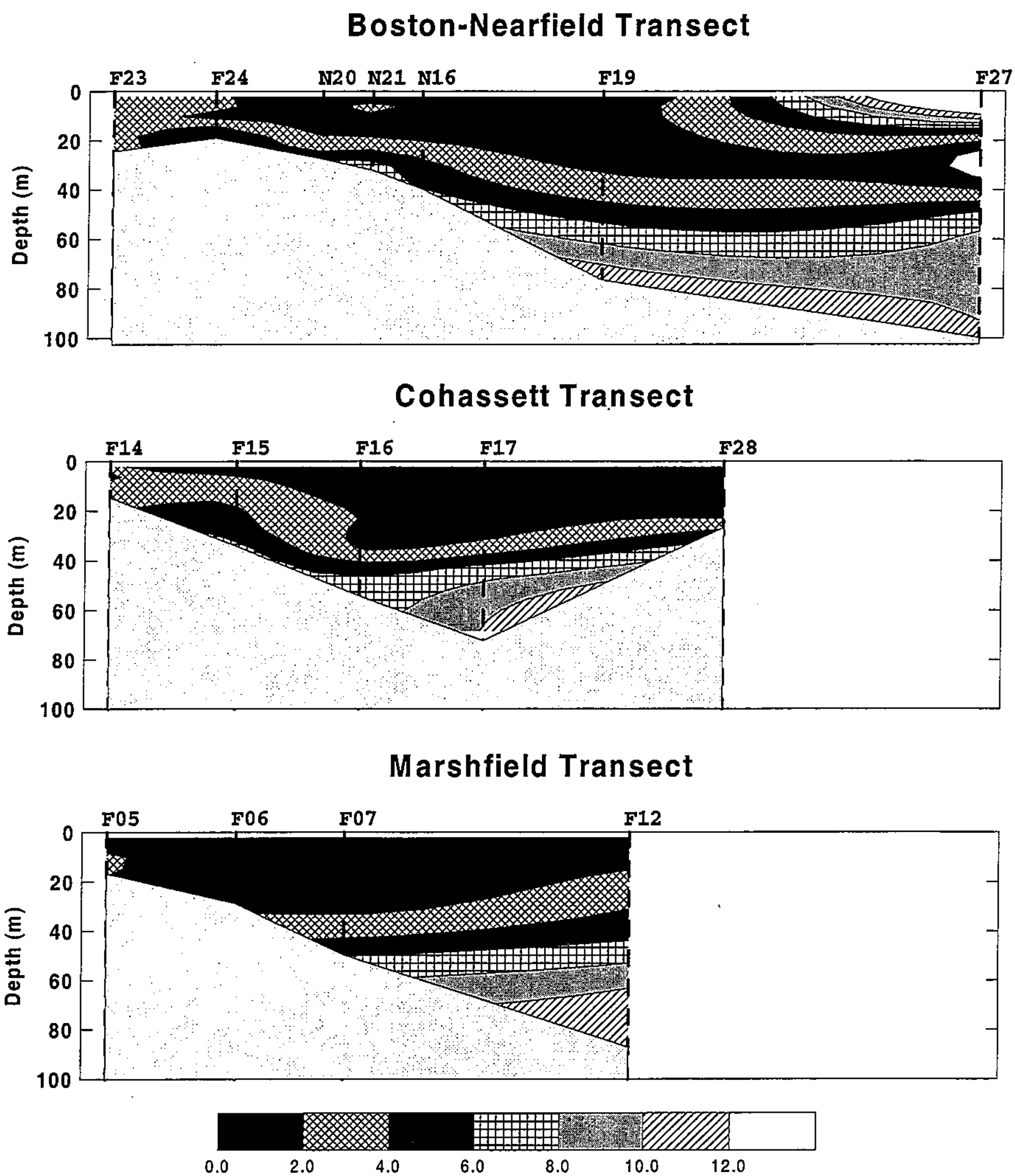


Cohassett Transect

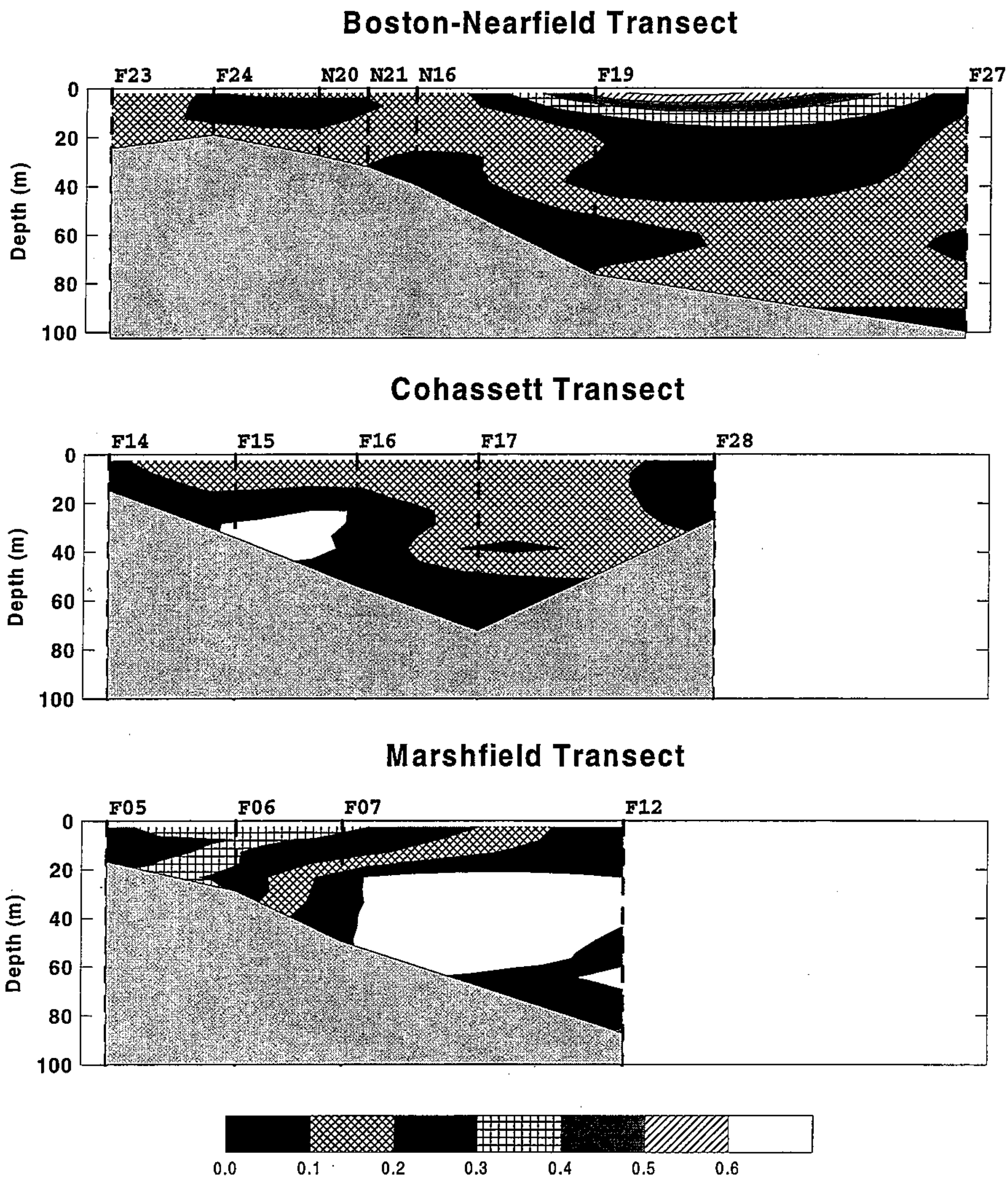


Marshfield Transect

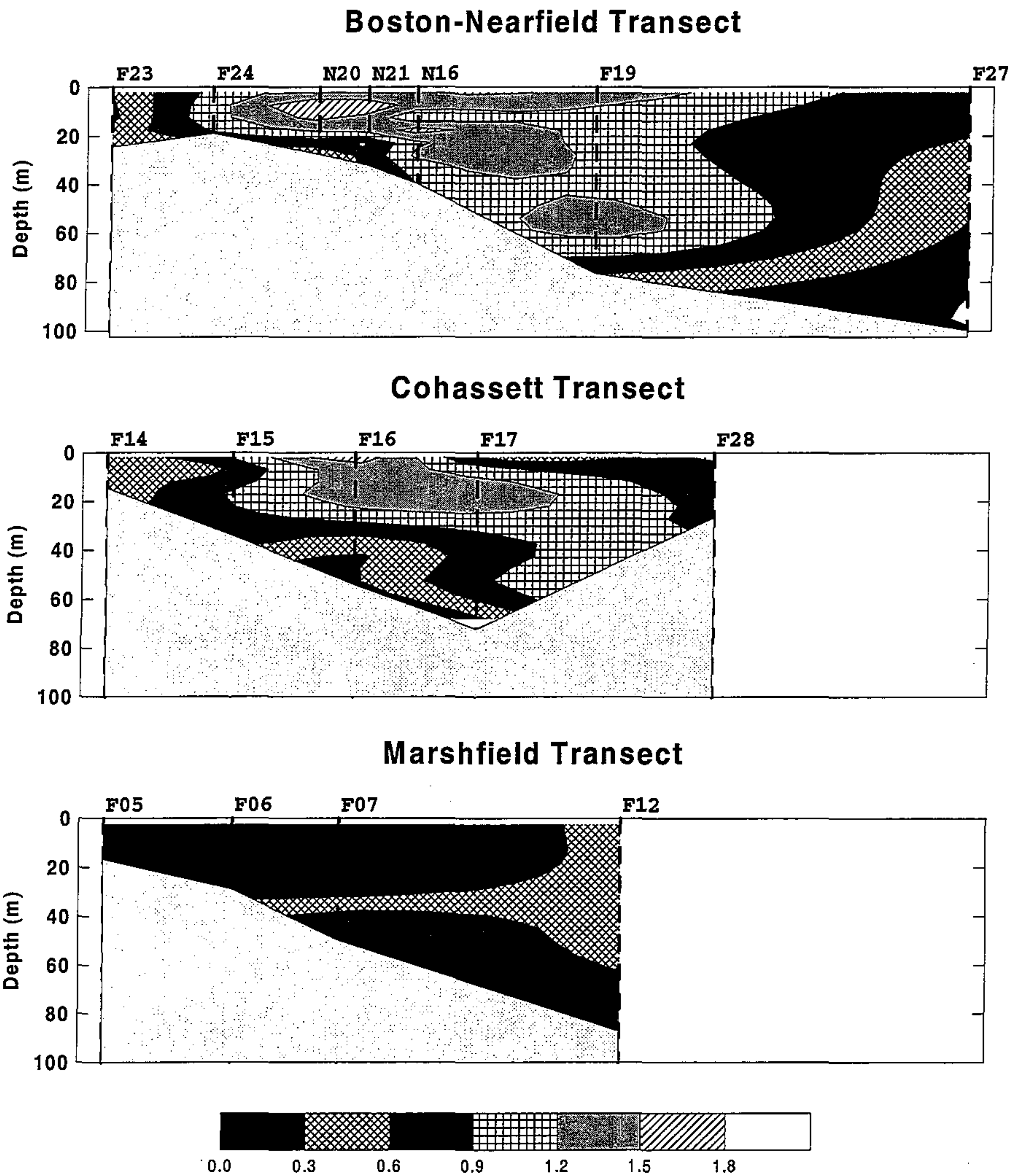




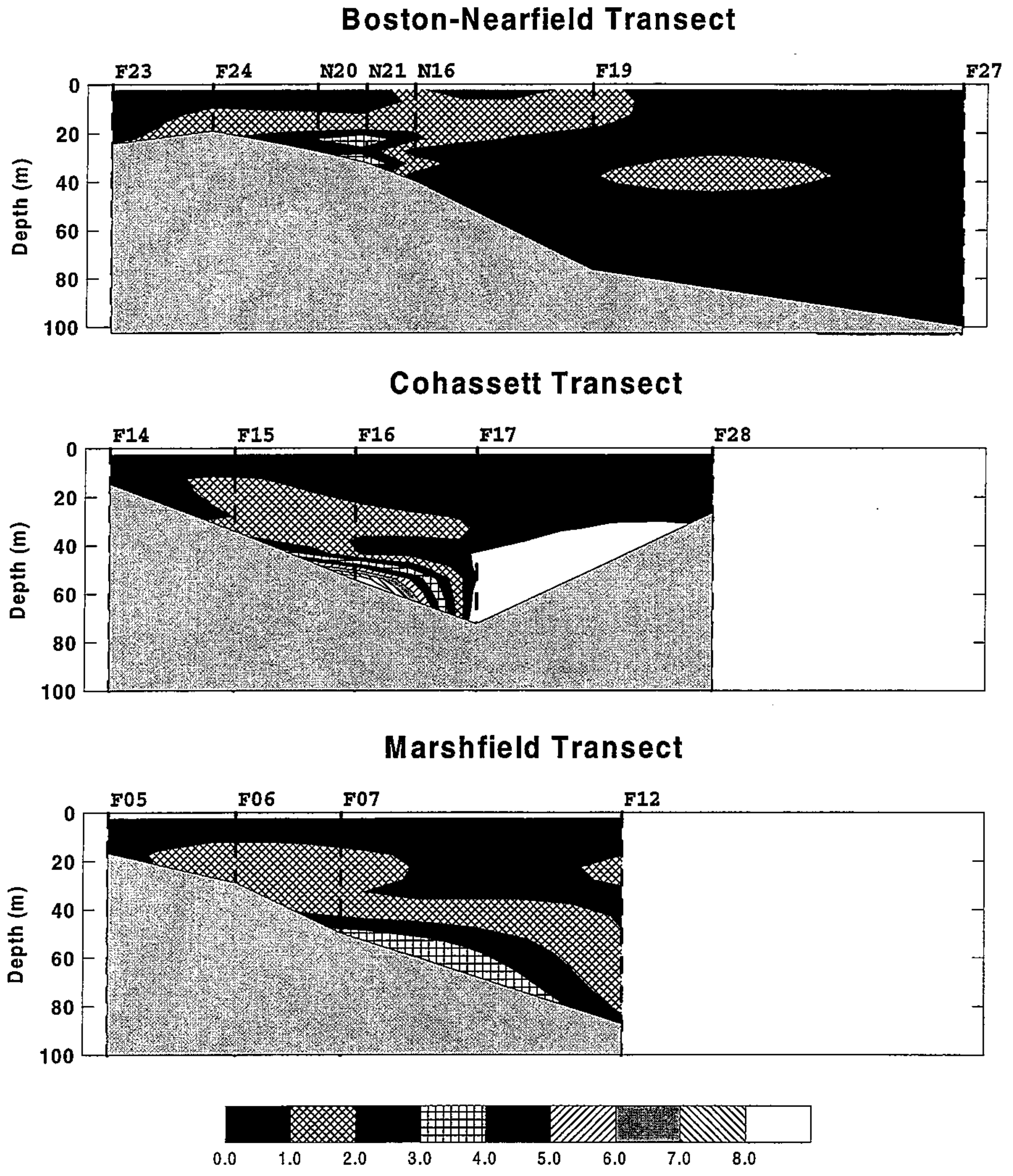
Silicate 9707



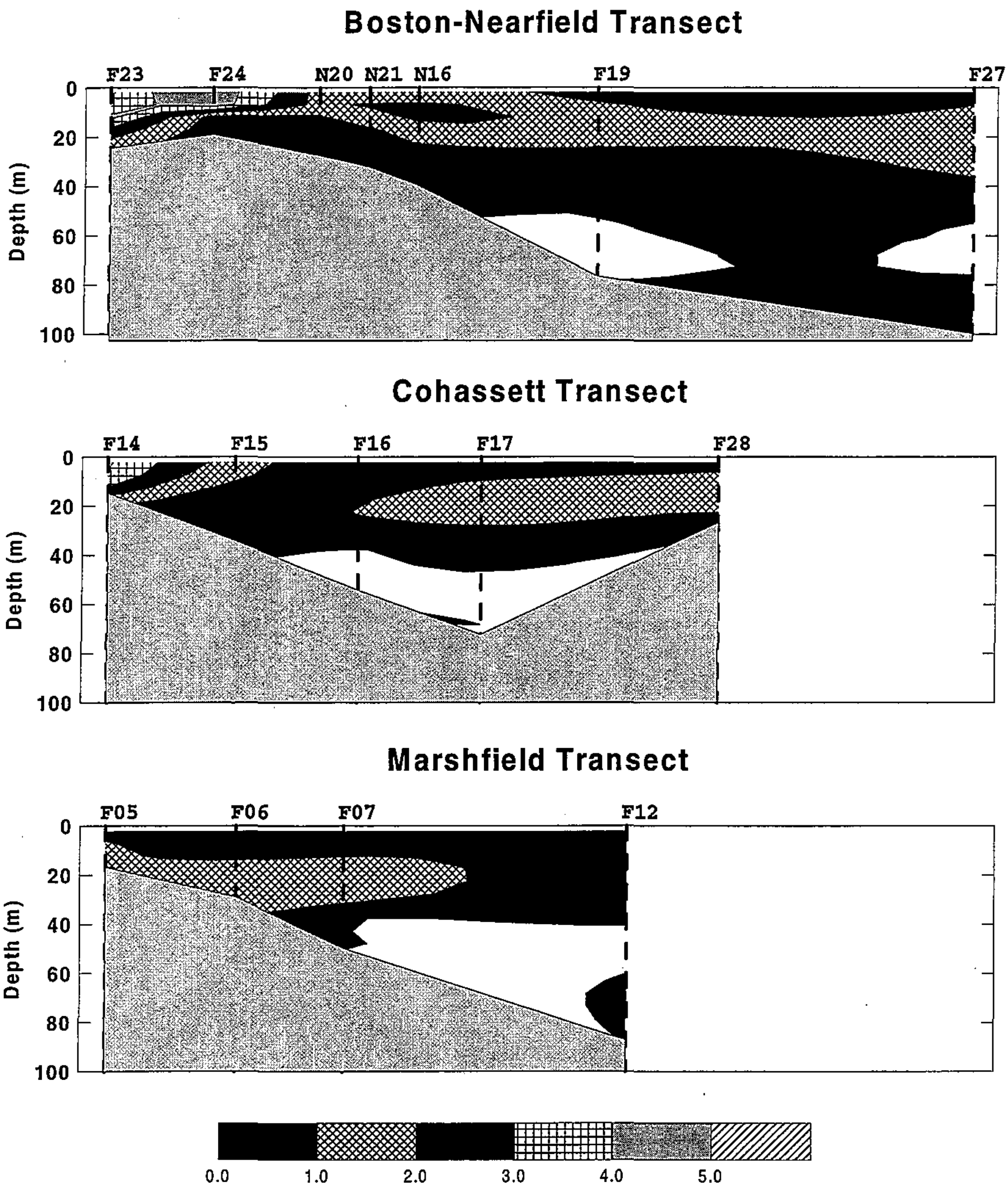
Fluorescence 9701



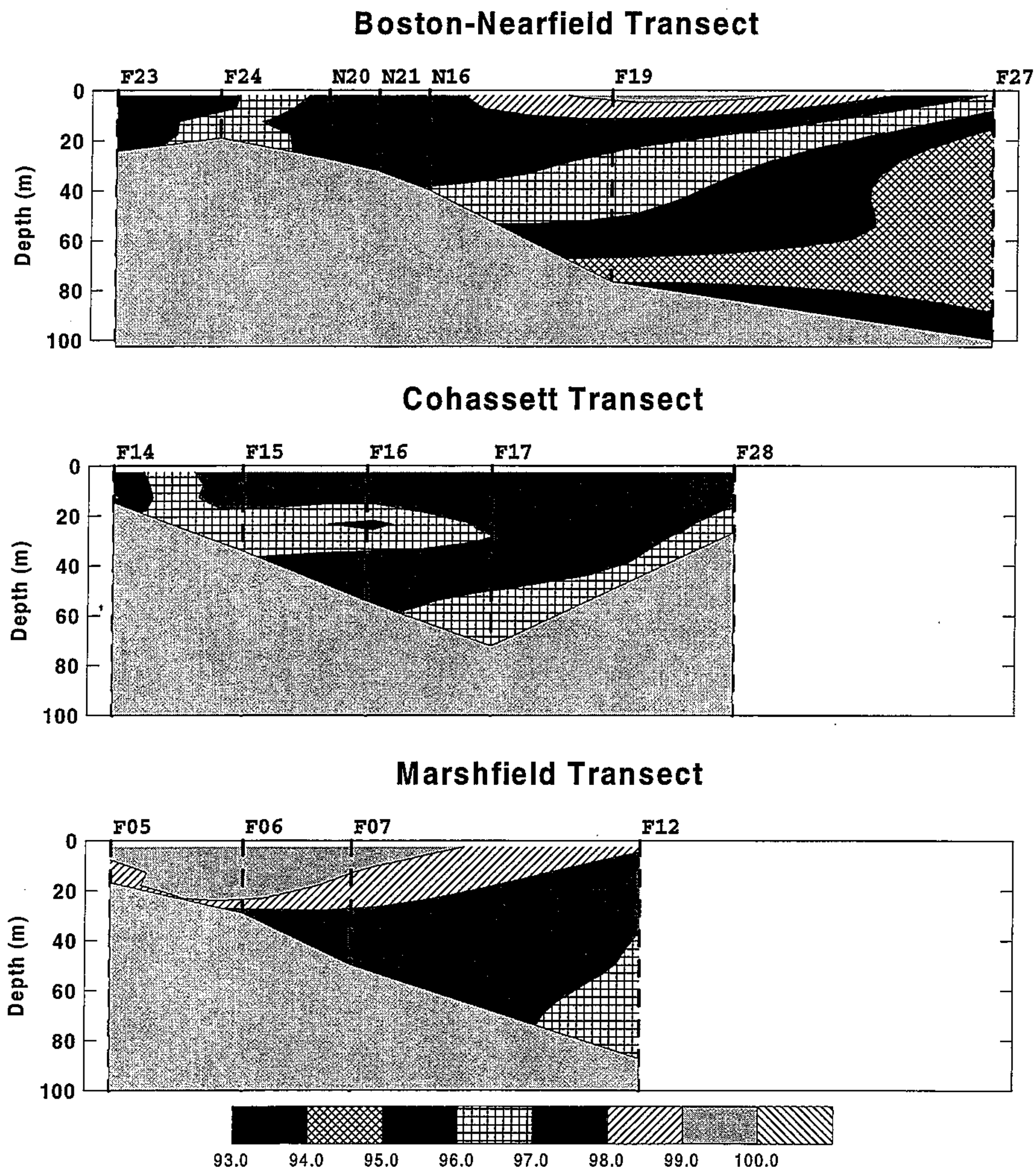
Fluorescence 9702



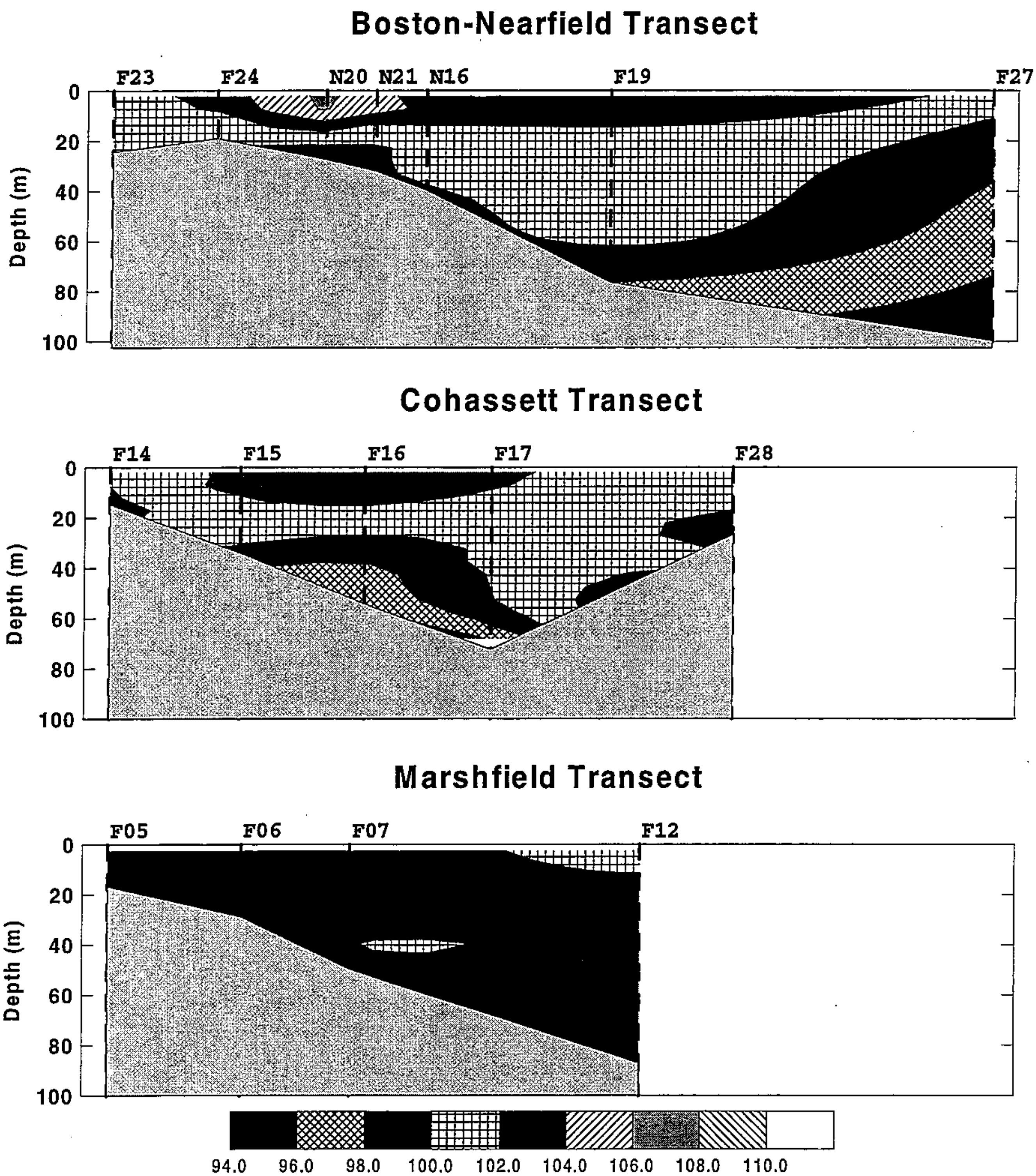
Fluorescence 9704



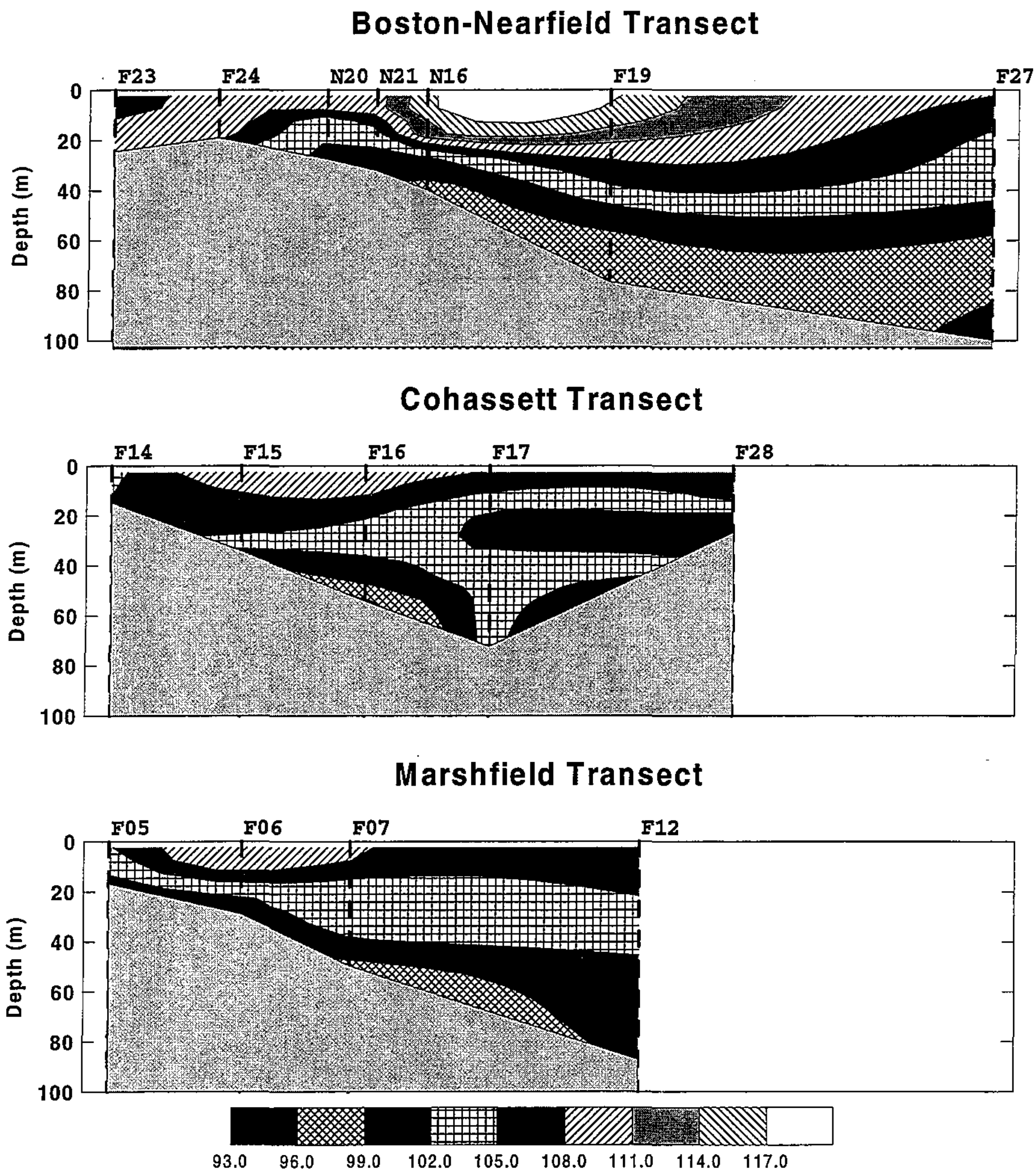
Fluorescence 9707



DO % Saturation 9701

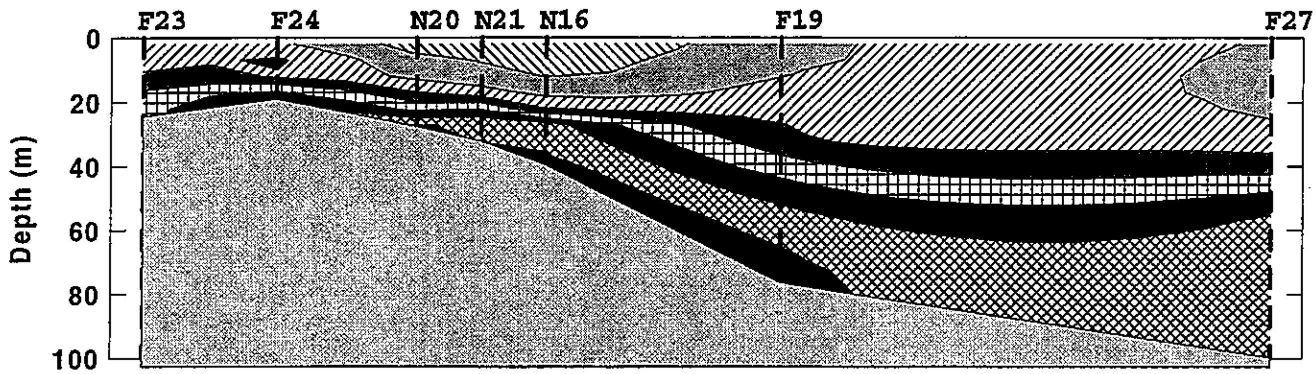


DO % Saturation 9702

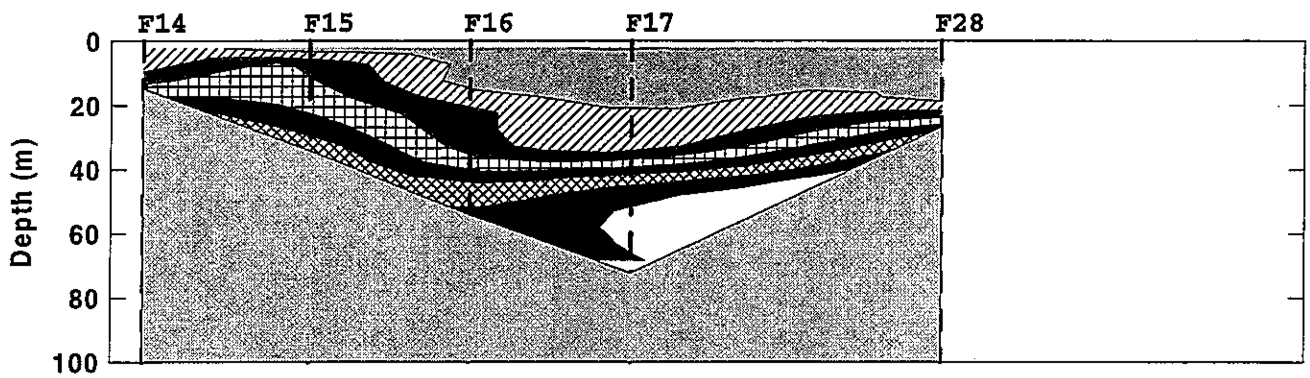


DO % Saturation 9704

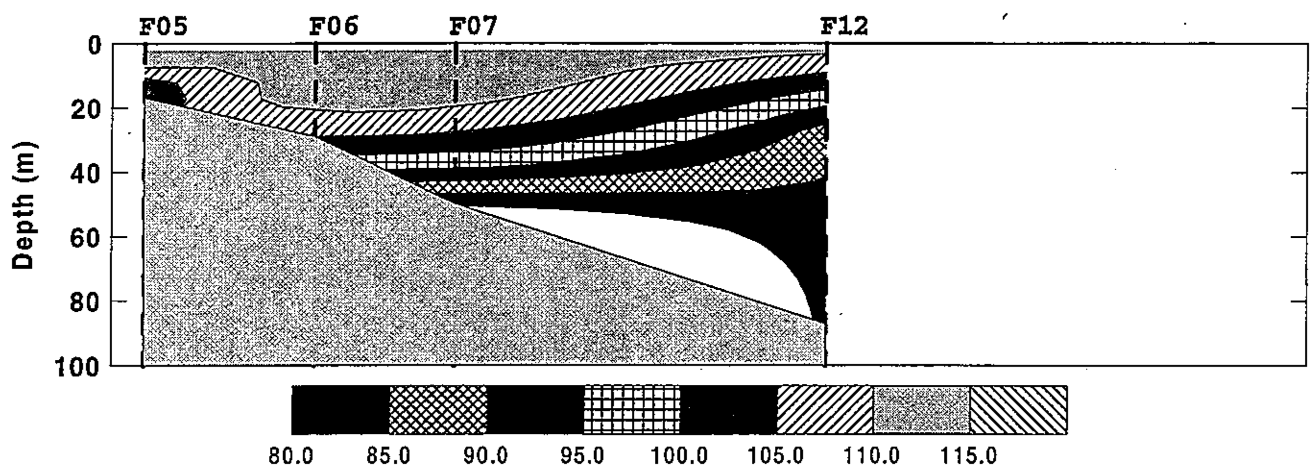
Boston-Nearfield Transect



Cohassett Transect



Marshfield Transect



DO % Saturation 9707

APPENDIX C

Nutrient Scatter Plots

Scatter plots are included for every survey conducted during the semi-annual period. Each plot includes all stations and all depths. The plots are organized by type of plot, and then by survey. Combined nearfield/farfield surveys show the regions with different symbols, including Boundary, Cape Cod Bay, Coastal, Boston Harbor, Nearfield, and Offshore. Available plots are summarized in the text.

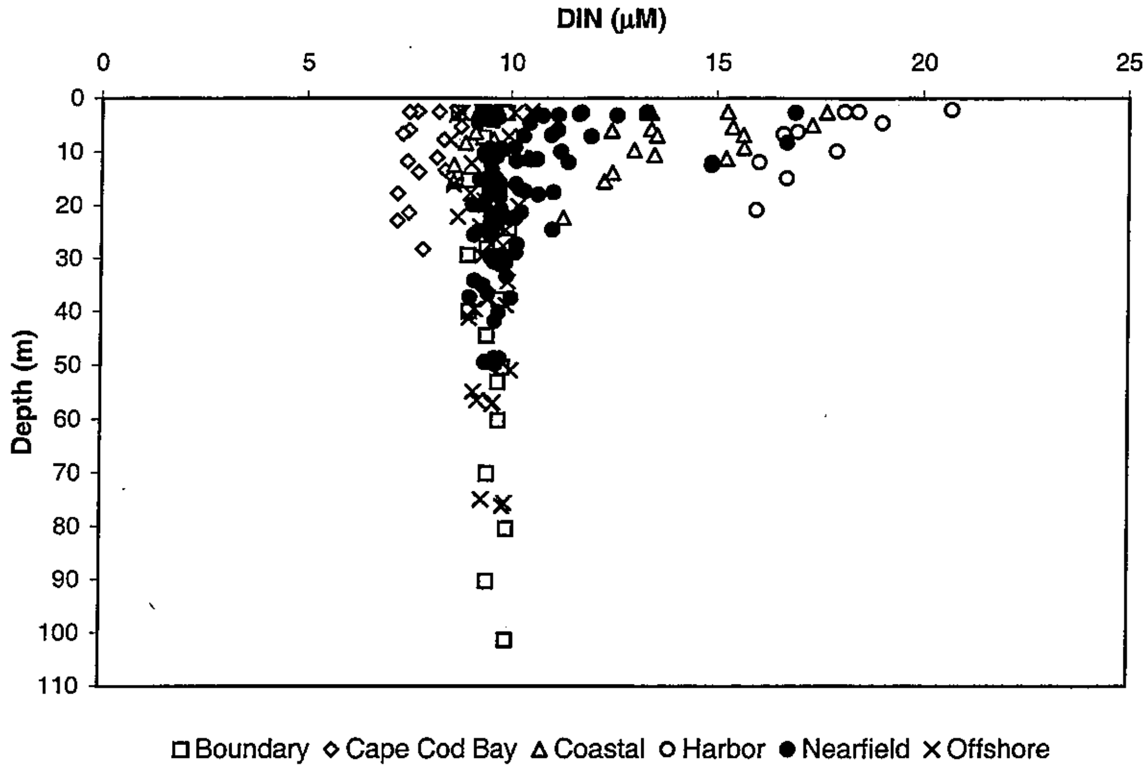


FIGURE 4-1
Depth vs. nutrient plots for farfield survey W9701, (Feb 97)

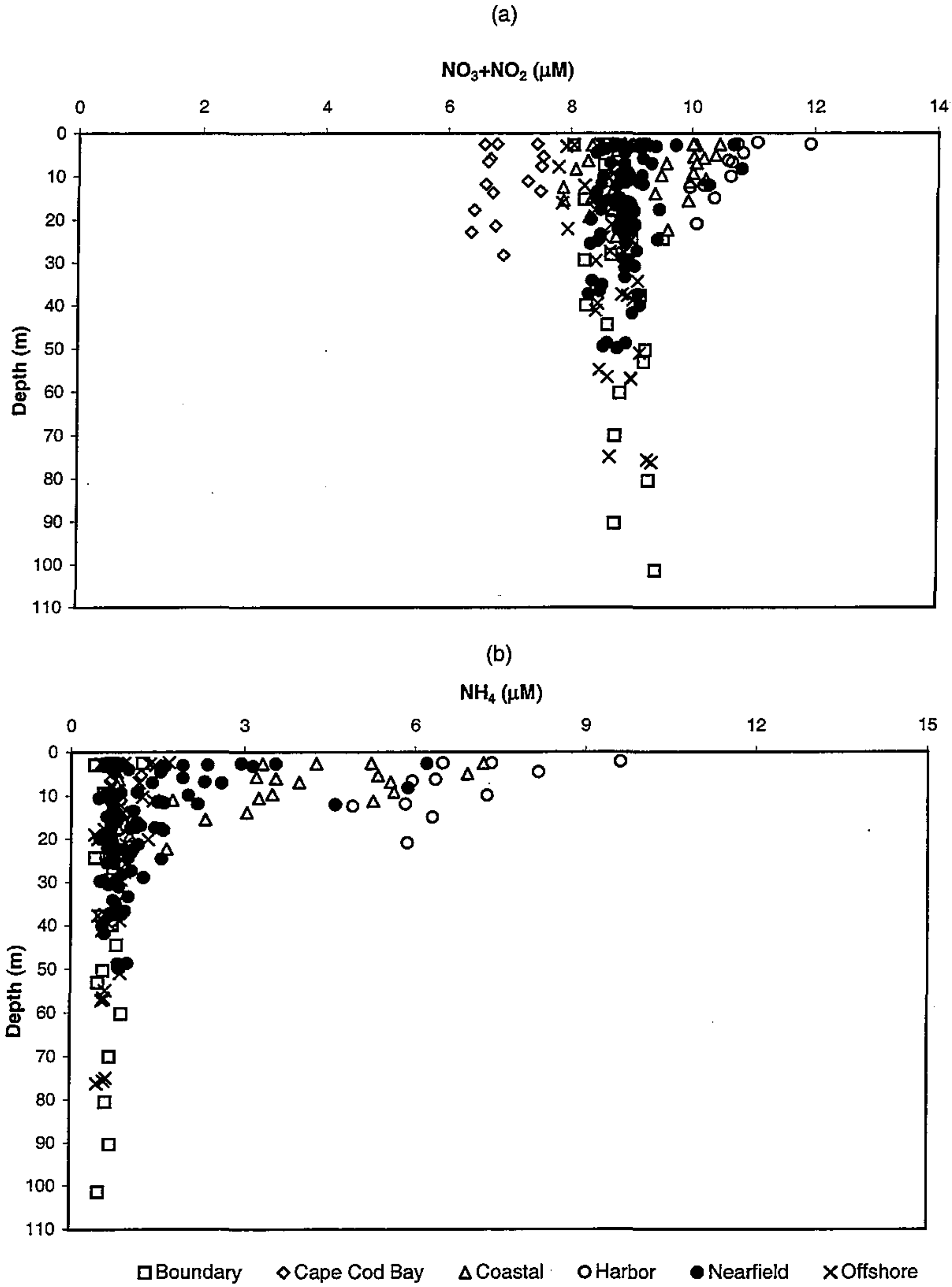


FIGURE 4-2

Depth vs. nutrient plots for farfield survey W9701, (Feb 97)

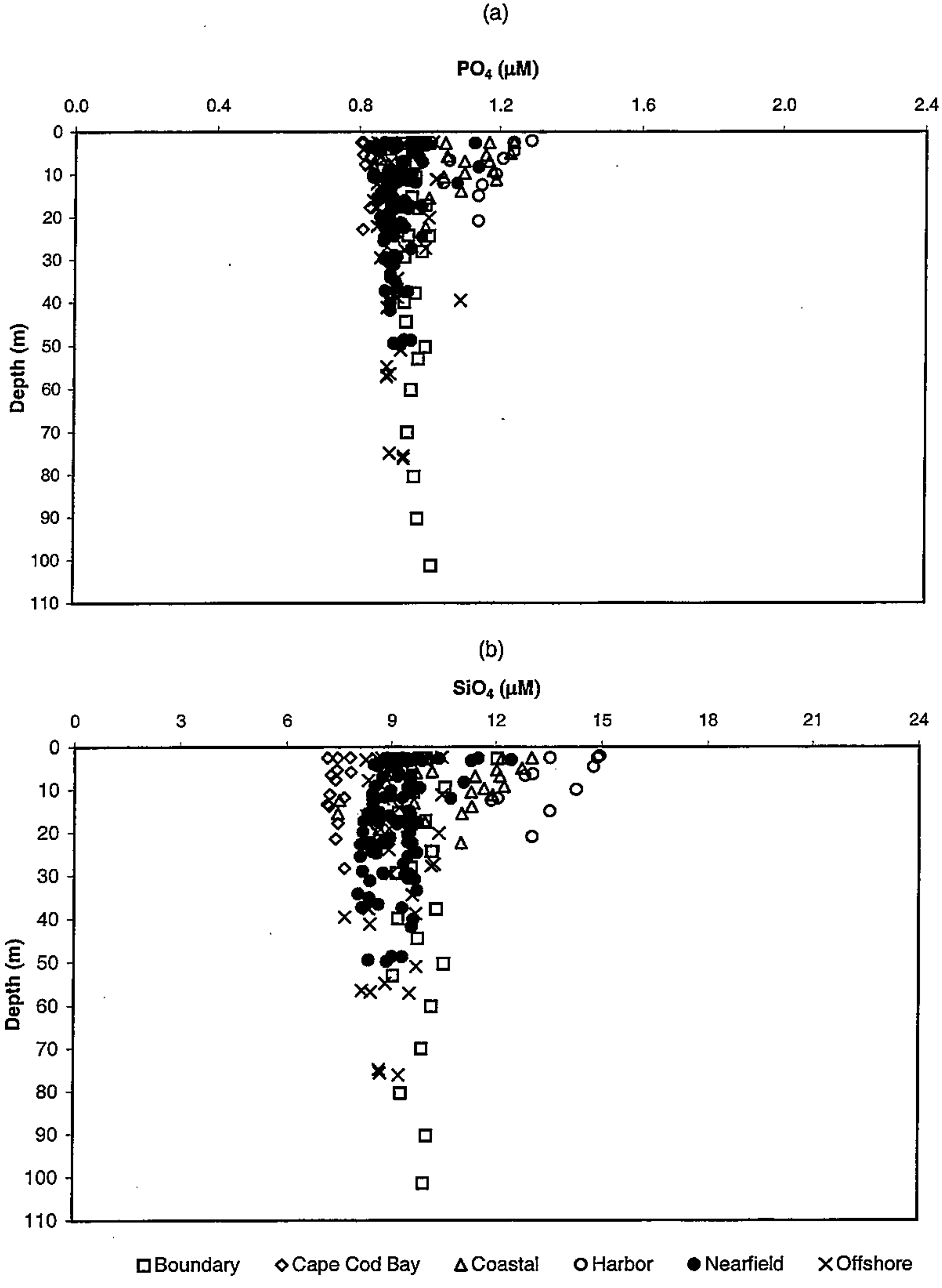
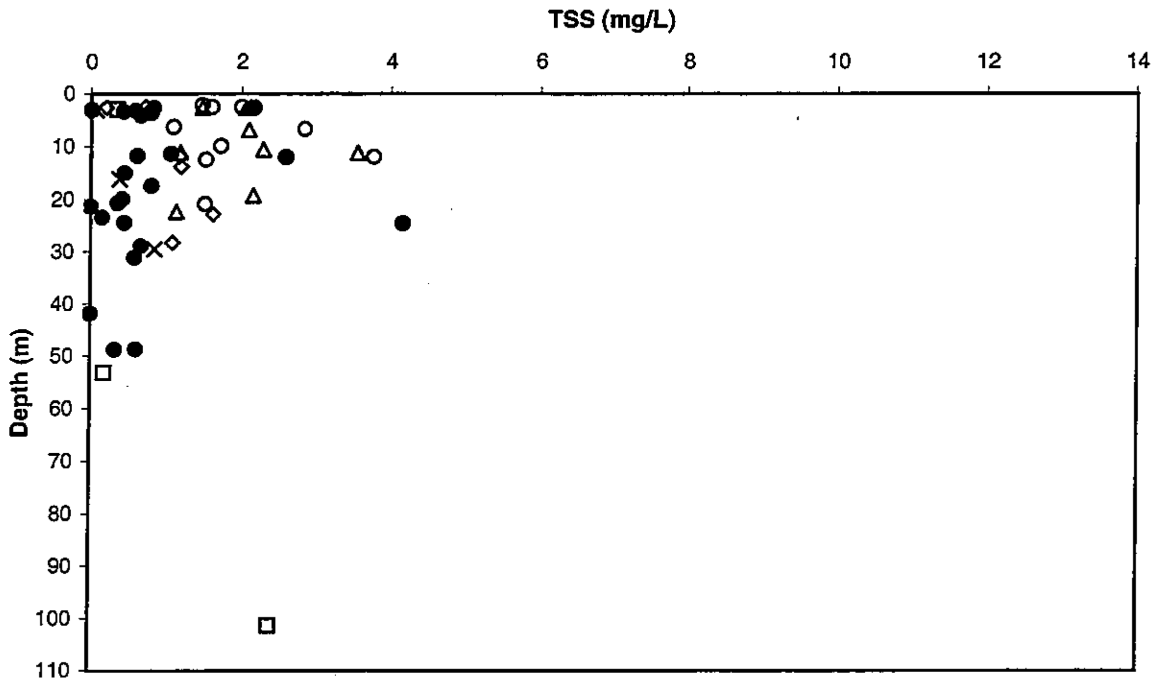


FIGURE 4-3

Depth vs. nutrient plots for farfield survey W9701, (Feb 97)

(a)



(b)

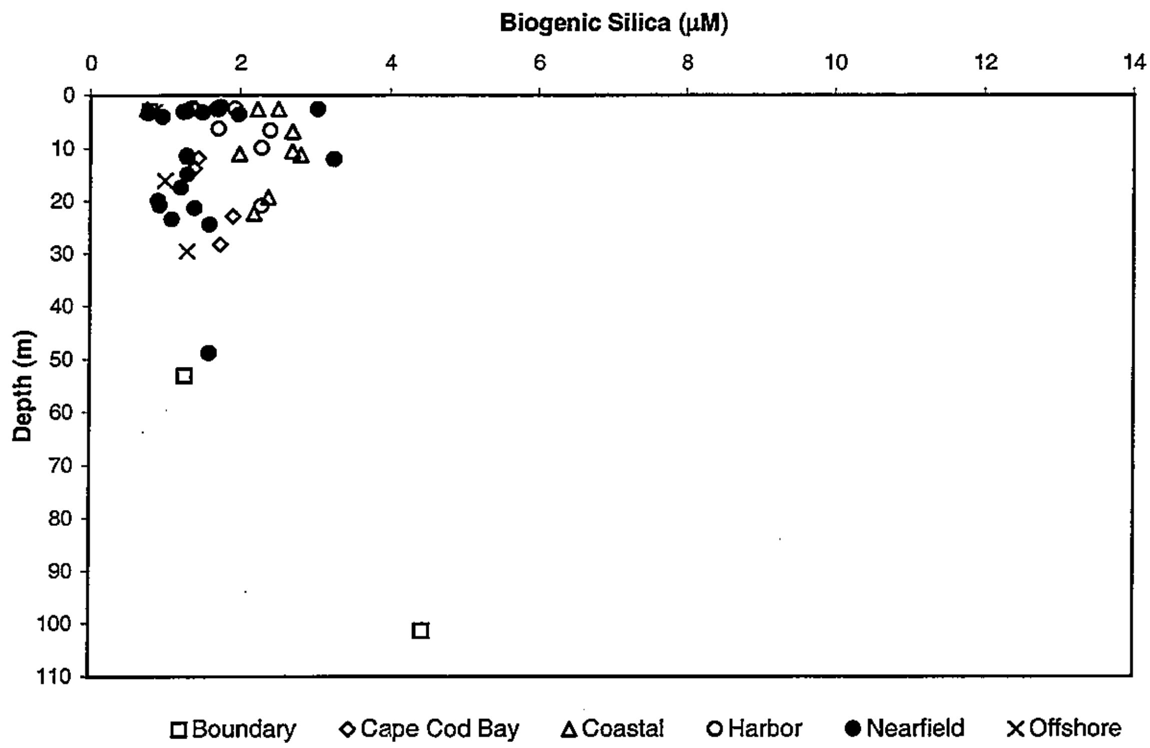


FIGURE 4-4

Depth vs. nutrient plots for farfield survey W9701, (Feb 97)

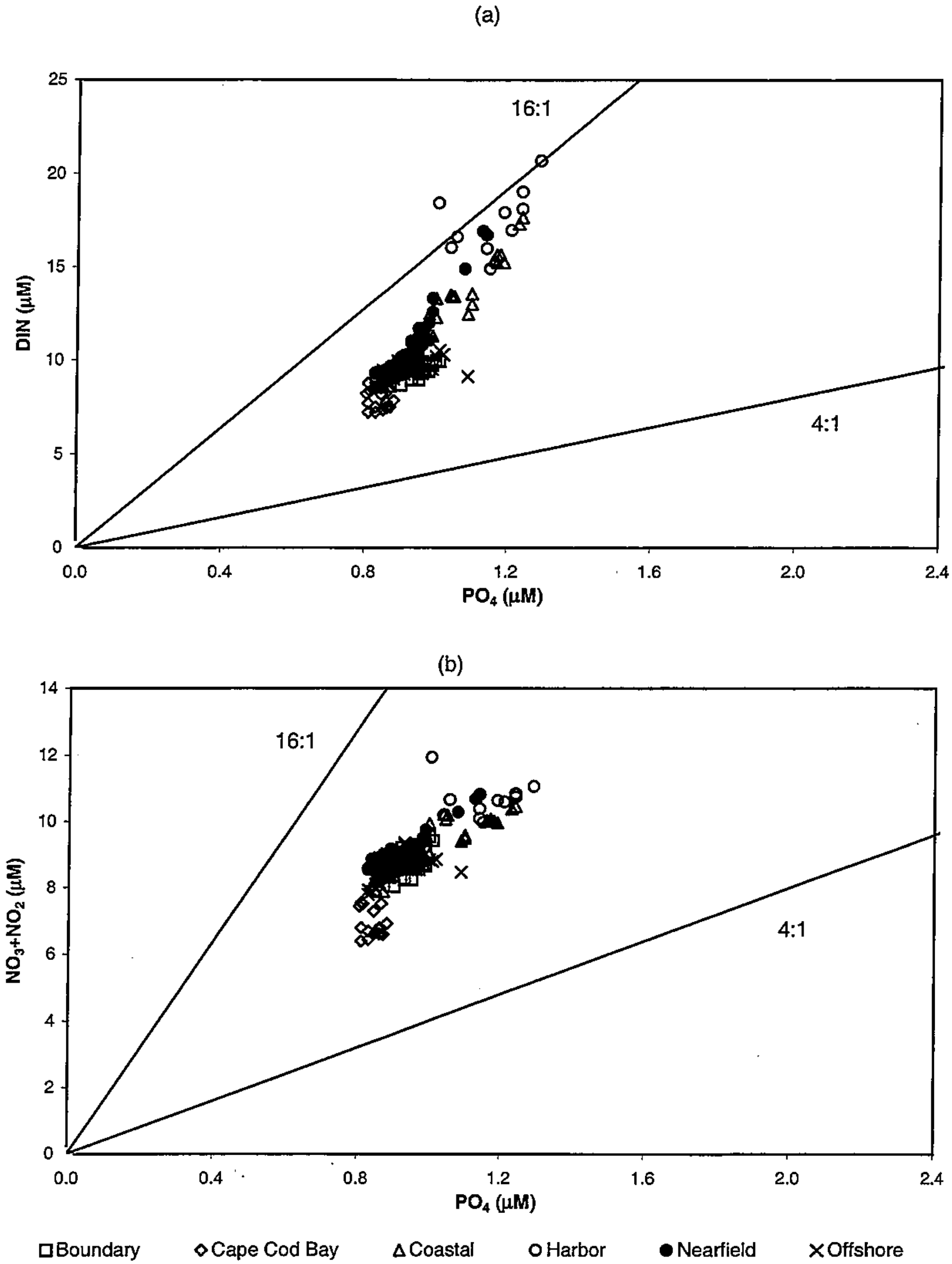


FIGURE 4-5

Nutrient vs. nutrient plots for farfield survey W9701, (Feb 97)

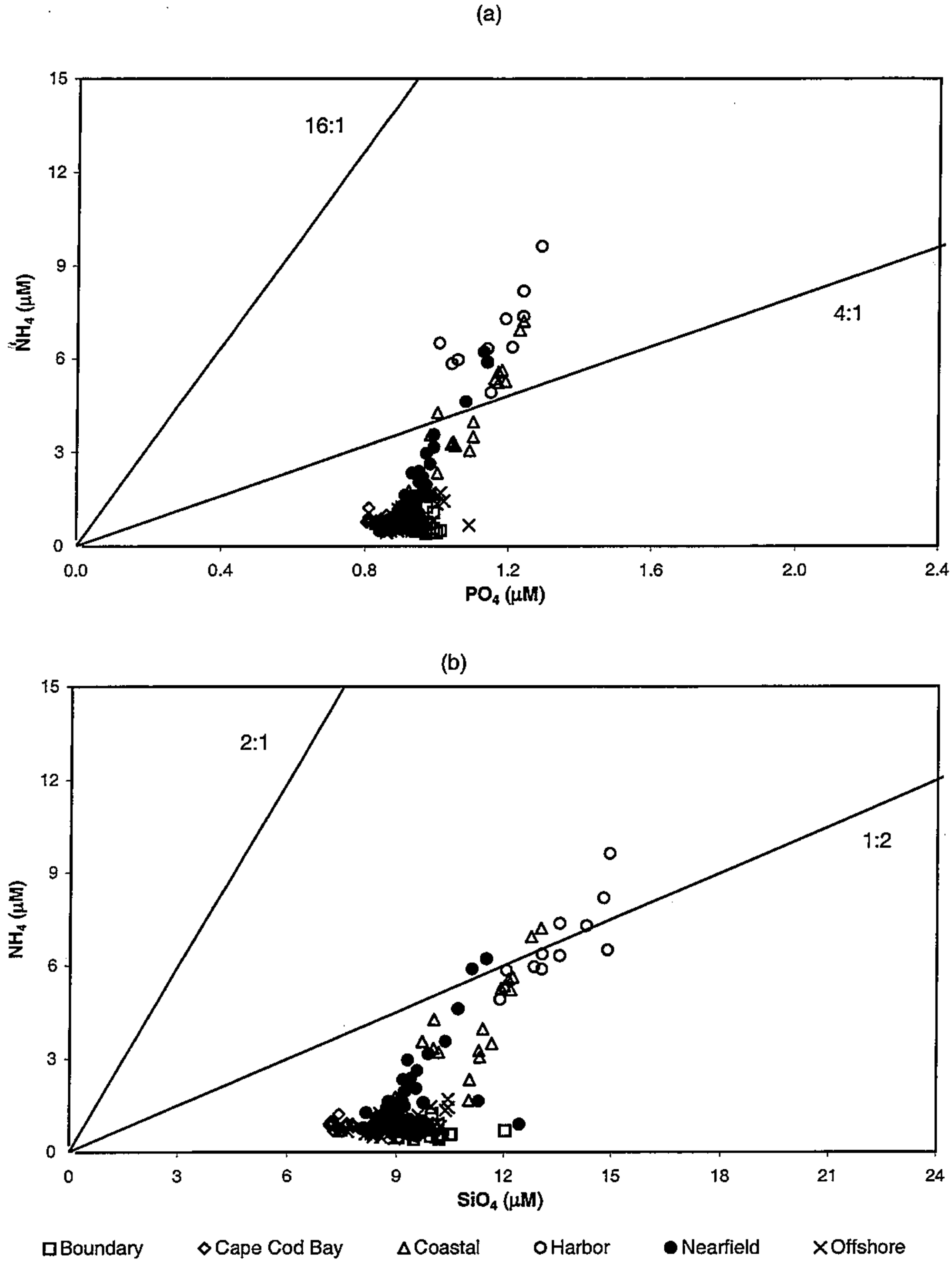


FIGURE 4-6

Nutrient vs. nutrient plots for farfield survey W9701, (Feb 97)

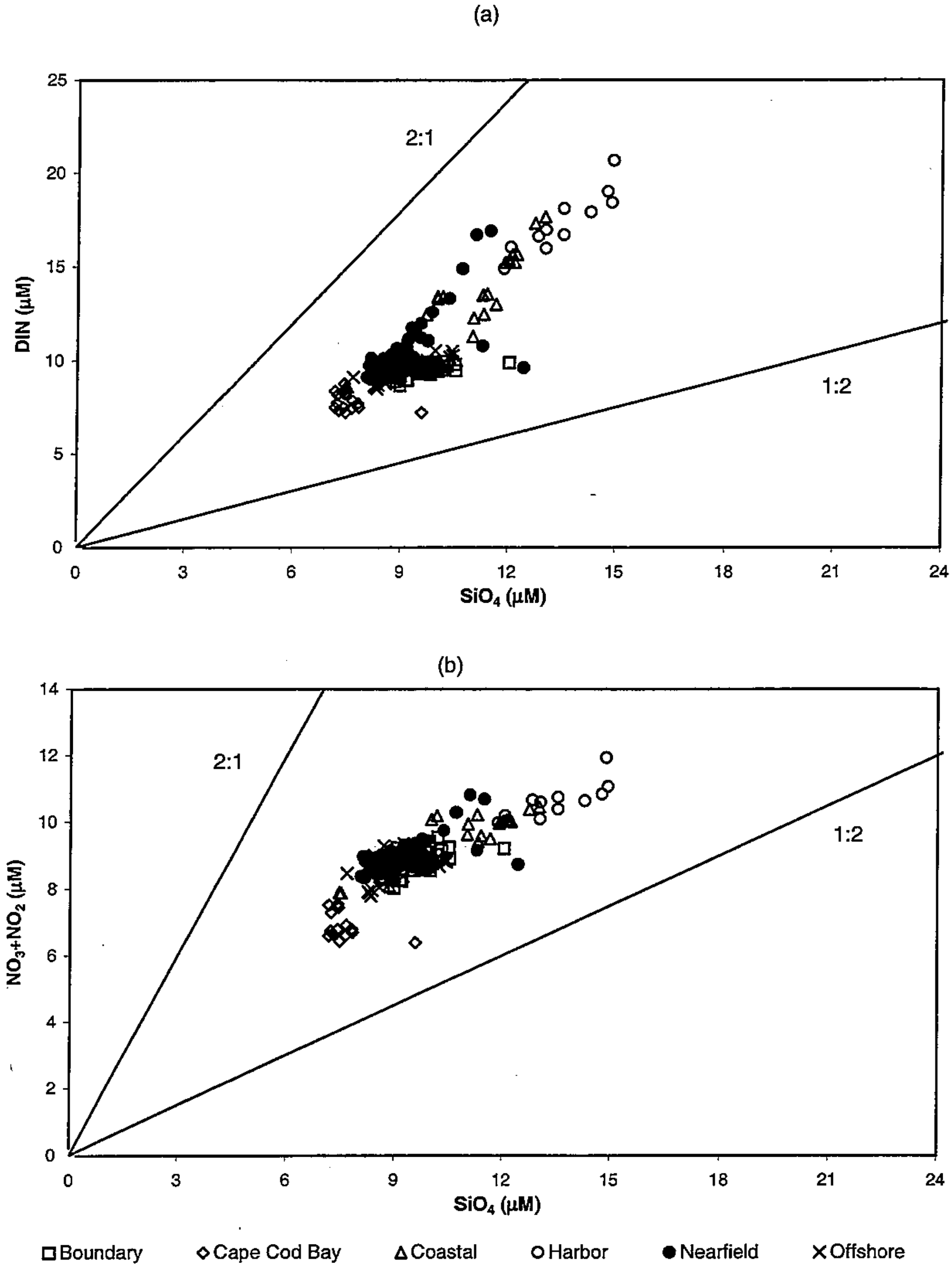


FIGURE 4-7
Nutrient vs. nutrient plots for farfield survey W9701, (Feb 97)

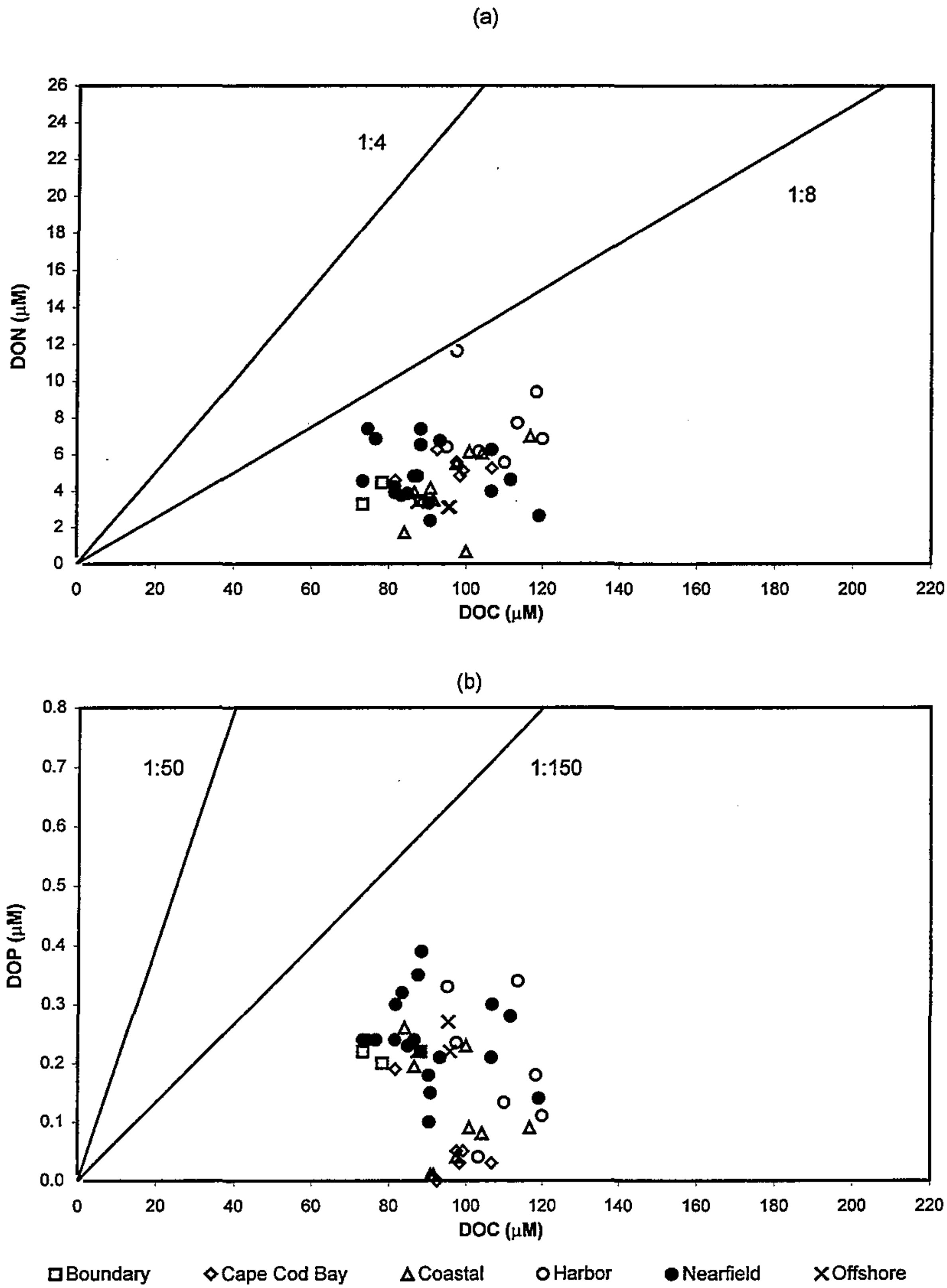


FIGURE 4-8

Nutrient vs. nutrient plots for farfield survey W9701, (Feb 97)

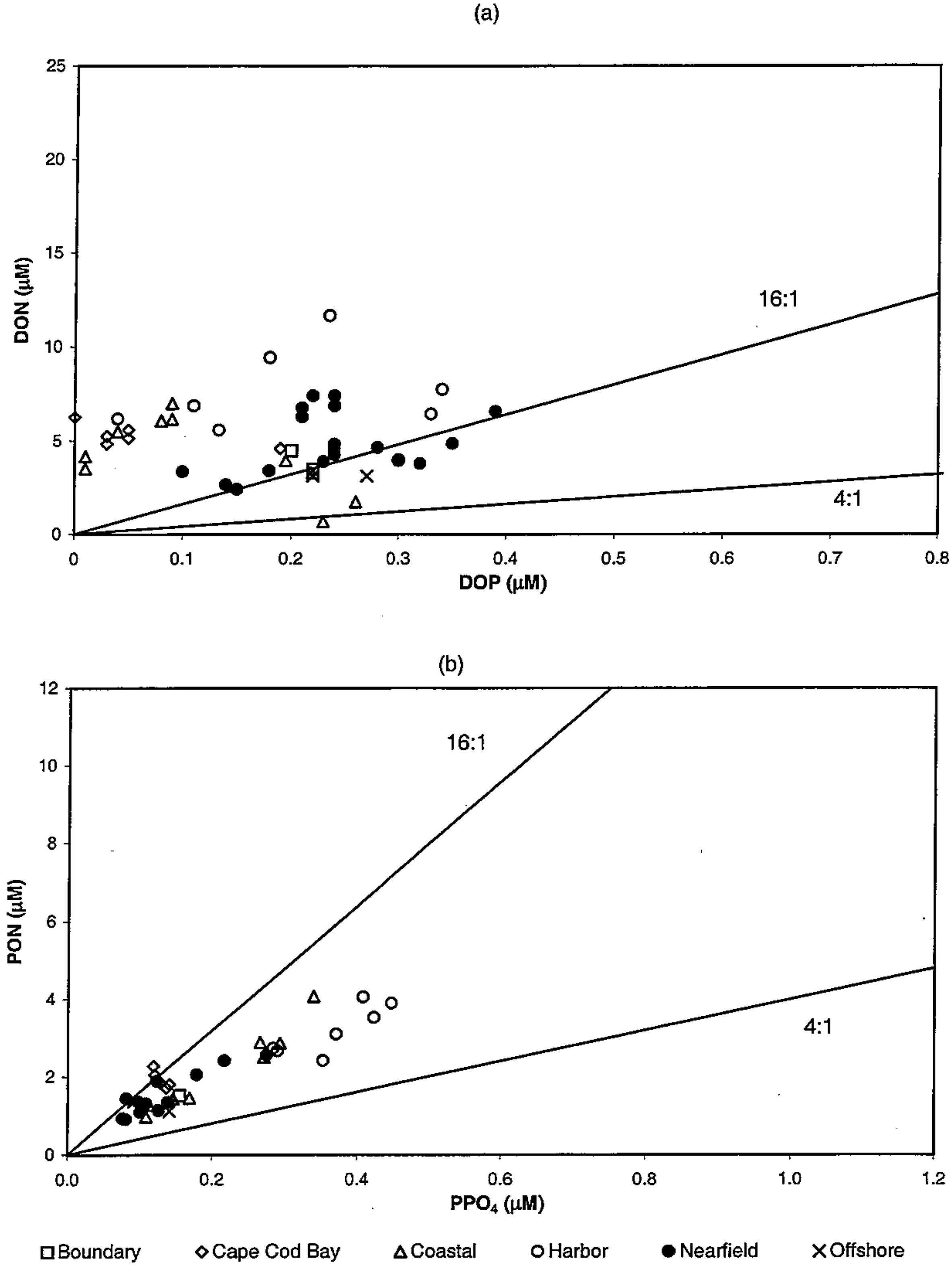


FIGURE 4-9
Nutrient vs. nutrient plots for farfield survey W9701, (Feb 97)

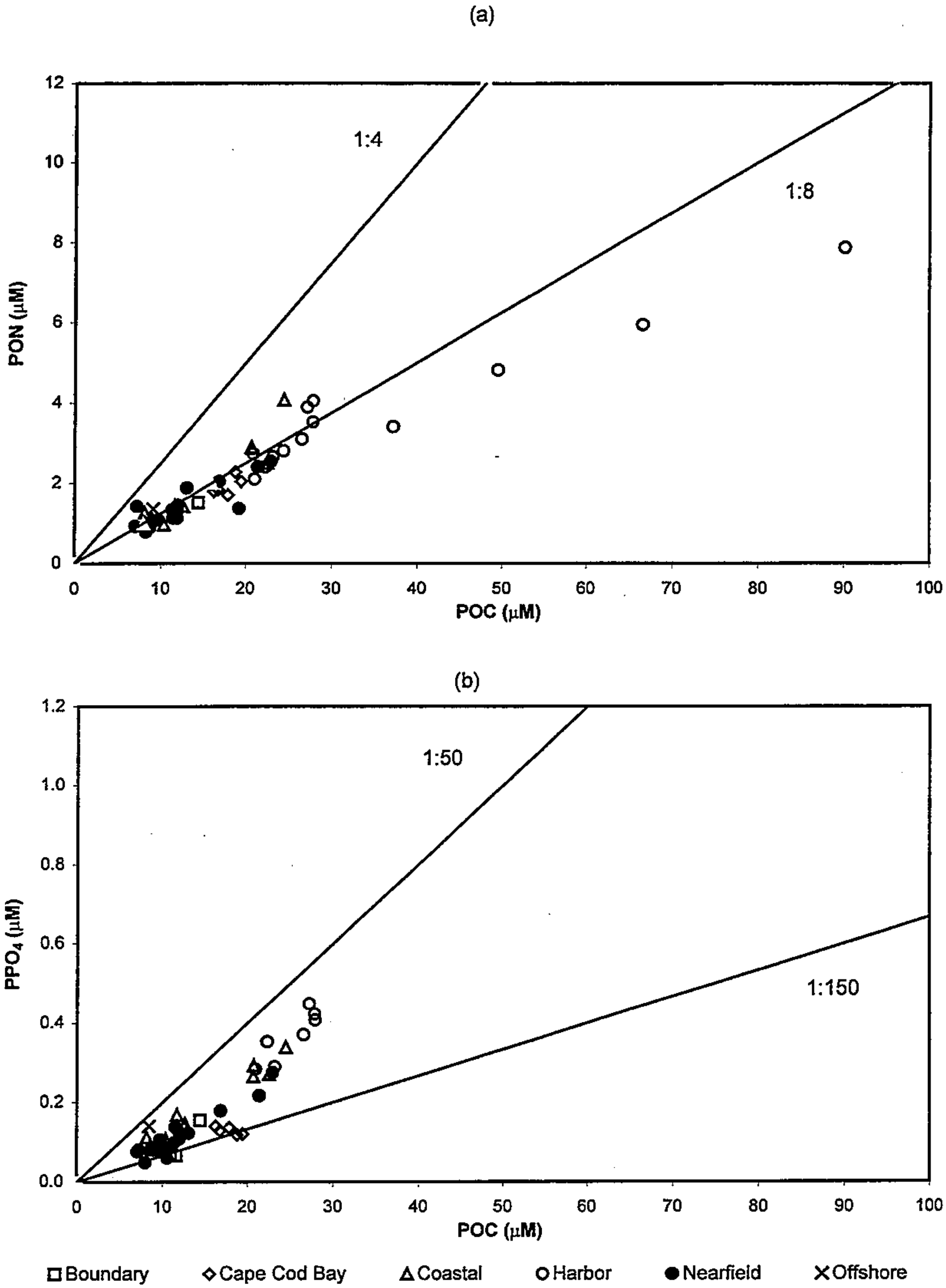


FIGURE 4-10

Nutrient vs. nutrient plots for farfield survey W9701, (Feb 97)

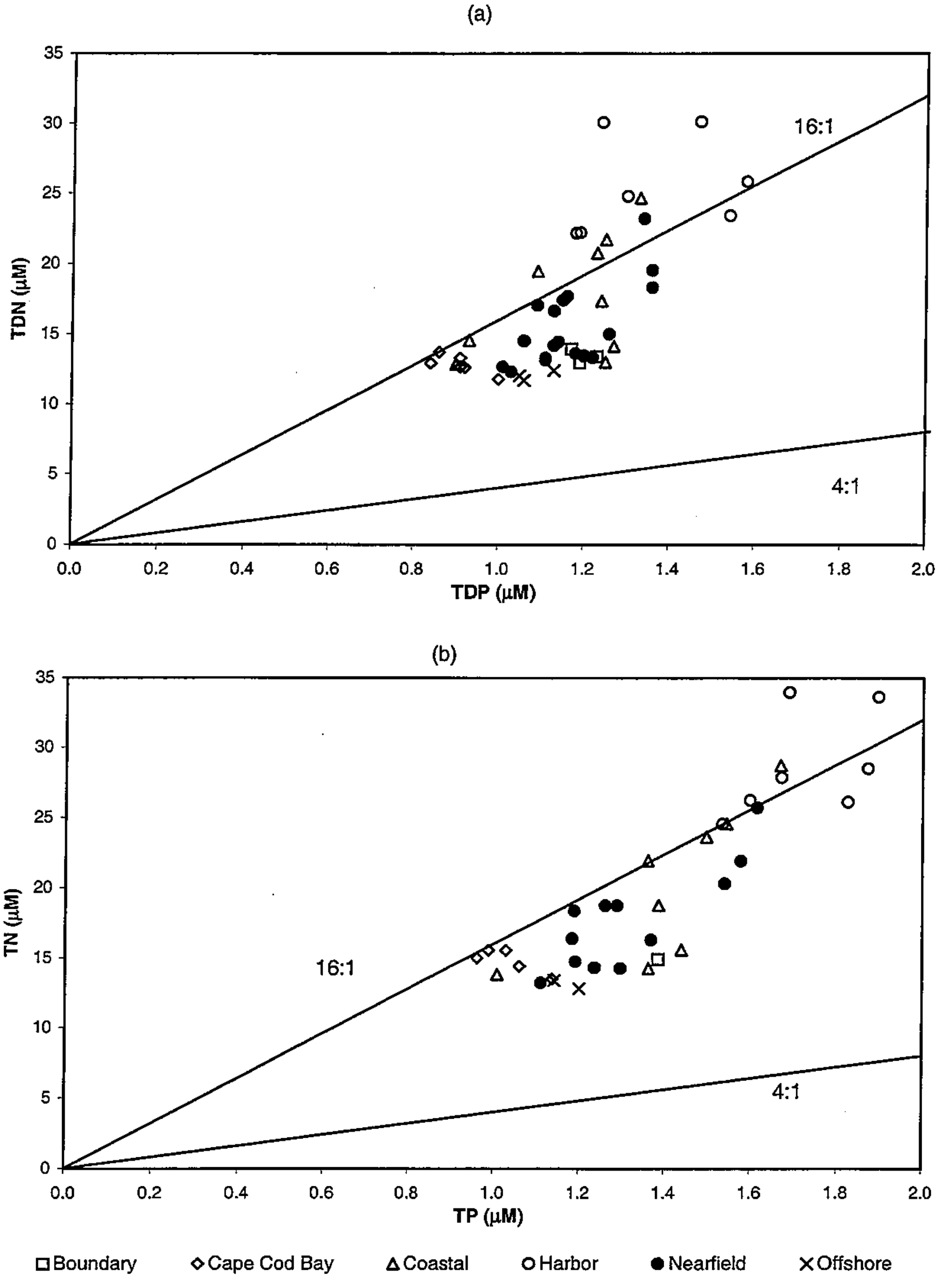


FIGURE 4-11
Nutrient vs. nutrient plots for farfield survey W9701, (Feb 97)

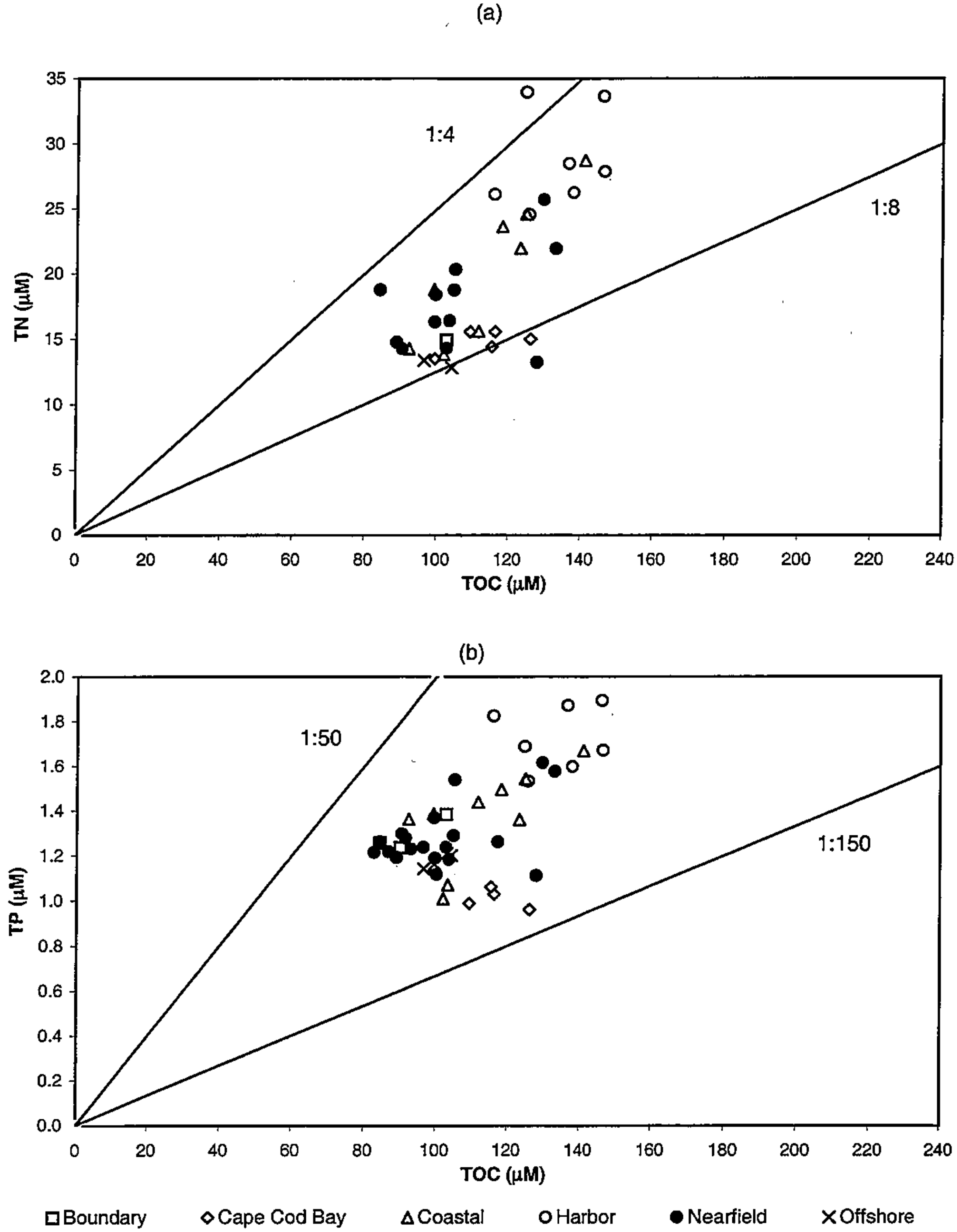


FIGURE 4-12
Depth vs. nutrient plots for farfield survey W9701, (Feb 97)

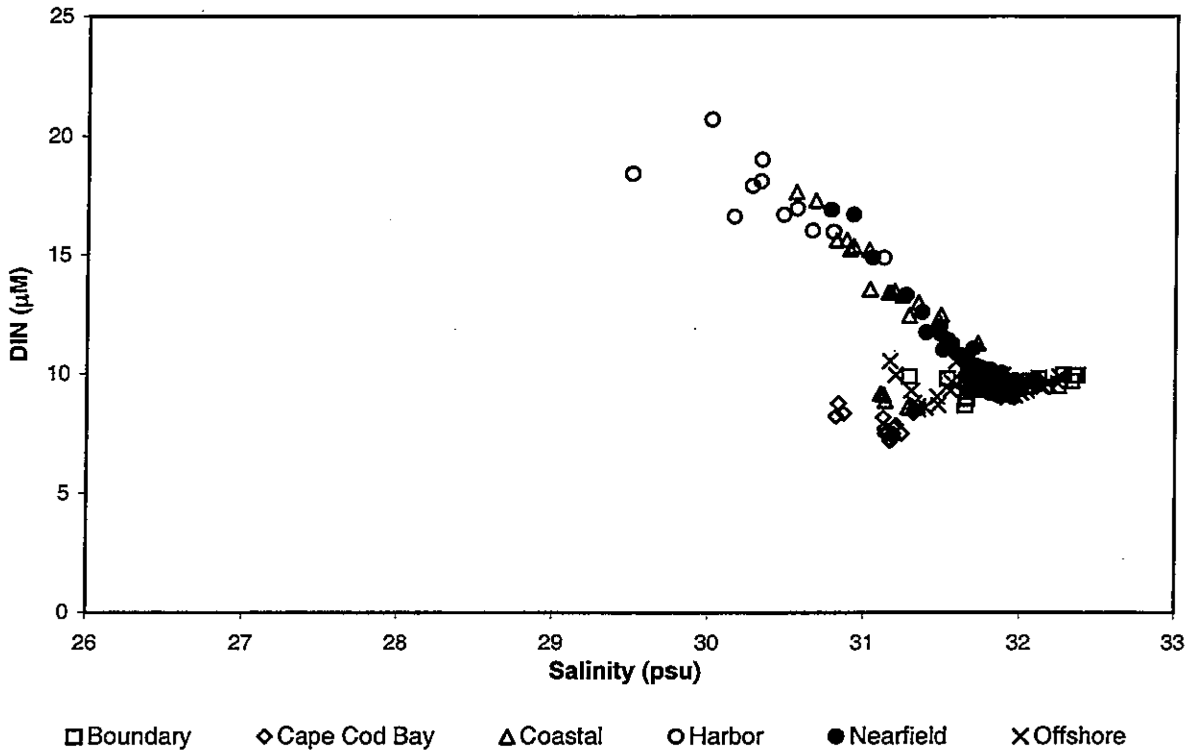


FIGURE 4-13

Nutrient vs. salinity plots for farfield survey W9701, (Feb 97)

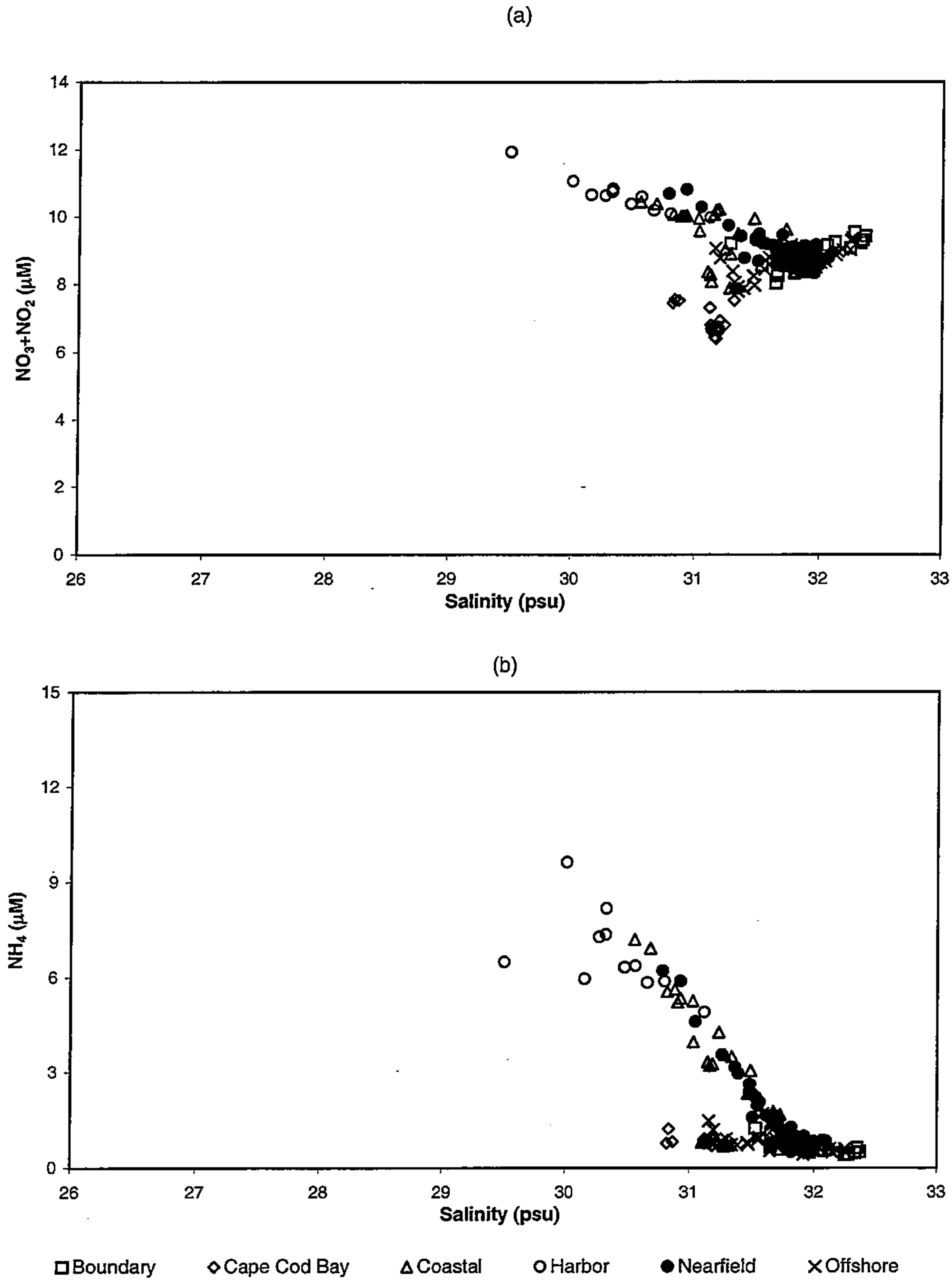


FIGURE 4-14
Nutrient vs. salinity plots for farfield survey W9701, (Feb 97)

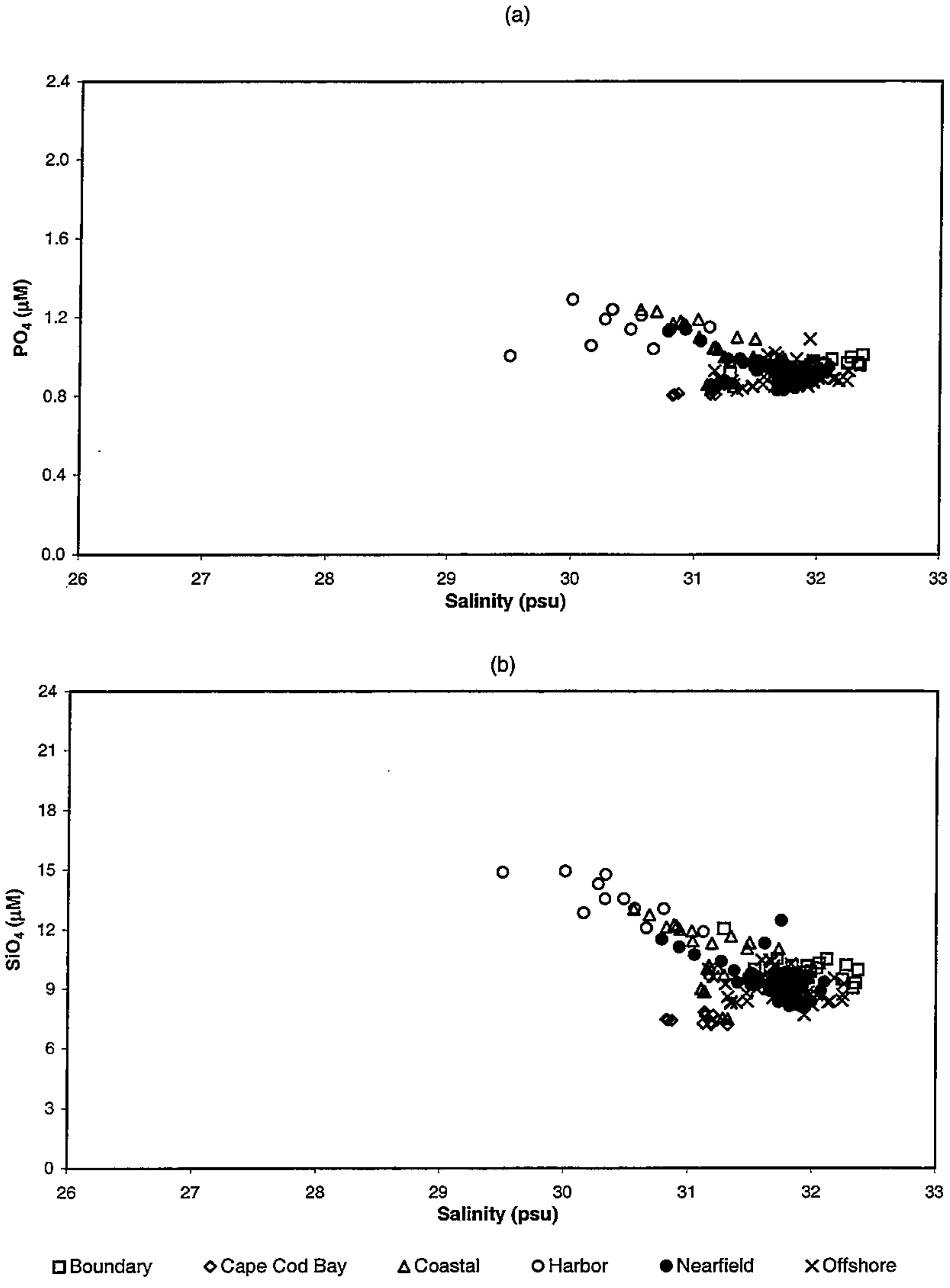


FIGURE 4-15

Nutrient vs. salinity plots for farfield survey W9701, (Feb 97)

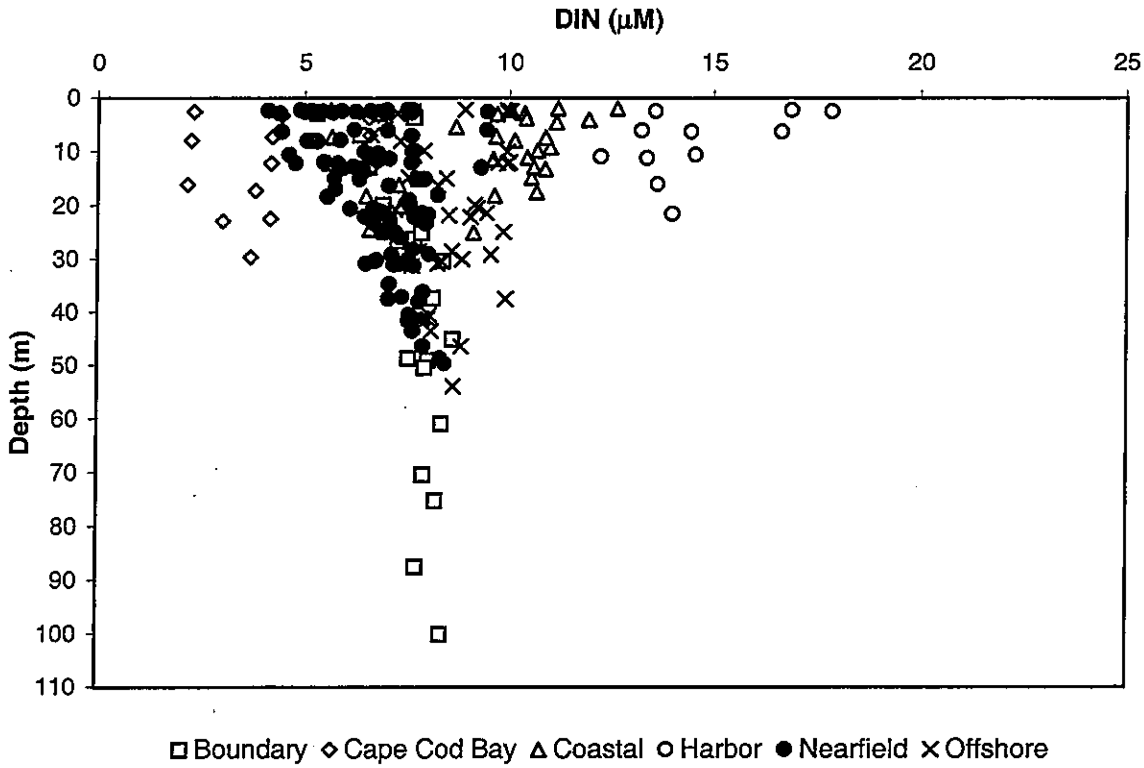


FIGURE 4-16
Depth vs. nutrient plots for farfield survey W9702, (Feb 97)

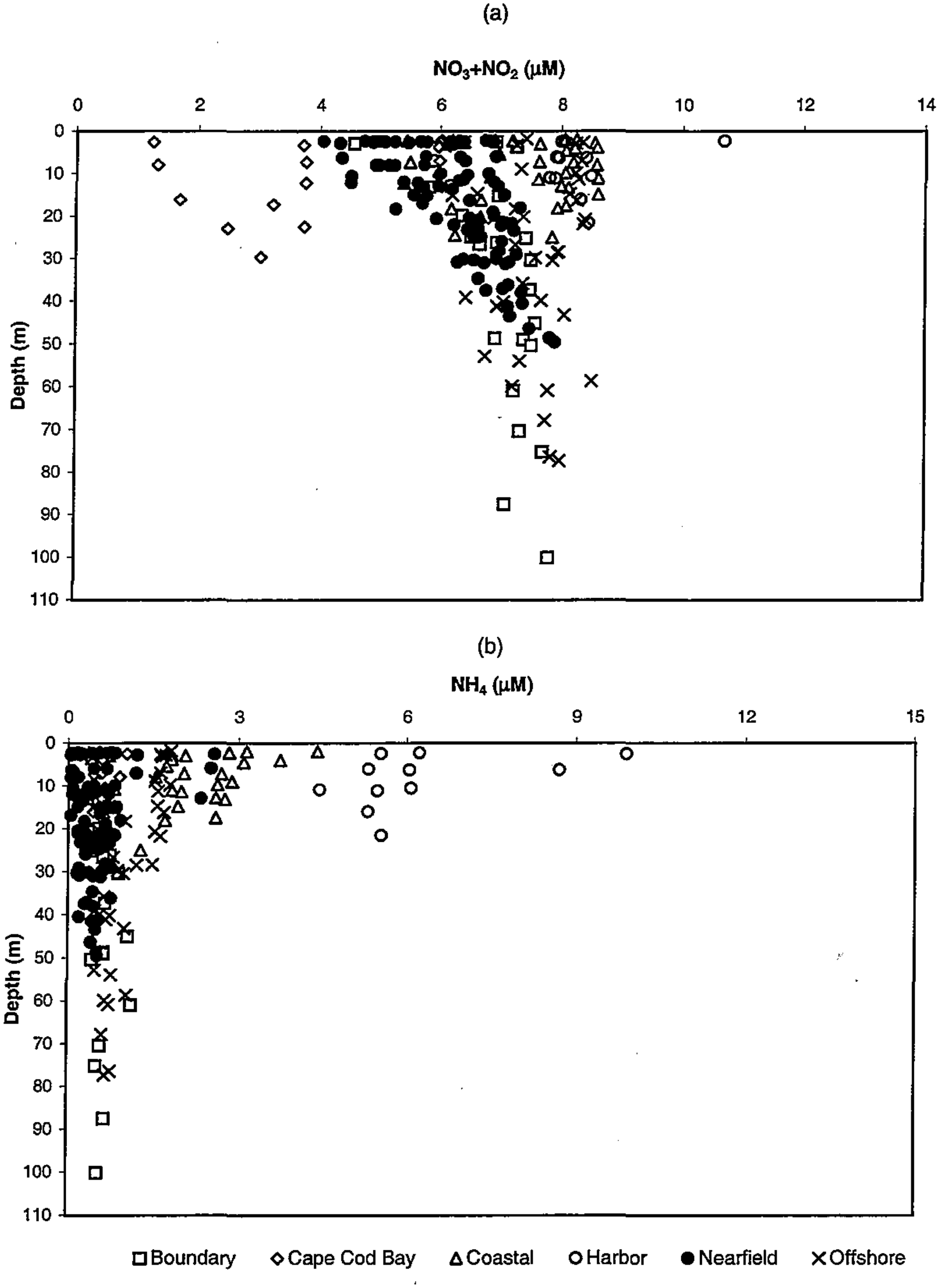
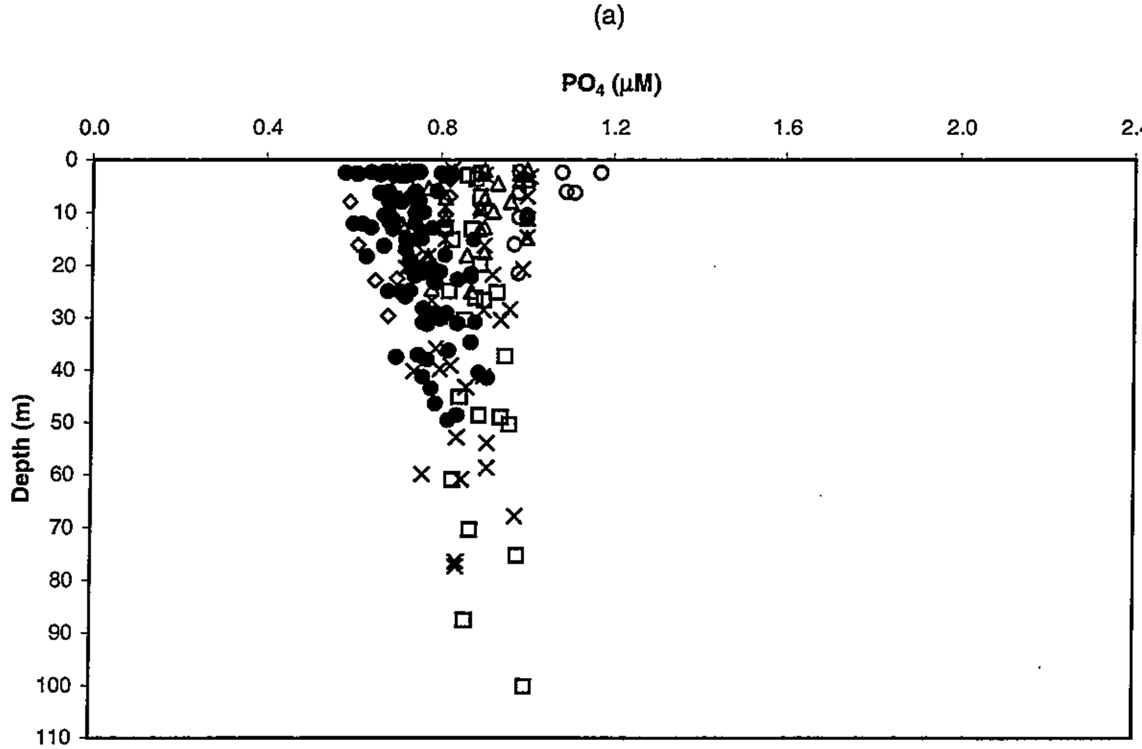


FIGURE 4-17
Depth vs. nutrient plots for farfield survey W9702, (Feb 97)



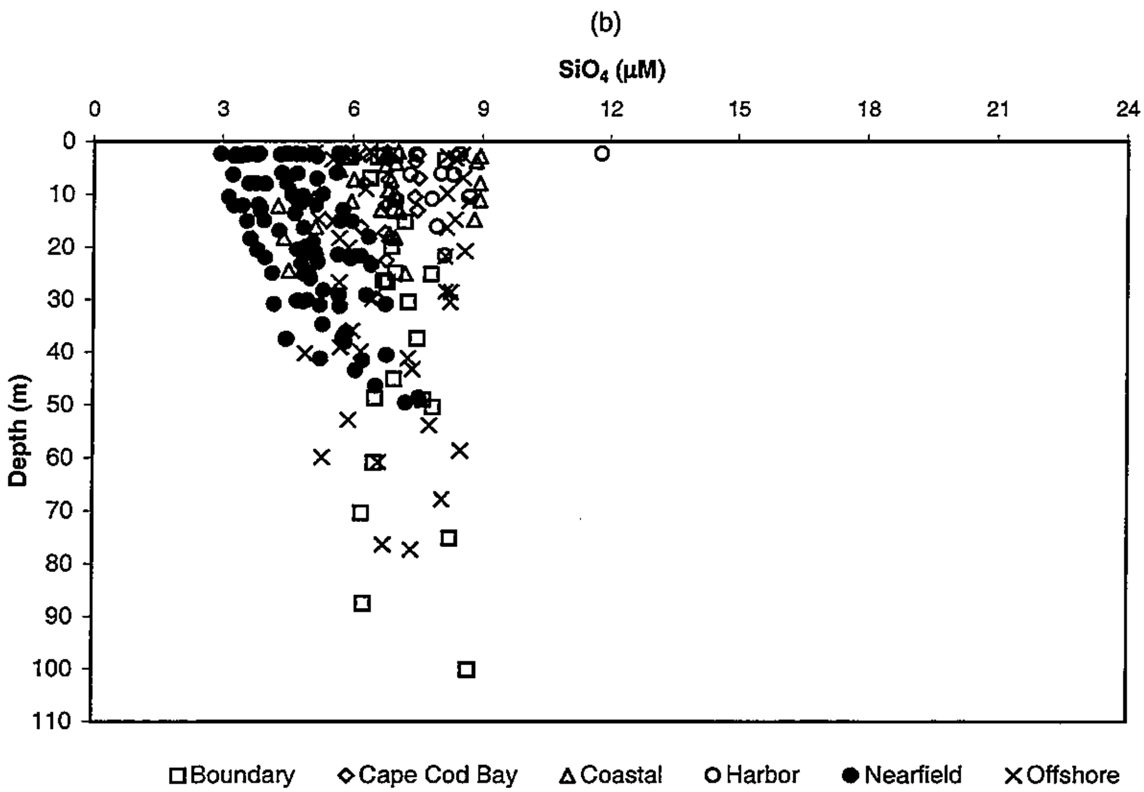


FIGURE 4-18

Depth vs. nutrient plots for farfield survey W9702, (Feb 97)

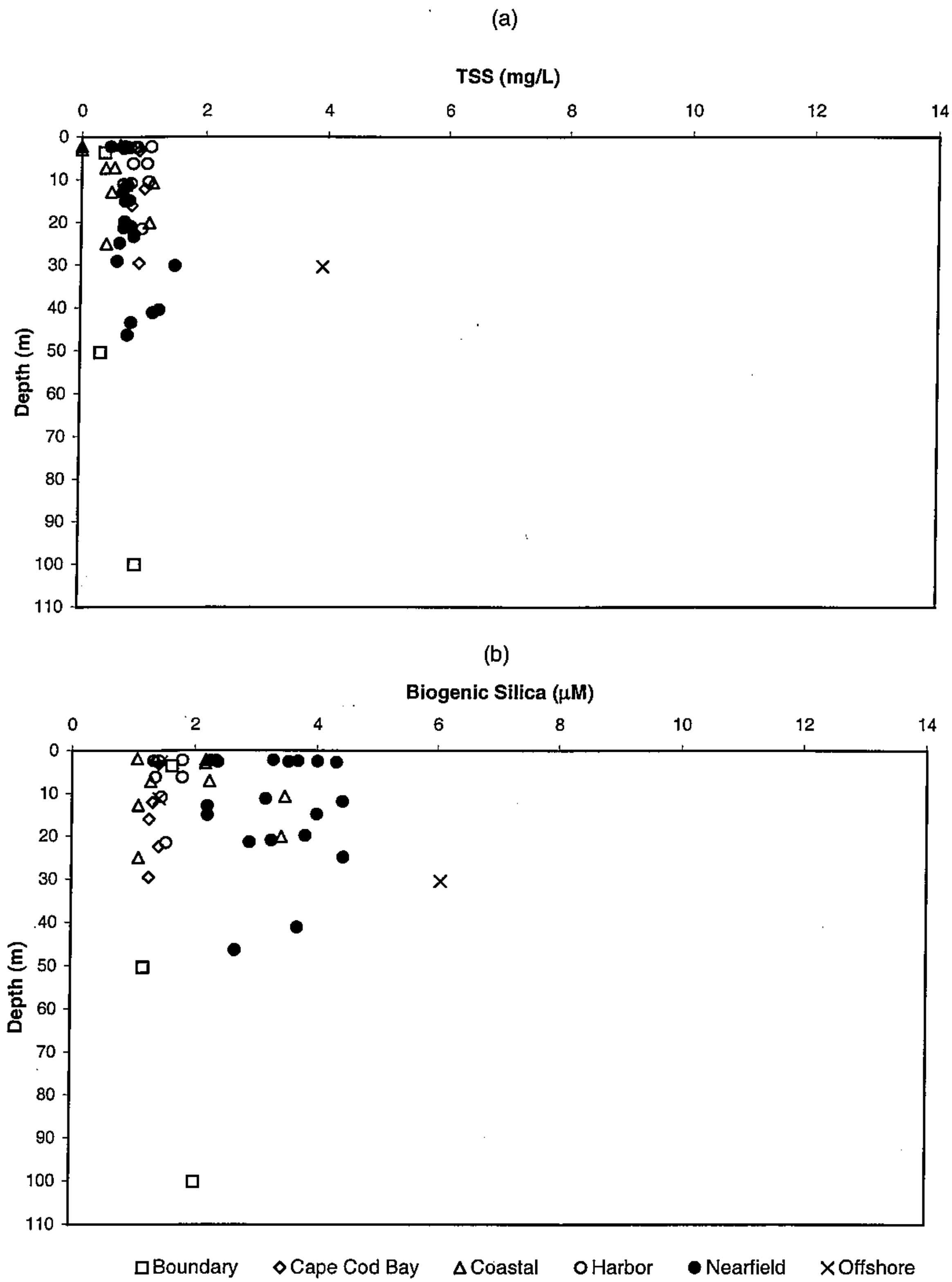


FIGURE 4-19
Depth vs. nutrient plots for farfield survey W9702, (Feb 97)

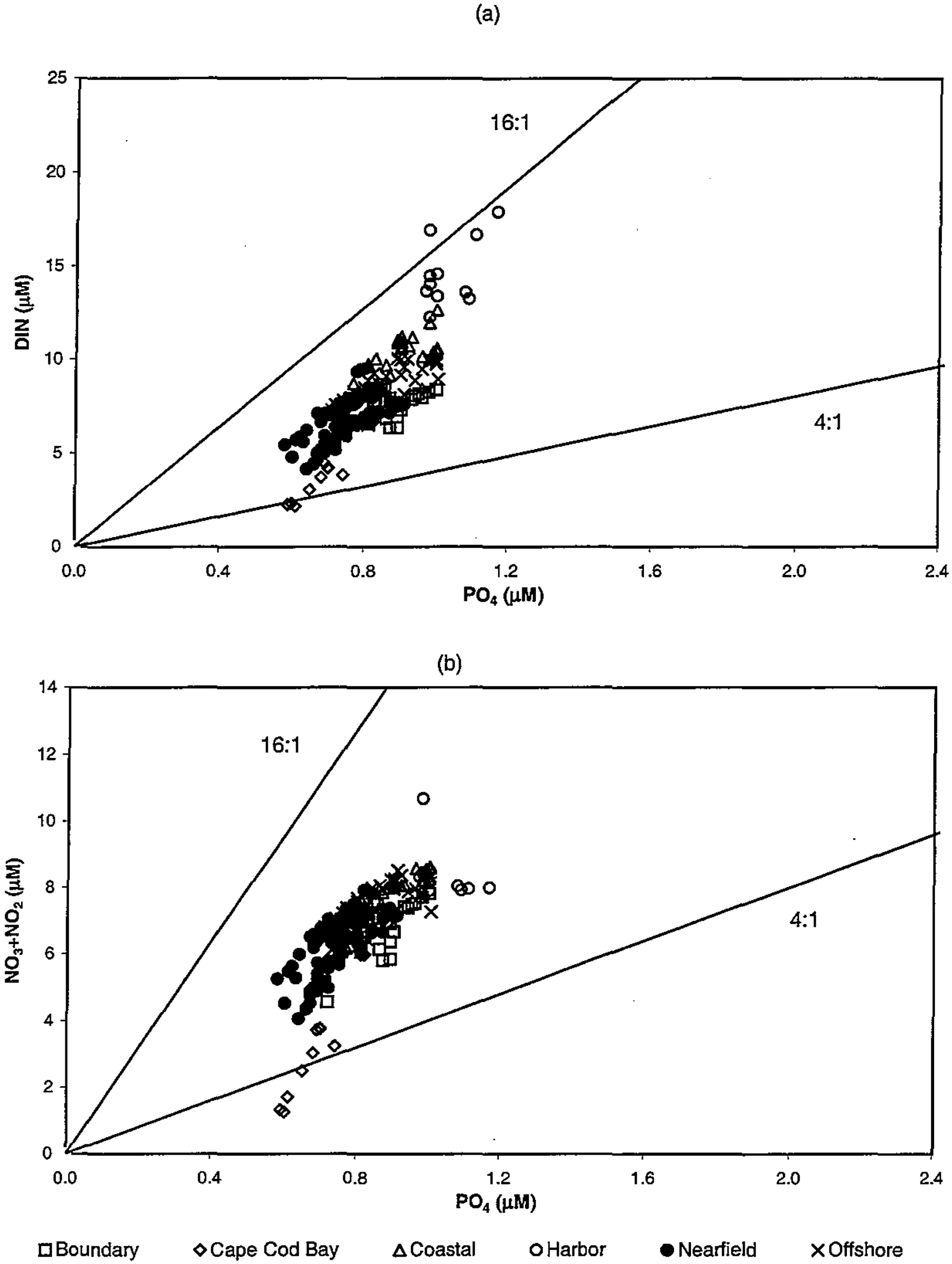


FIGURE 4-20
Nutrient vs. nutrient plots for farfield survey W9702, (Feb 97)

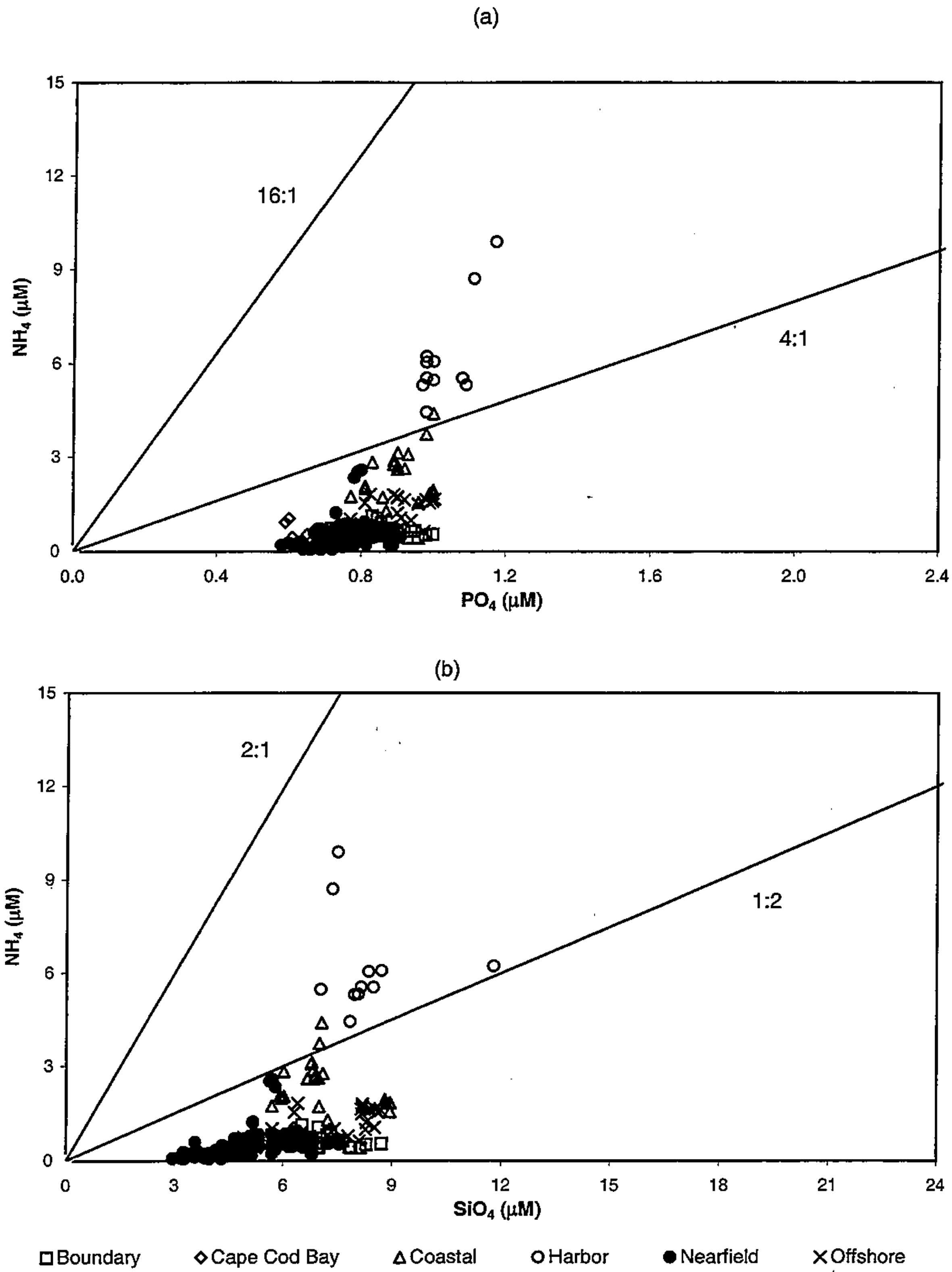


FIGURE 4-21
Nutrient vs. nutrient plots for farfield survey W9702, (Feb 97)

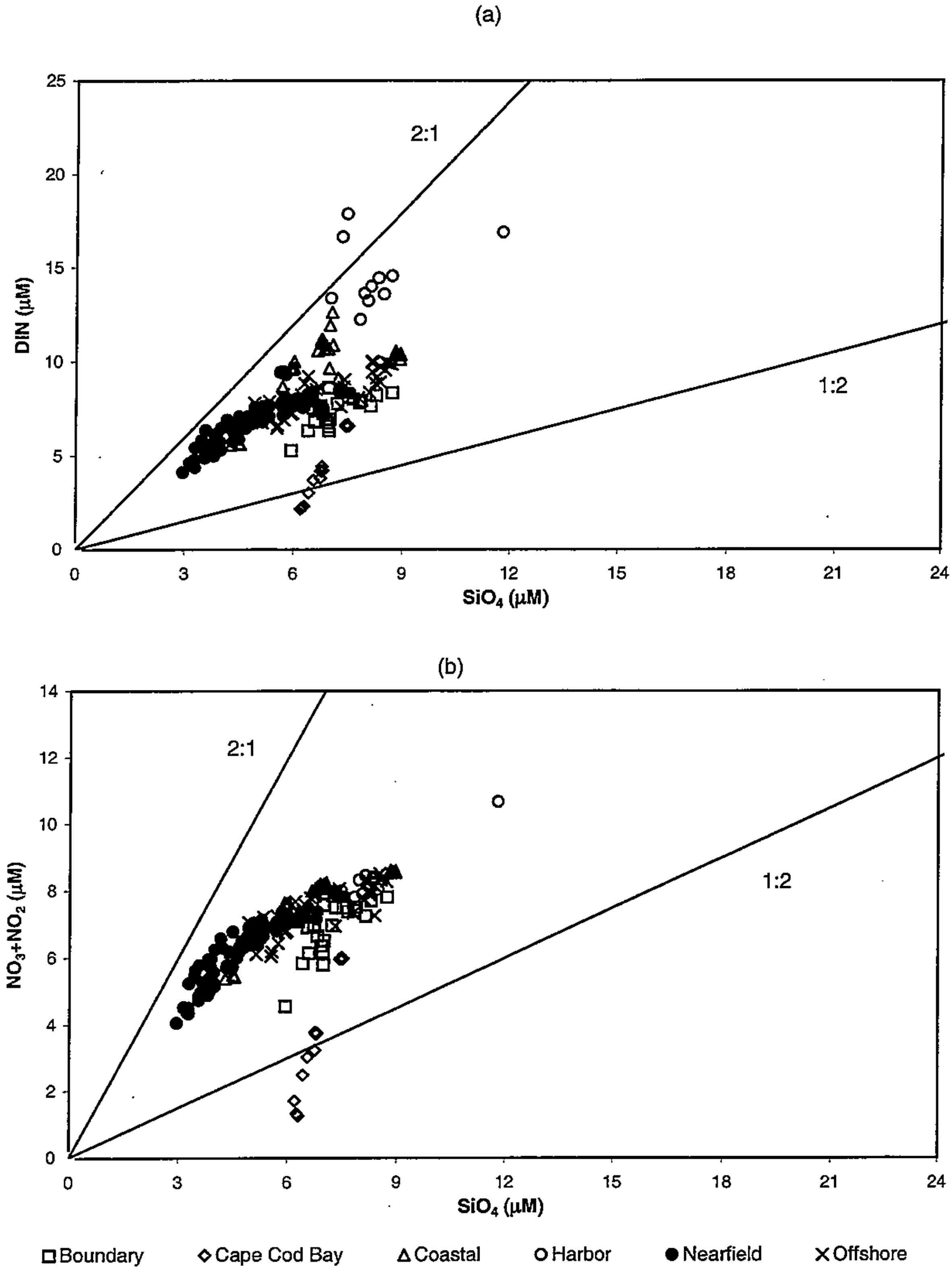


FIGURE 4-22
Nutrient vs. nutrient plots for farfield survey W9702, (Feb 97)

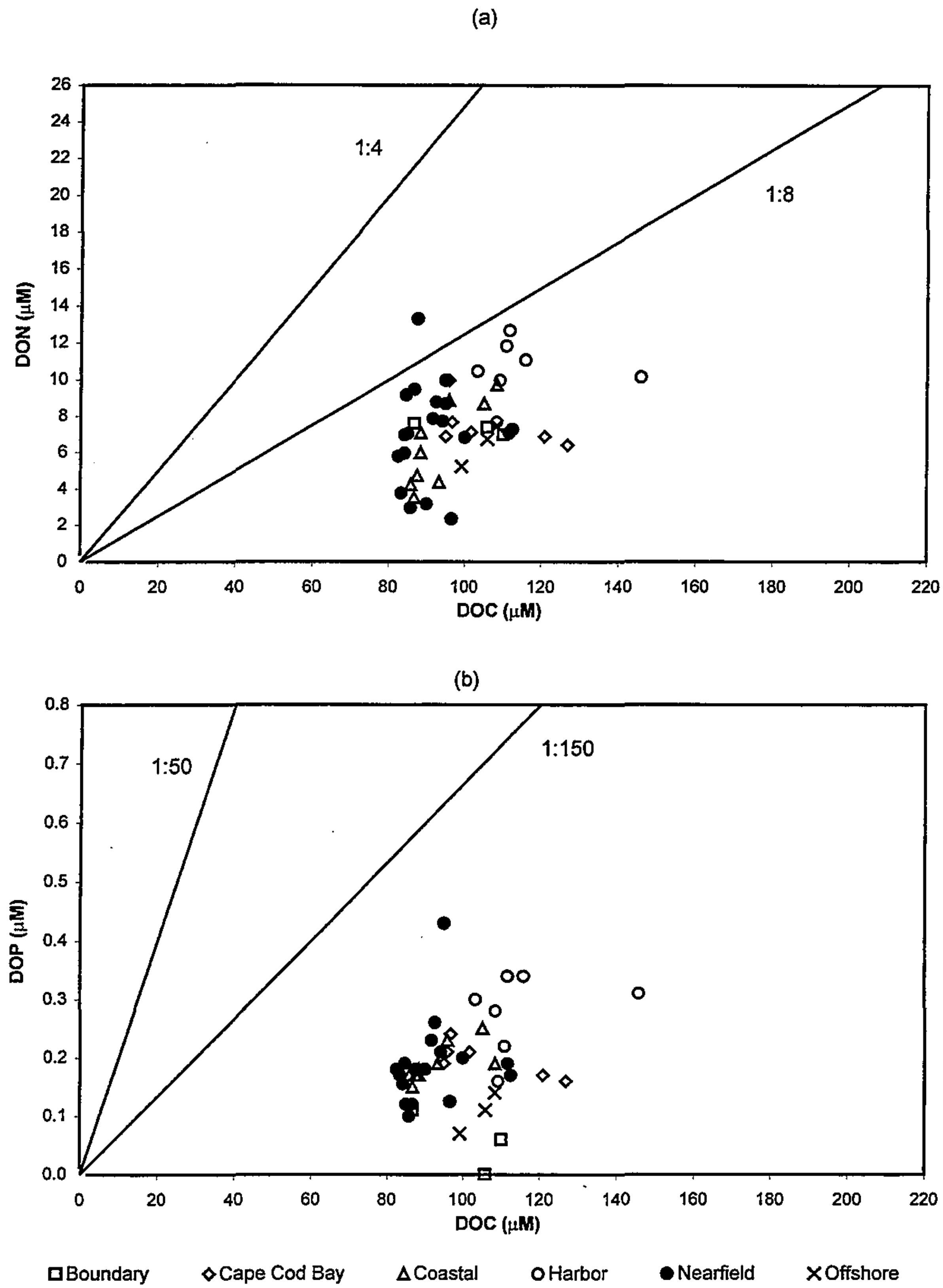


FIGURE 4-23
Nutrient vs. nutrient plots for farfield survey W9702, (Feb 97)

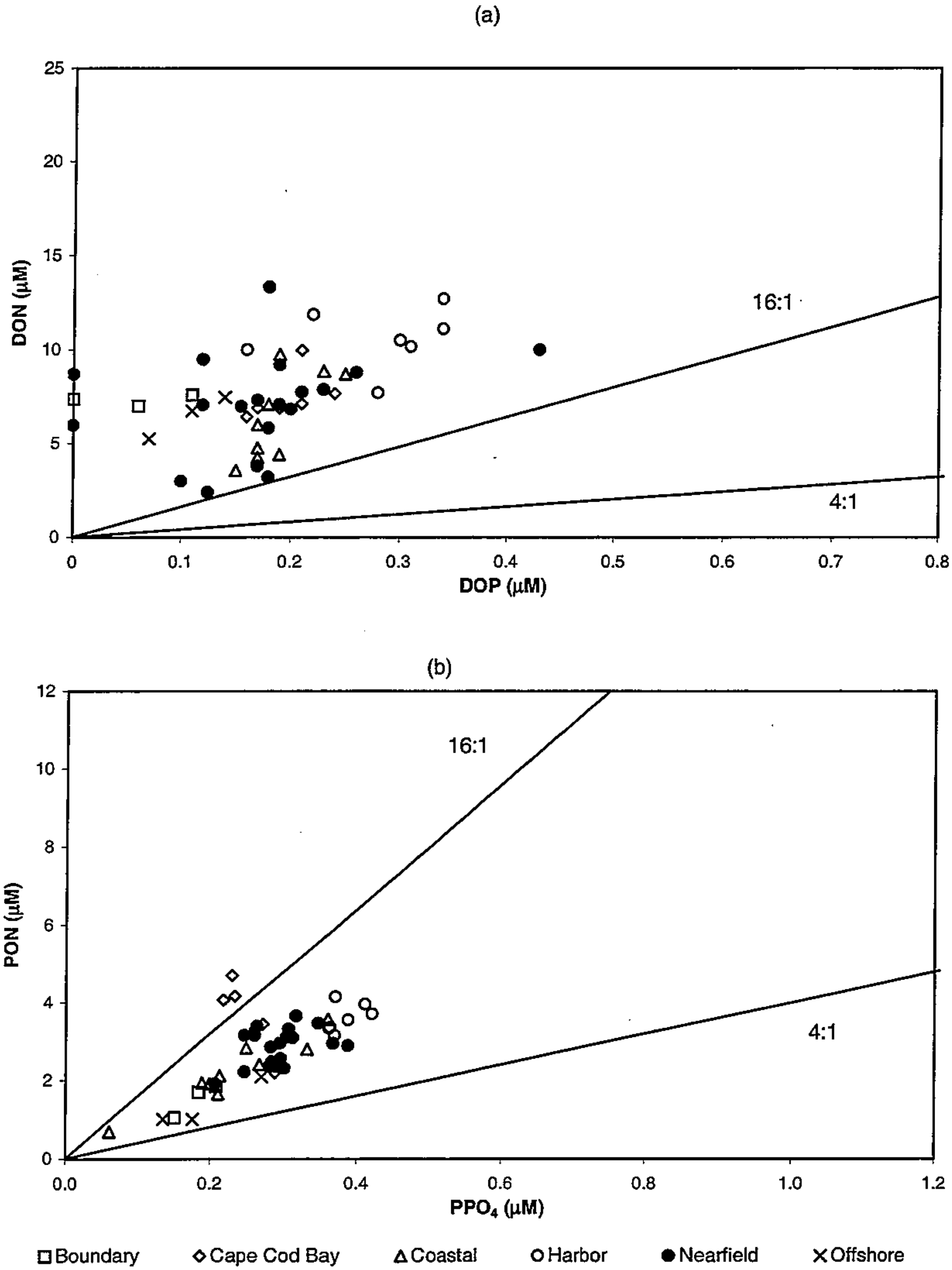


FIGURE 4-24
Nutrient vs. nutrient plots for farfield survey W9702, (Feb 97)

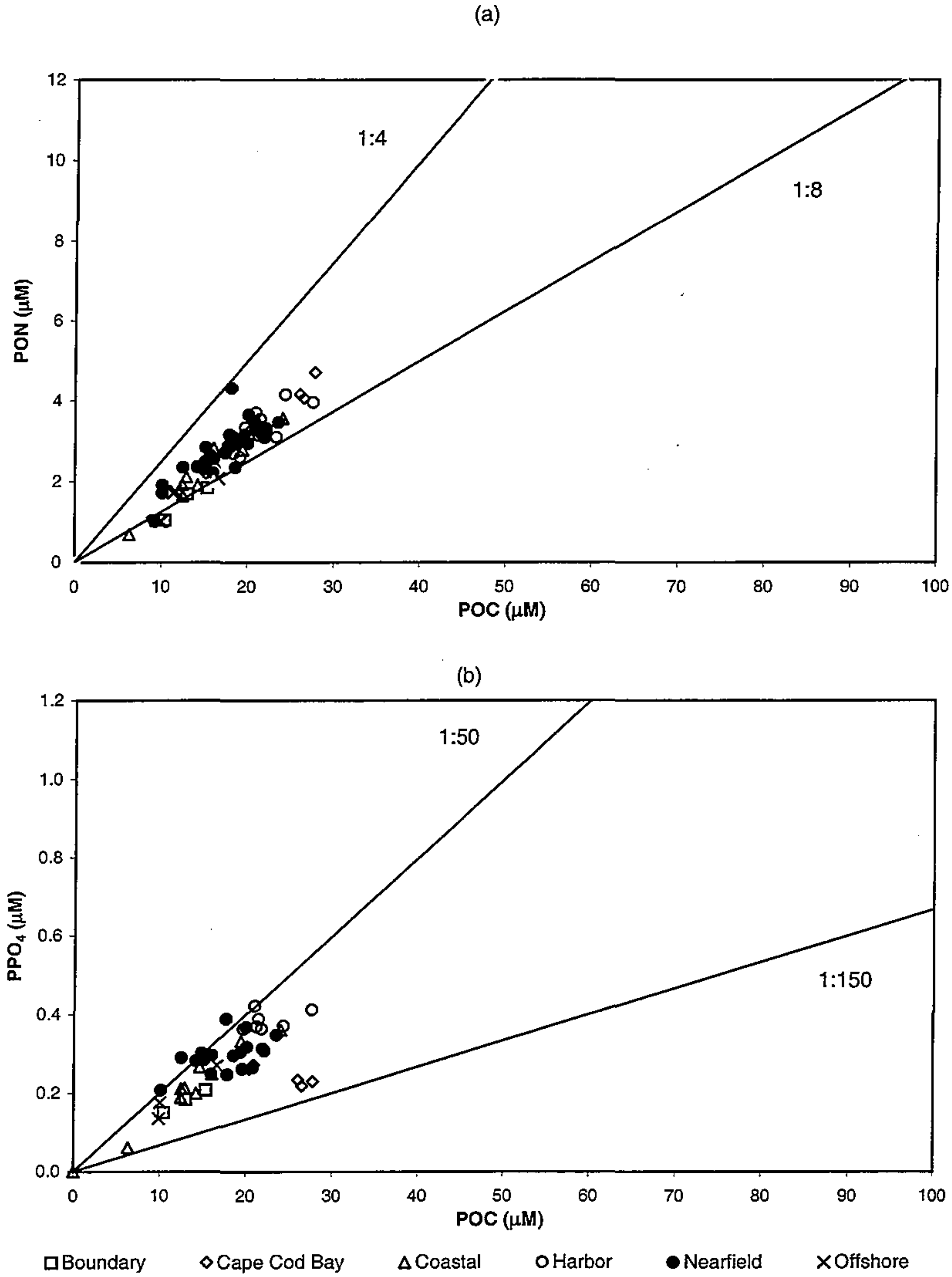


FIGURE 4-25
Nutrient vs. nutrient plots for farfield survey W9702, (Feb 97)

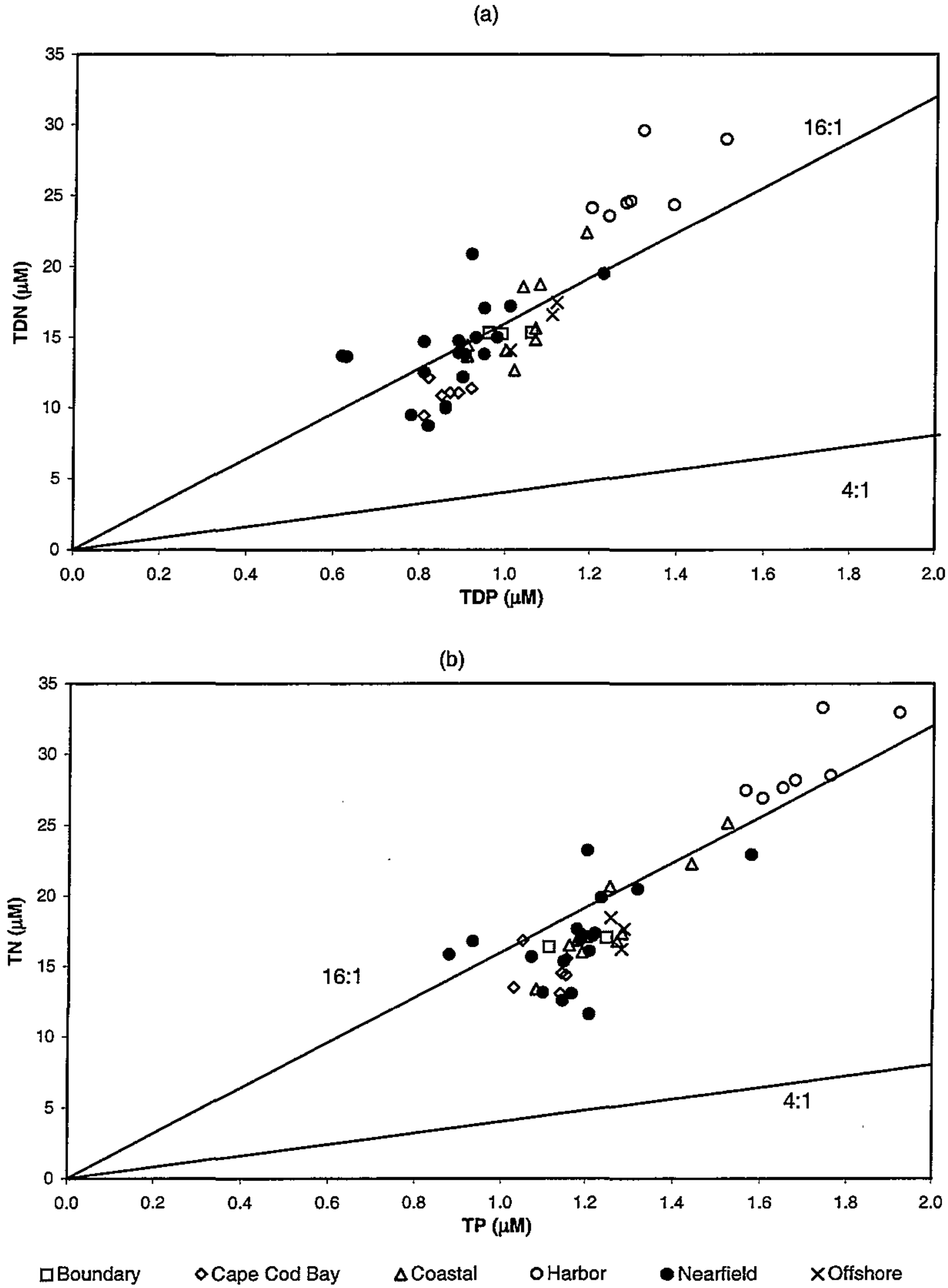


FIGURE 4-26
Nutrient vs. nutrient plots for farfield survey W9702, (Feb 97)

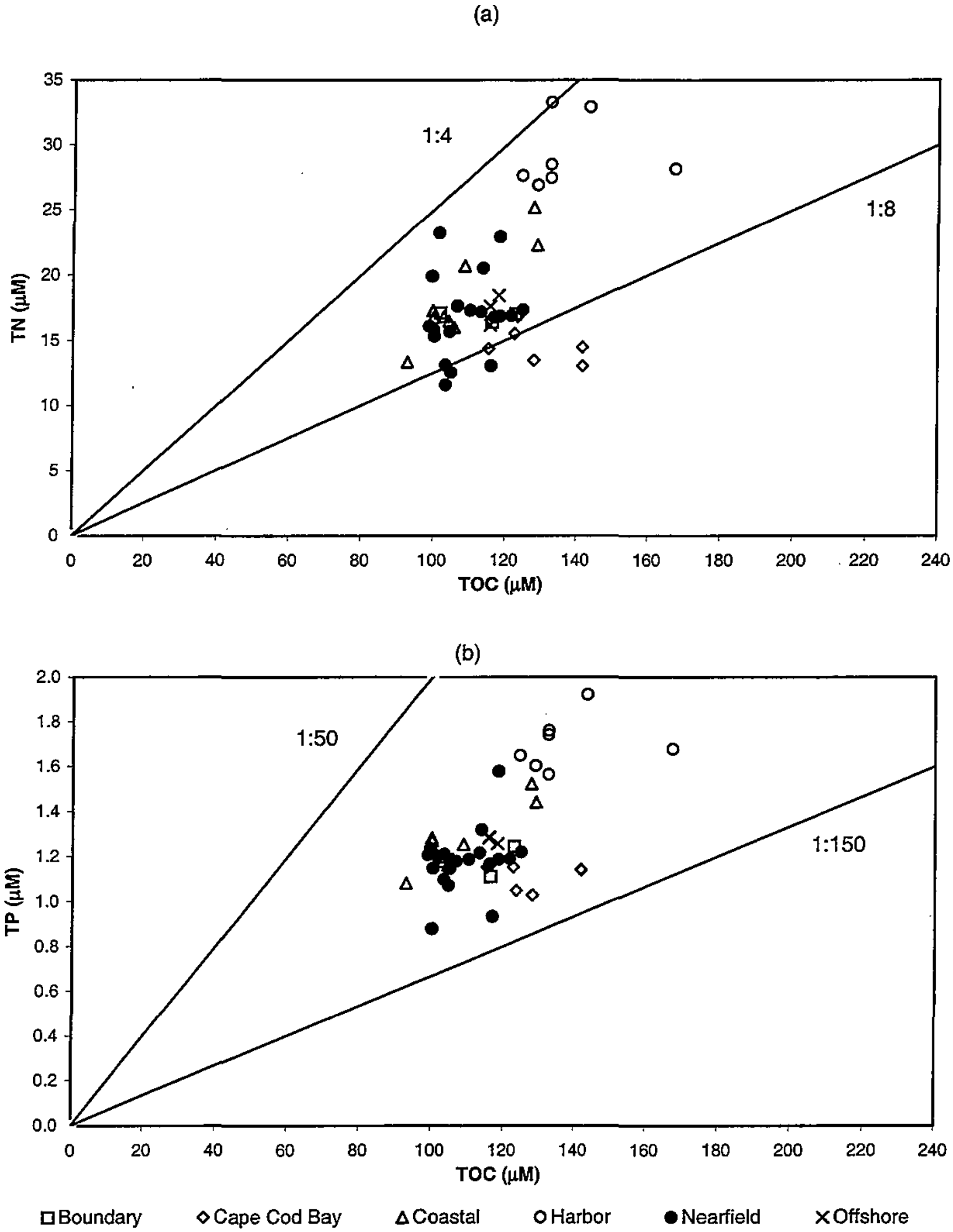


FIGURE 4-27
Depth vs. nutrient plots for farfield survey W9702, (Feb 97)

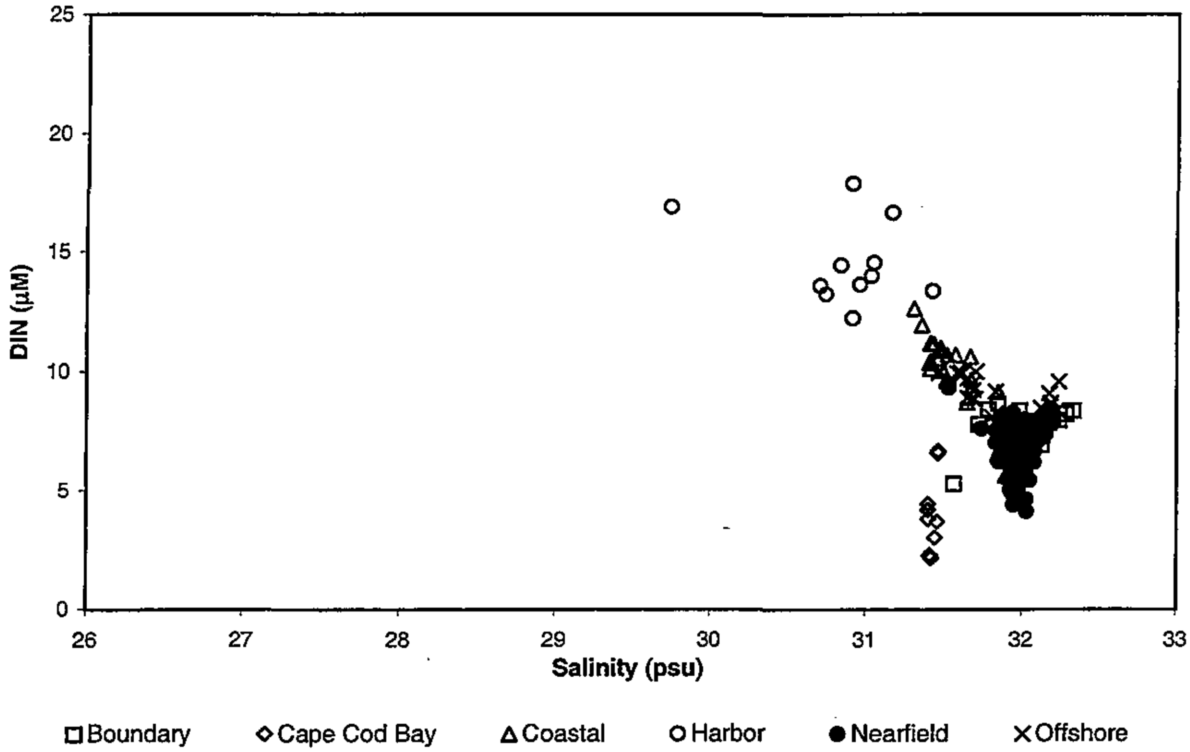


FIGURE 4-28
Nutrient vs. salinity plots for farfield survey W9702, (Feb 97)

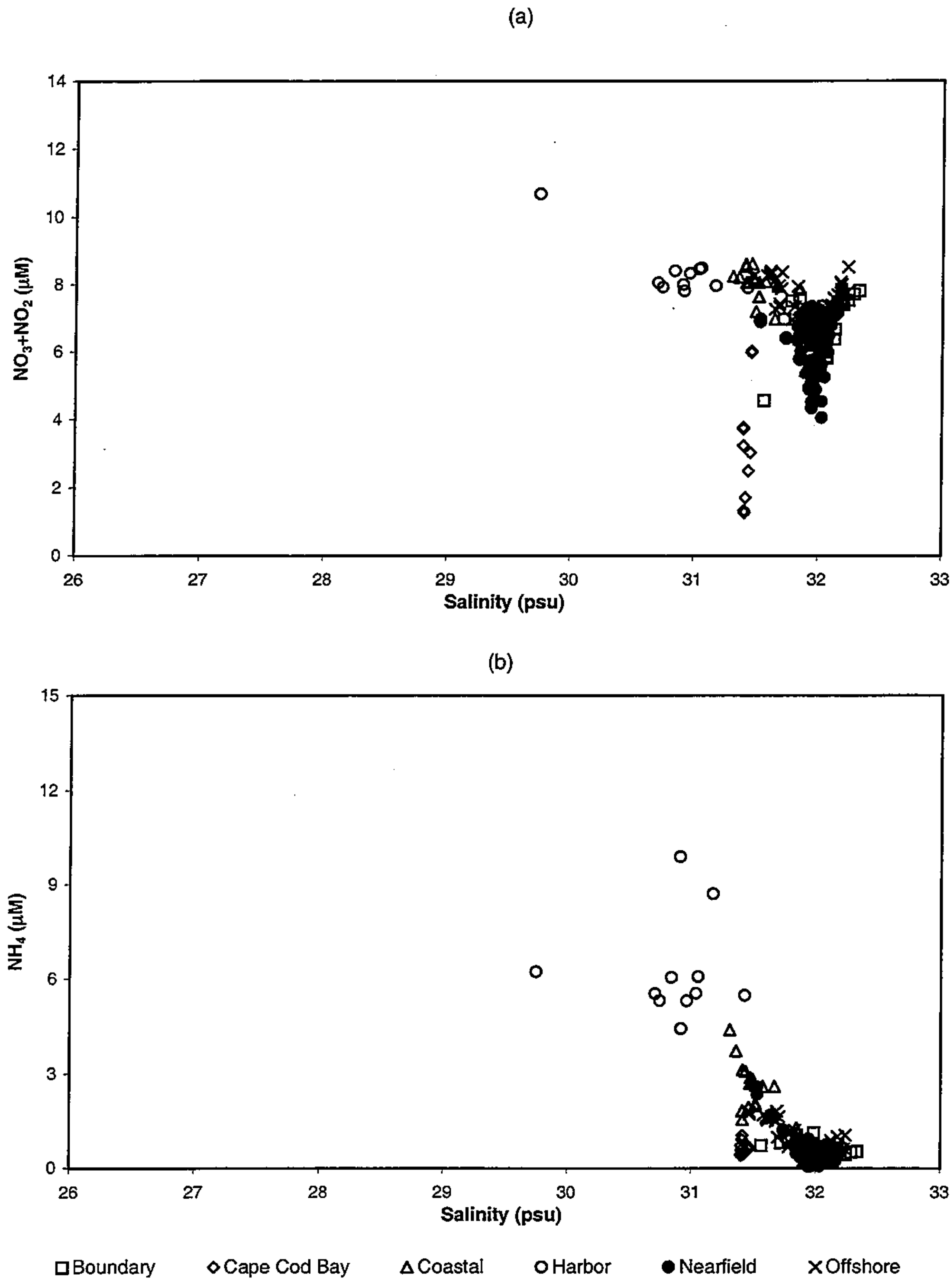


FIGURE 4-29

Nutrient vs. salinity plots for farfield survey W9702, (Feb 97)

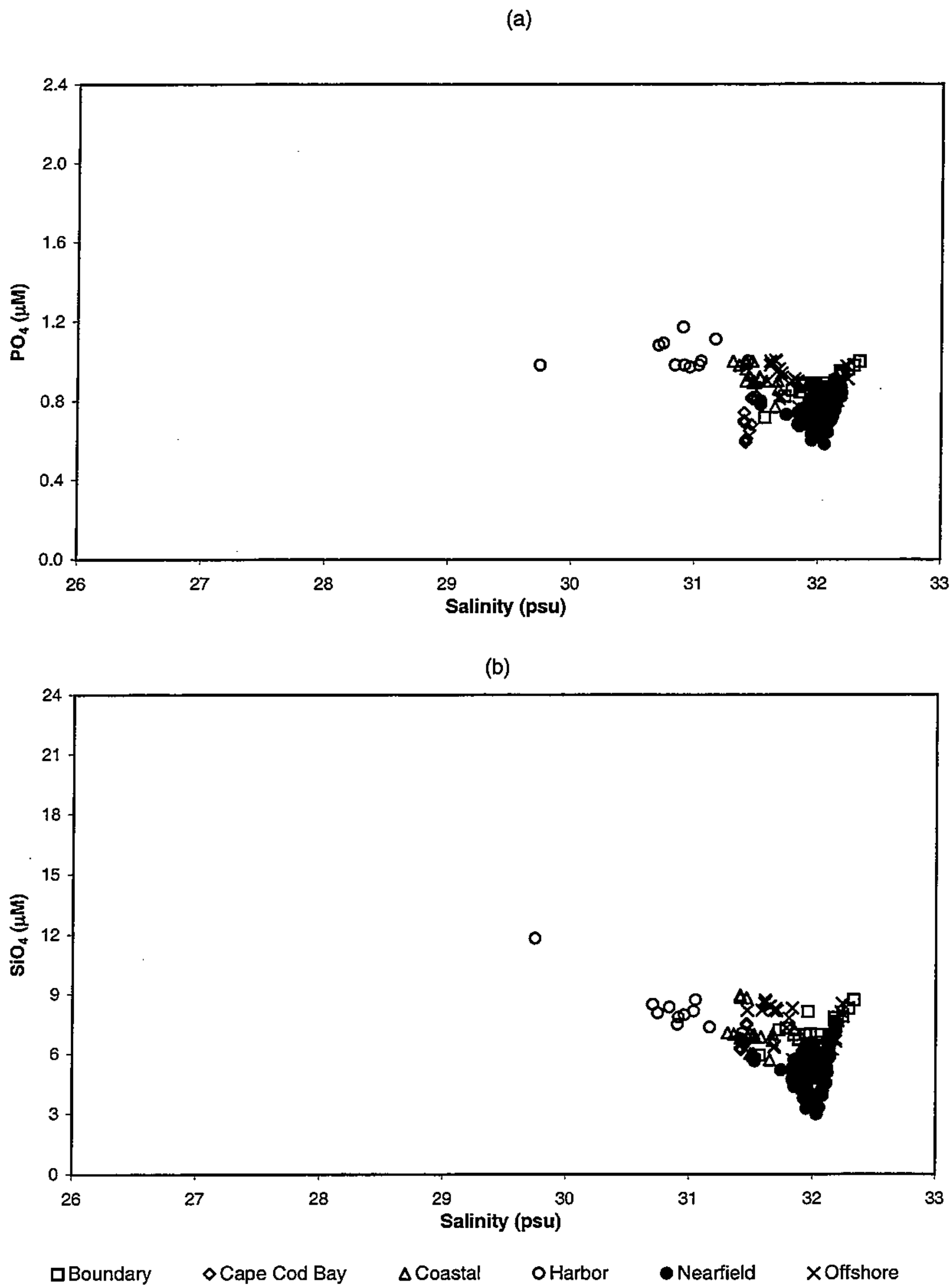


FIGURE 4-30

Nutrient vs. salinity plots for farfield survey W9702, (Feb 97)

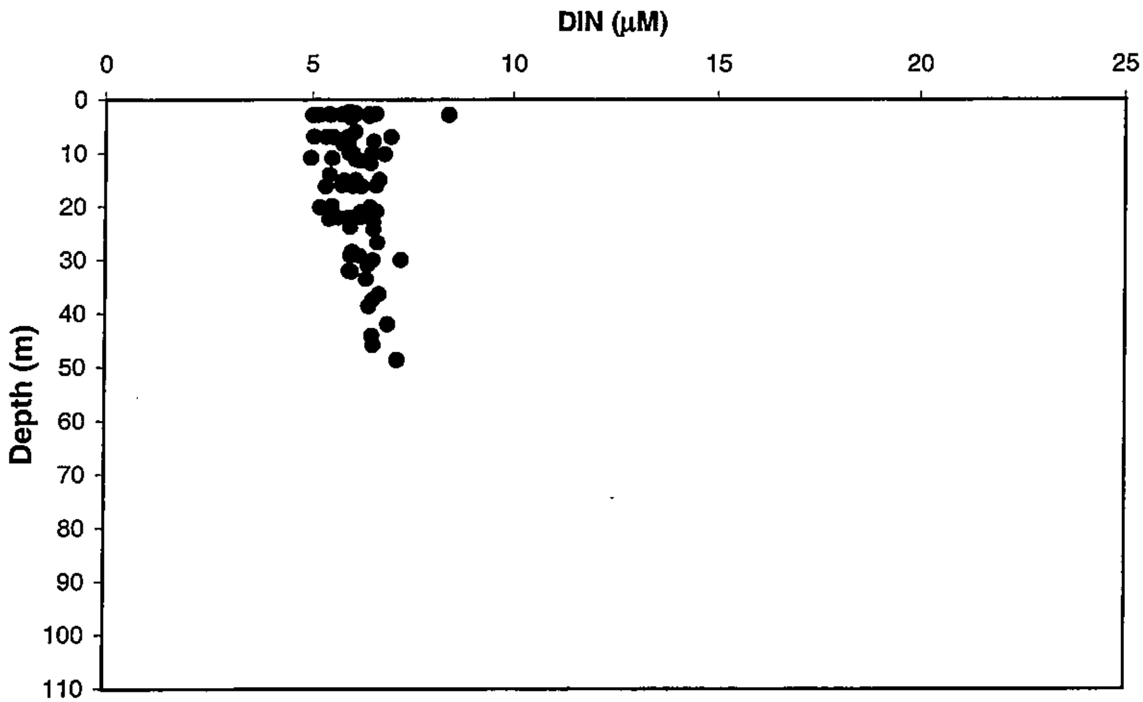
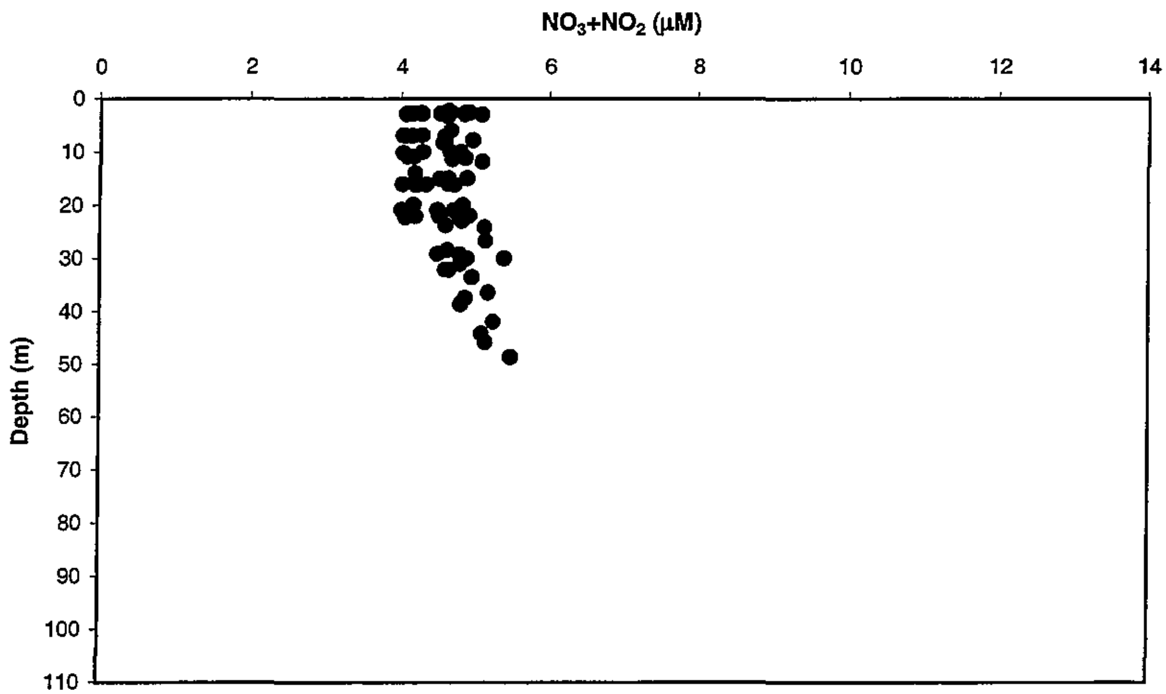


FIGURE 4-31
Depth vs. nutrient plots for nearfield survey W9703, (Mar 97)

(a)



(b)

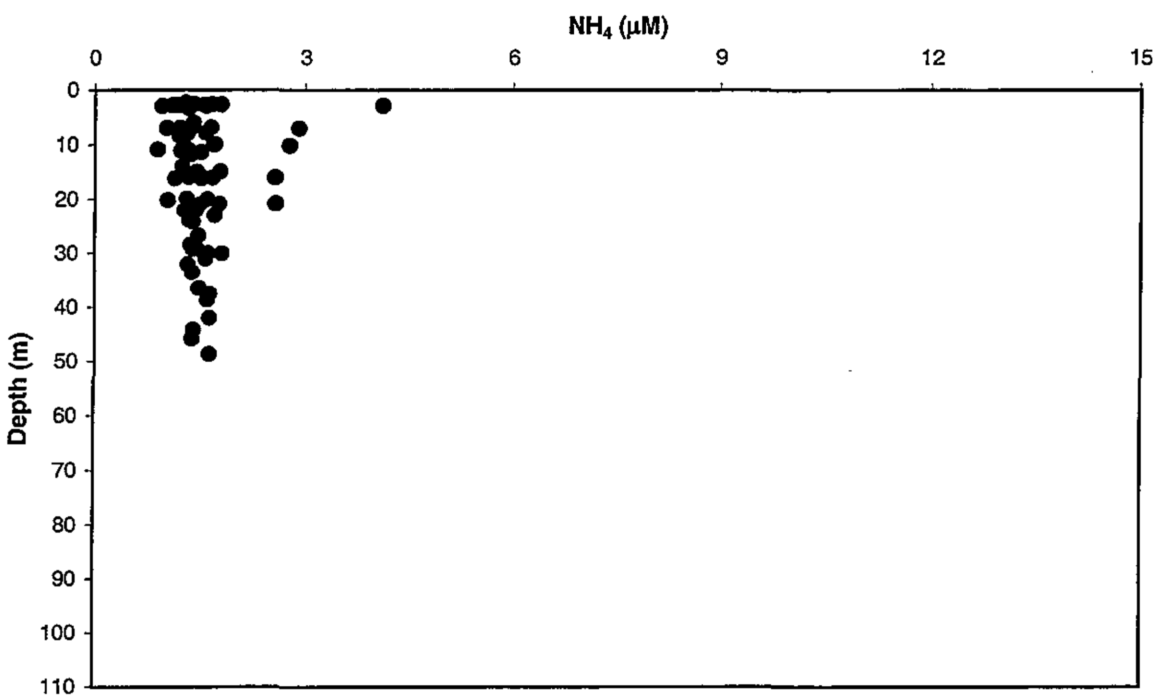
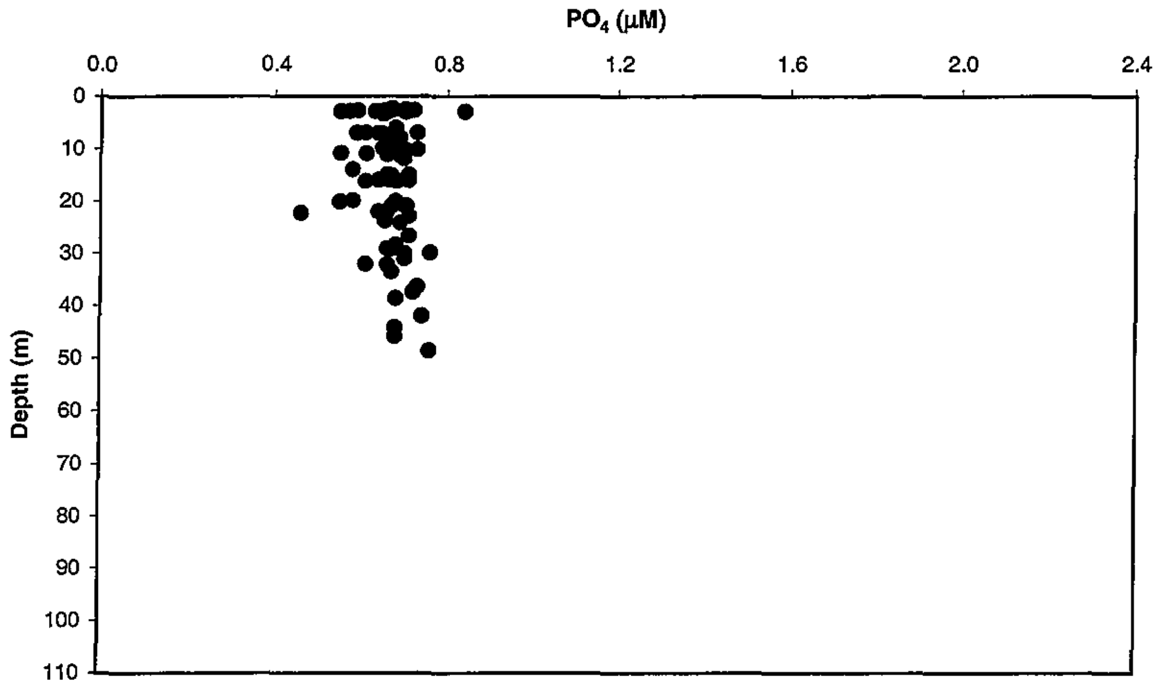


FIGURE 4-32
Depth vs. nutrient plots for nearfield survey W9703, (Mar 97)

(a)



(b)

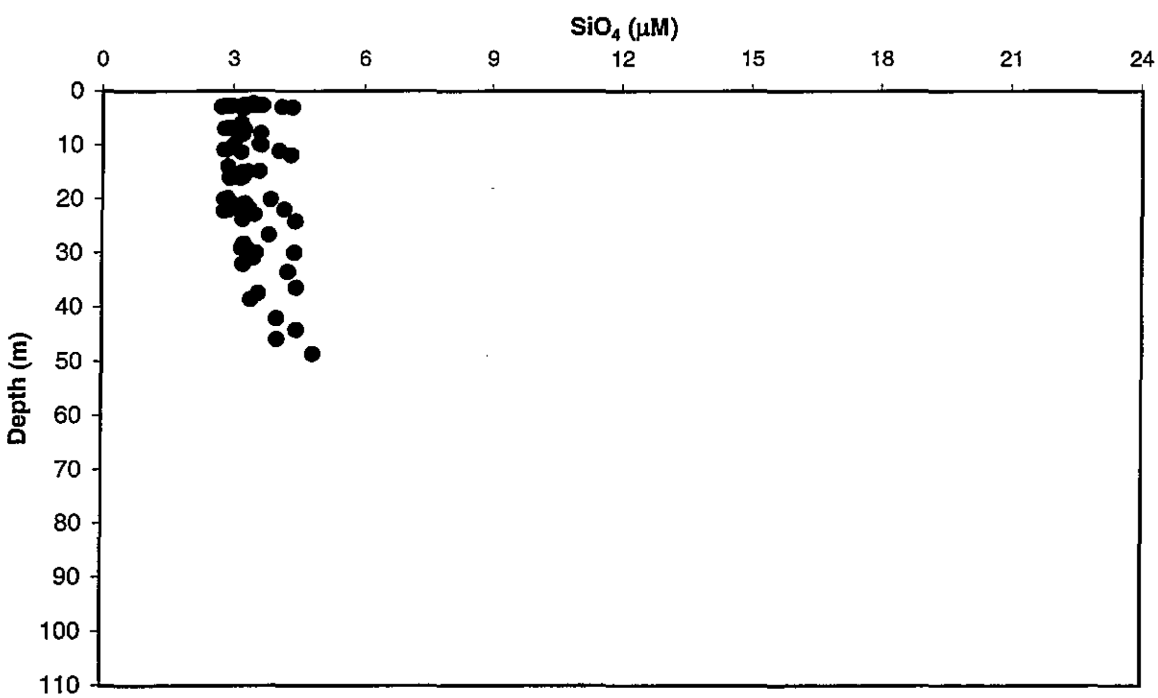
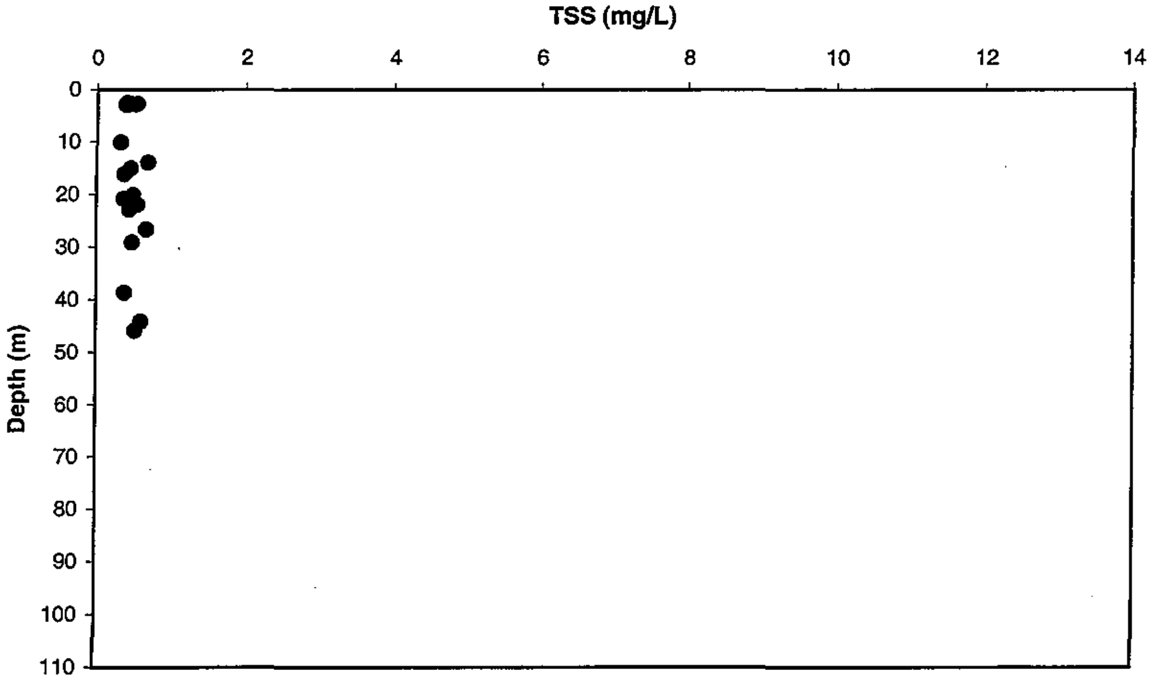


FIGURE 4-33

Depth vs. nutrient plots for nearfield survey W9703, (Mar 97)

(a)



(b)

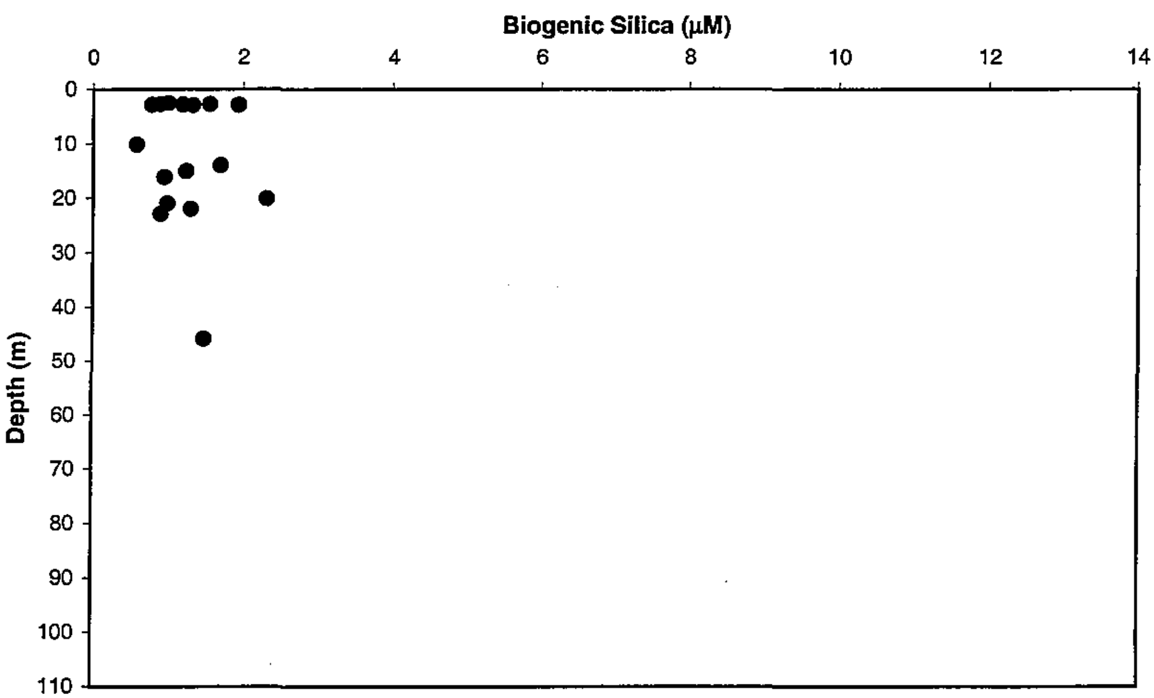


FIGURE 4-34
Depth vs. nutrient plots for nearfield survey W9703, (Mar 97)

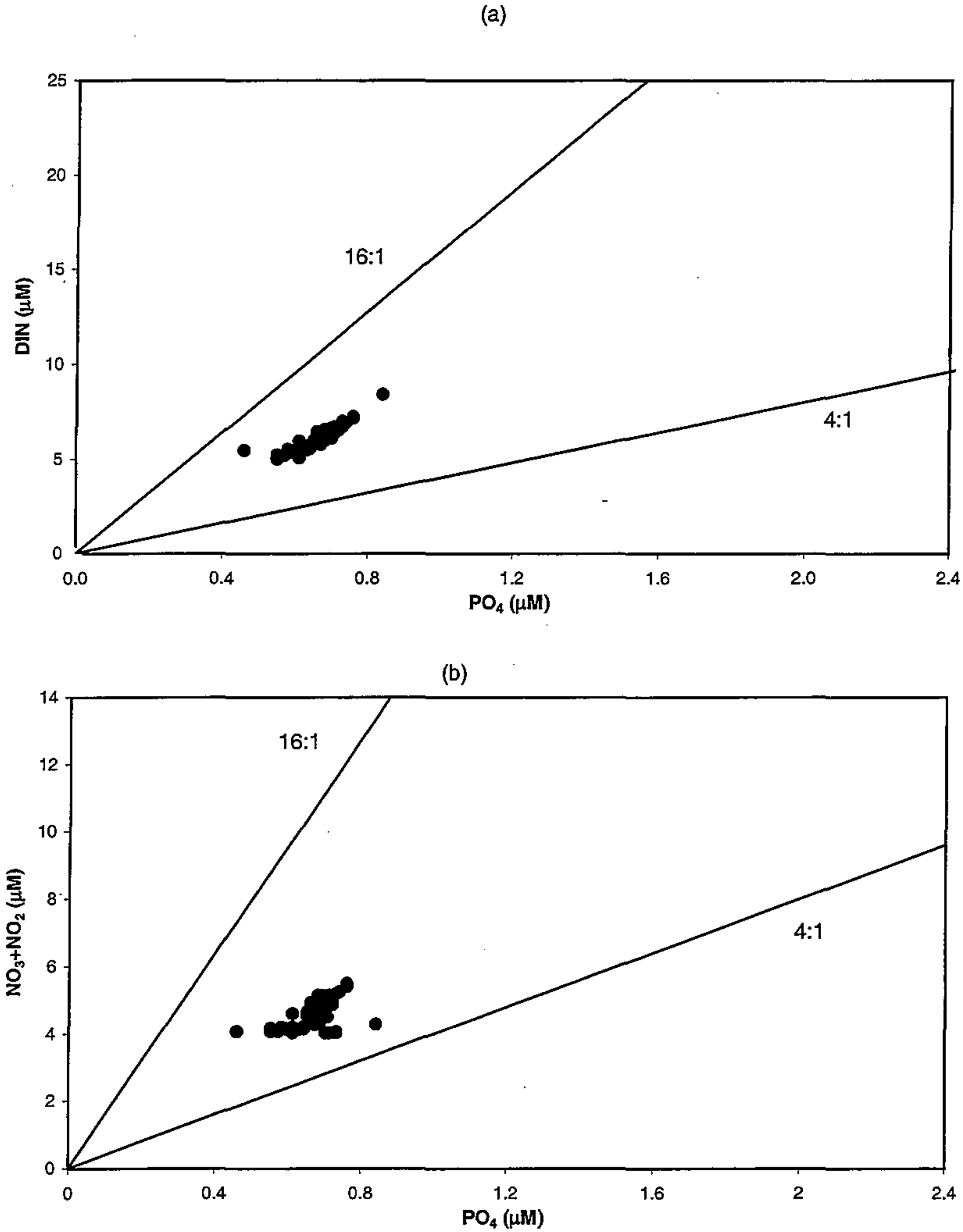
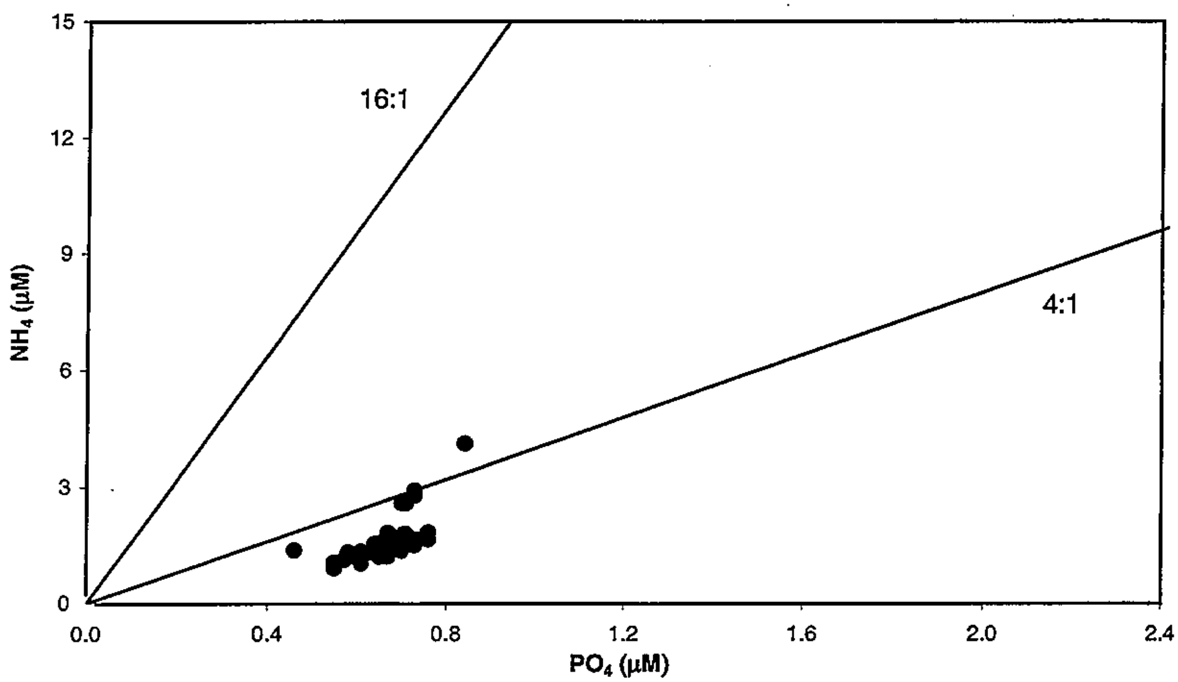


FIGURE 4-35

Nutrient vs. nutrient plots for nearfield survey W9703, (Mar 97)

(a)



(b)

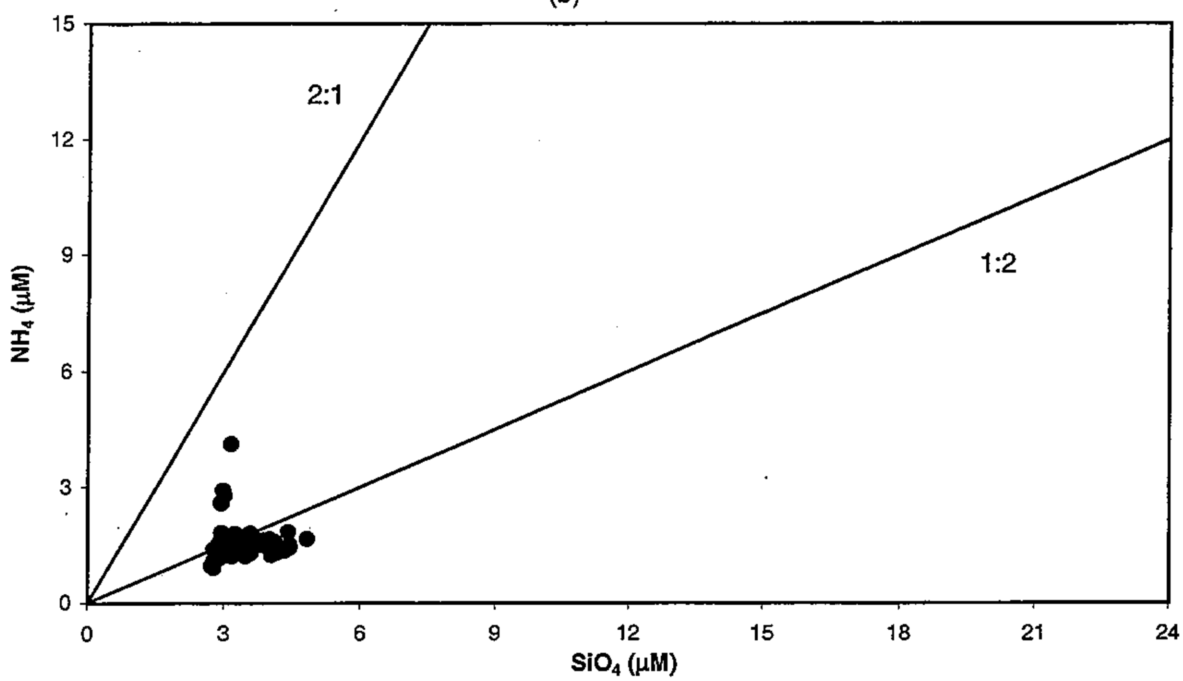


FIGURE 4-36

Nutrient vs. nutrient plots for nearfield survey W9703, (Mar 97)

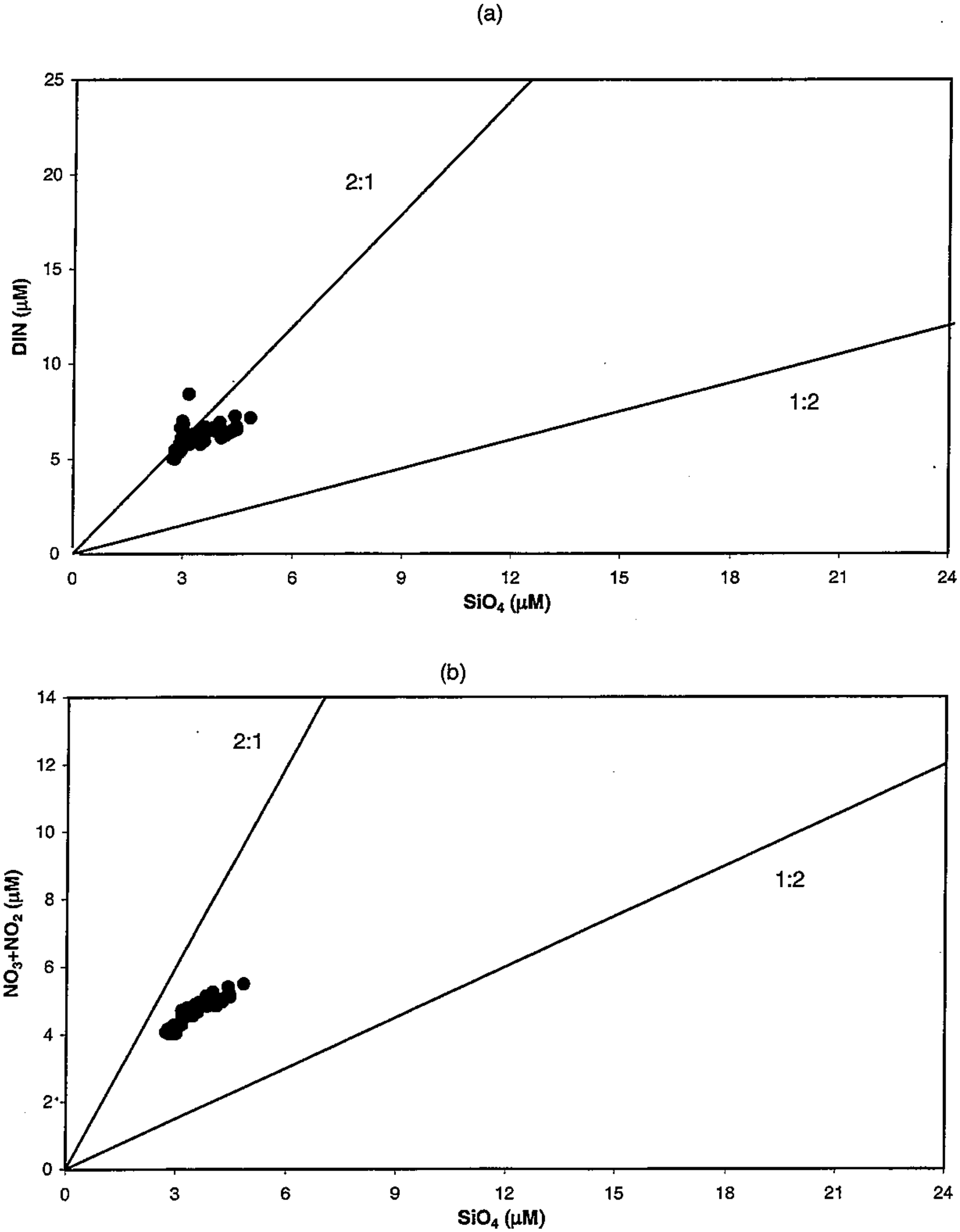
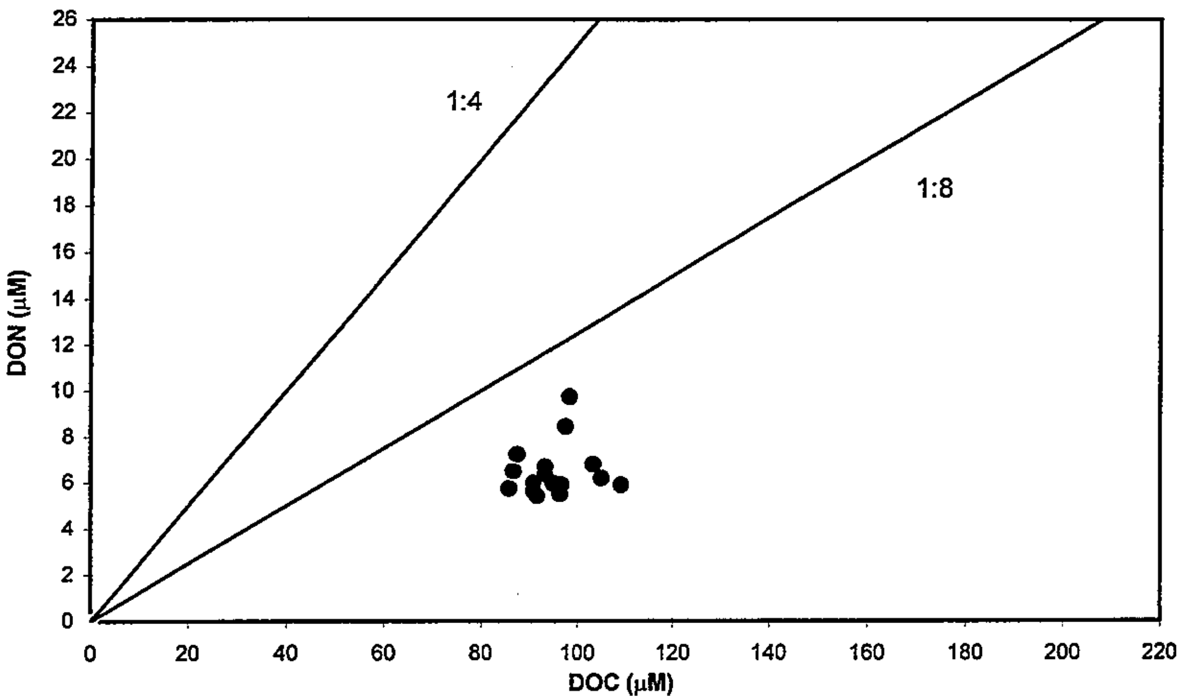


FIGURE 4-37
Nutrient vs. nutrient plots for nearfield survey W9703, (Mar 97)

(a)



(b)

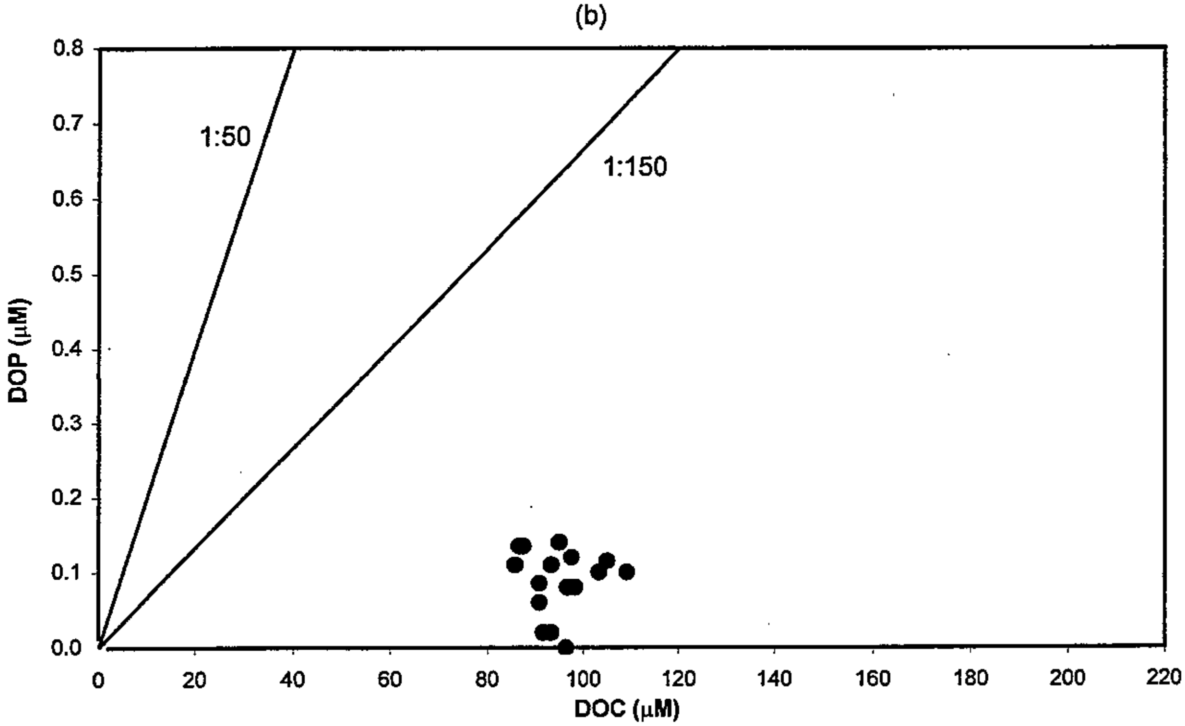
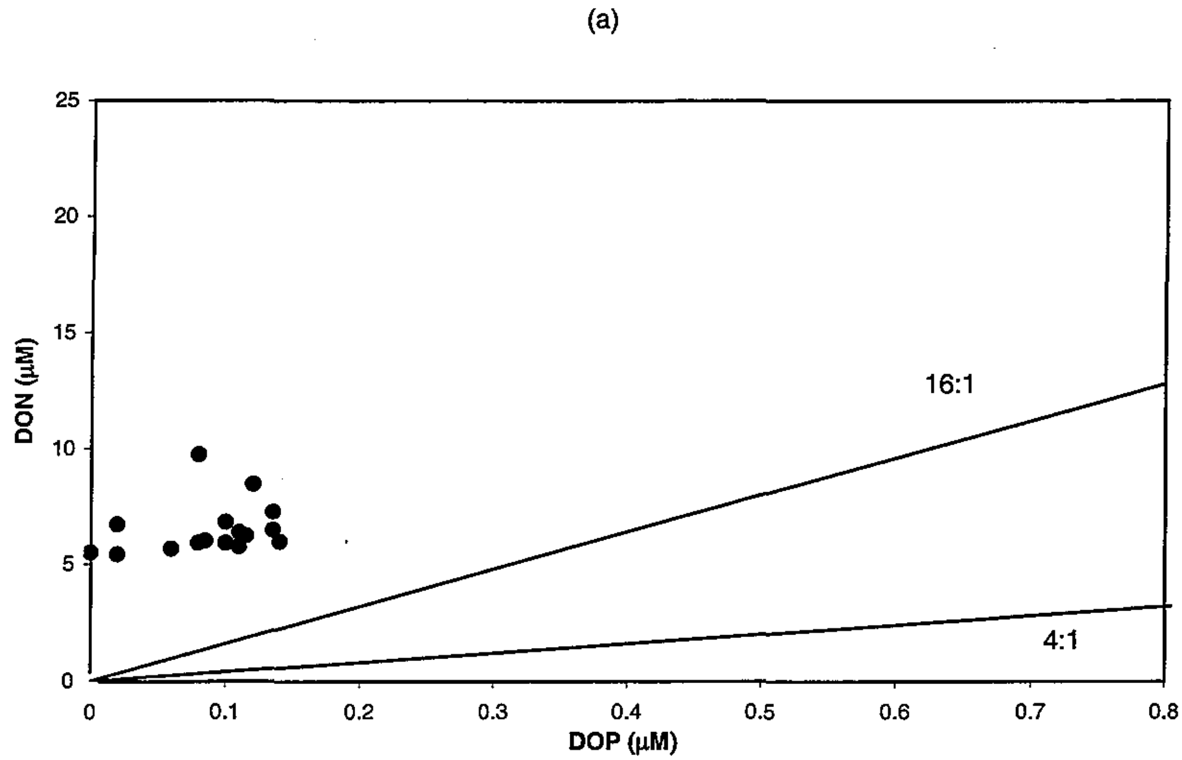


FIGURE 4-38

Nutrient vs. nutrient plots for nearfield survey W9703, (Mar 97)



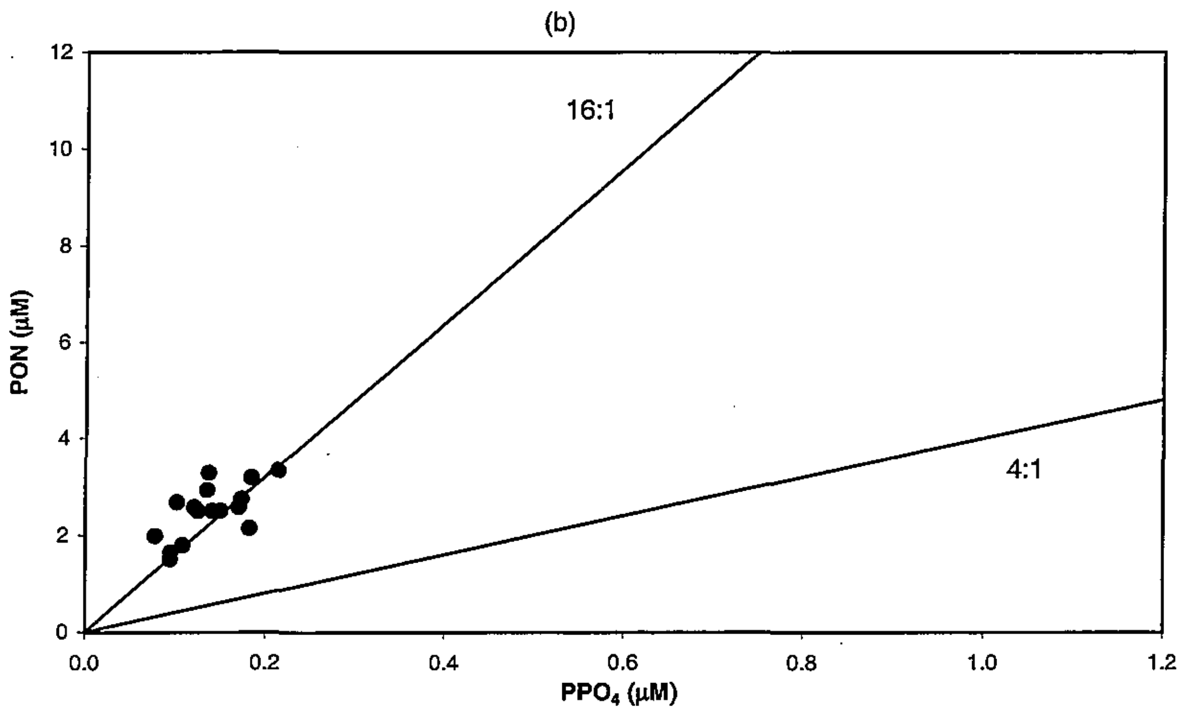
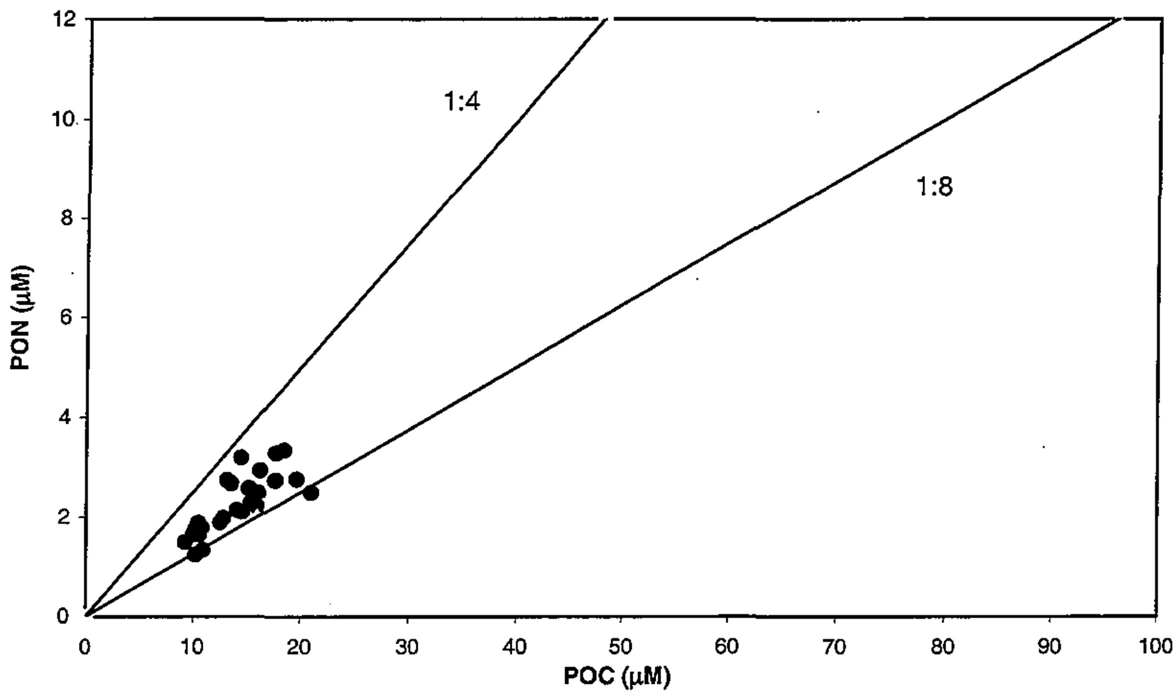


FIGURE 4-39

Nutrient vs. nutrient plots for nearfield survey W9703, (Mar 97)

(a)



(b)

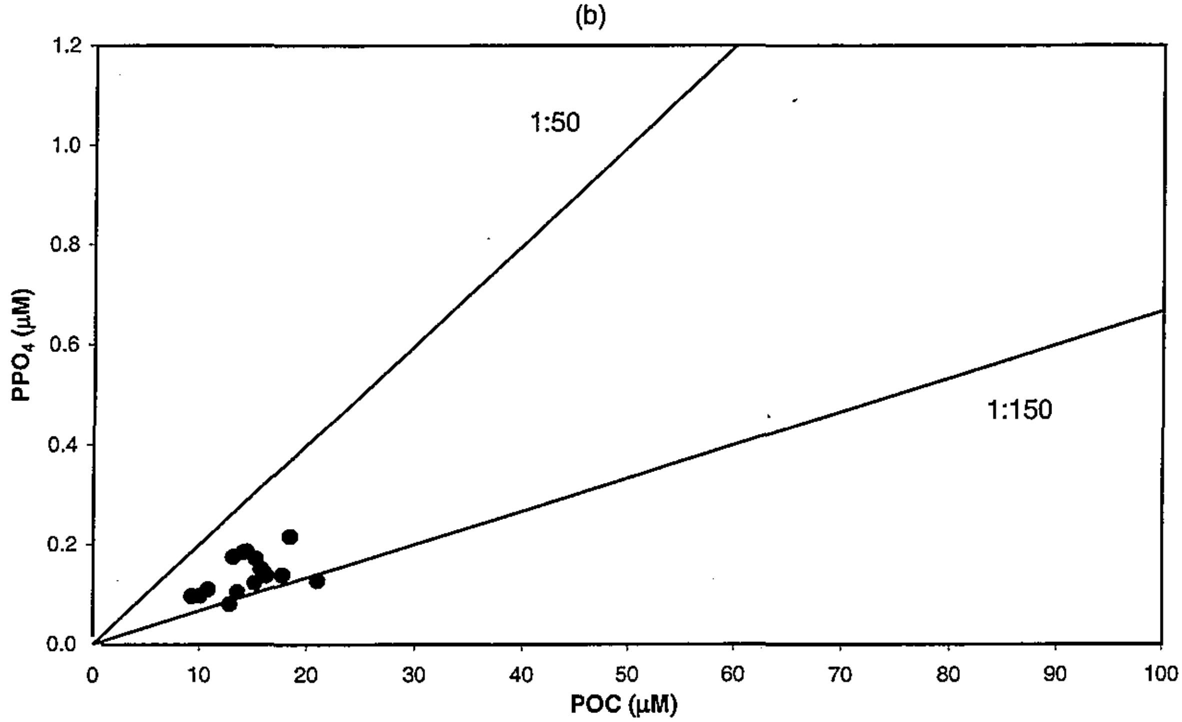


FIGURE 4-40

Nutrient vs. nutrient plots for nearfield survey W9703, (Mar 97)

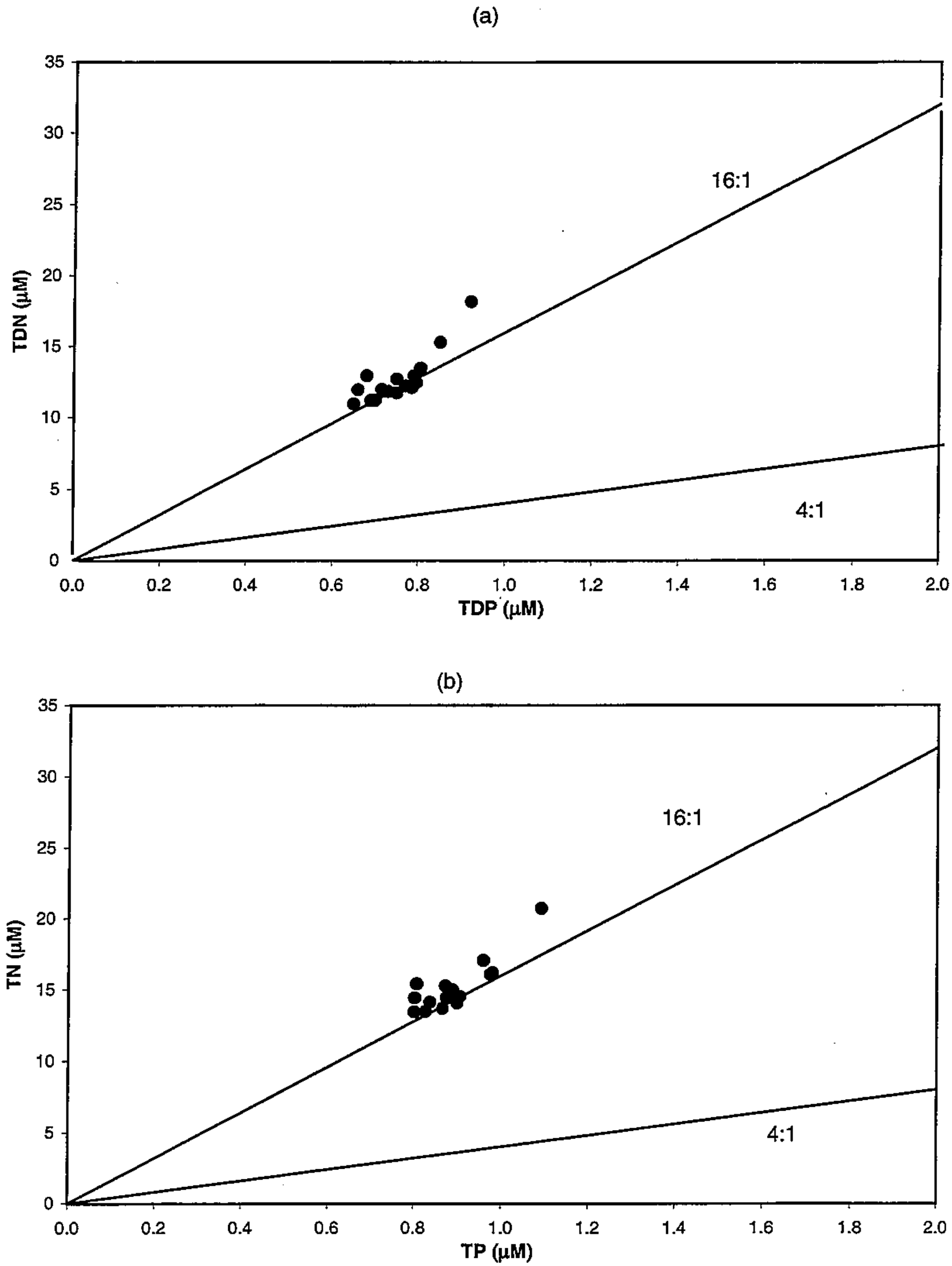
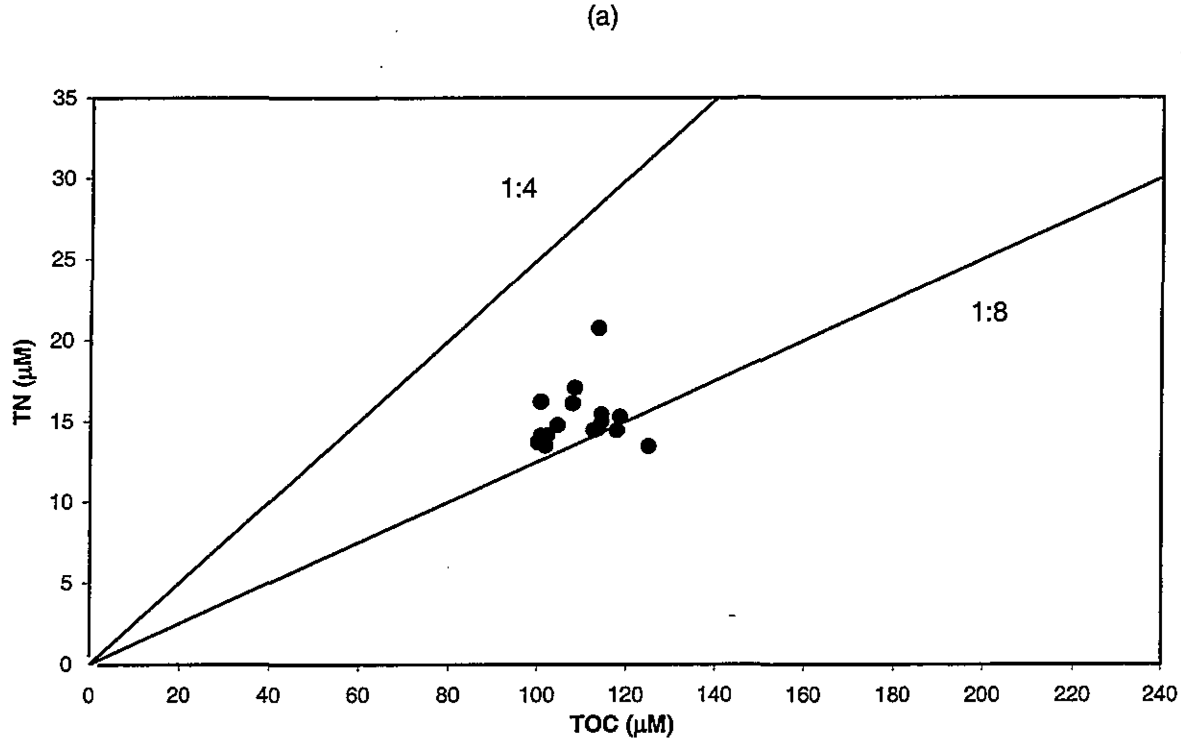


FIGURE 4-41
Nutrient vs. nutrient plots for nearfield survey W9703, (Mar 97)



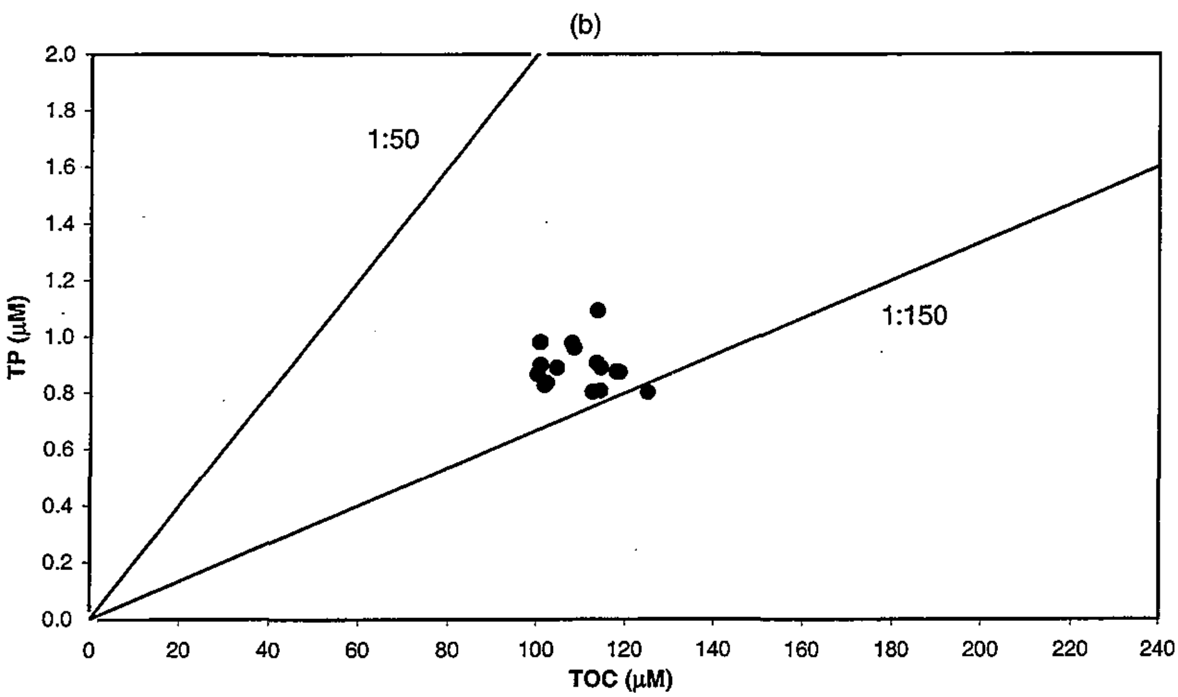


FIGURE 4-42
Depth vs. nutrient plots for nearfield survey W9703, (Mar 97)

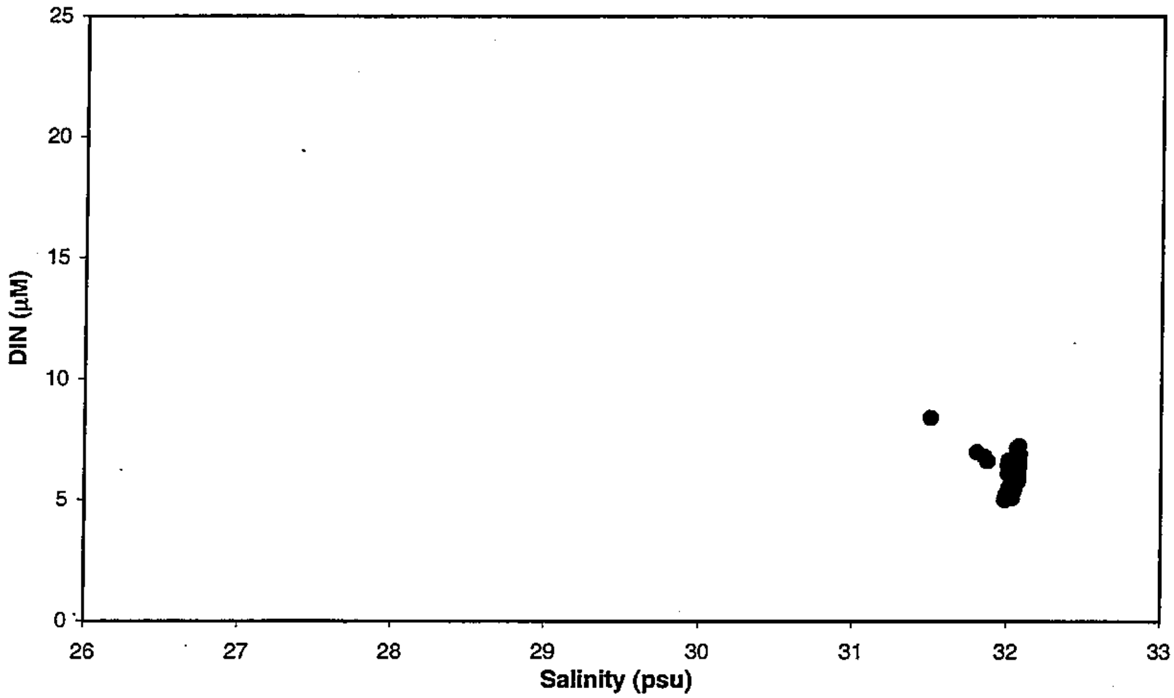
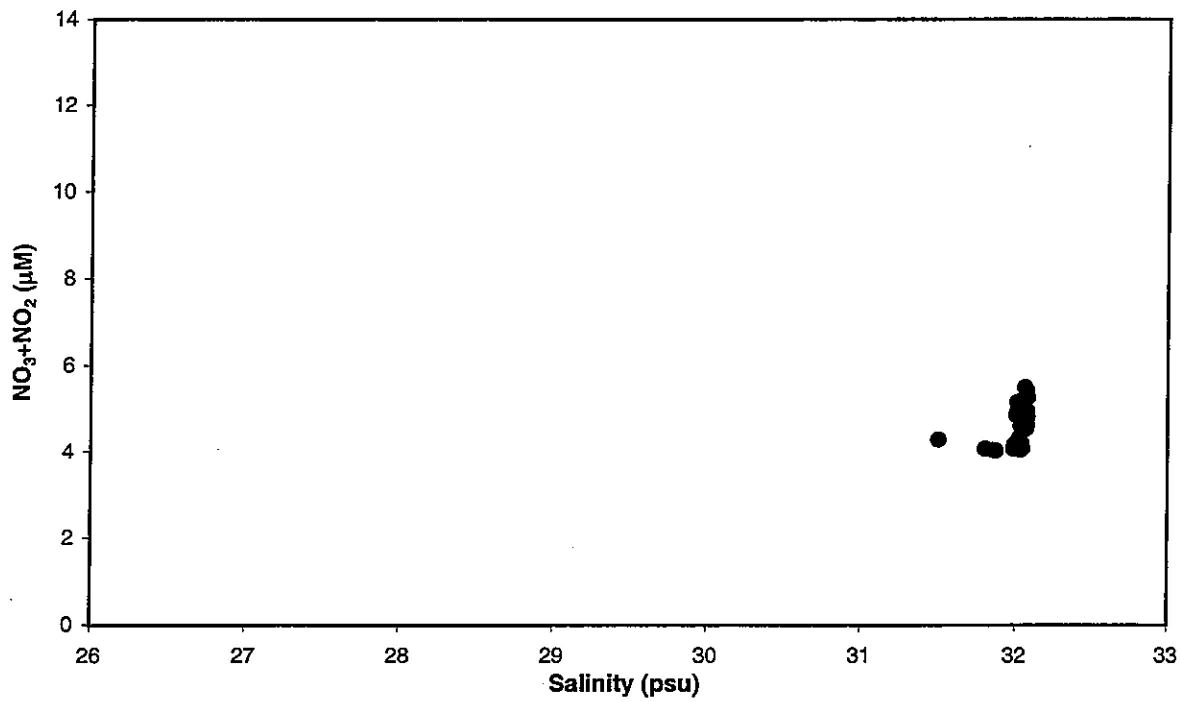


FIGURE 4-43
Nutrient vs. salinity plots for nearfield survey W9703, (Mar 97)

(a)



(b)

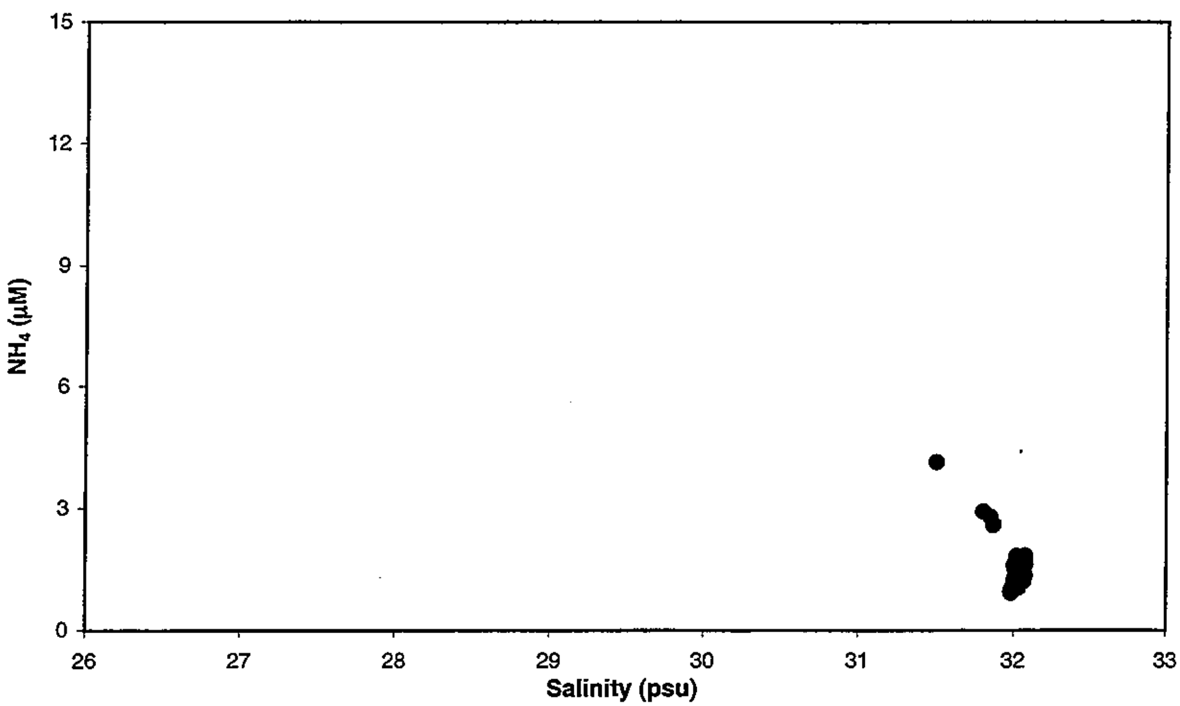
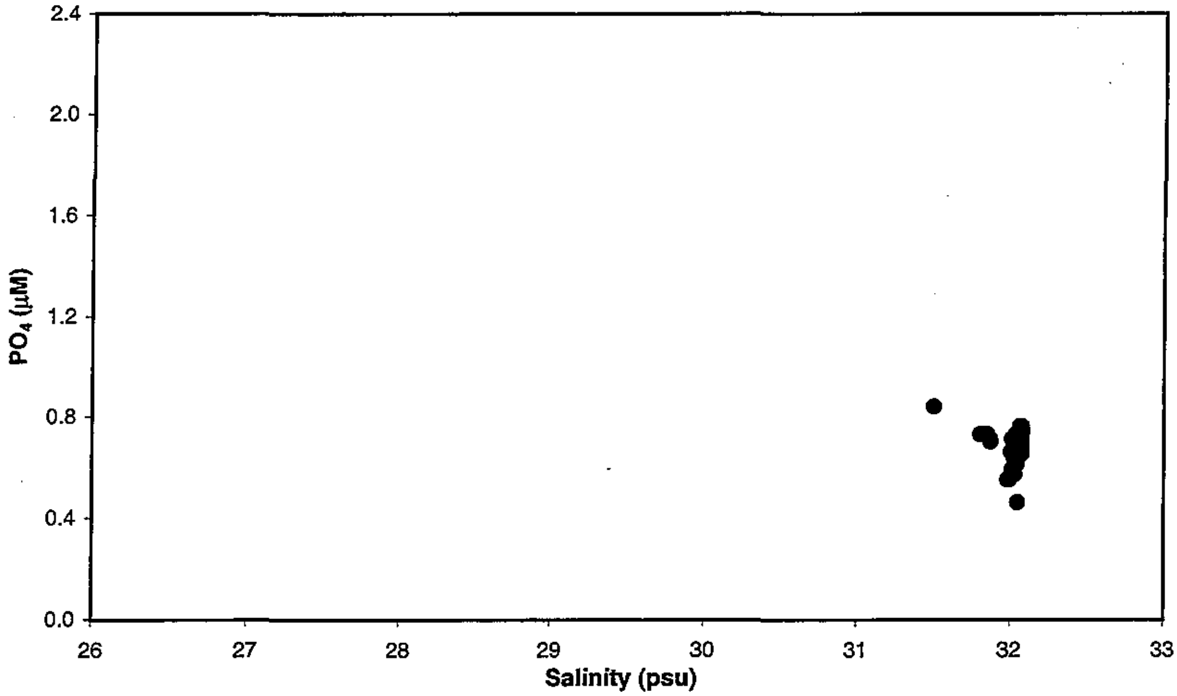


FIGURE 4-44
Nutrient vs. salinity plots for nearfield survey W9703, (Mar 97)

(a)



(b)

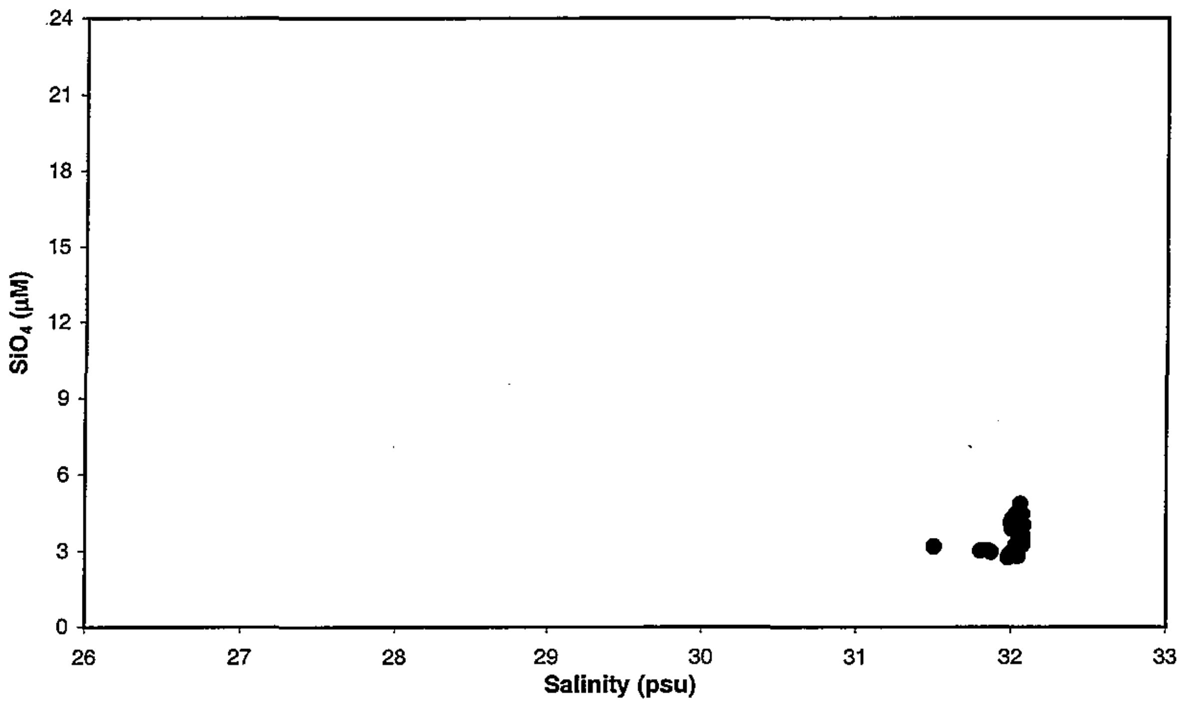


FIGURE 4-45
Nutrient vs. salinity plots for nearfield survey W9703, (Mar 97)

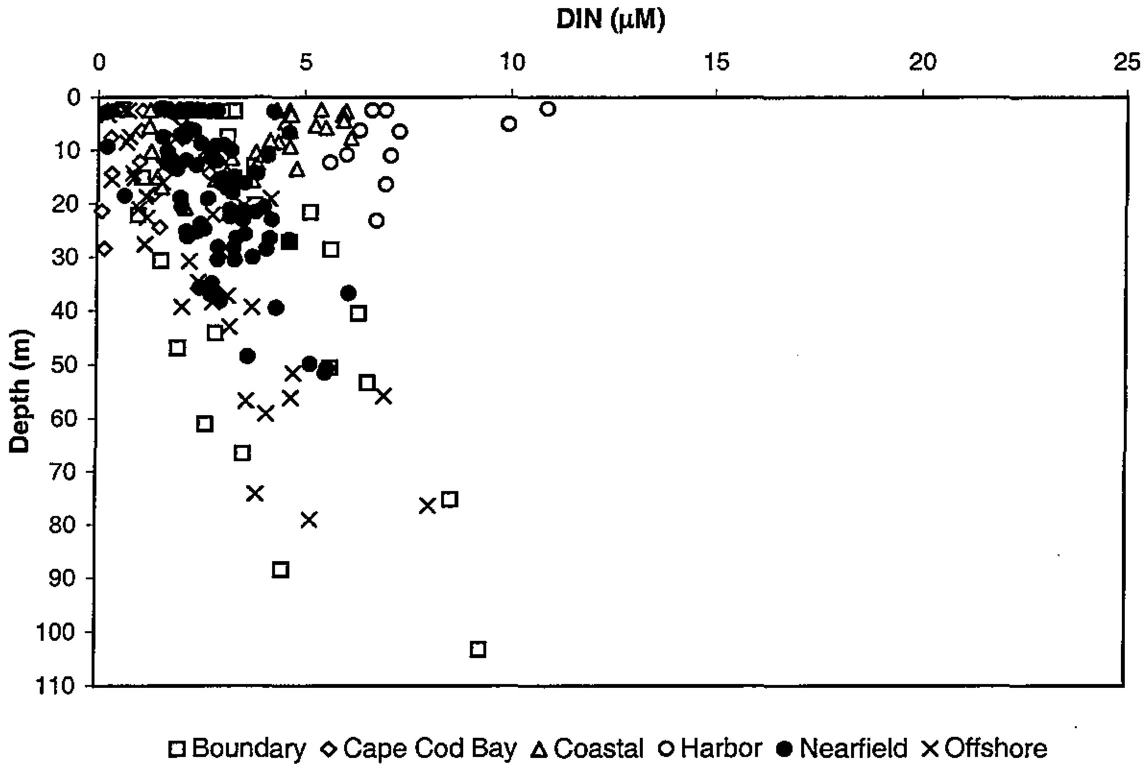


FIGURE 4-46
Depth vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

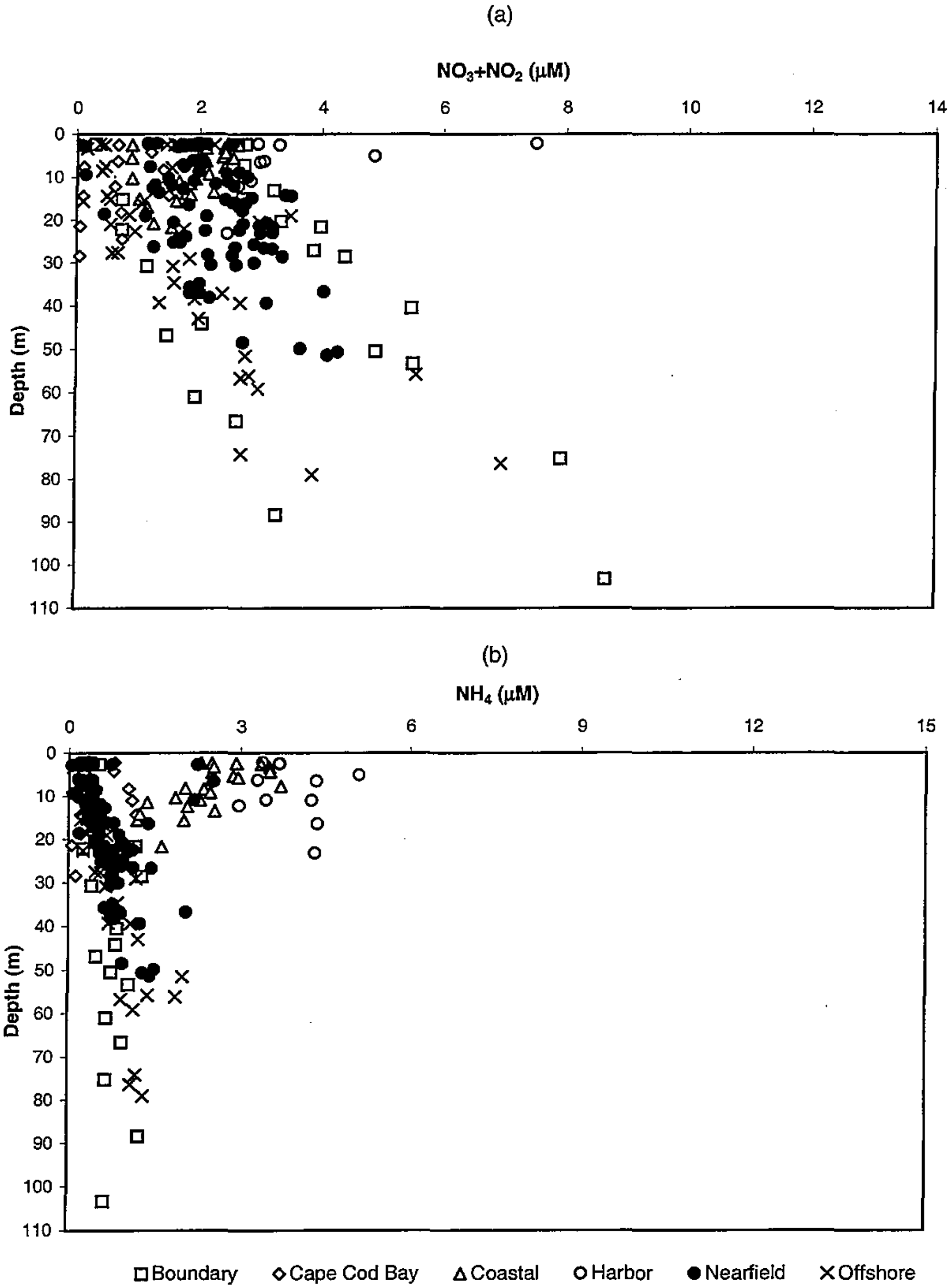


FIGURE 4-47

Depth vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

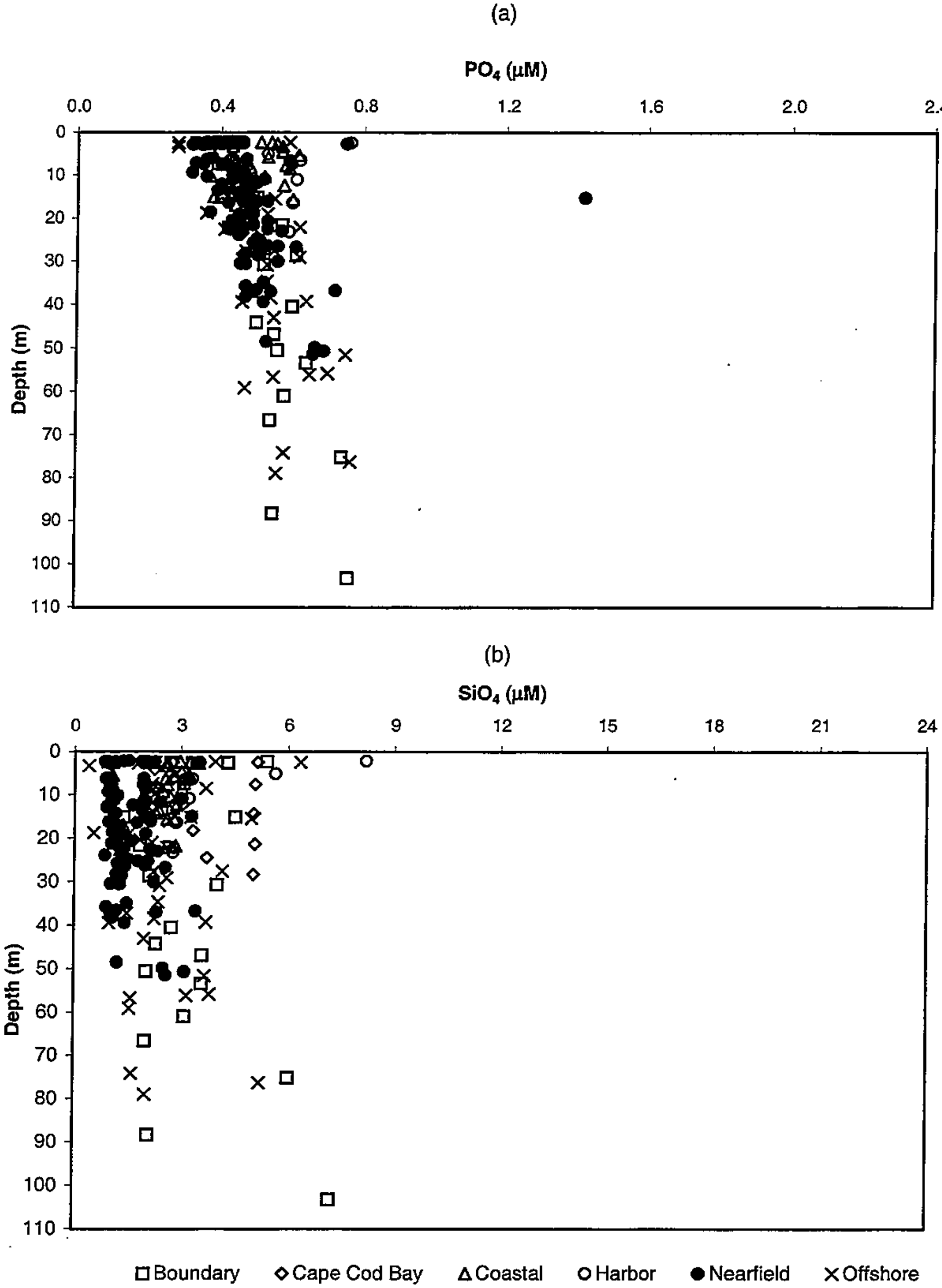


FIGURE 4-48
Depth vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

(a)

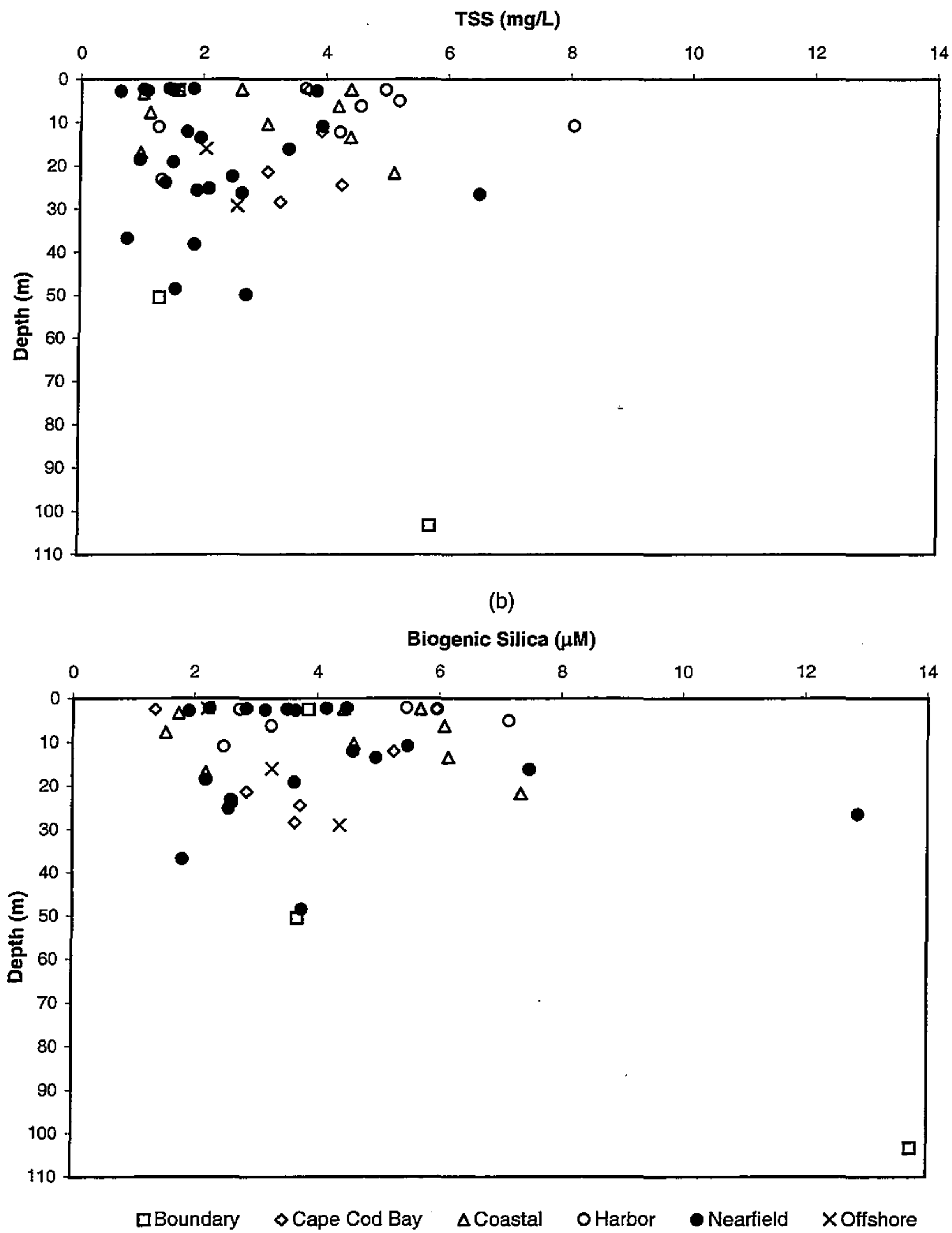


FIGURE 4-49
Depth vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

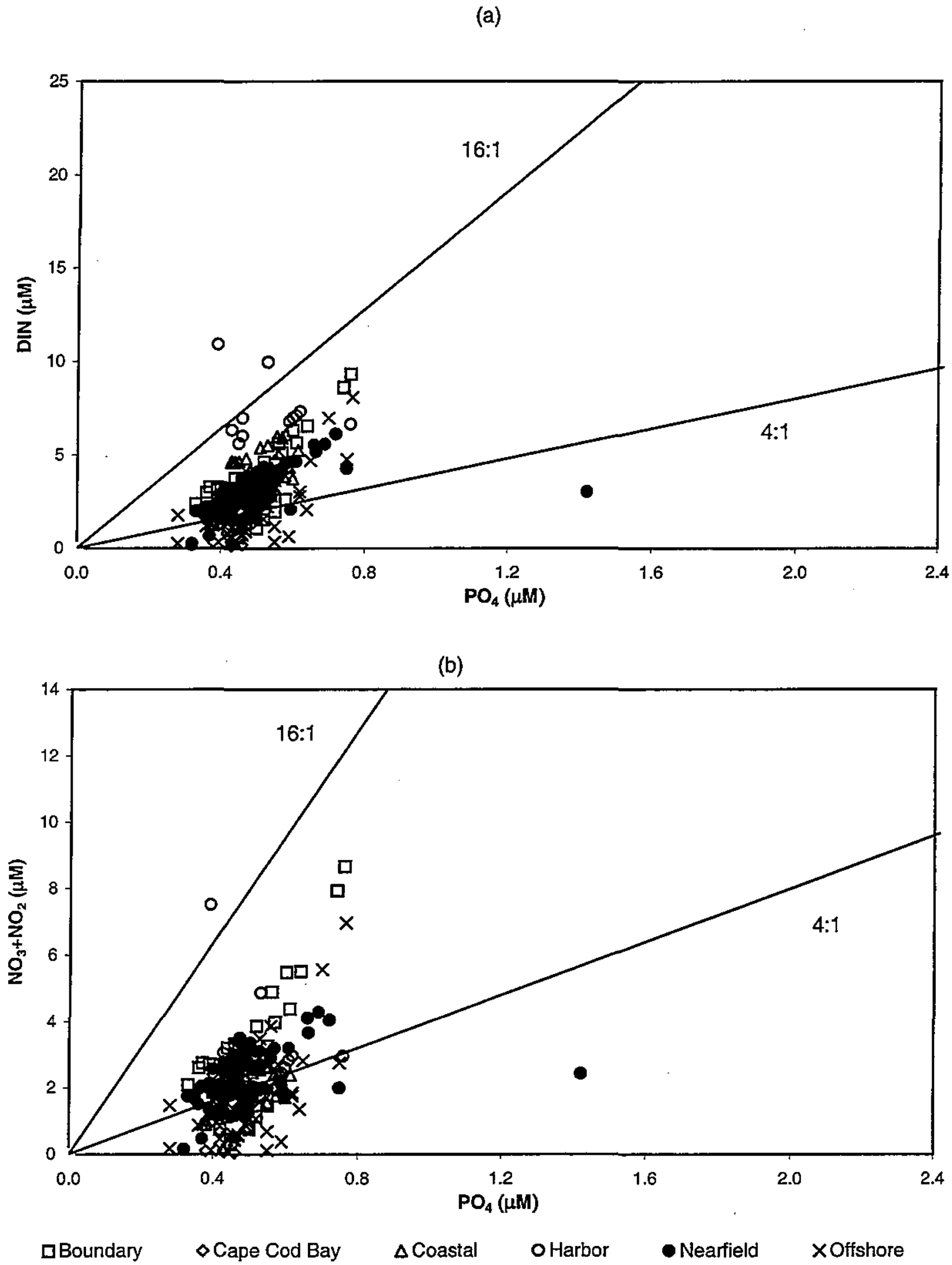


FIGURE 4-50
Nutrient vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

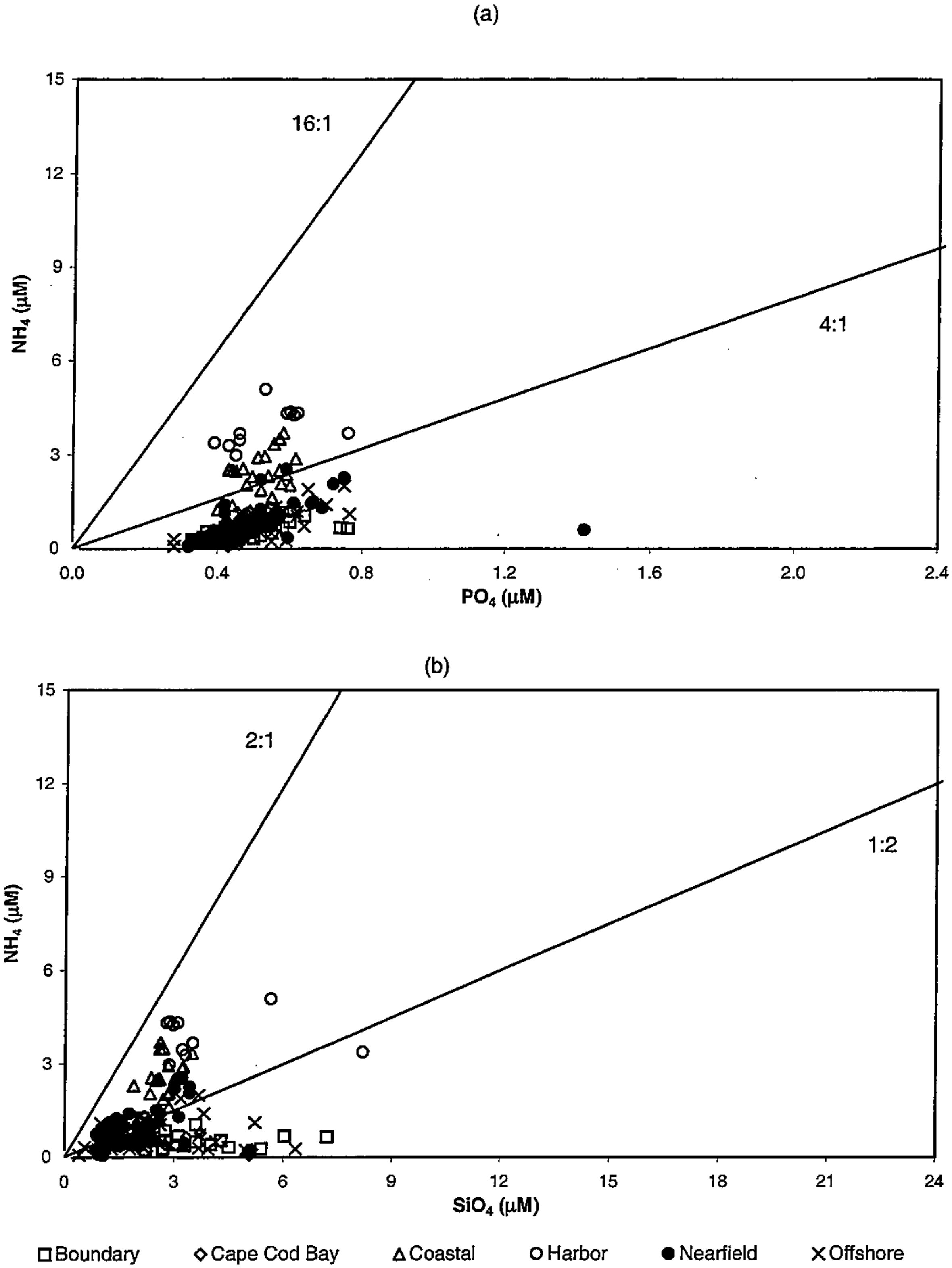


FIGURE 4-51
Nutrient vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

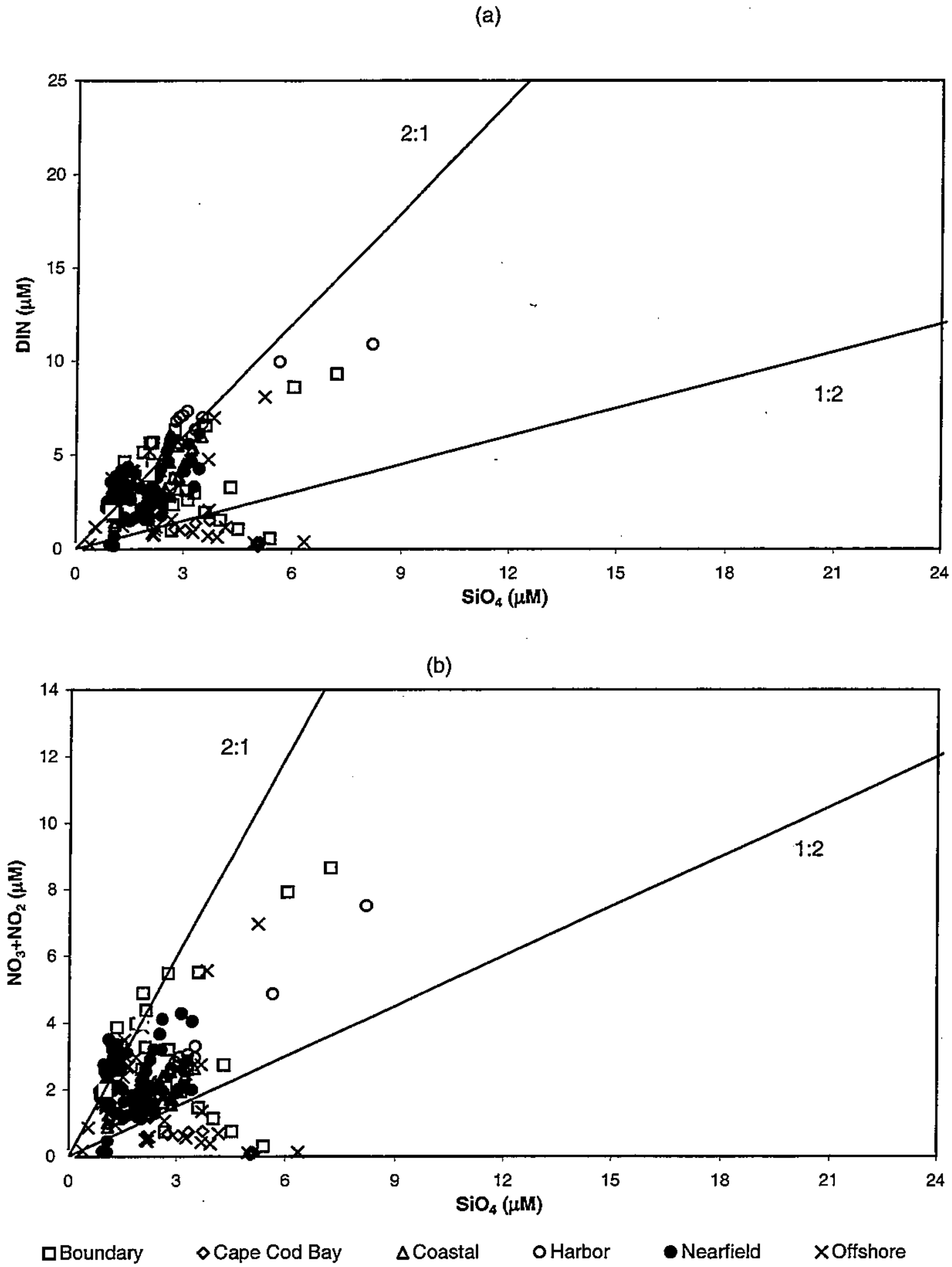


FIGURE 4-52

Nutrient vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

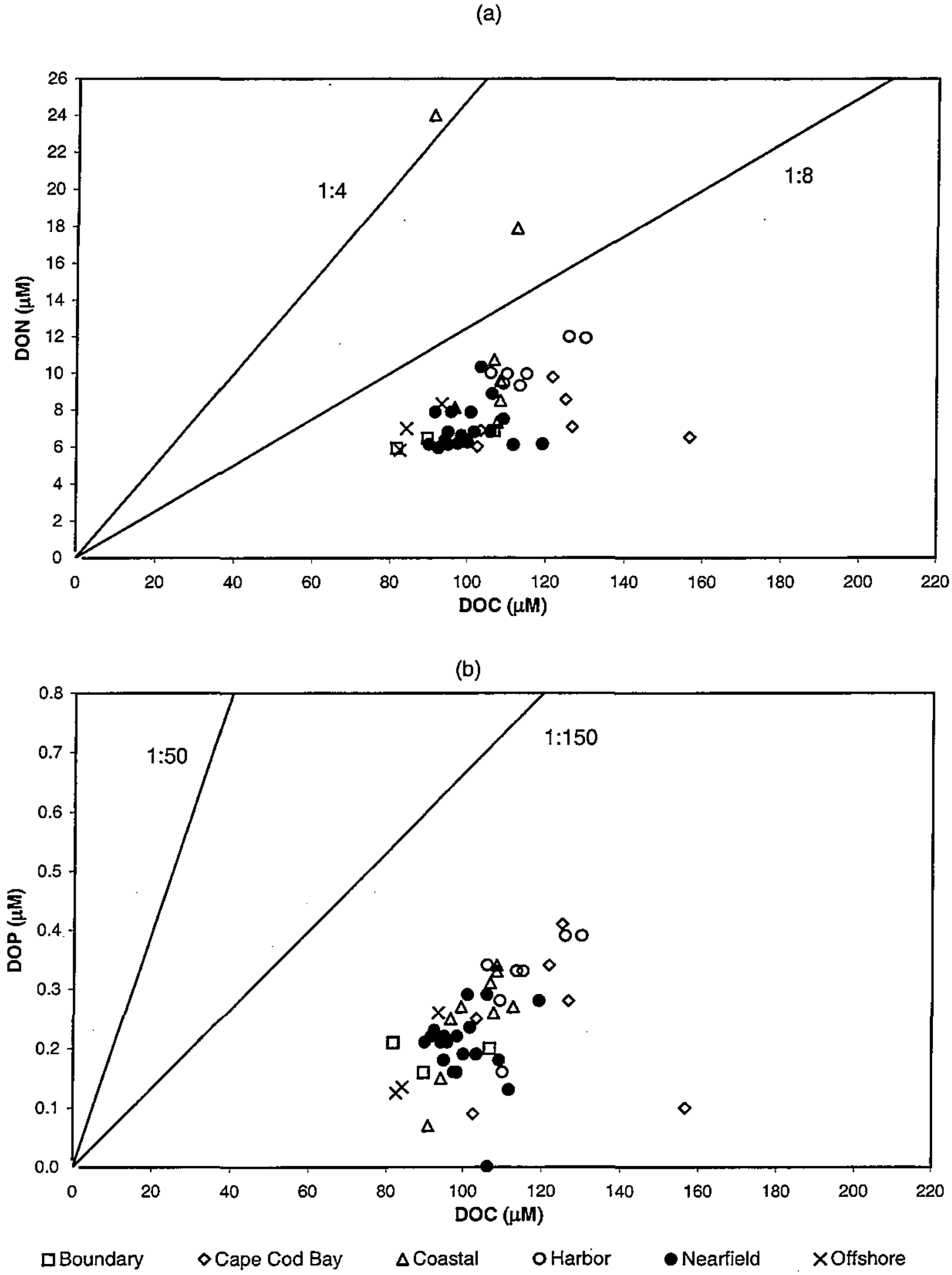


FIGURE 4-53
Nutrient vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

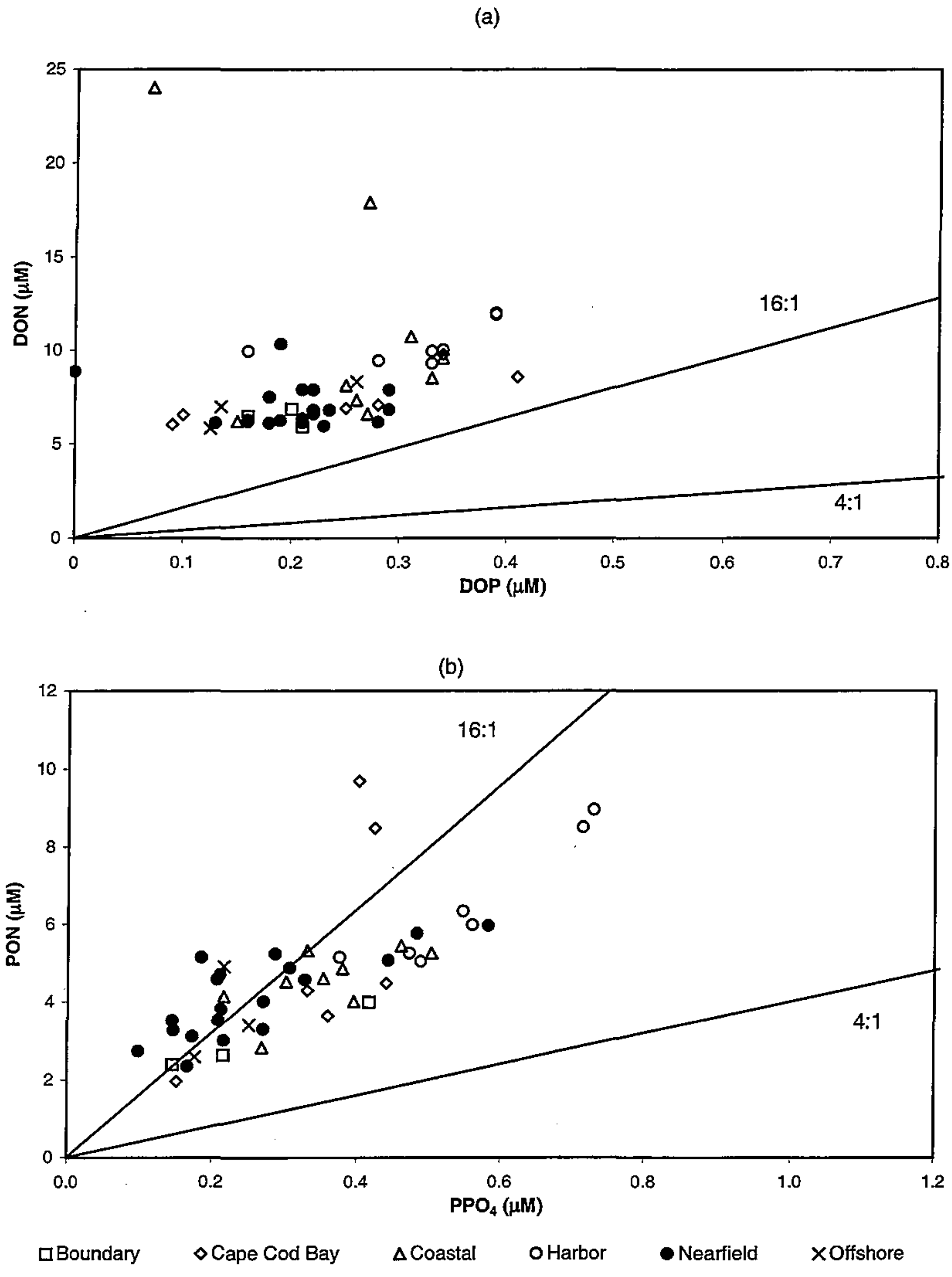


FIGURE 4-54

Nutrient vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

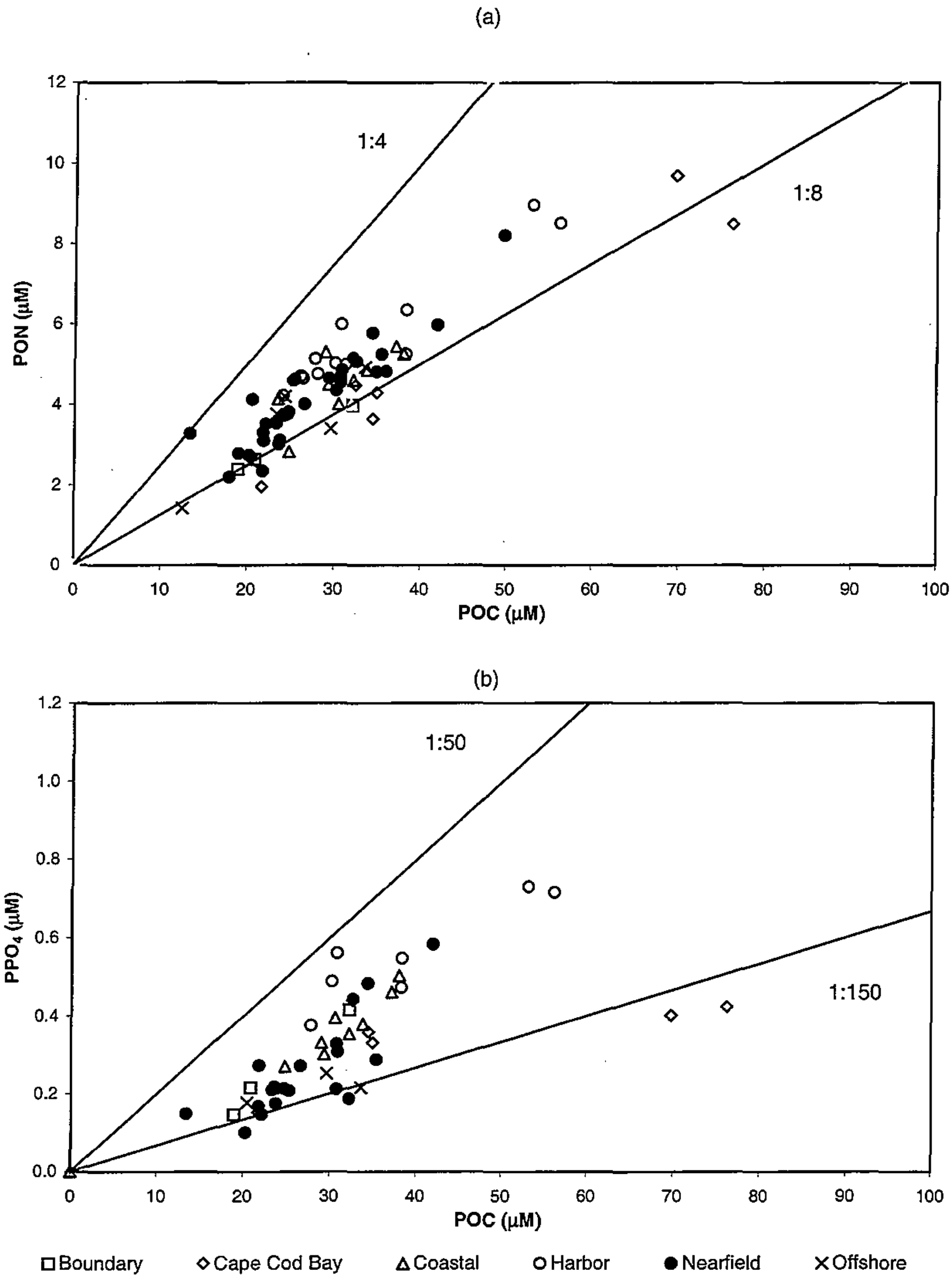


FIGURE 4-55

Nutrient vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

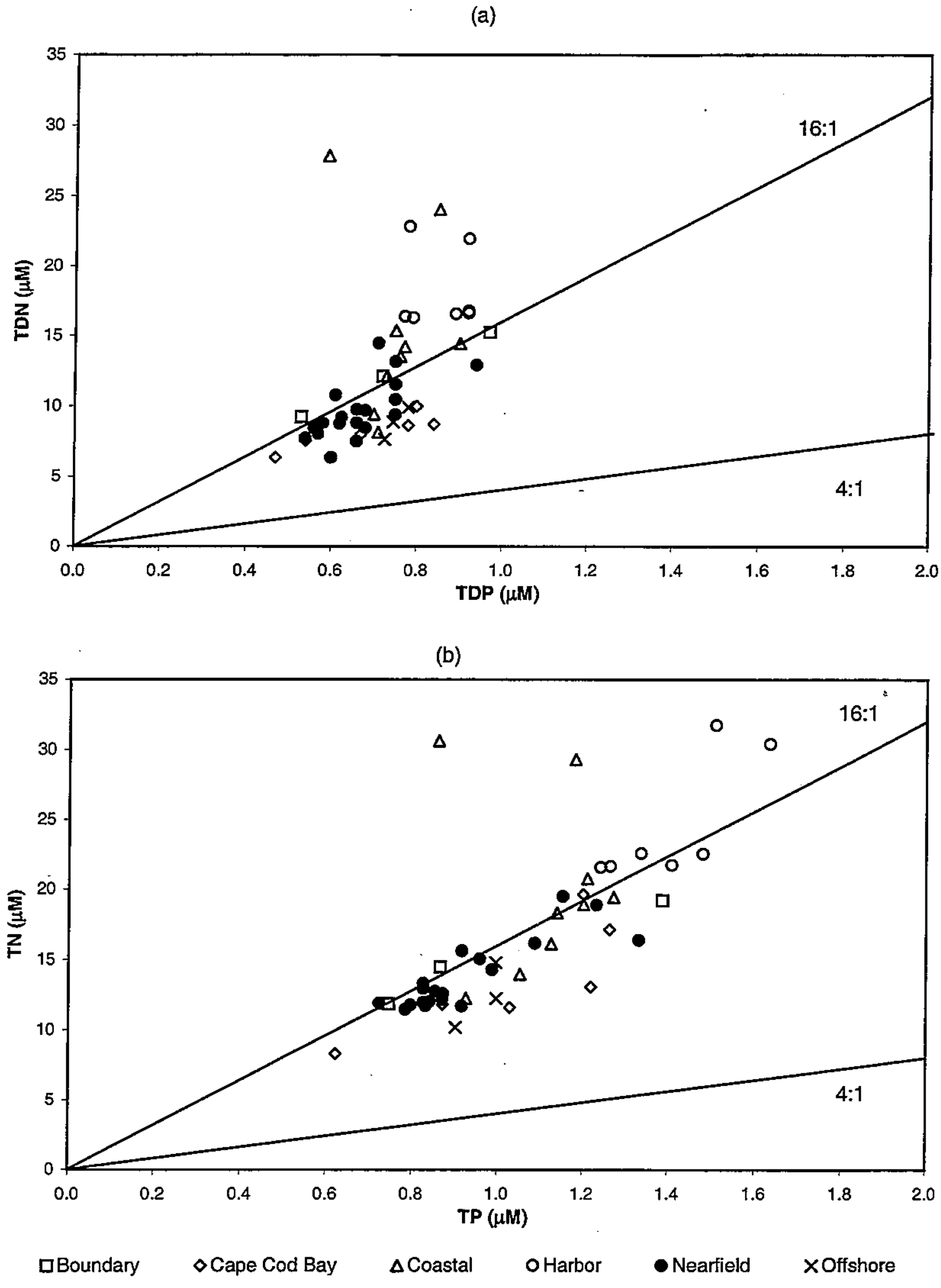


FIGURE 4-56
Nutrient vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

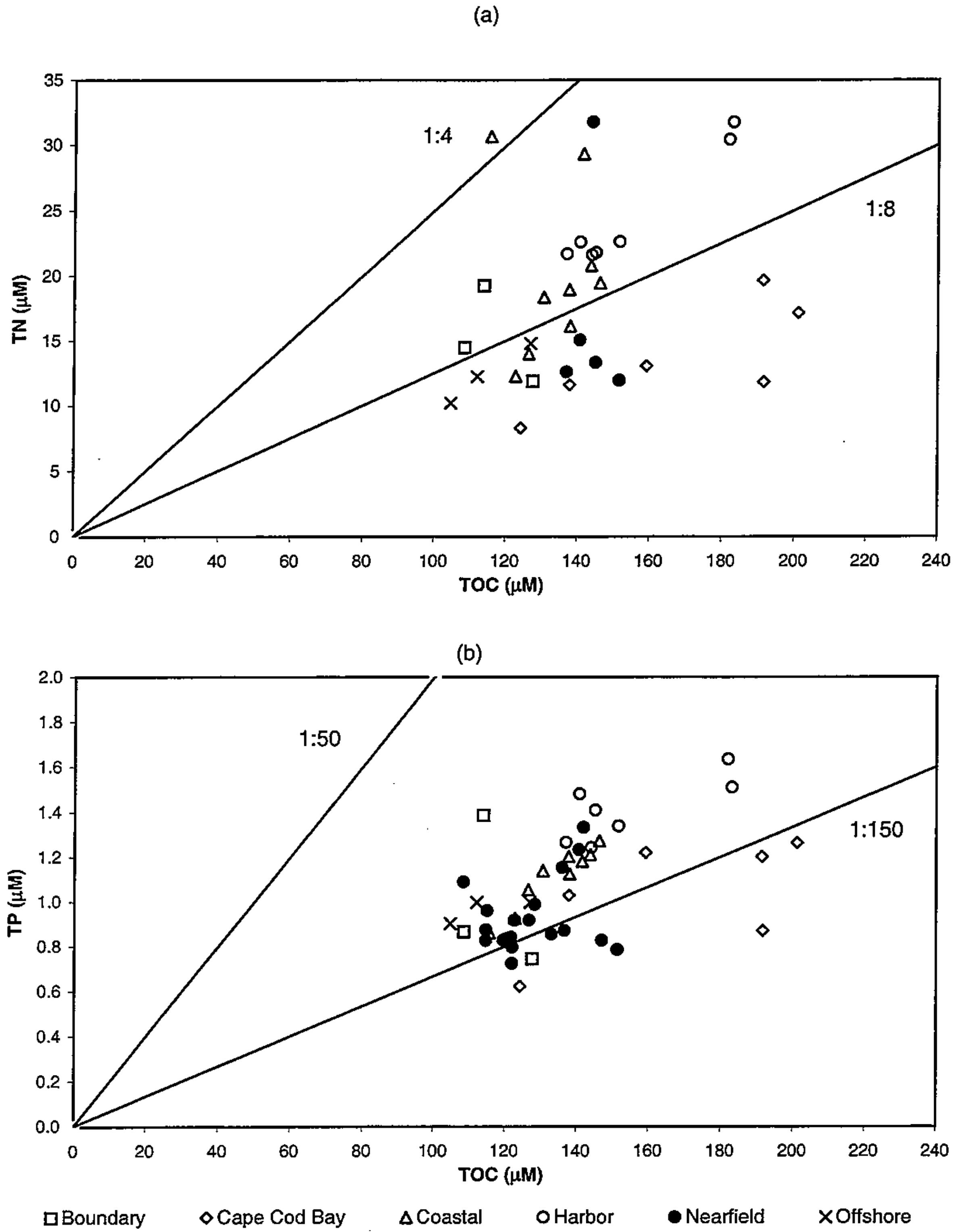


FIGURE 4-57
Depth vs. nutrient plots for farfield survey W9704, (Mar-Apr 97)

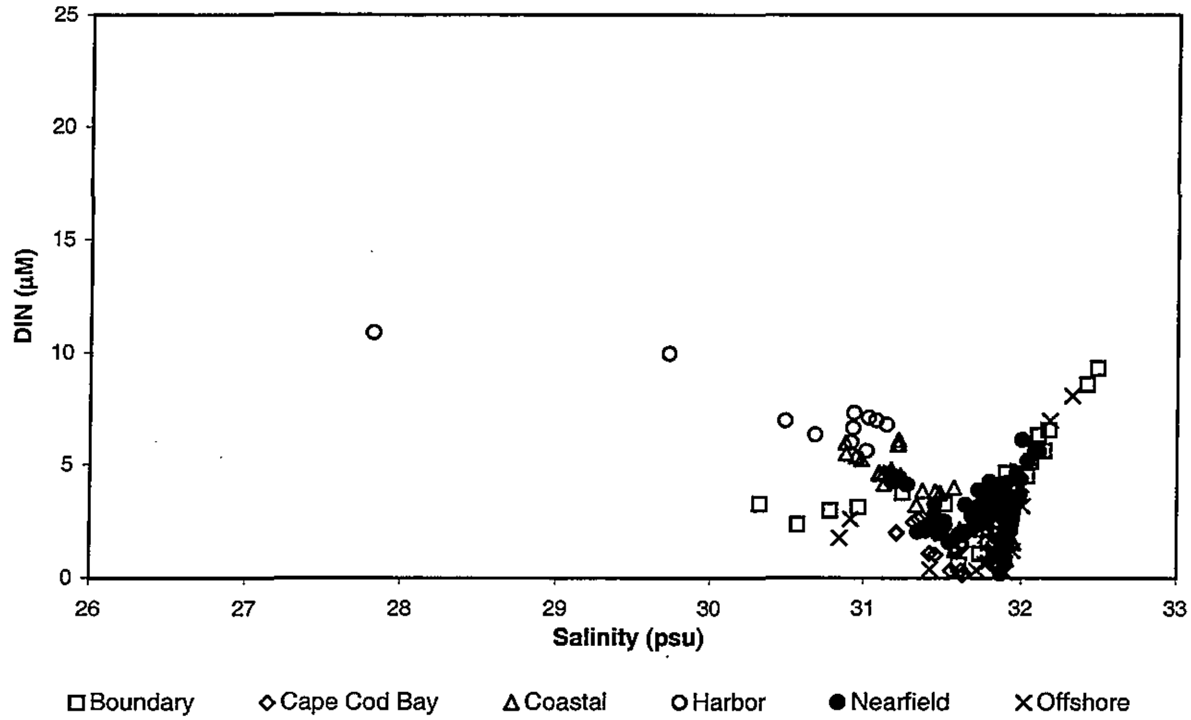


FIGURE 4-58
Nutrient vs. salinity plots for farfield survey W9704, (Mar-Apr 97)

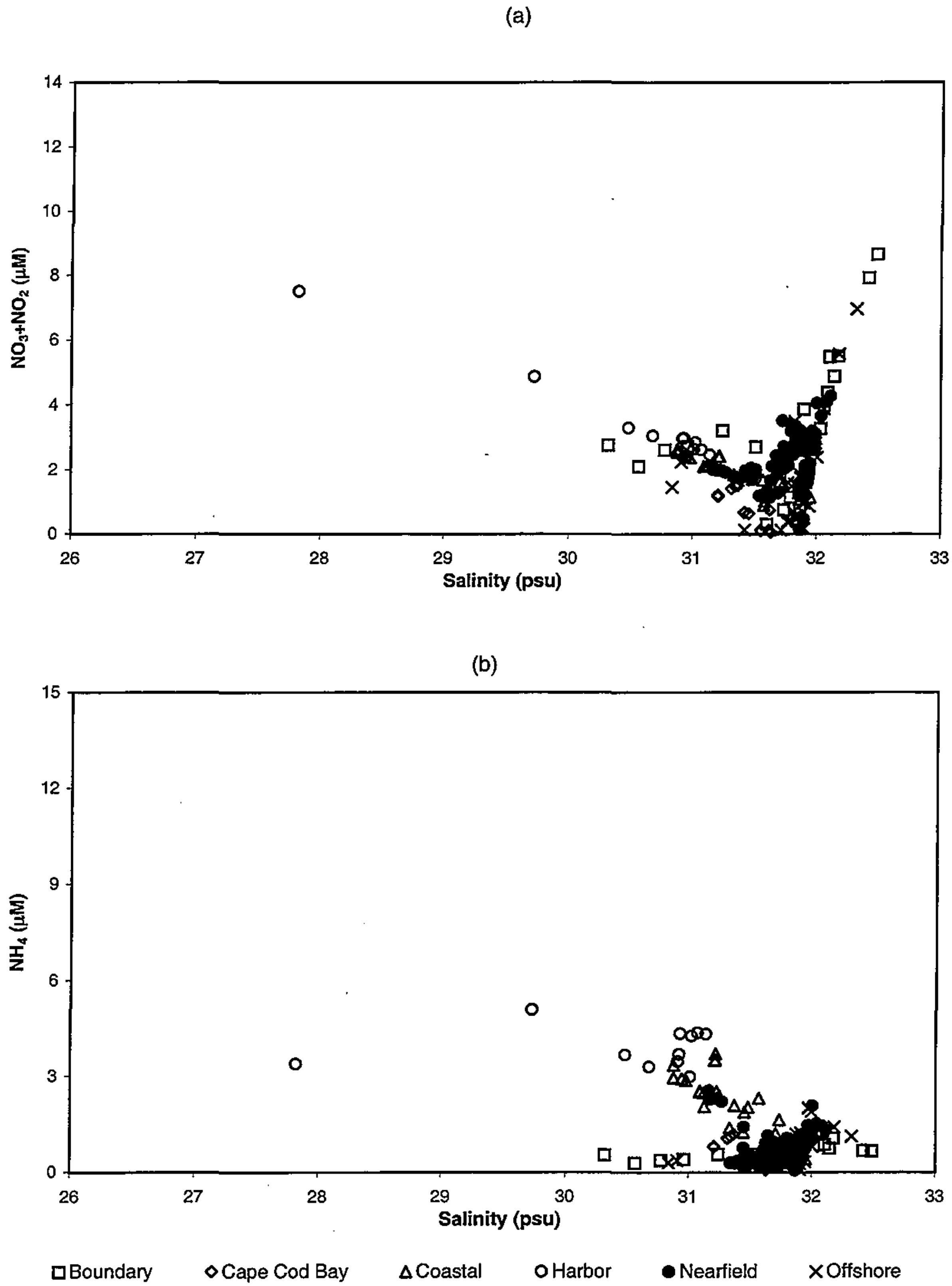


FIGURE 4-59

Nutrient vs. salinity plots for farfield survey W9704, (Mar-Apr 97)

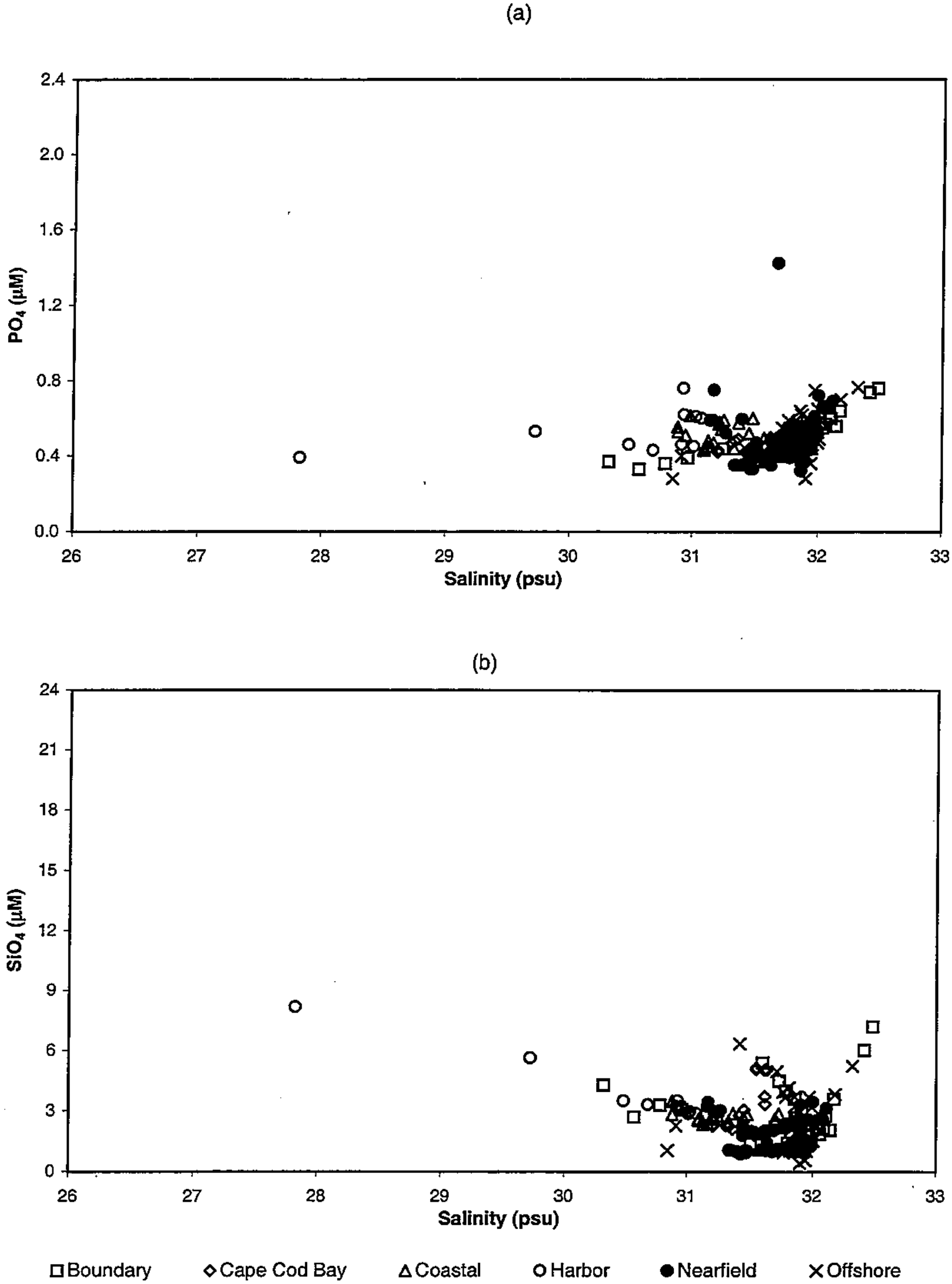


FIGURE 4-60
Nutrient vs. salinity plots for farfield survey W9704, (Mar-Apr 97)

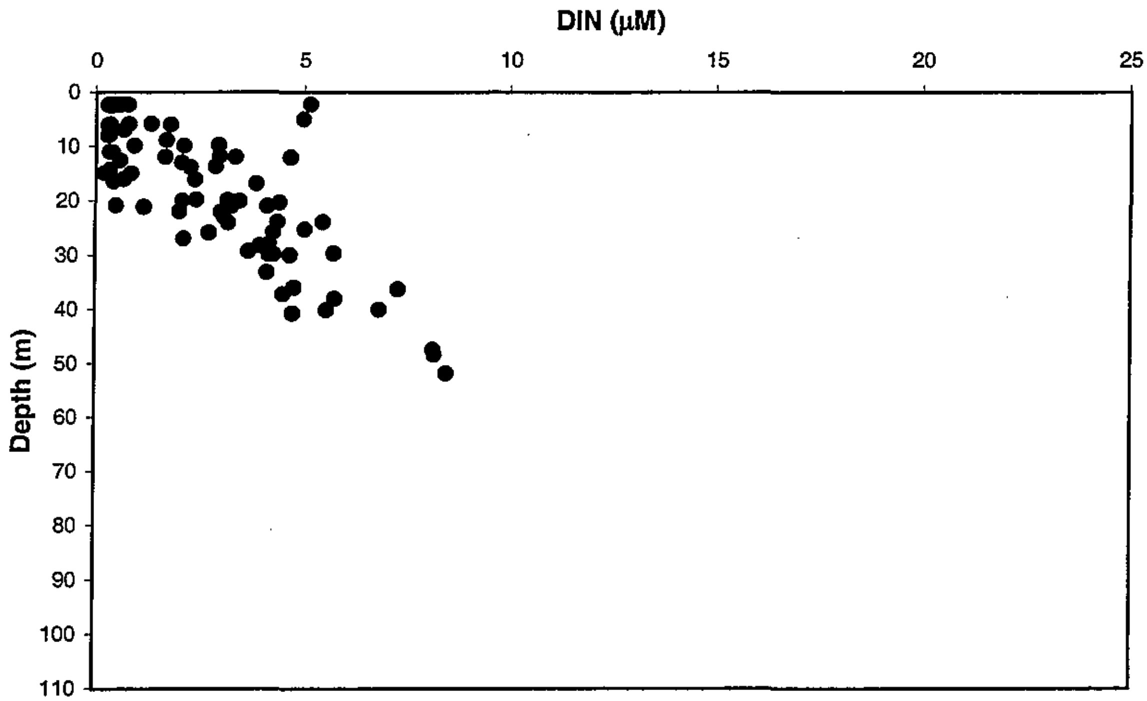
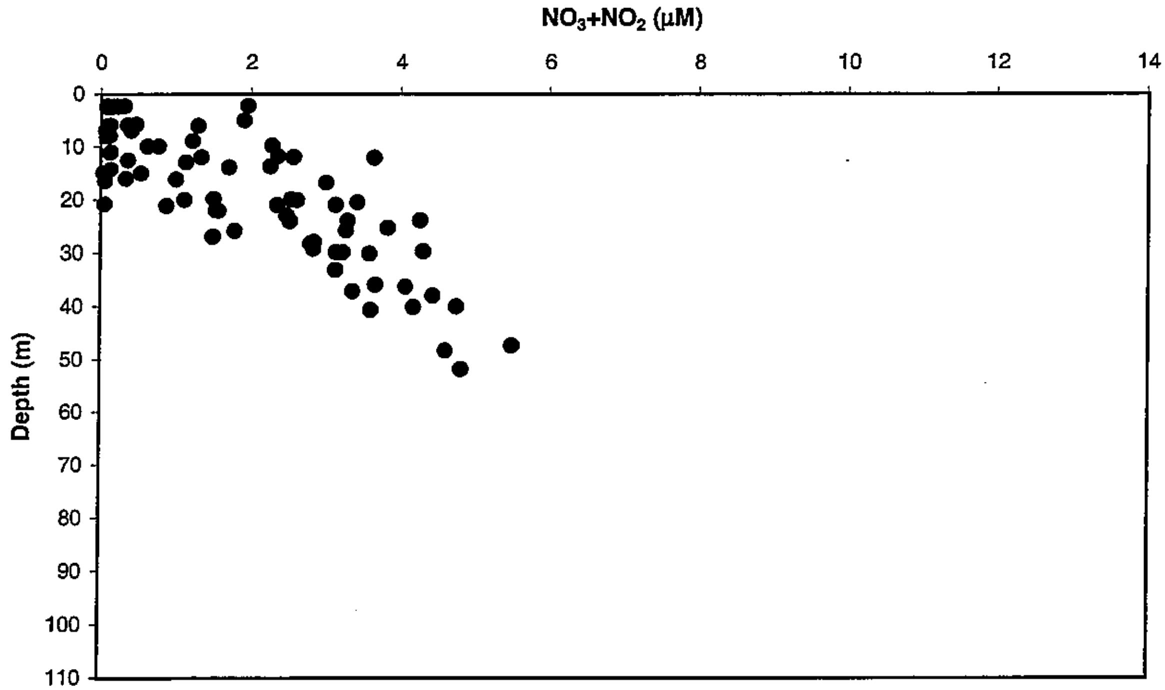


FIGURE 4-61
Depth vs. nutrient plots for nearfield survey W9705, (Apr 97)

(a)



(b)

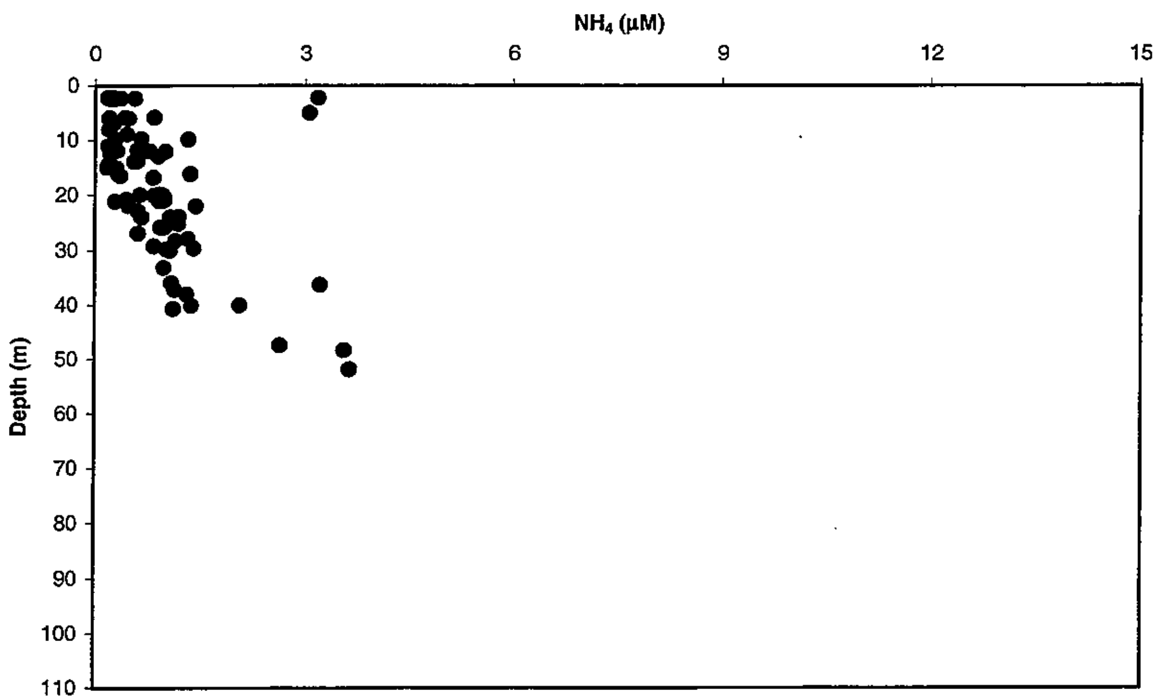
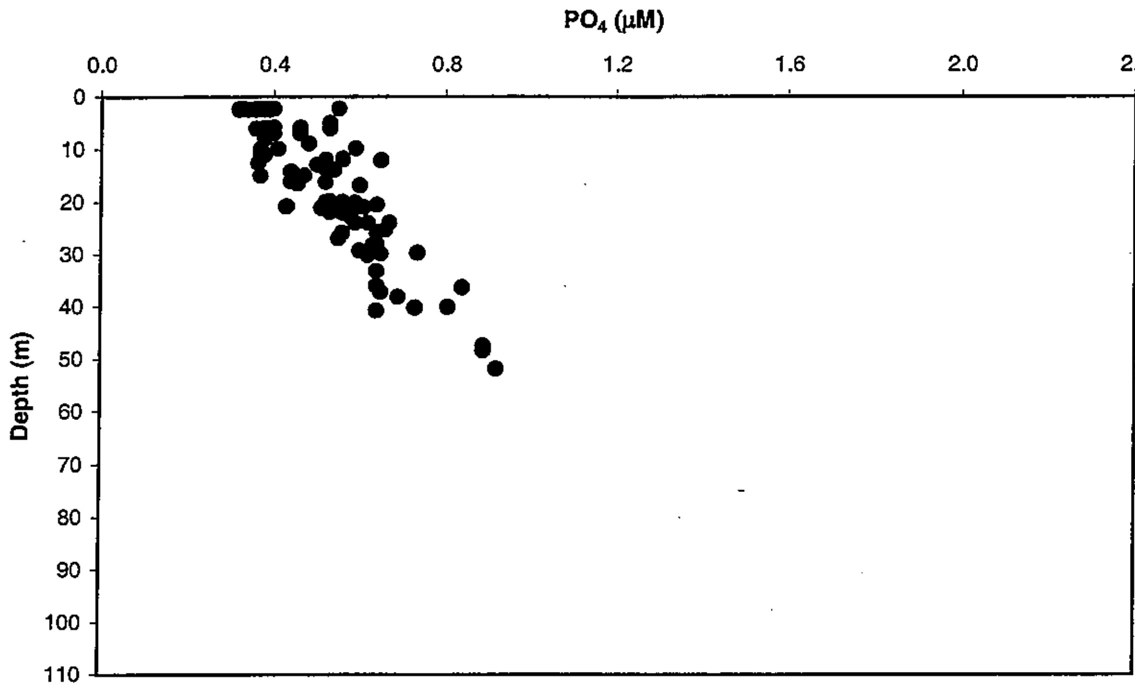


FIGURE 4-62
Depth vs. nutrient plots for nearfield survey W9705, (Apr 97)

(a)



(b)

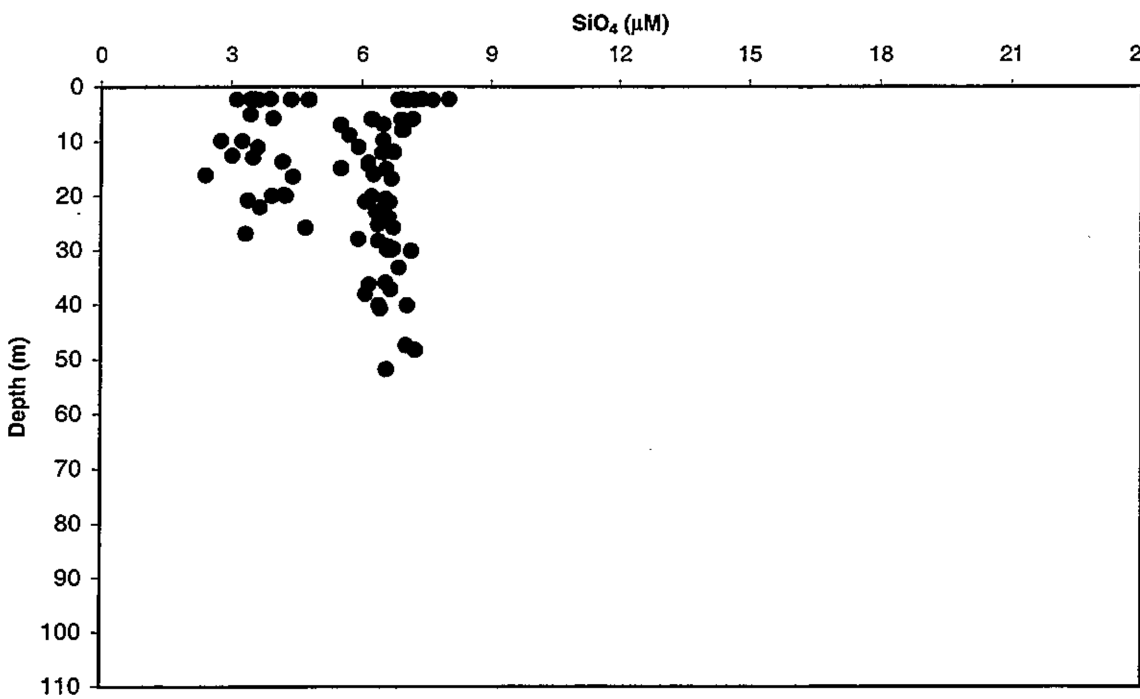
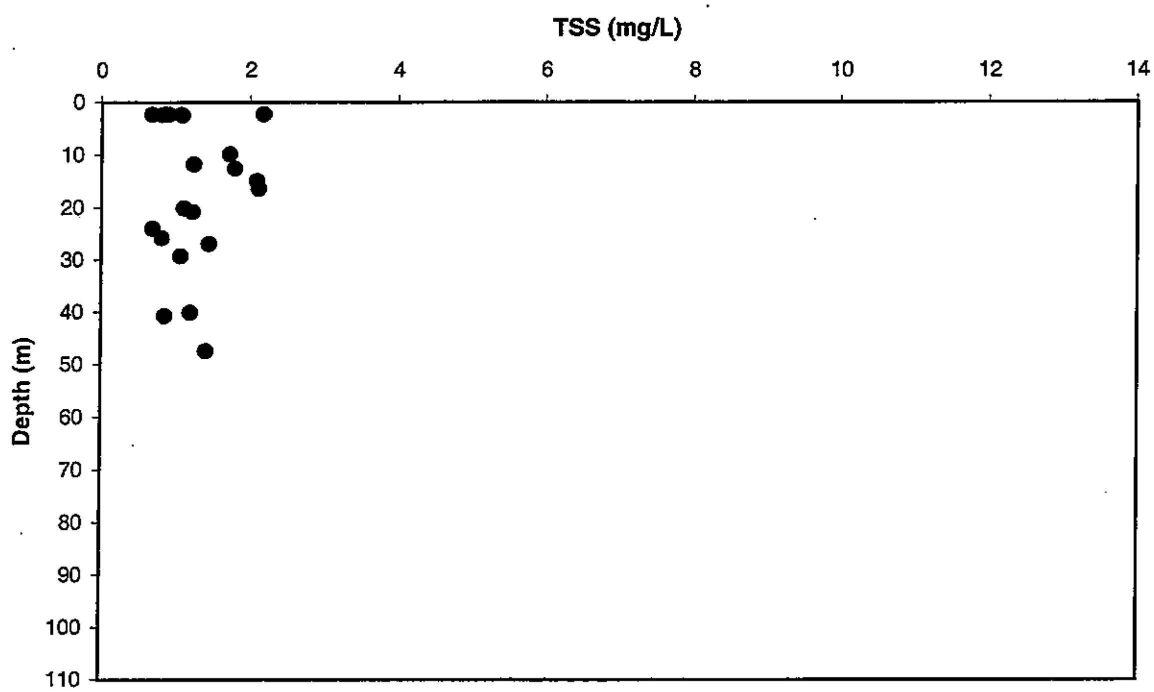


FIGURE 4-63

Depth vs. nutrient plots for nearfield survey W9705, (Apr 97)

(a)



(b)

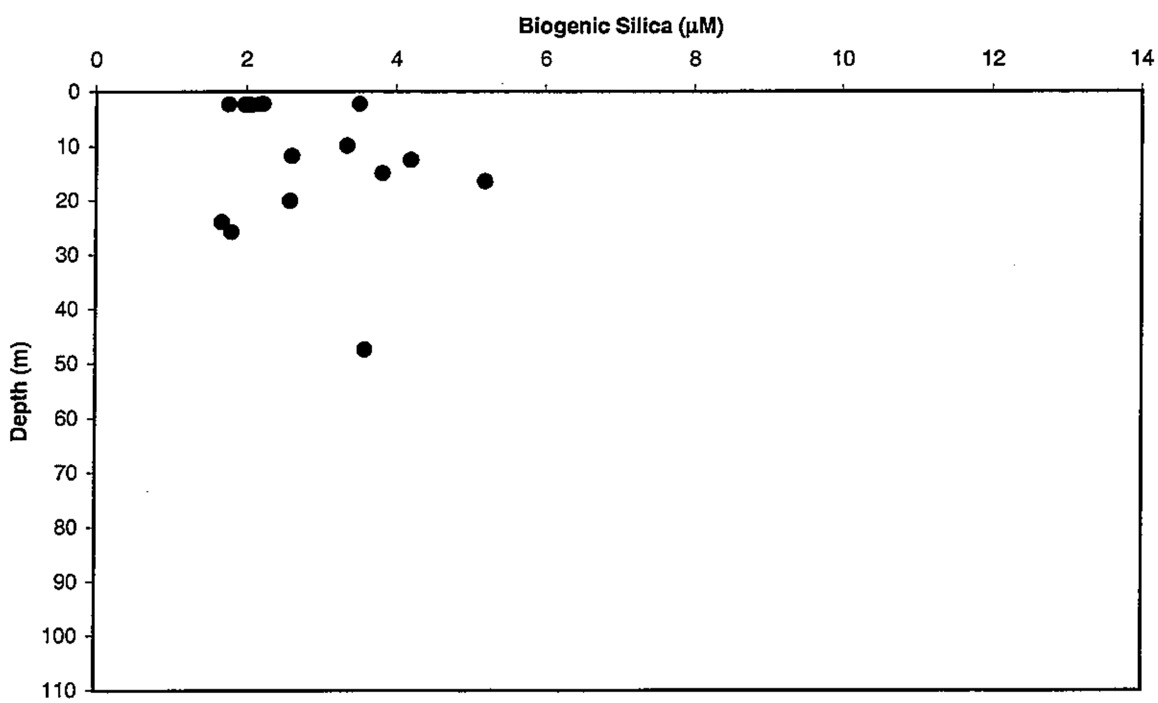
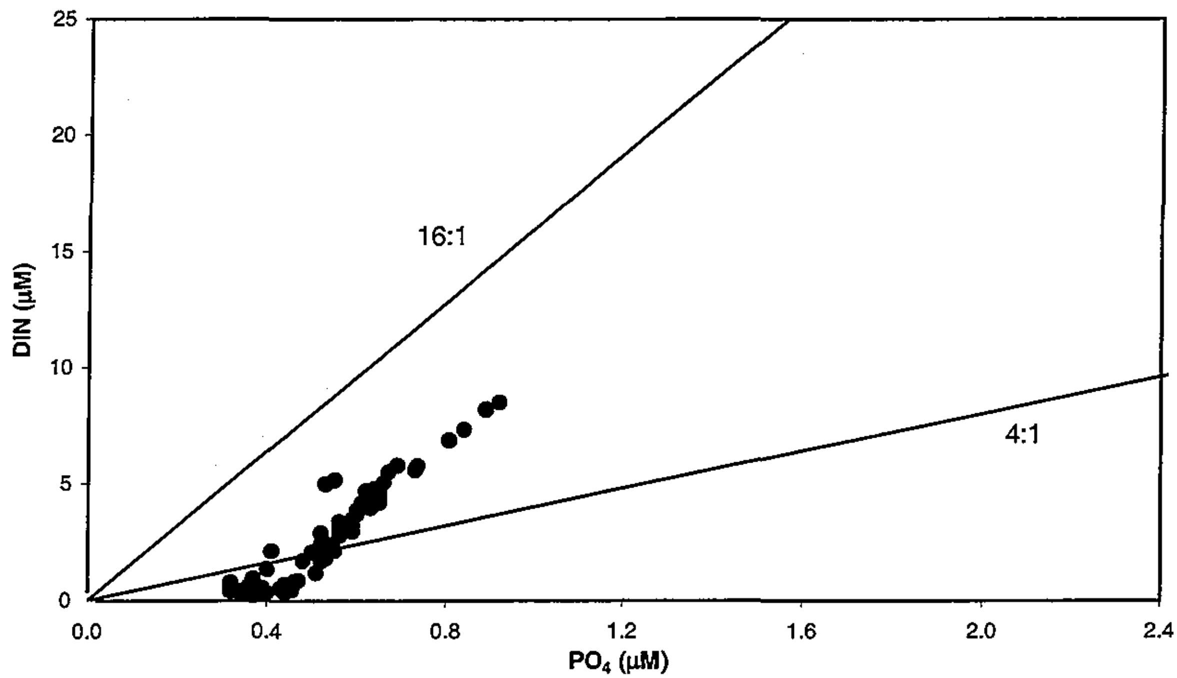


FIGURE 4-64
Depth vs. nutrient plots for nearfield survey W9705, (Apr 97)

(a)



(b)

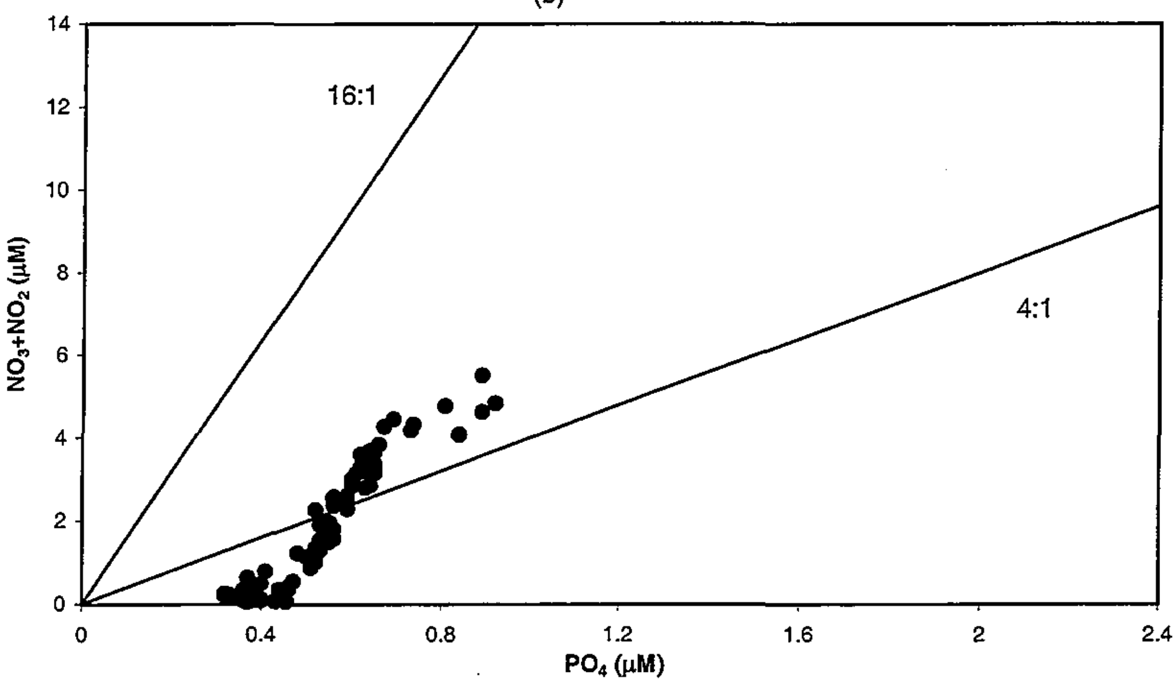


FIGURE 4-65

Nutrient vs. nutrient plots for nearfield survey W9705, (Apr 97)

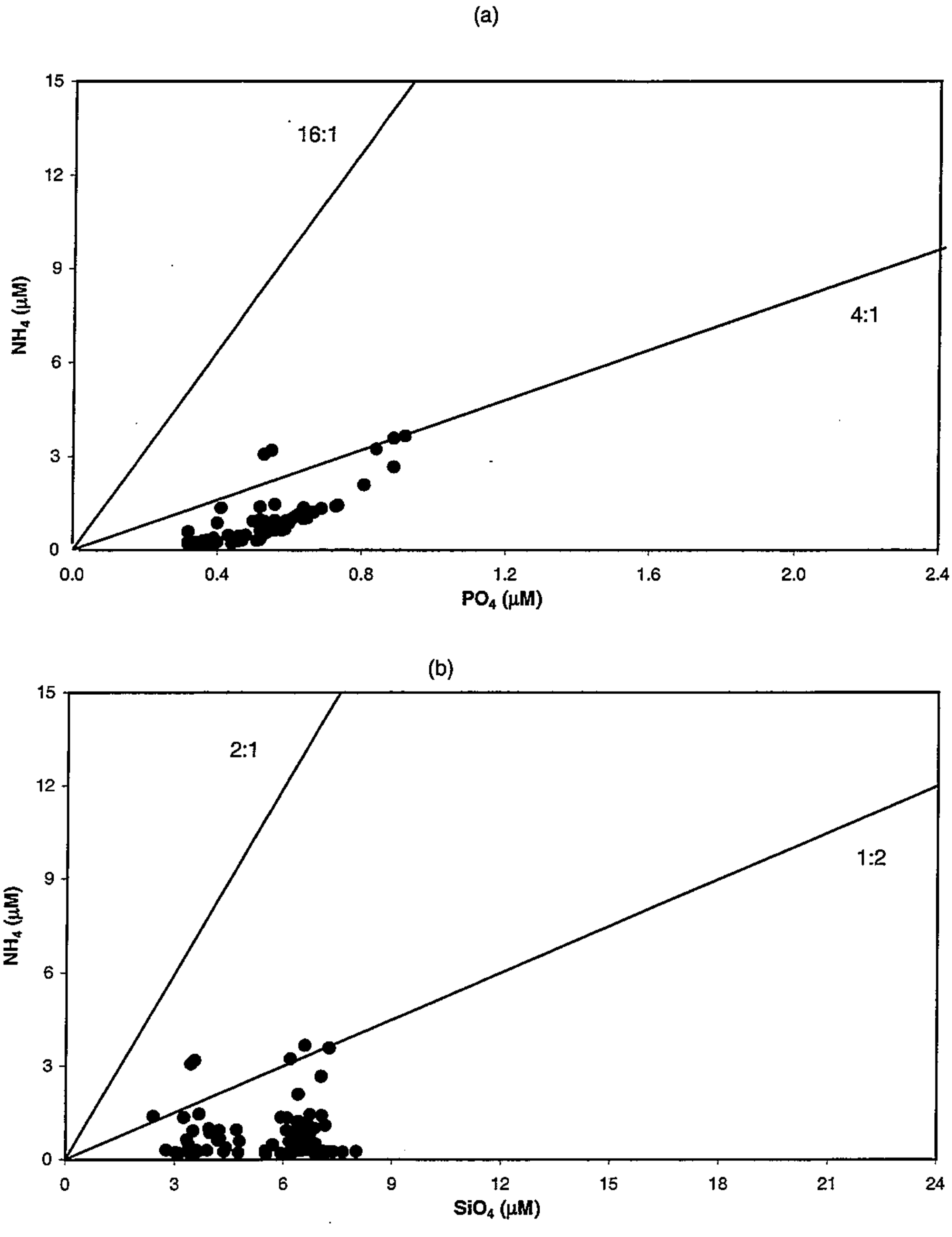


FIGURE 4-66
Nutrient vs. nutrient plots for nearfield survey W9705, (Apr 97)

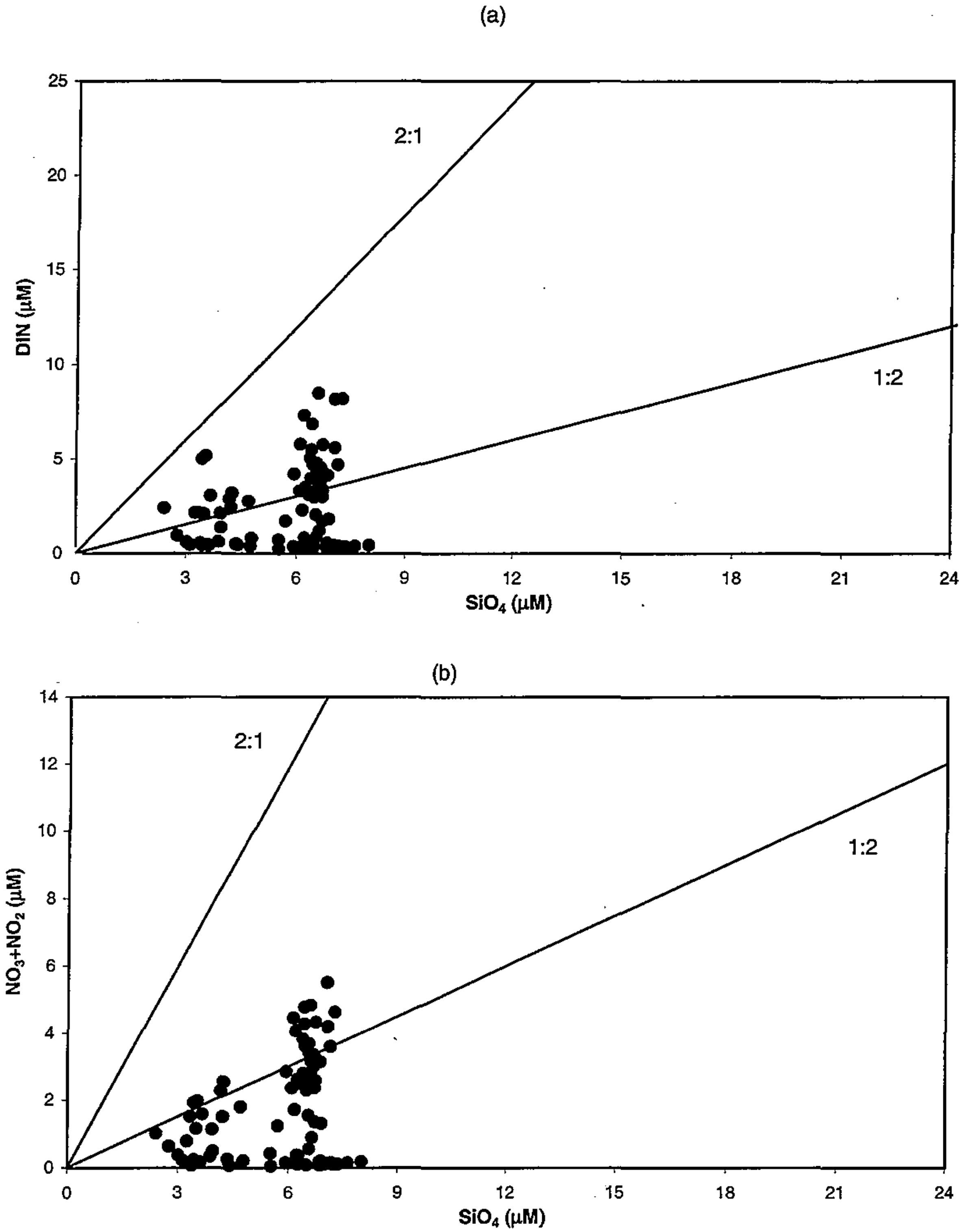
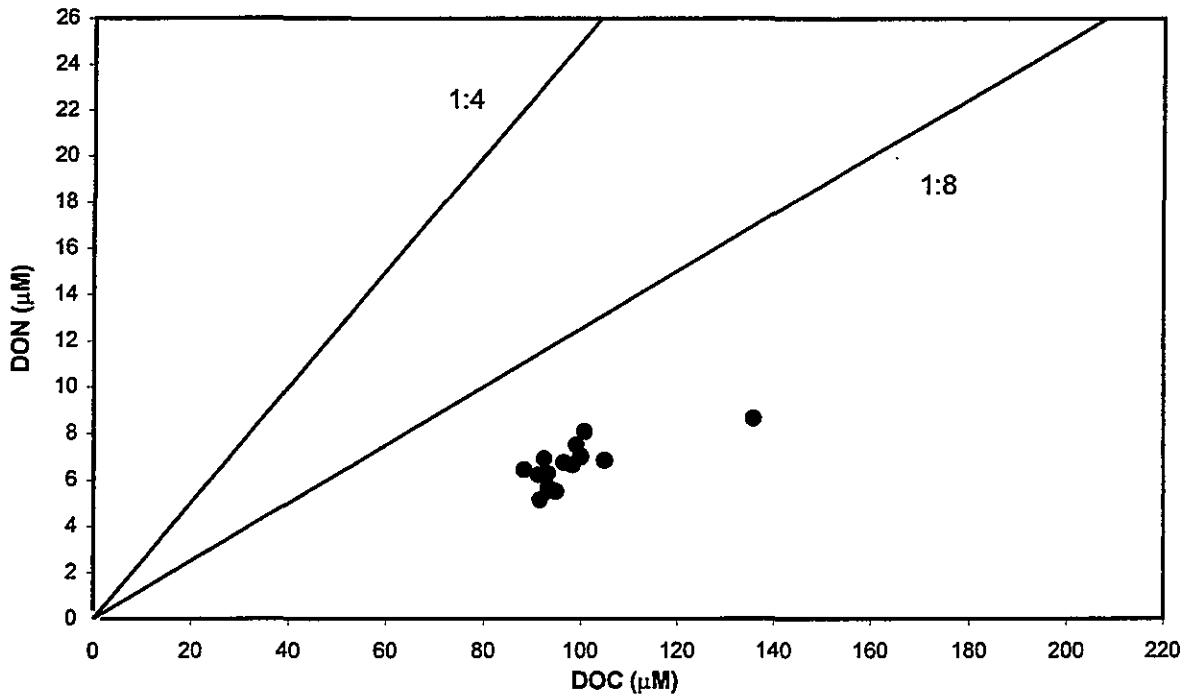


FIGURE 4-67
Nutrient vs. nutrient plots for nearfield survey W9705, (Apr 97)

(a)



(b)

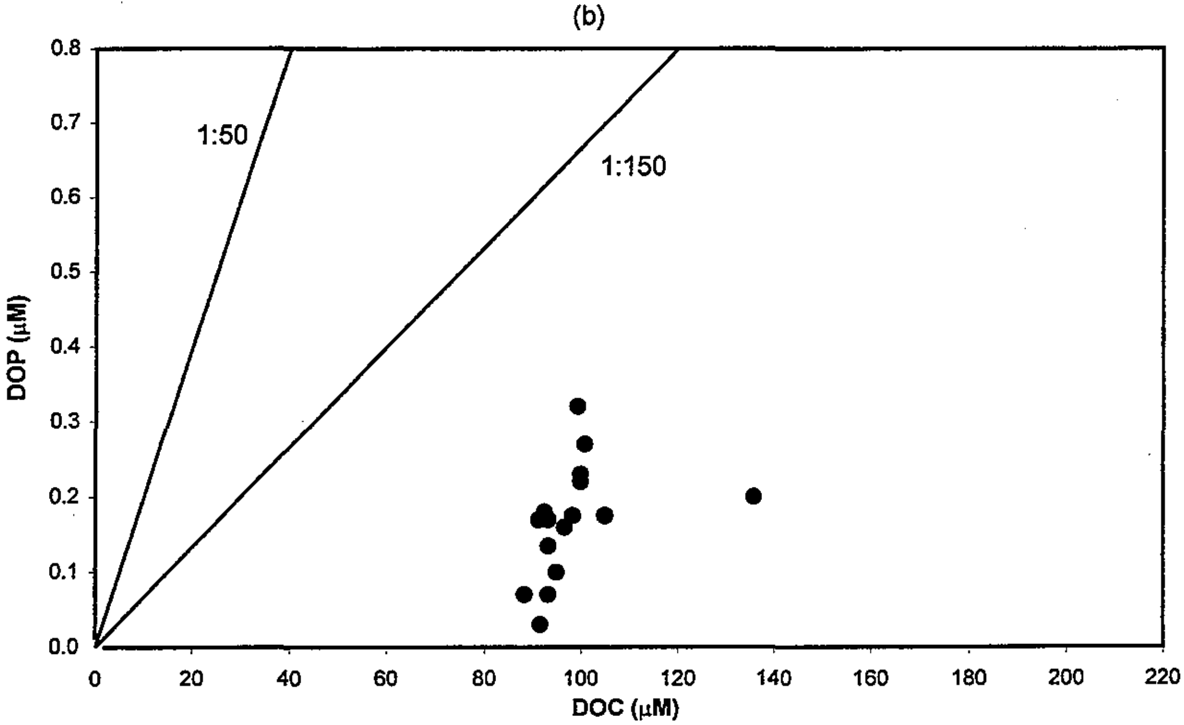


FIGURE 4-68

Nutrient vs. nutrient plots for nearfield survey W9705, (Apr 97)

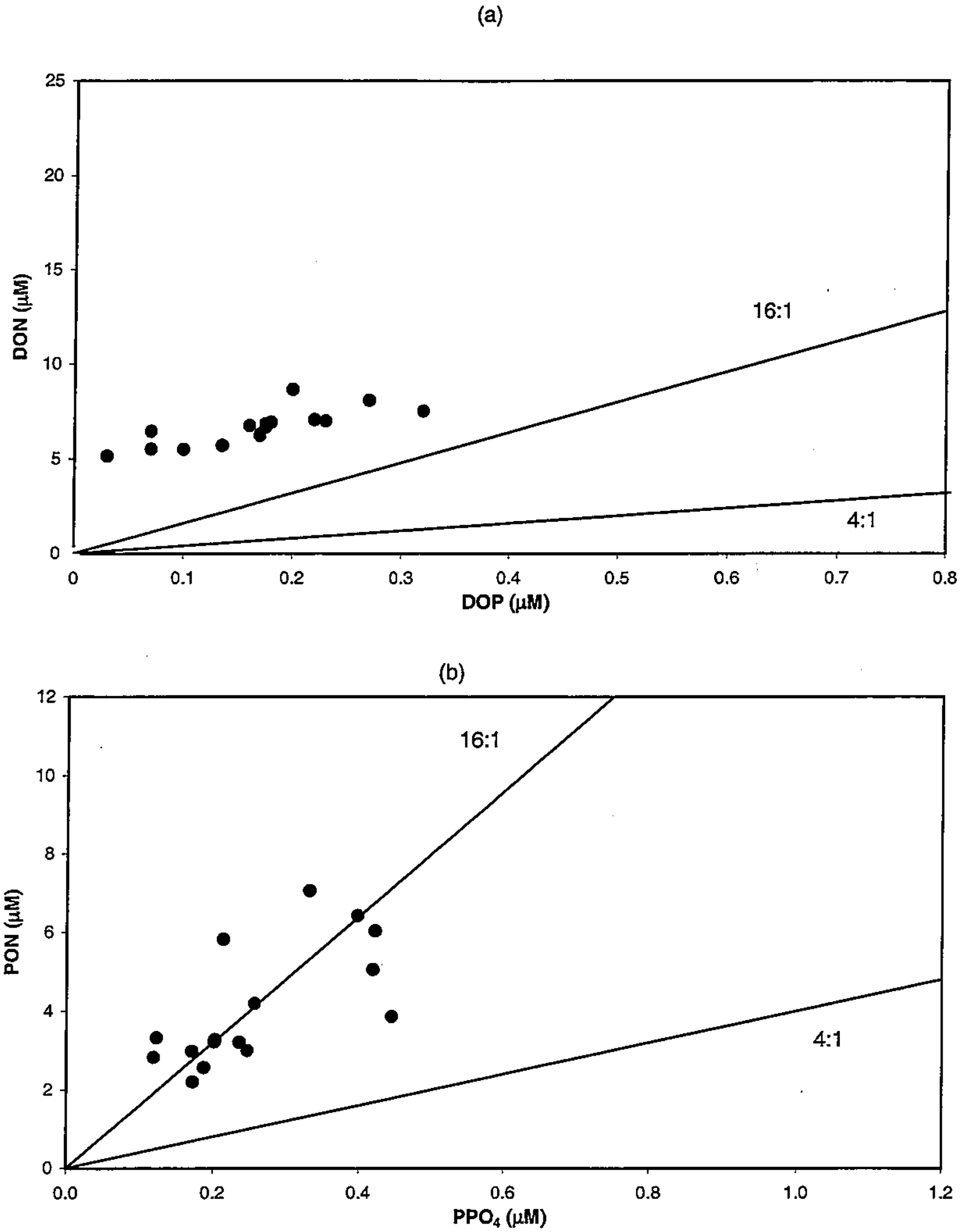


FIGURE 4-69
Nutrient vs. nutrient plots for nearfield survey W9705, (Apr 97)

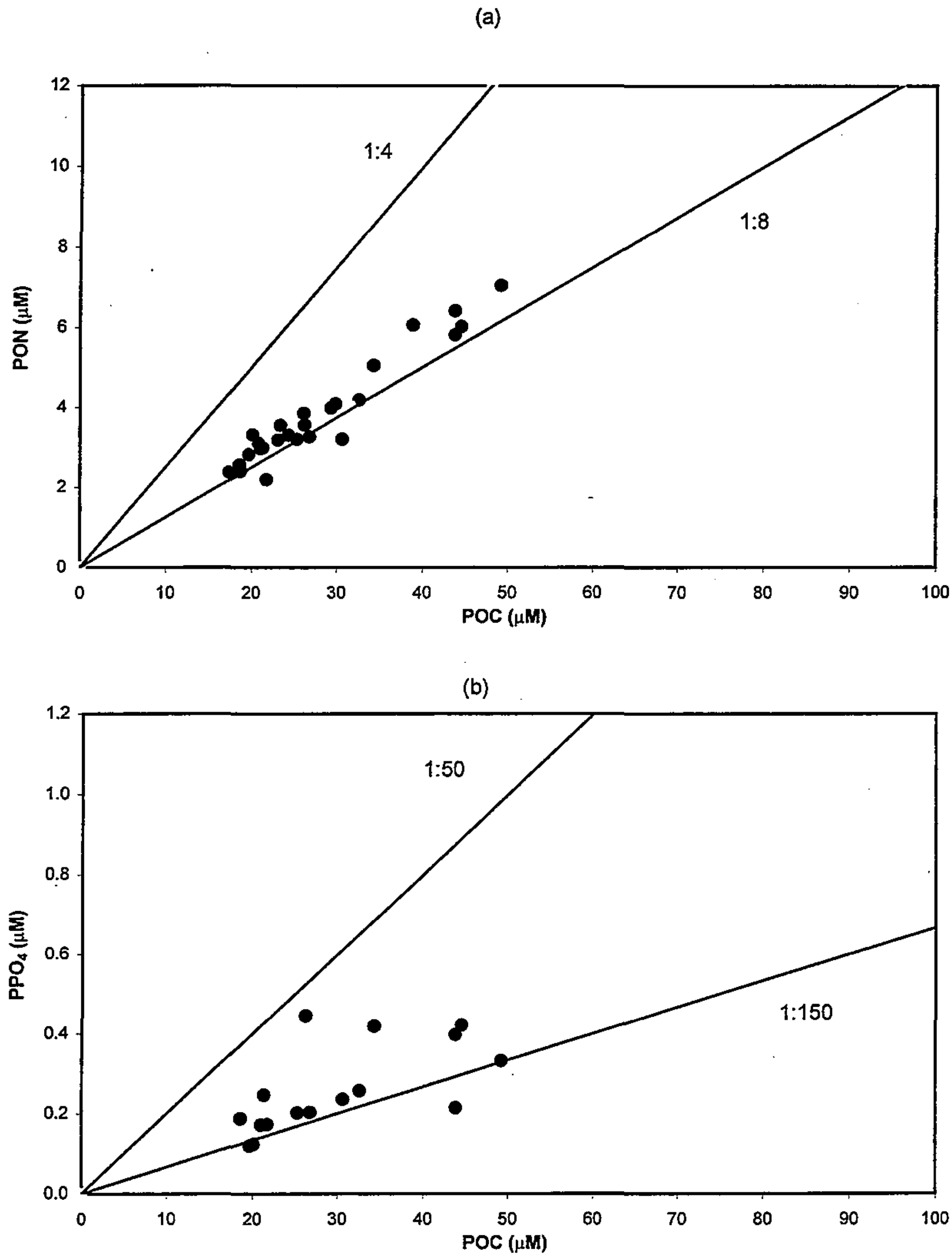
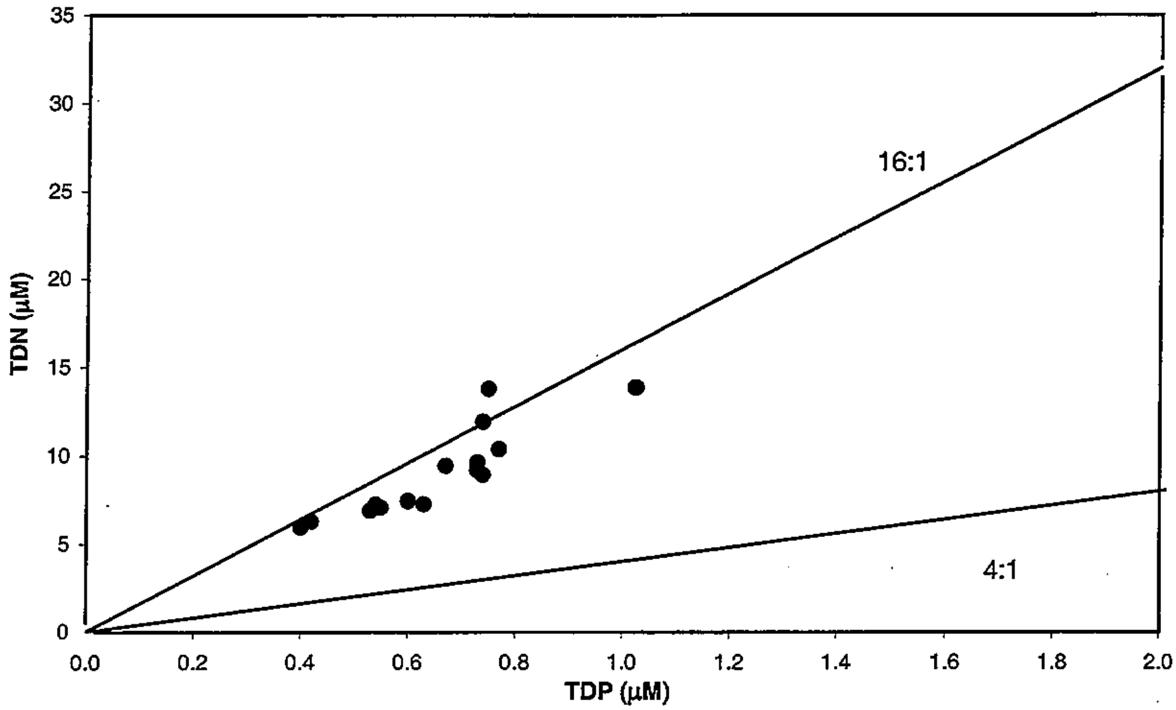


FIGURE 4-70
Nutrient vs. nutrient plots for nearfield survey W9705, (Apr 97)

(a)



(b)

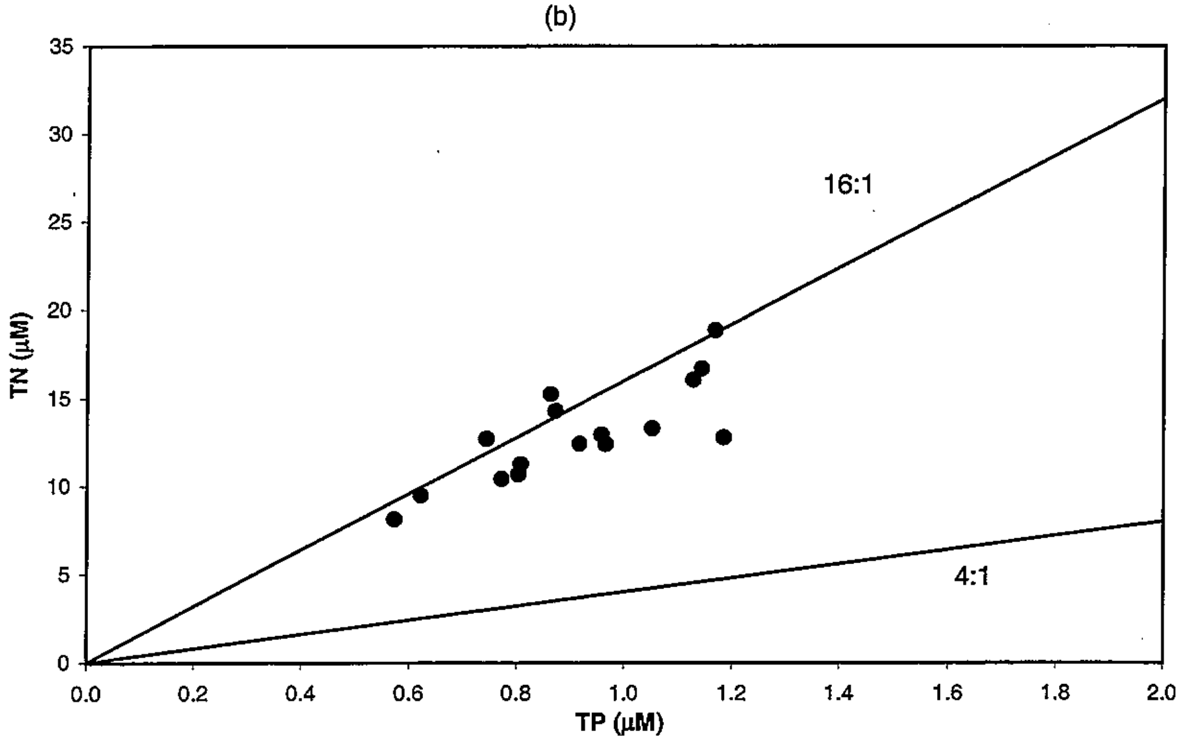
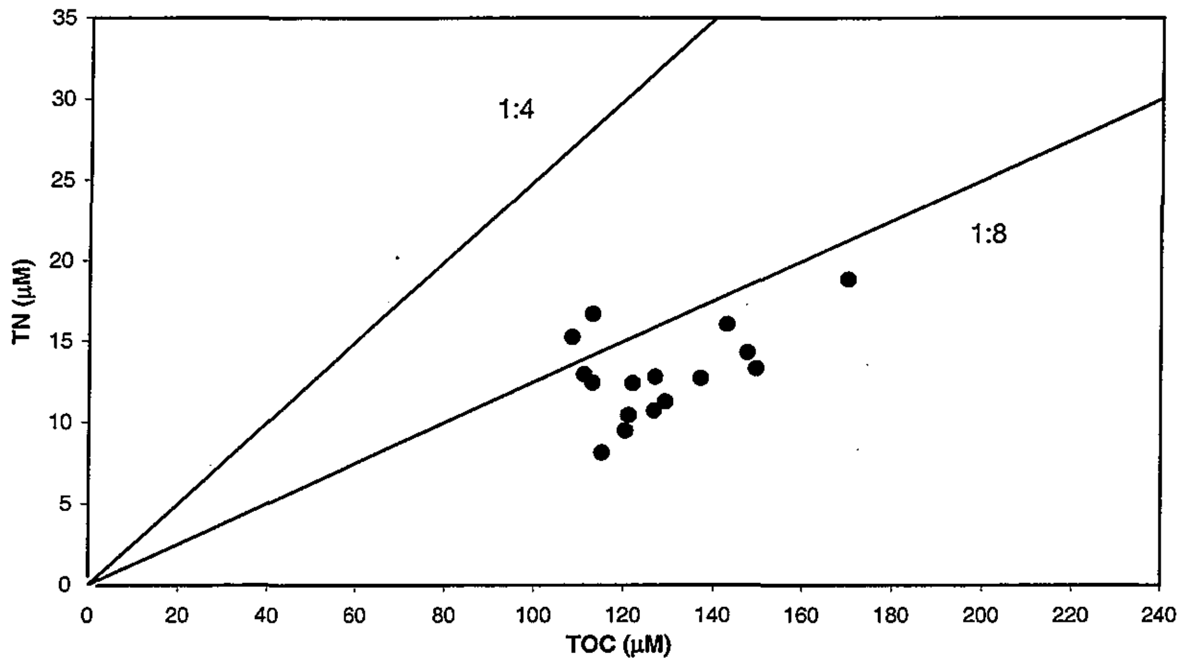


FIGURE 4-71
Nutrient vs. nutrient plots for nearfield survey W9705, (Apr 97)

(a)



(b)

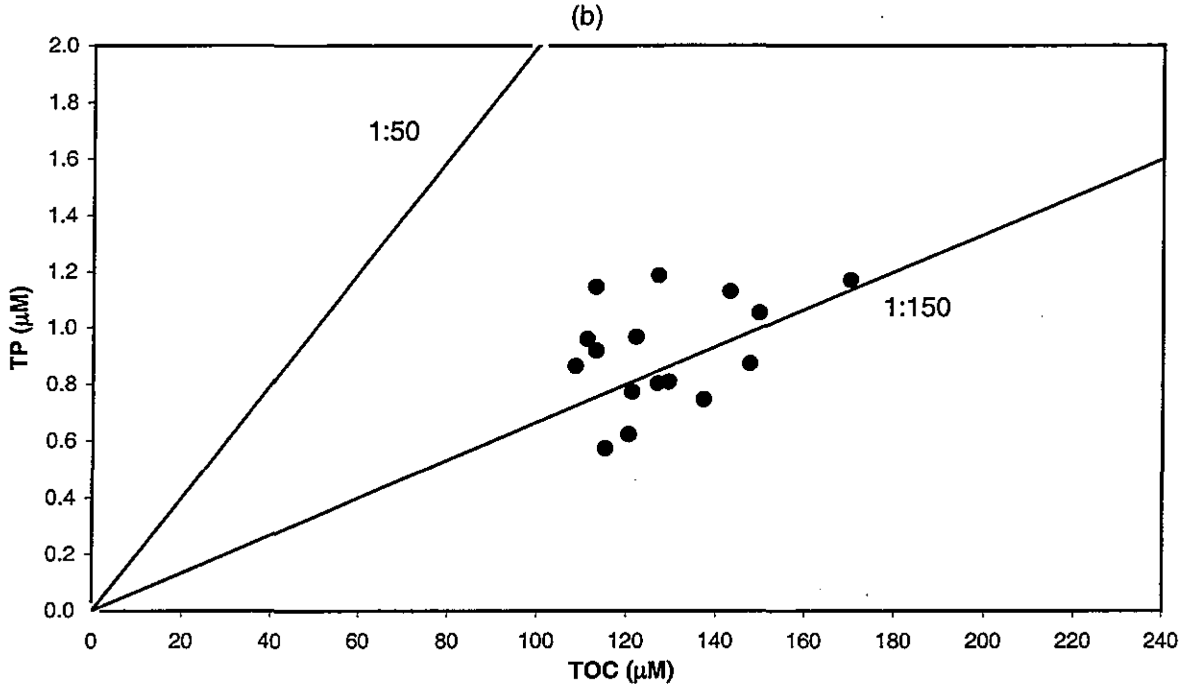


FIGURE 4-72
Depth vs. nutrient plots for nearfield survey W9705, (Apr 97)

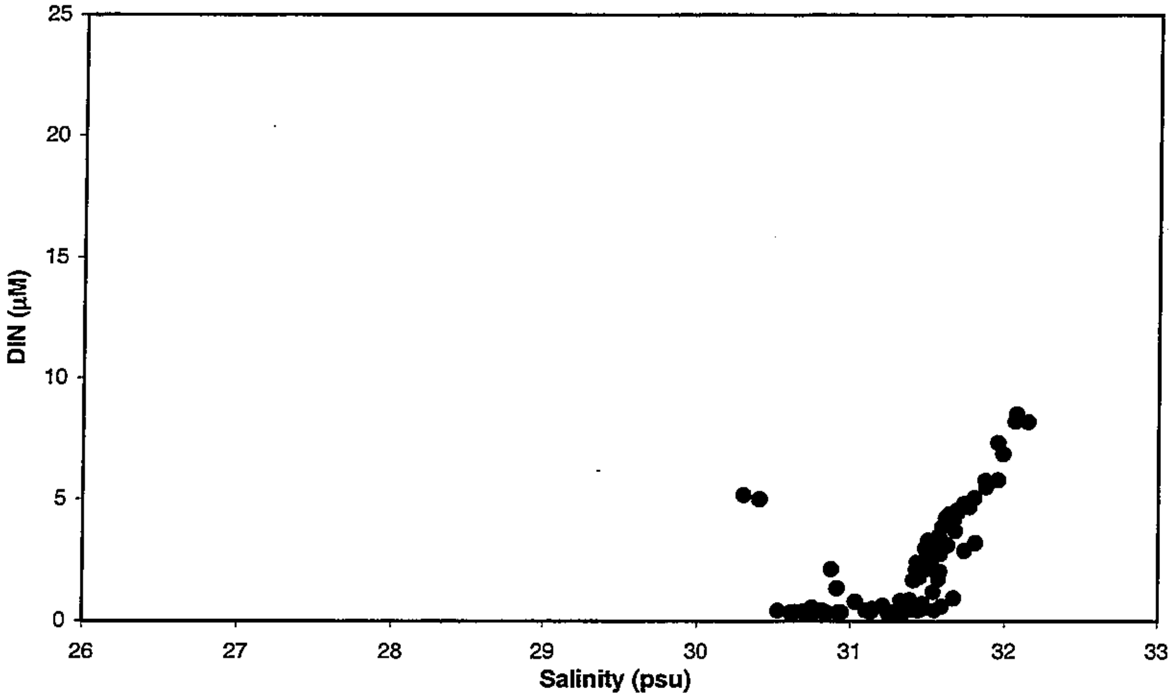
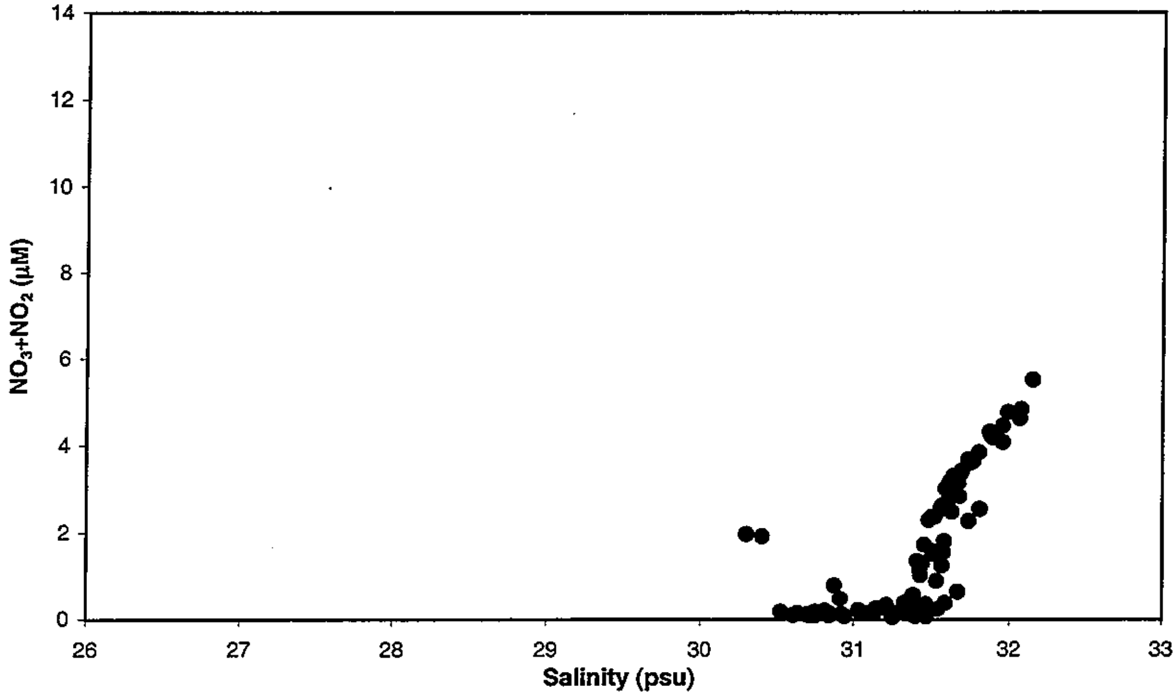


FIGURE 4-73
Nutrient vs. salinity plots for nearfield survey W9705, (Apr 97)

(a)



(b)

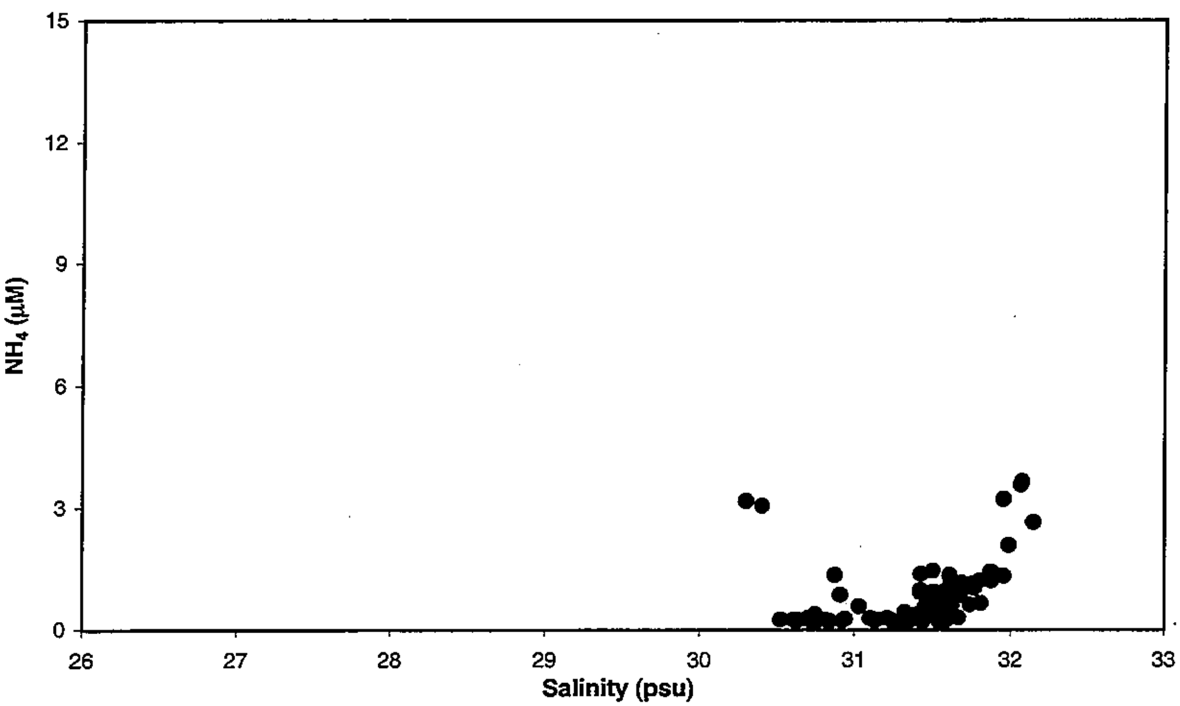
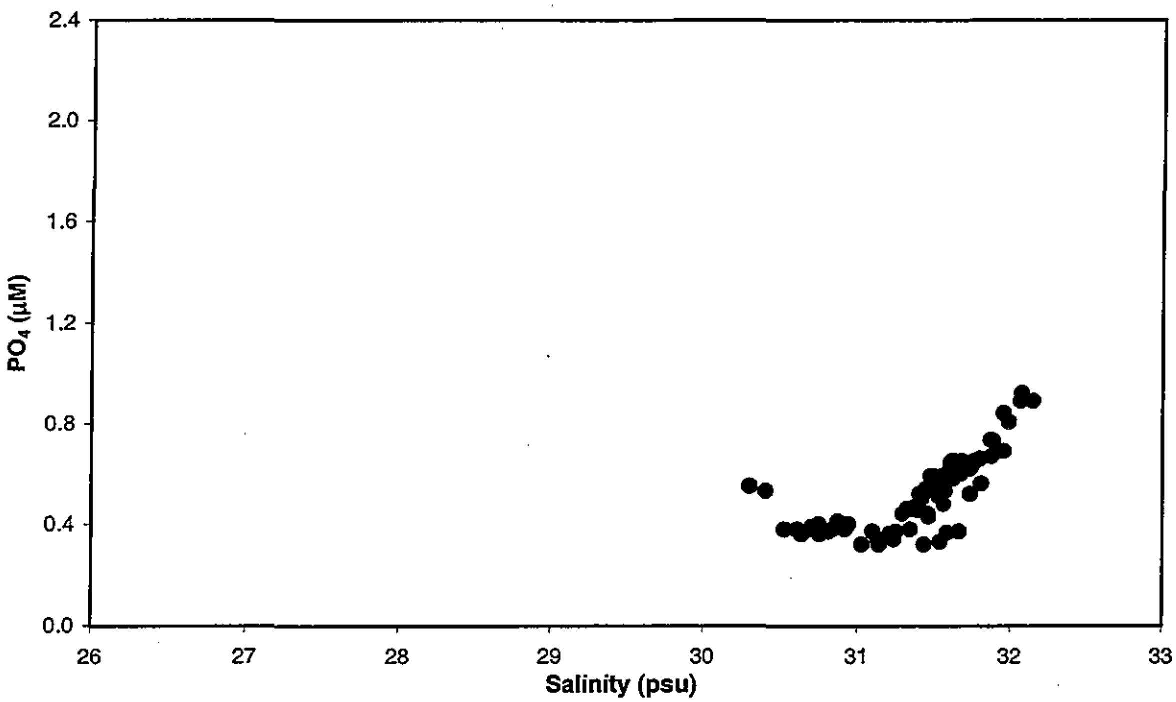


FIGURE 4-74

Nutrient vs. salinity plots for nearfield survey W9705, (Apr 97)

(a)



(b)

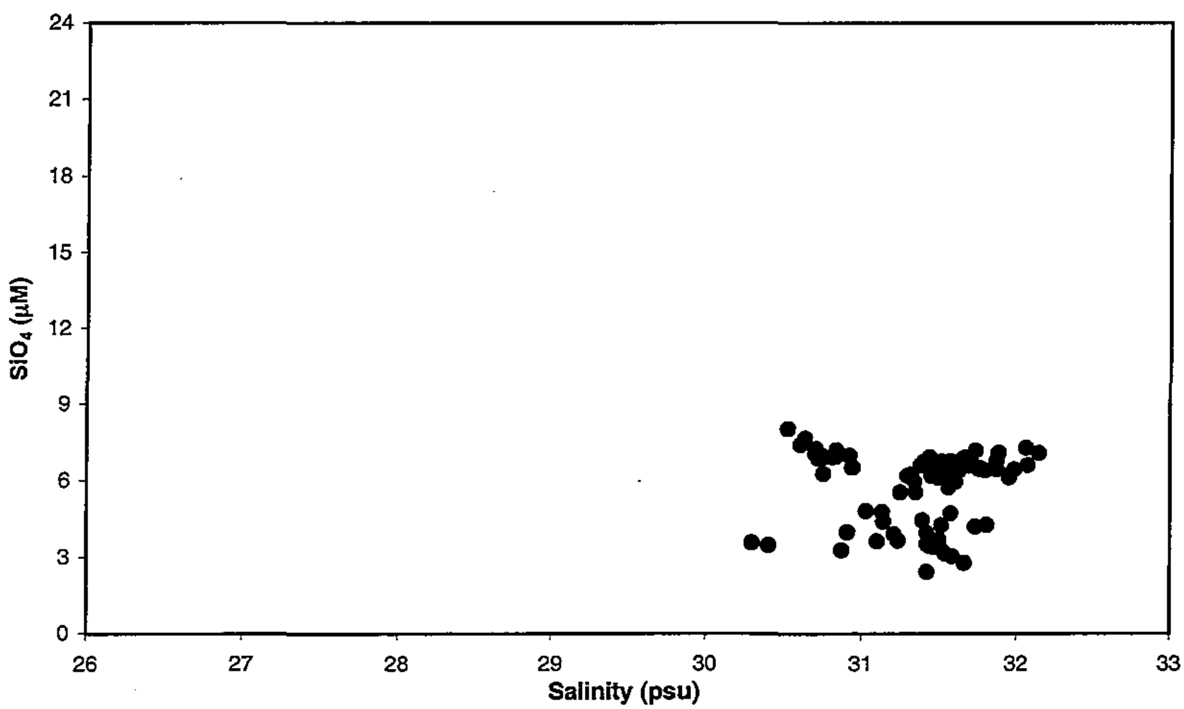


FIGURE 4-75

Nutrient vs. salinity plots for nearfield survey W9705, (Apr 97)

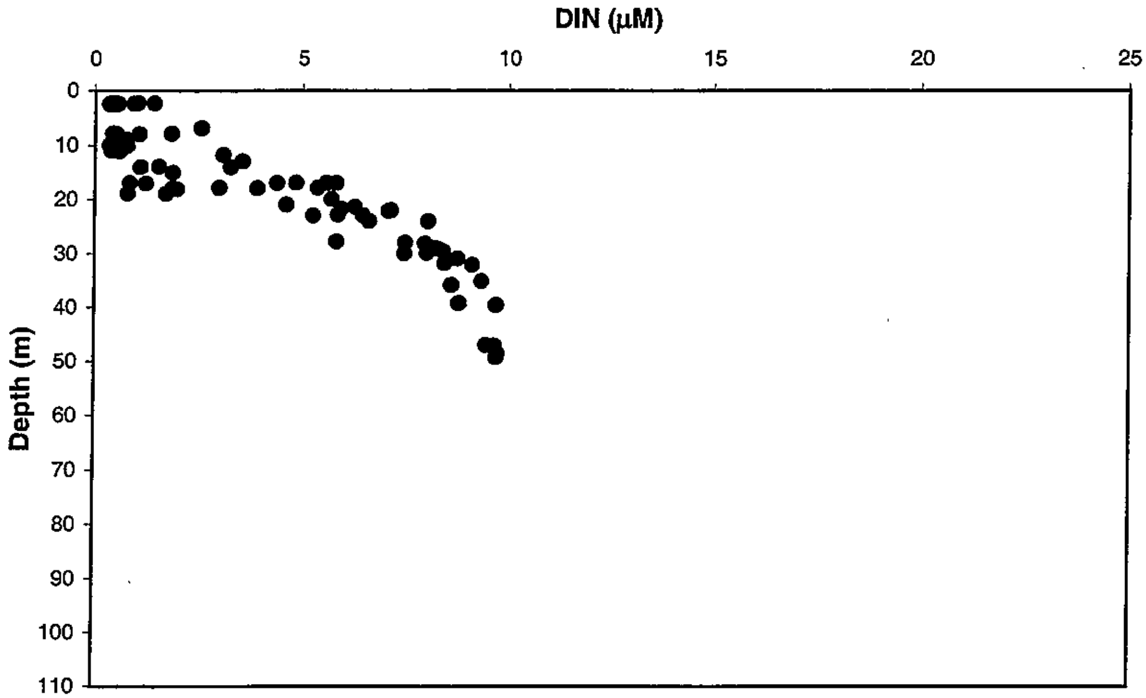


FIGURE 4-76
Depth vs. nutrient plots for nearfield survey W9706, (May 97)

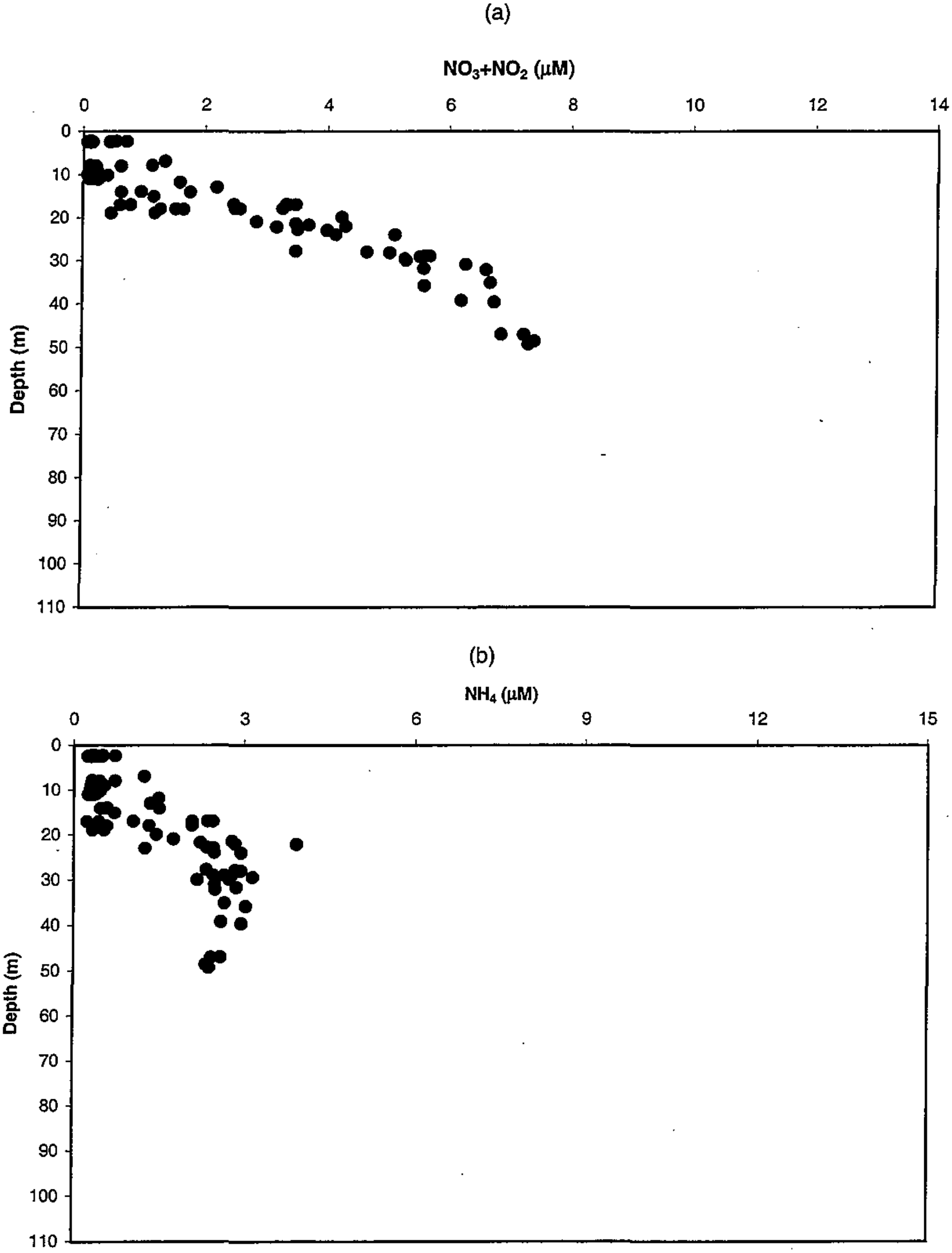
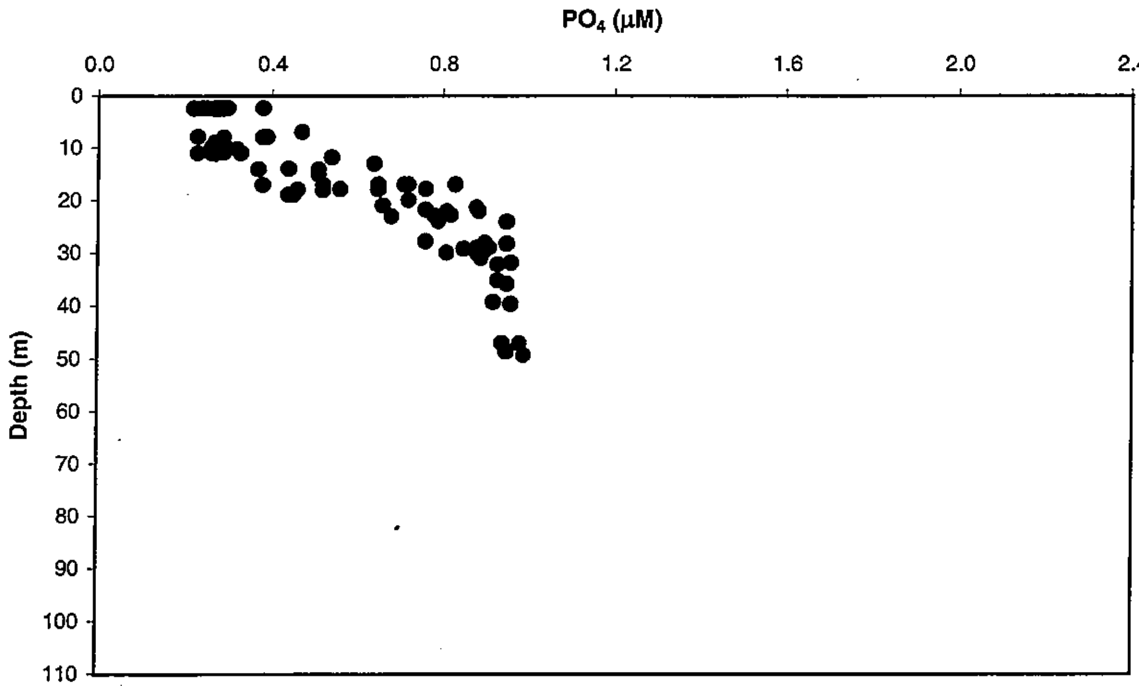


FIGURE 4-77
Depth vs. nutrient plots for nearfield survey W9706, (May 97)

(a)



(b)

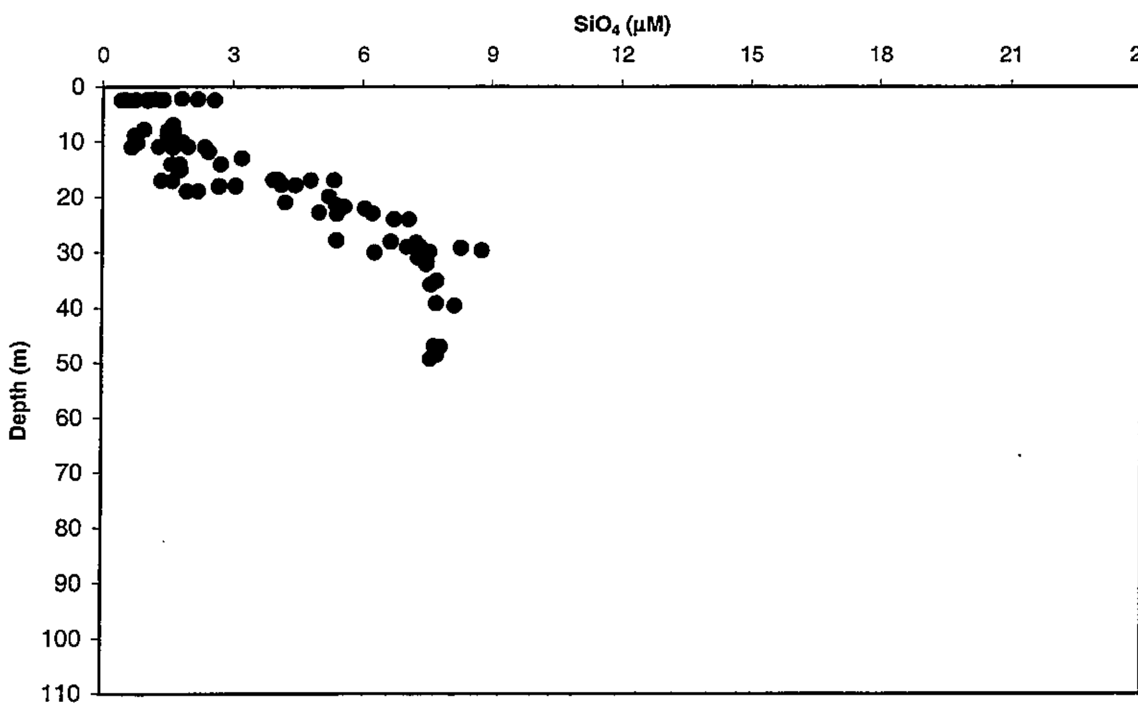
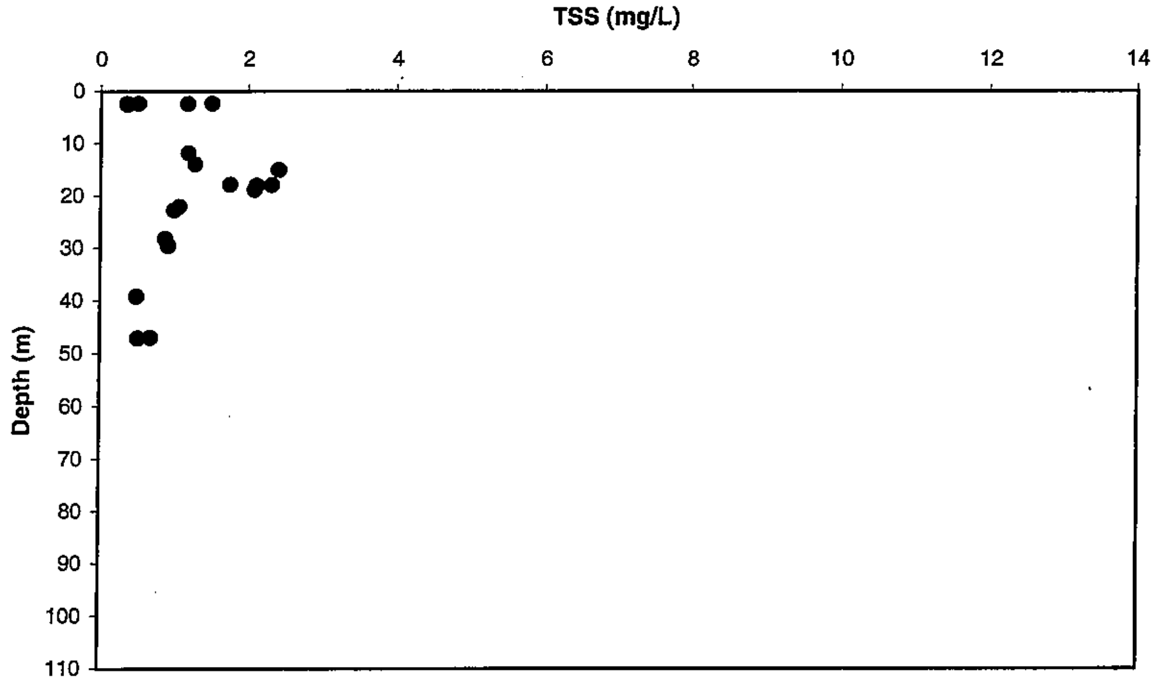


FIGURE 4-78

Depth vs. nutrient plots for nearfield survey W9706, (May 97)

(a)



(b)

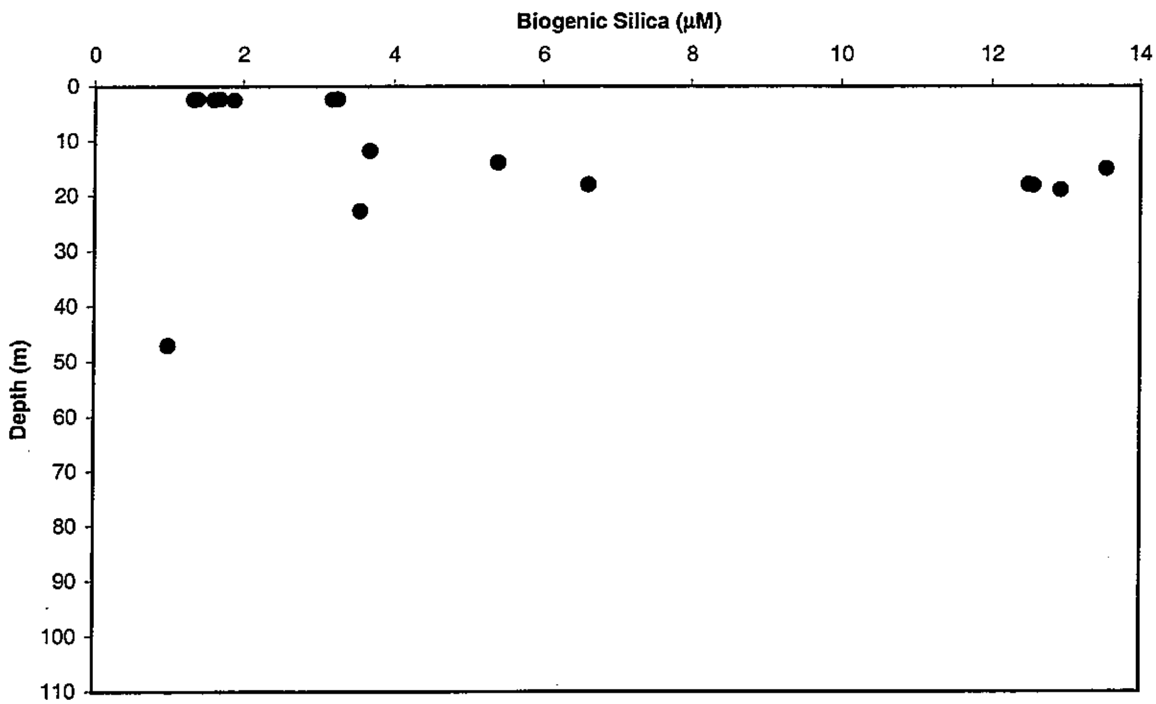
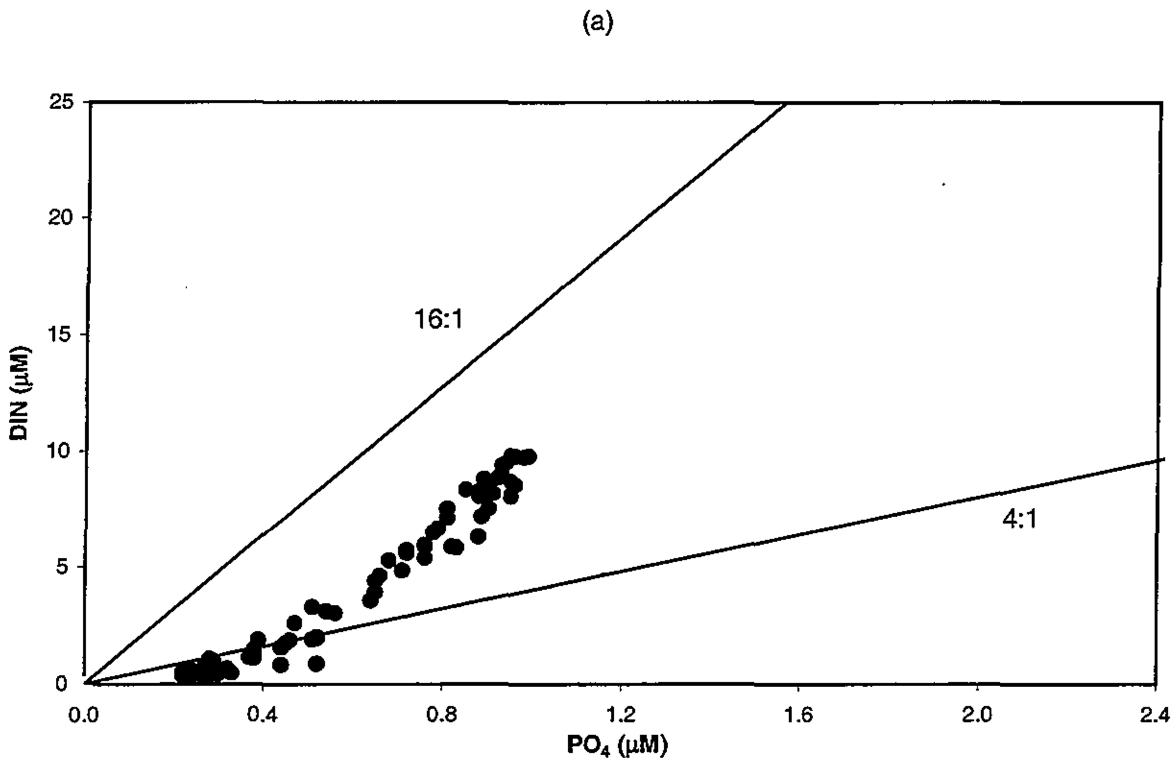


FIGURE 4-79
Depth vs. nutrient plots for nearfield survey W9706, (May 97)



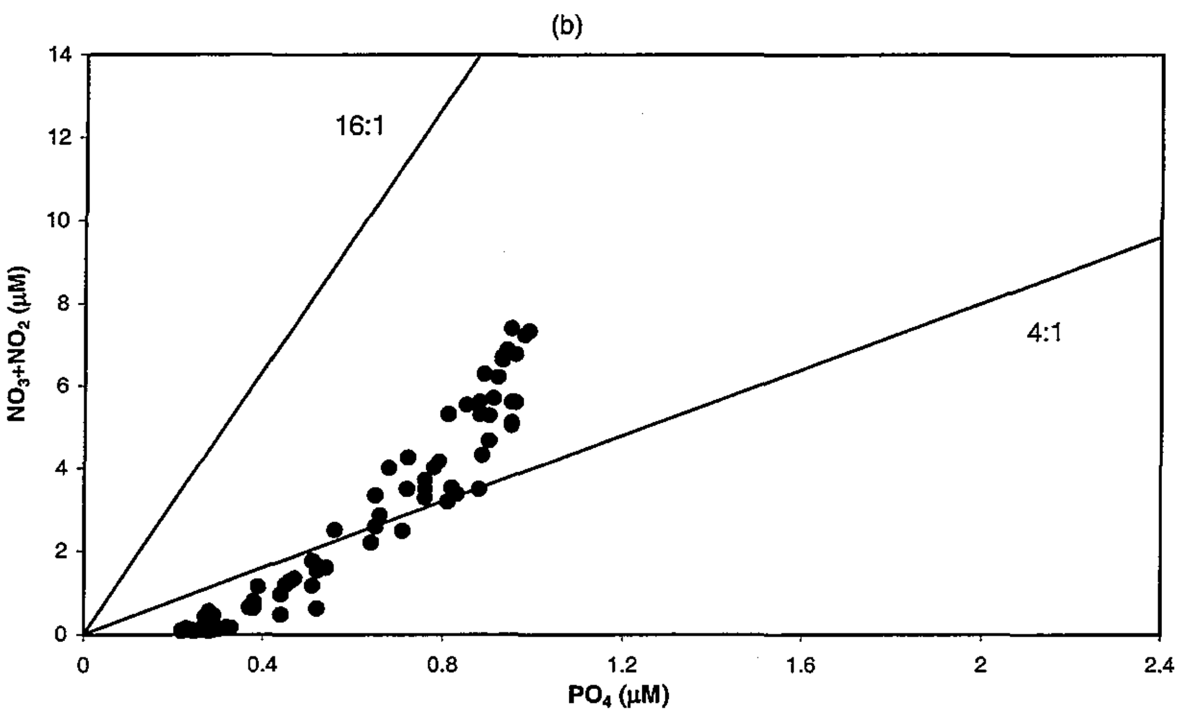


FIGURE 4-80

Nutrient vs. nutrient plots for nearfield survey W9706, (May 97)

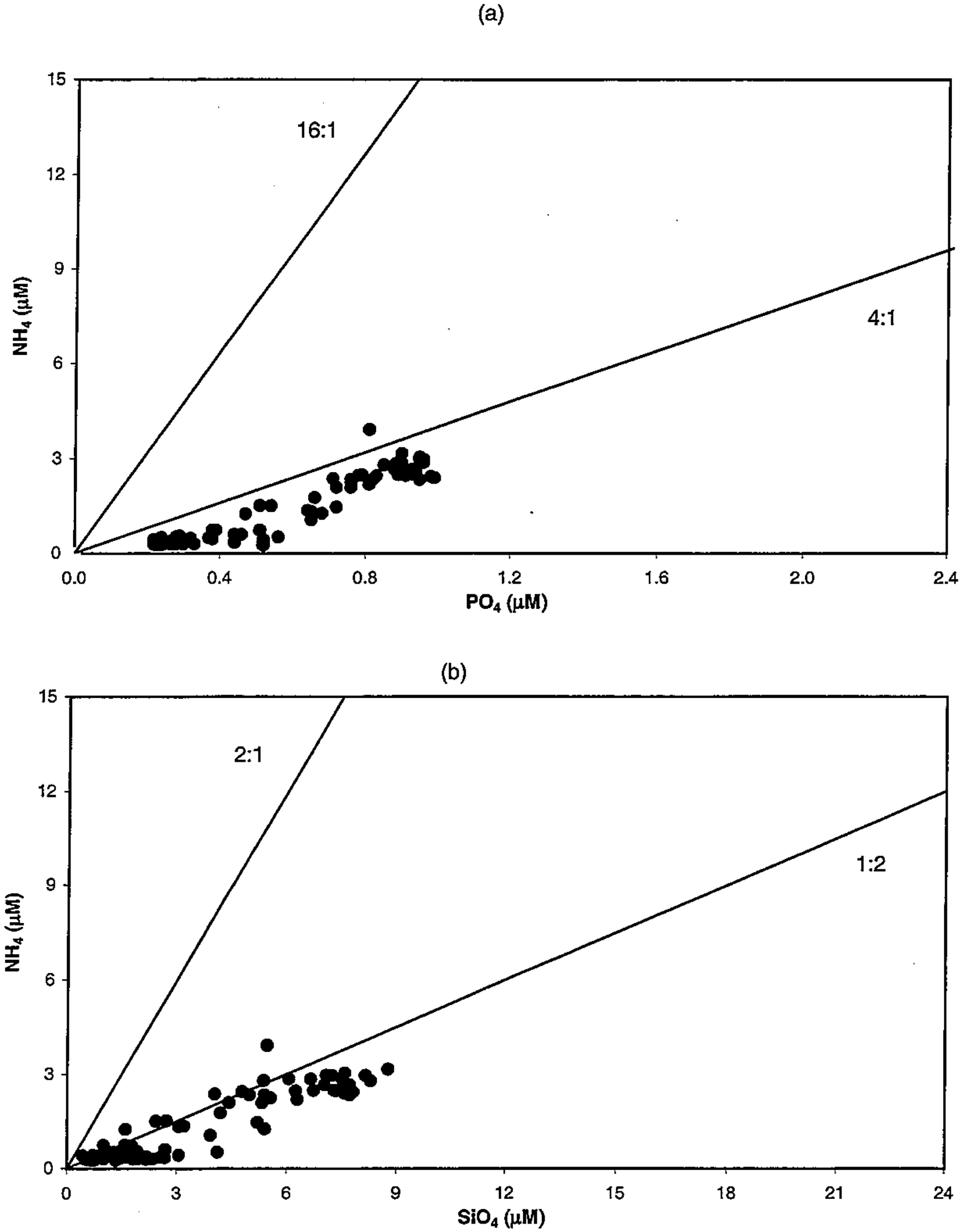


FIGURE 4-81
Nutrient vs. nutrient plots for nearfield survey W9706, (May 97)

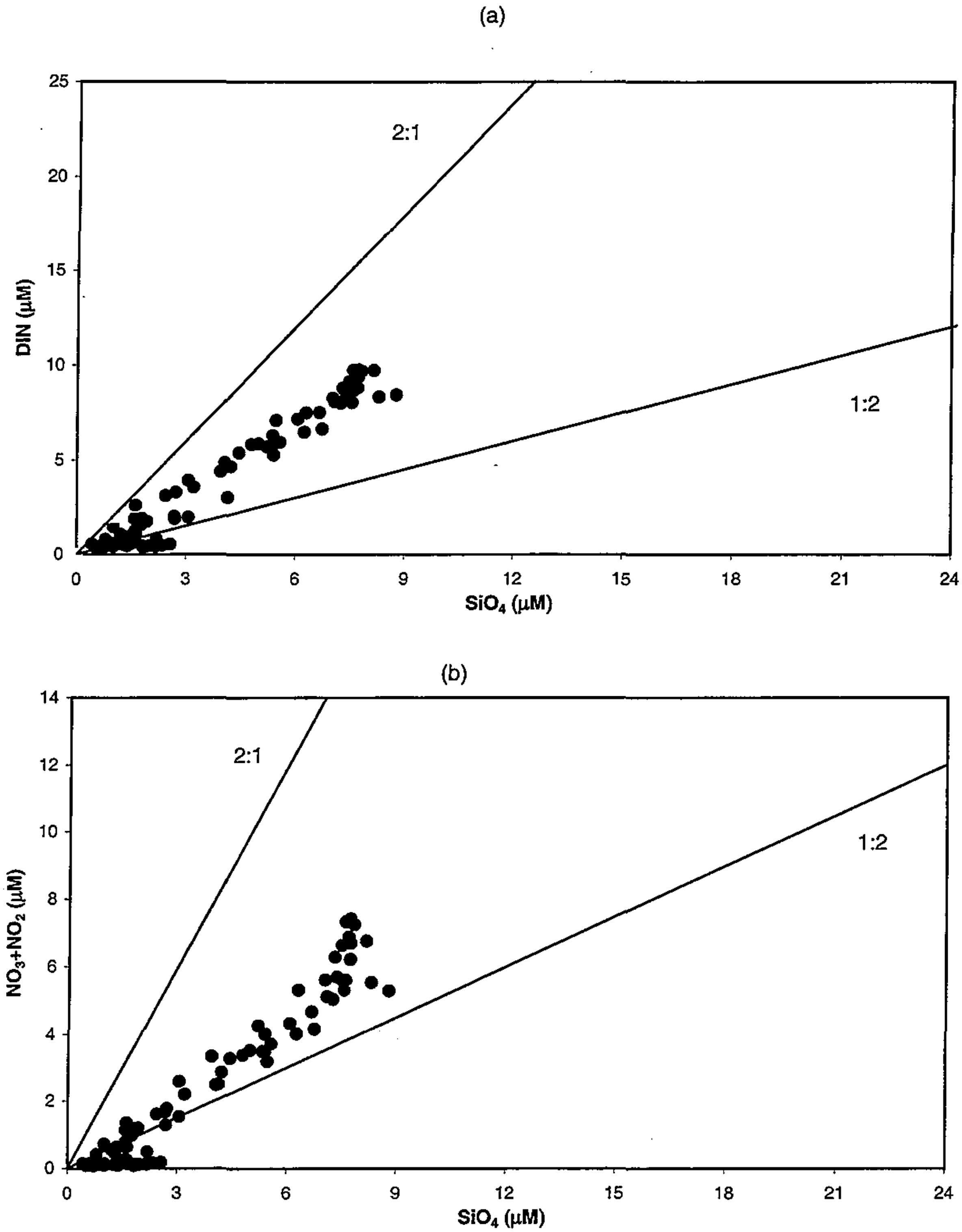
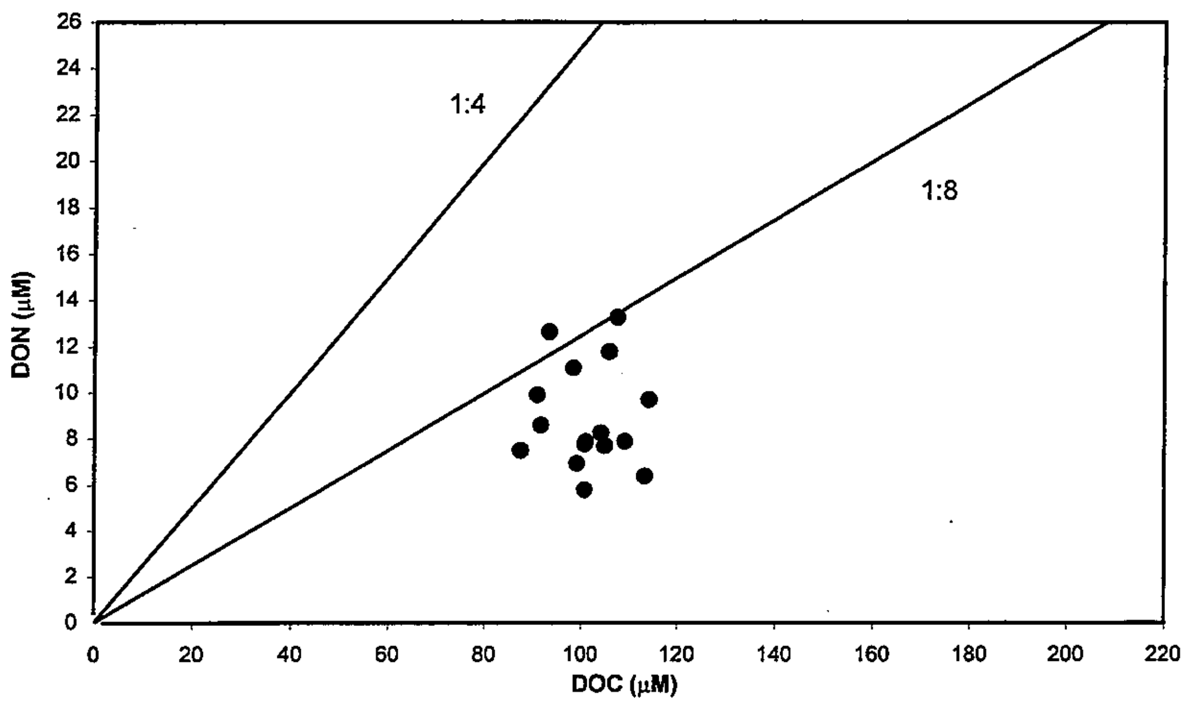


FIGURE 4-82
Nutrient vs. nutrient plots for nearfield survey W9706, (May 97)

(a)



(b)

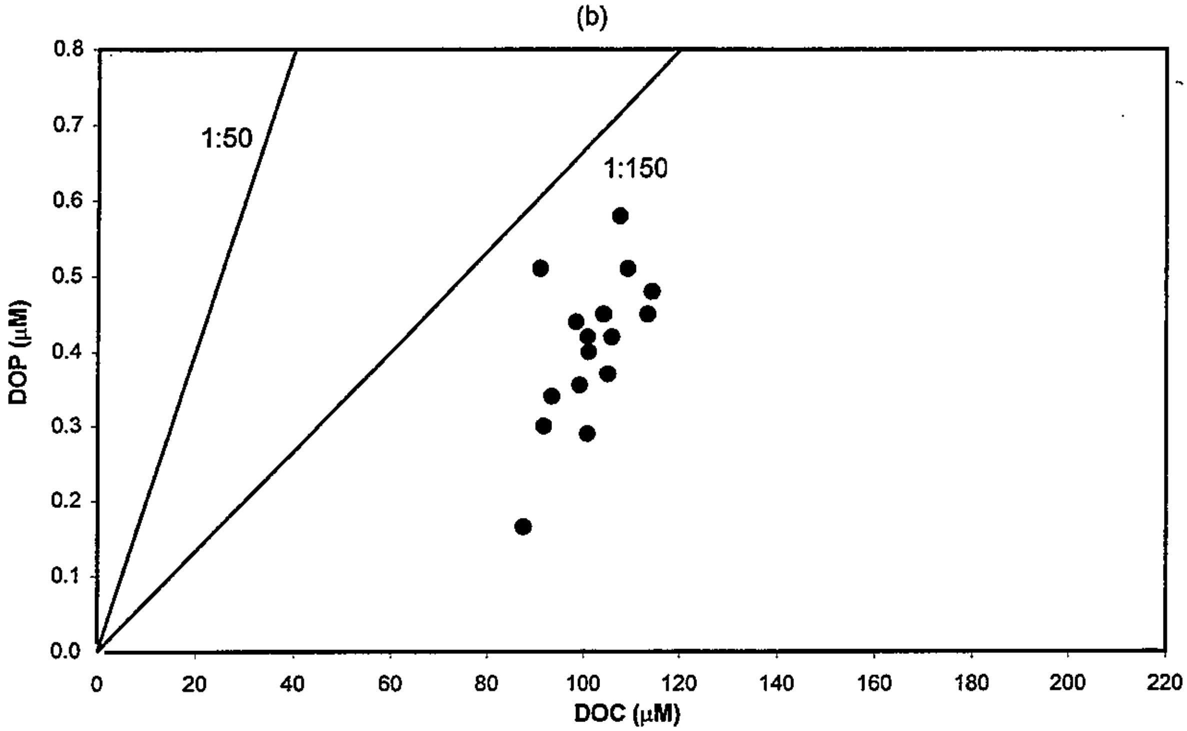
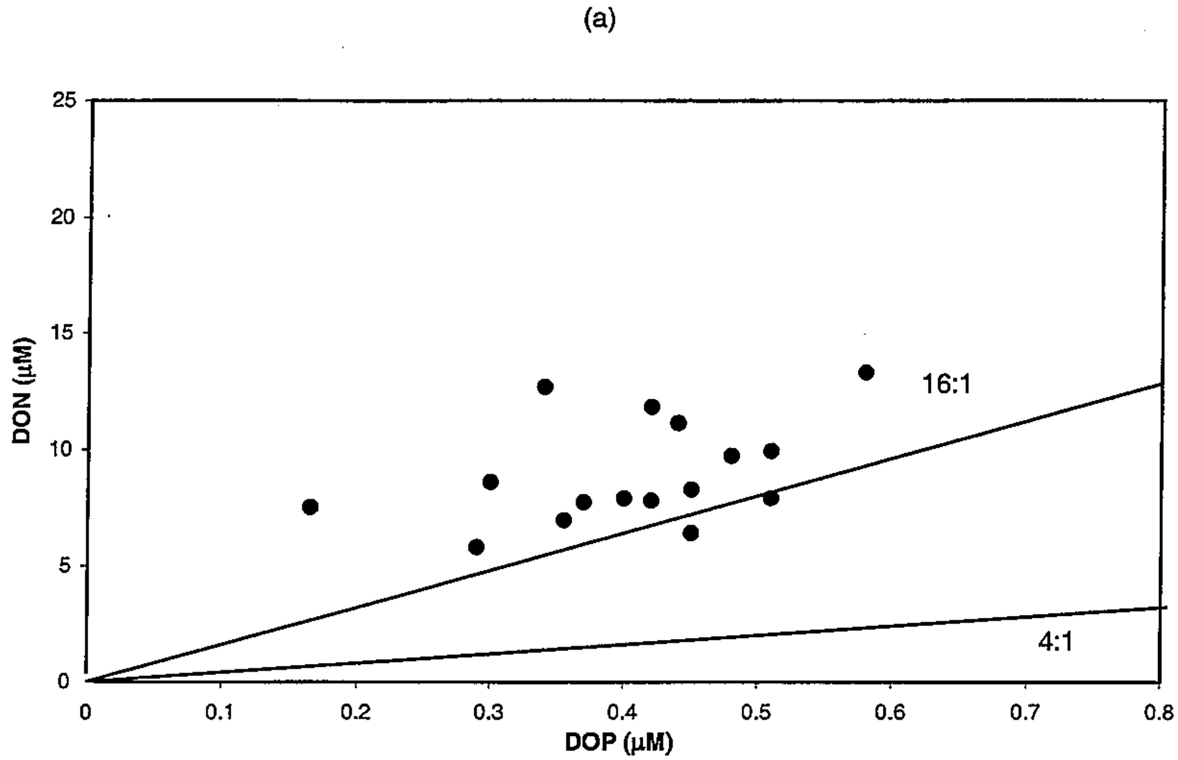


FIGURE 4-83

Nutrient vs. nutrient plots for nearfield survey W9706, (May 97)



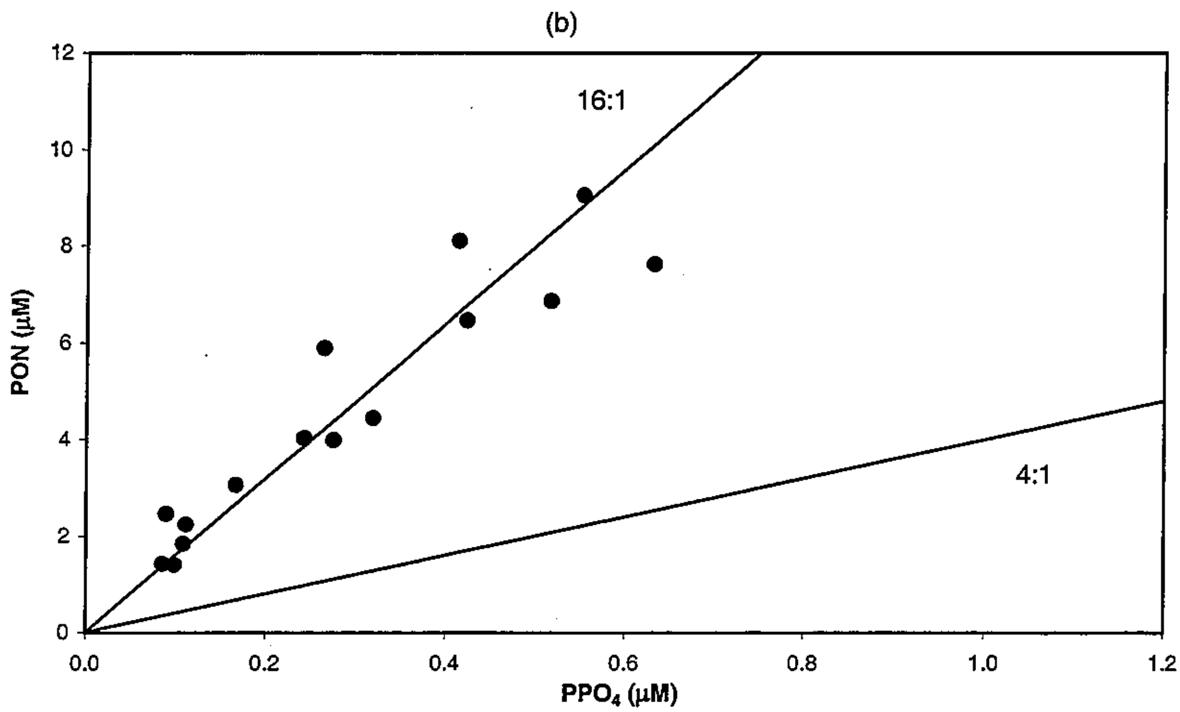


FIGURE 4-84

Nutrient vs. nutrient plots for nearfield survey W9706, (May 97)

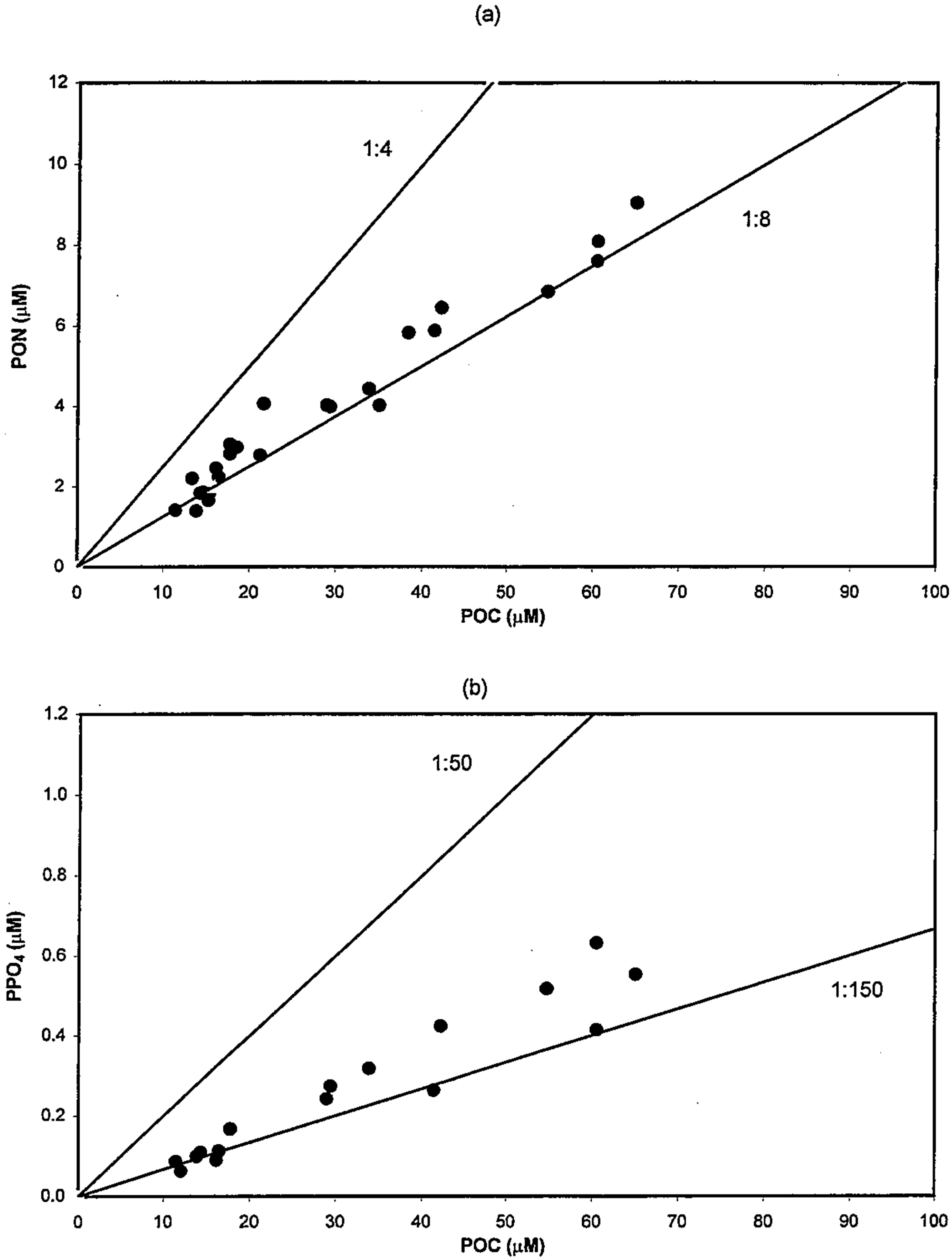
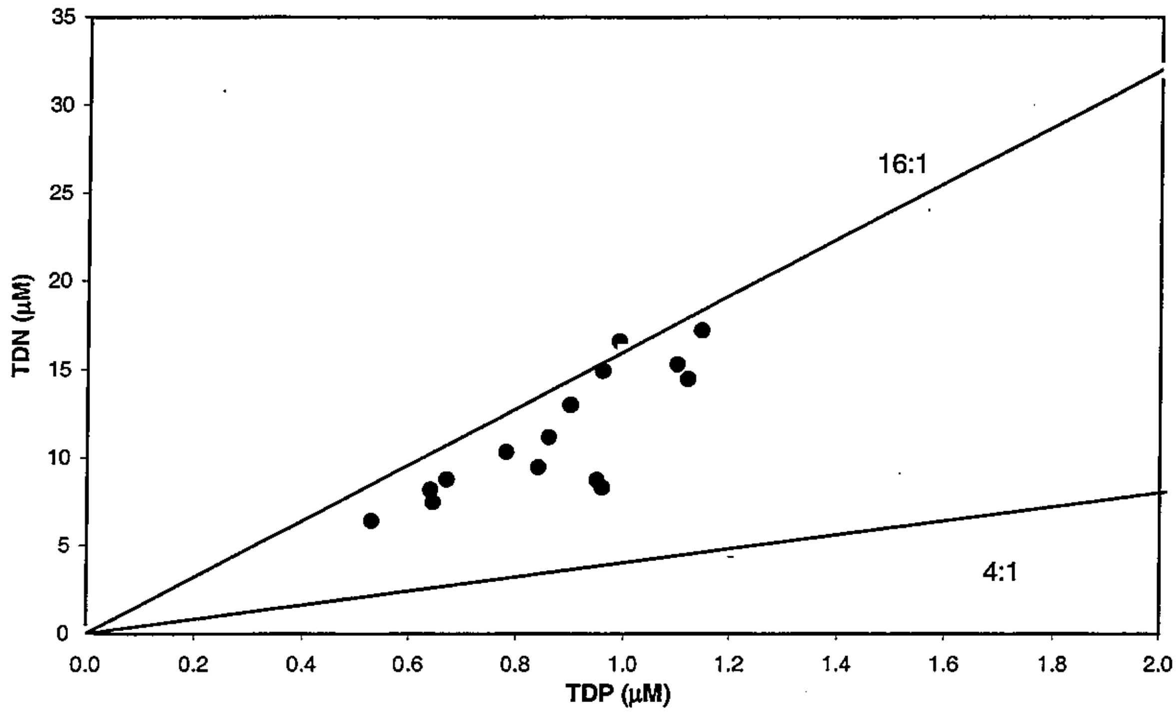


FIGURE 4-85

Nutrient vs. nutrient plots for nearfield survey W9706, (May 97)

(a)



(b)

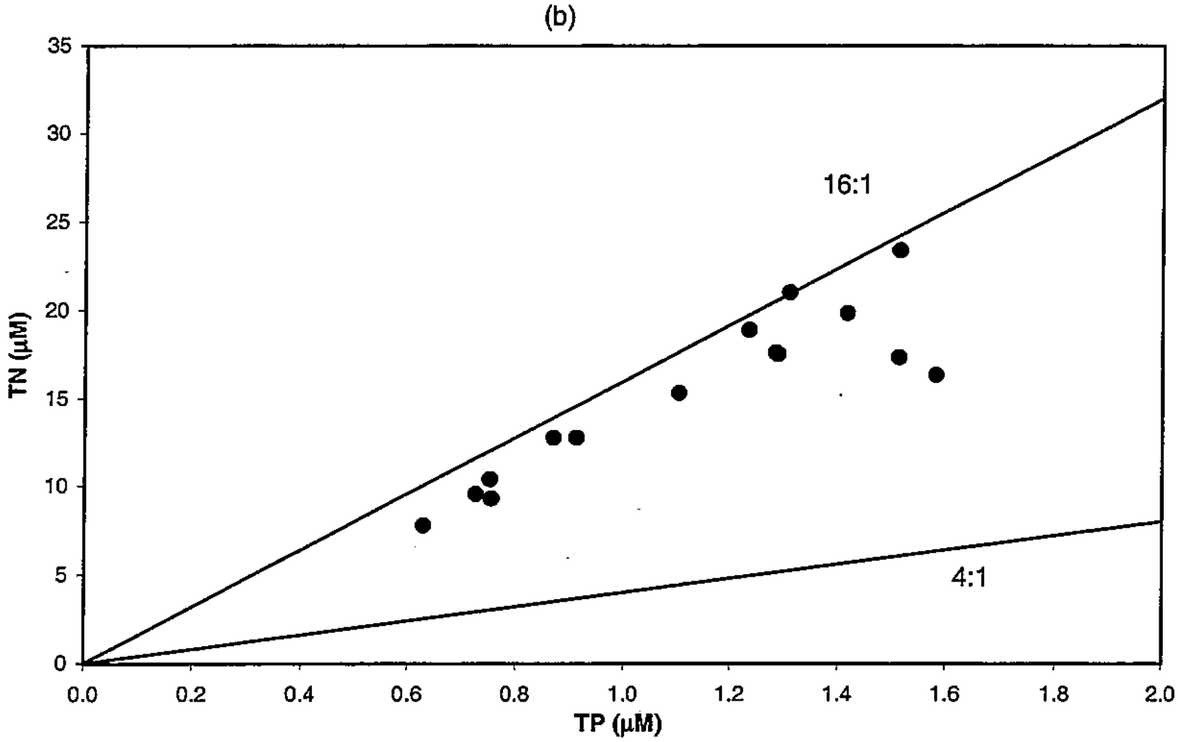


FIGURE 4-86
Nutrient vs. nutrient plots for nearfield survey W9706, (May 97)

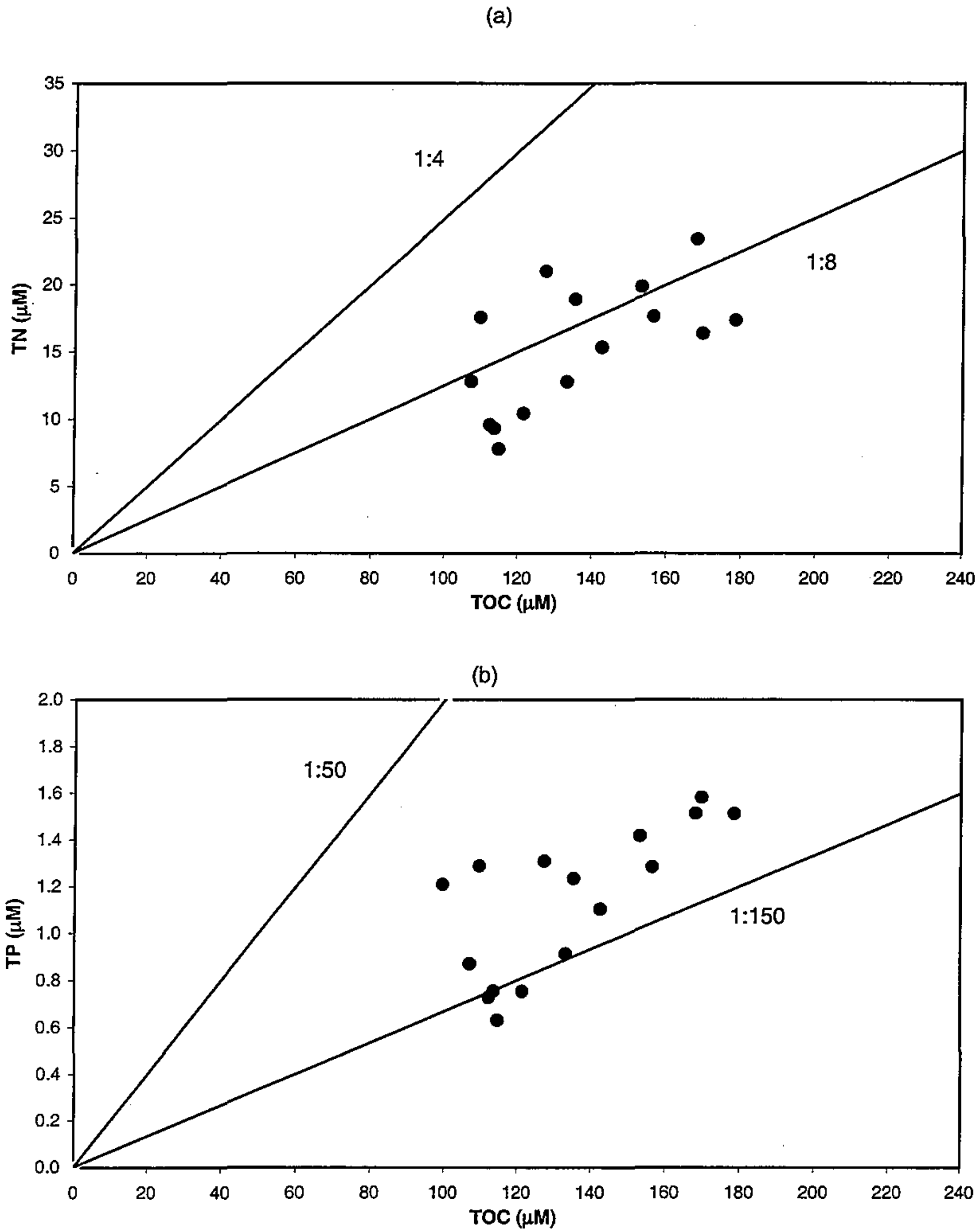


FIGURE 4-87
Depth vs. nutrient plots for nearfield survey W9706, (May 97)

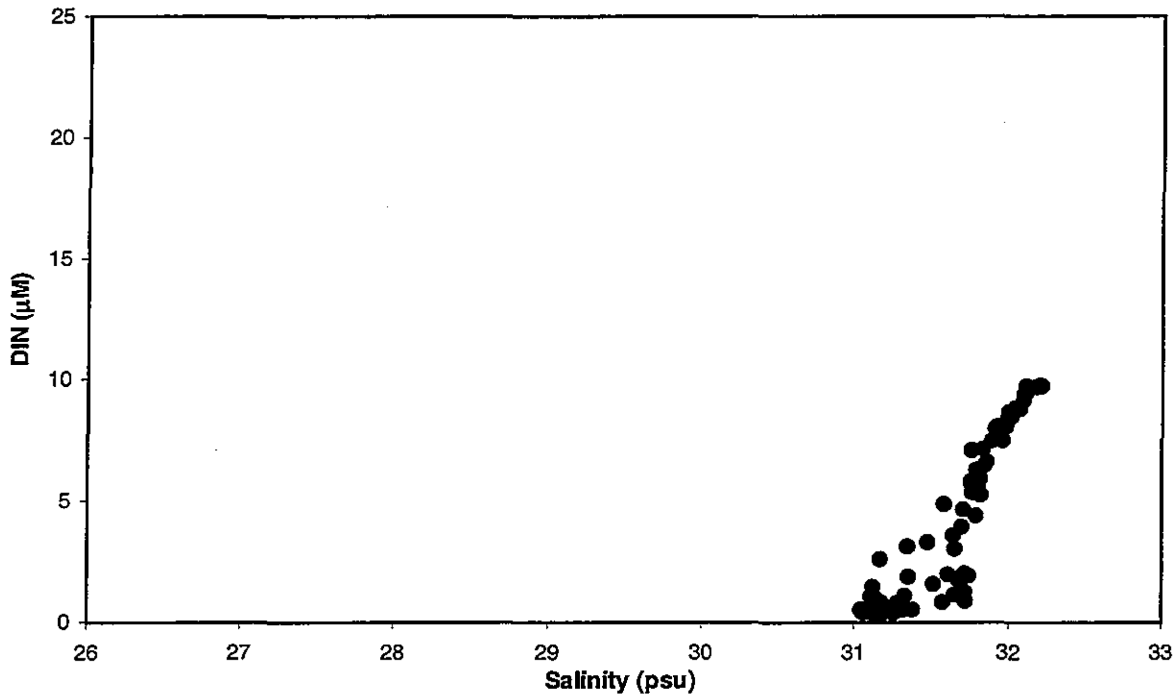
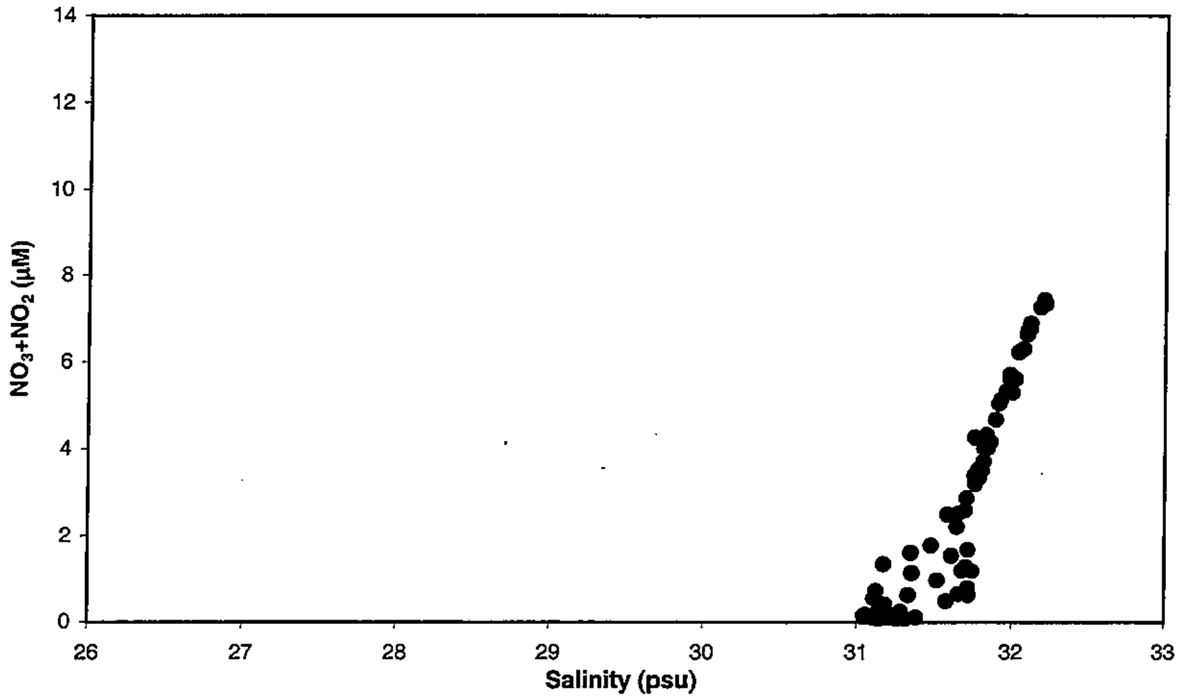


FIGURE 4-88
Nutrient vs. salinity plots for nearfield survey W9706, (May 97)

(a)



(b)

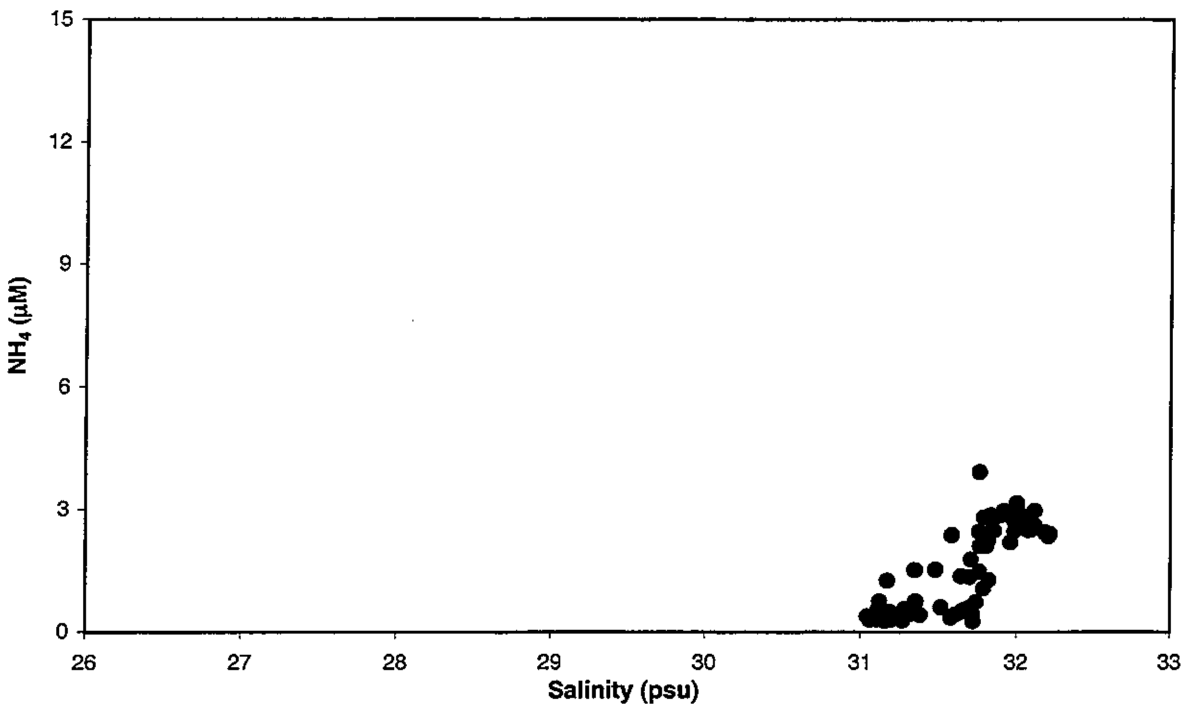
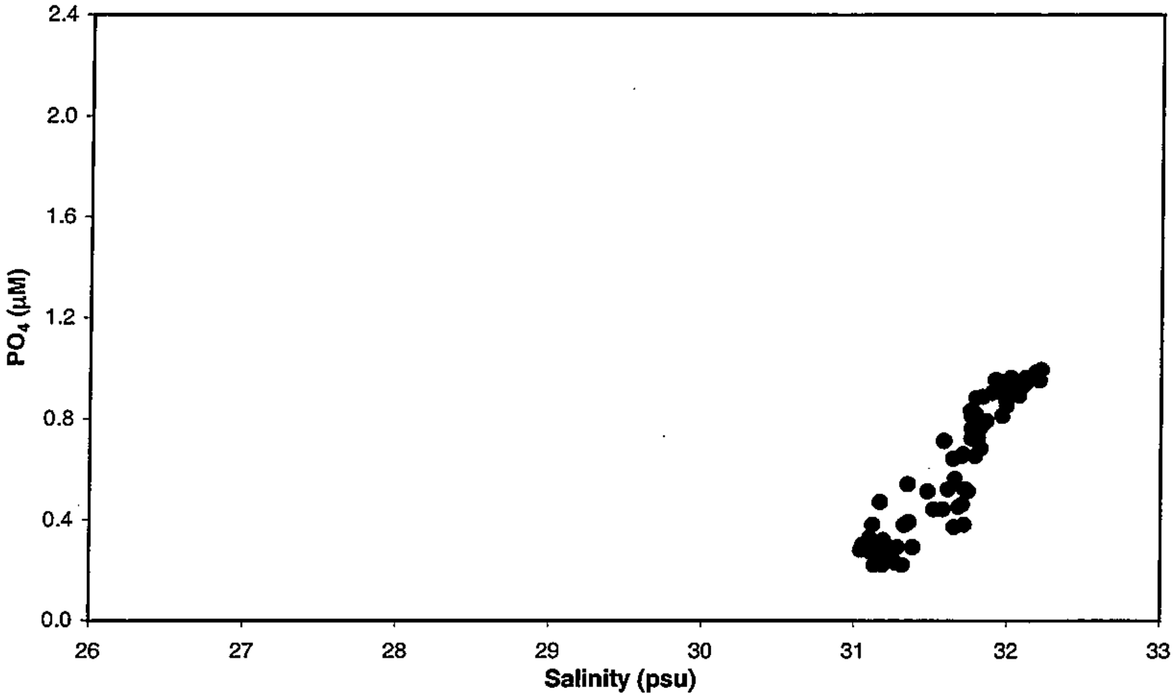


FIGURE 4-89

Nutrient vs. salinity plots for nearfield survey W9706, (May 97)

(a)



(b)

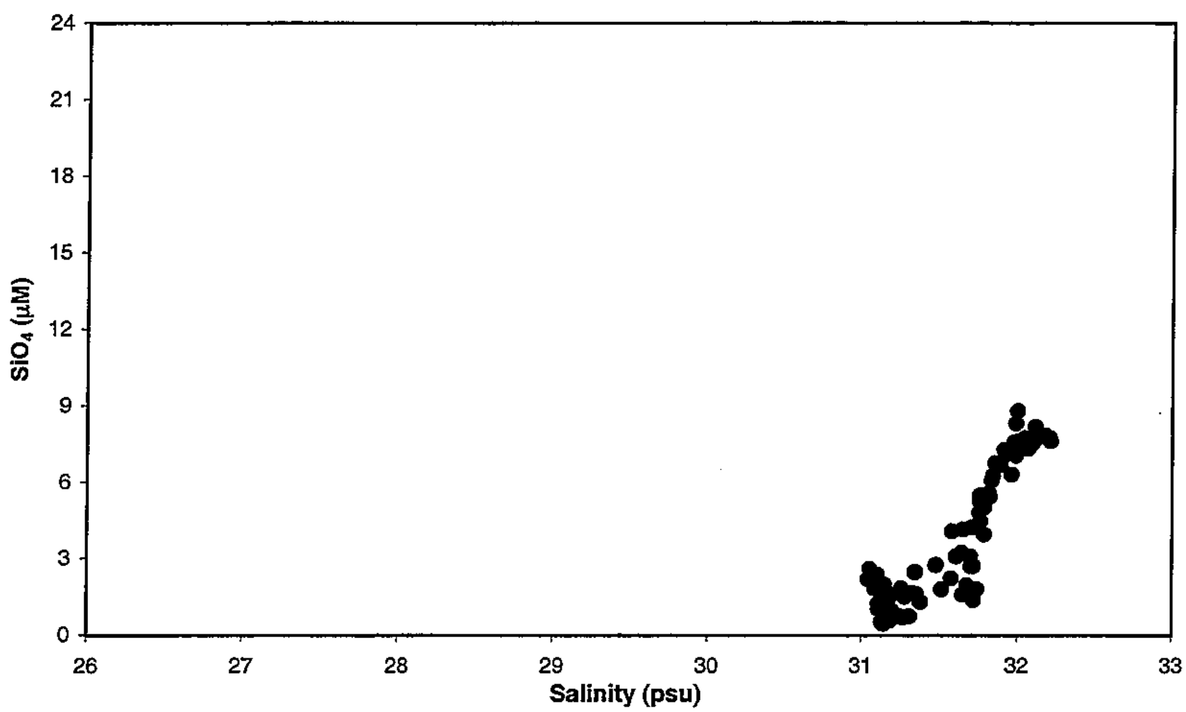


FIGURE 4-90

Nutrient vs. salinity plots for nearfield survey W9706, (May 97)

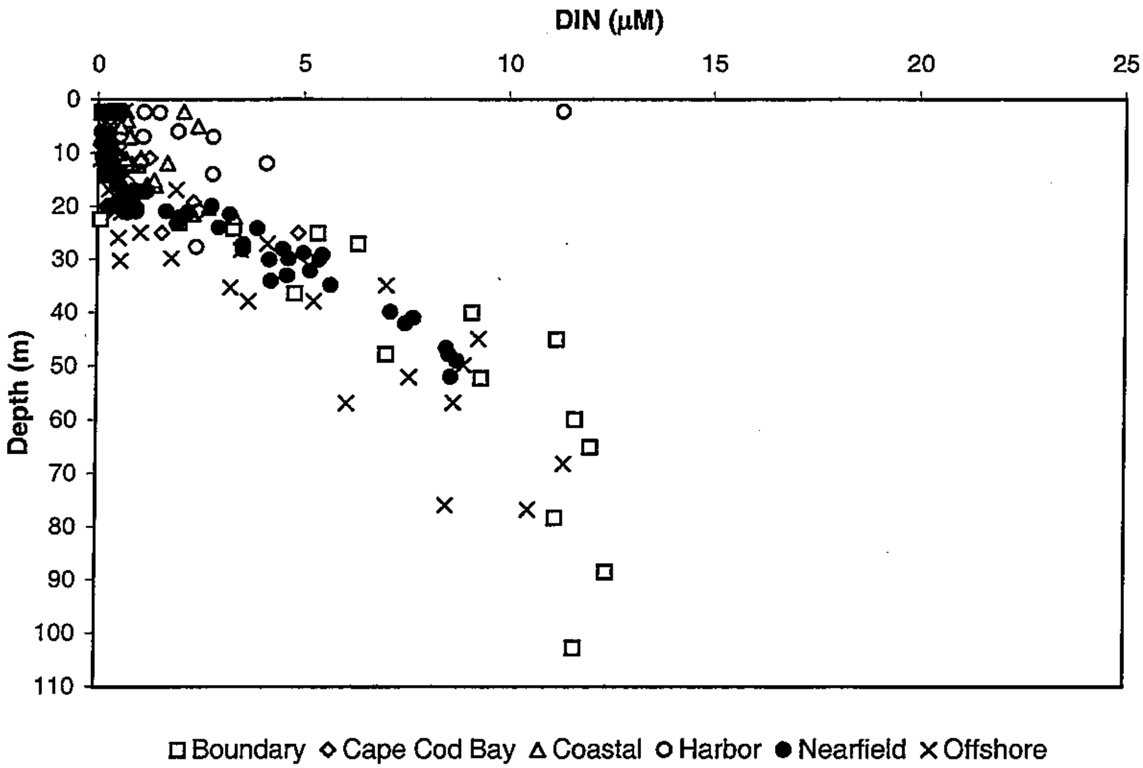


FIGURE 4-91
Depth vs. nutrient plots for farfield survey W9707, (Jun 97)

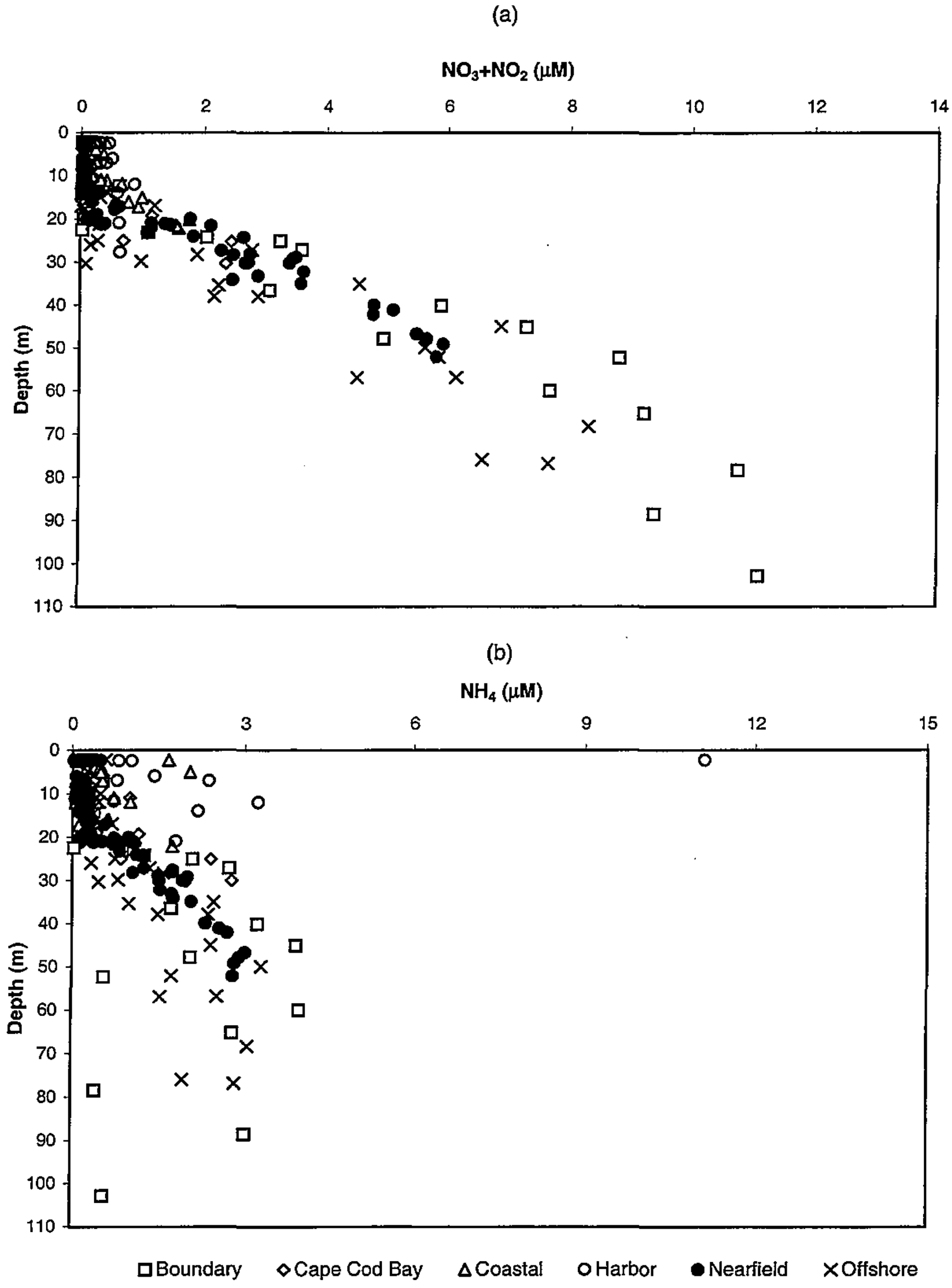
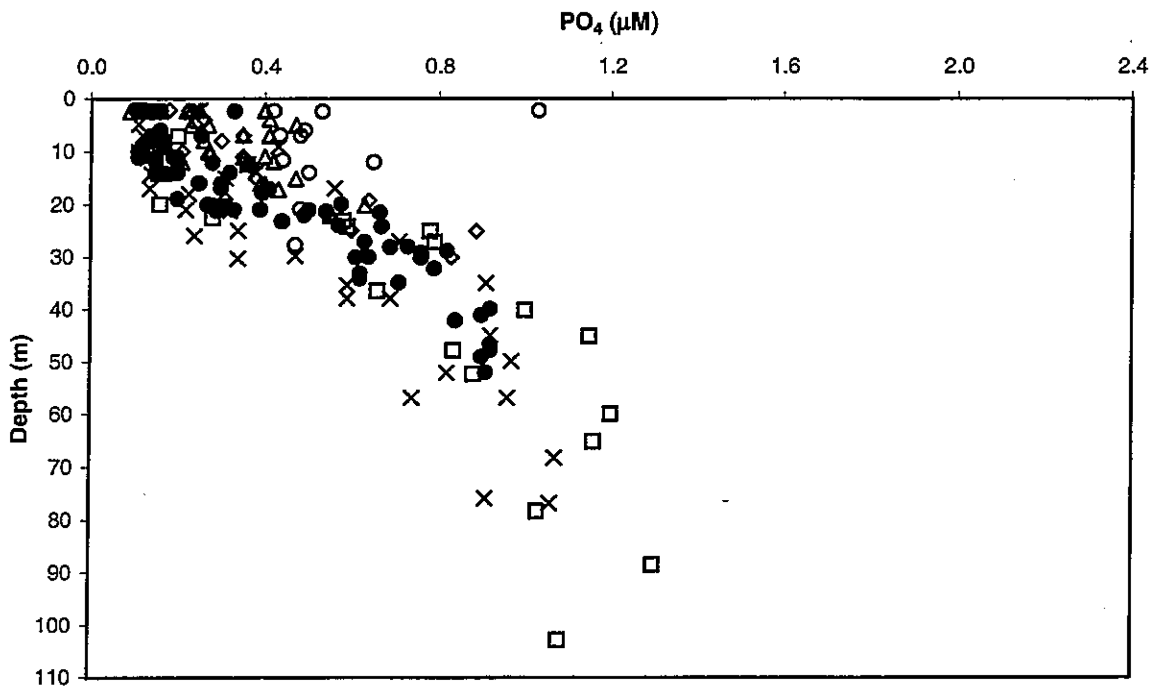


FIGURE 4-92
Depth vs. nutrient plots for farfield survey W9707, (Jun 97)

(a)



(b)

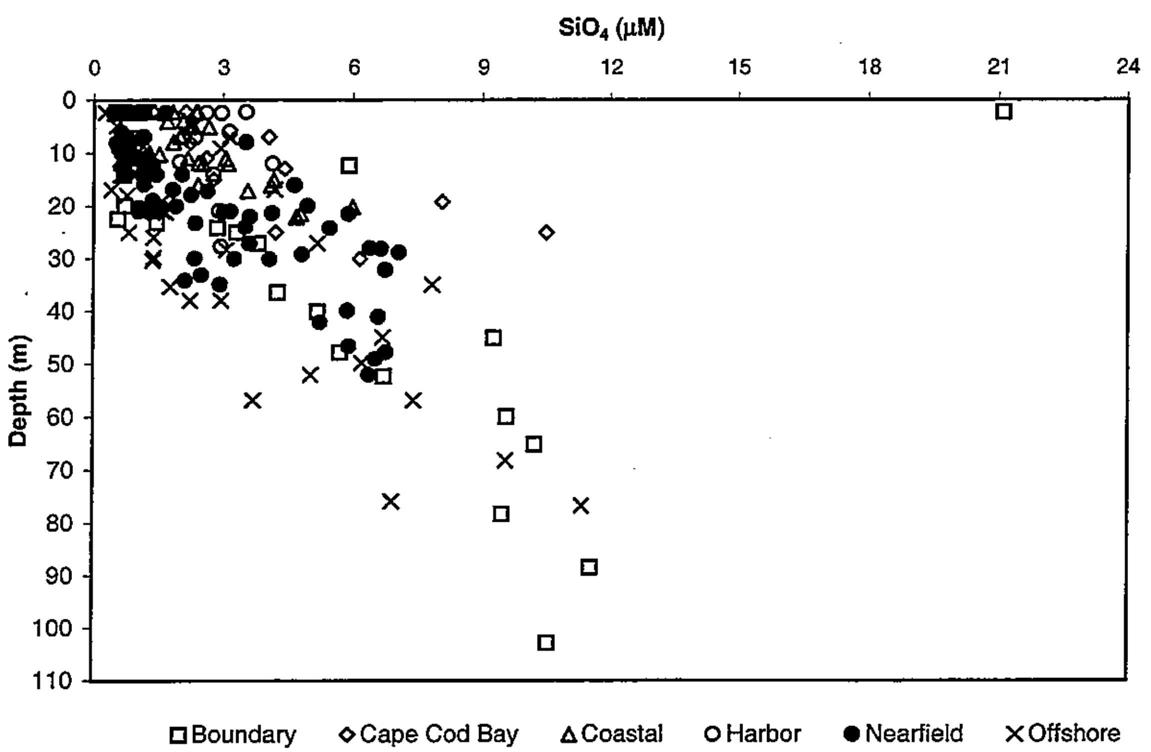


FIGURE 4-93

Depth vs. nutrient plots for farfield survey W9707, (Jun 97)

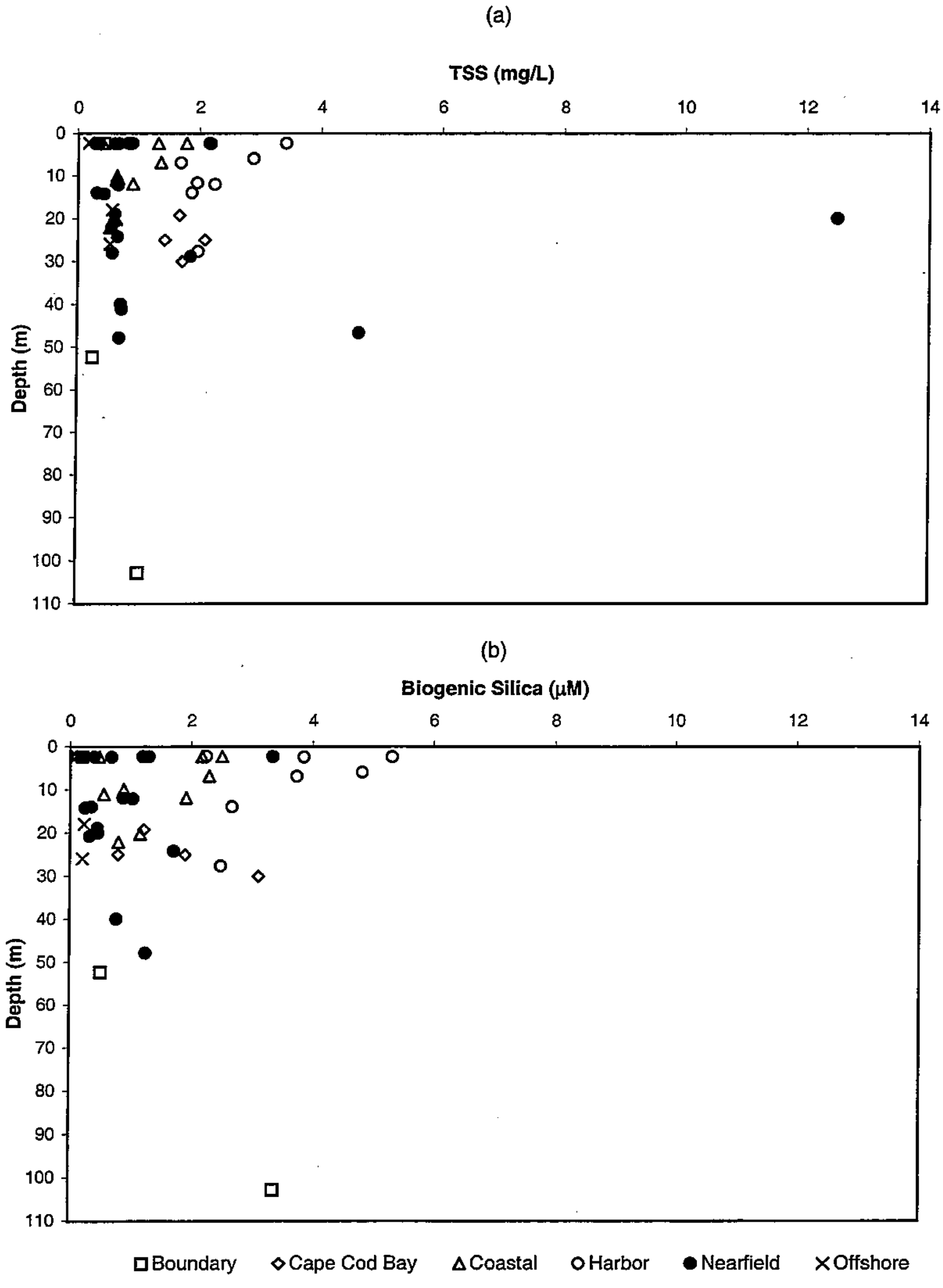


FIGURE 4-94
Depth vs. nutrient plots for farfield survey W9707, (Jun 97)

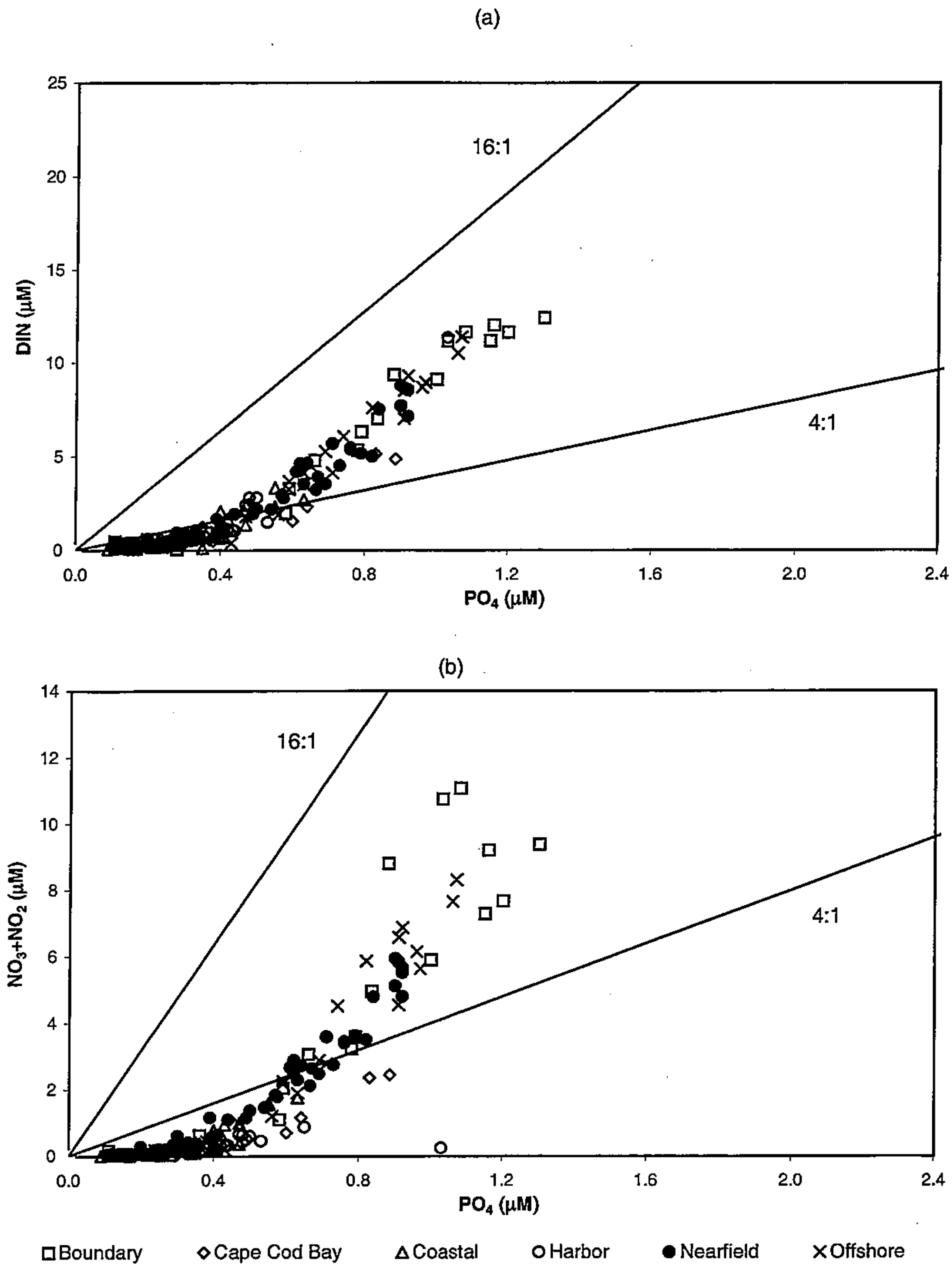


FIGURE 4-95
Nutrient vs. nutrient plots for farfield survey W9707, (Jun 97)

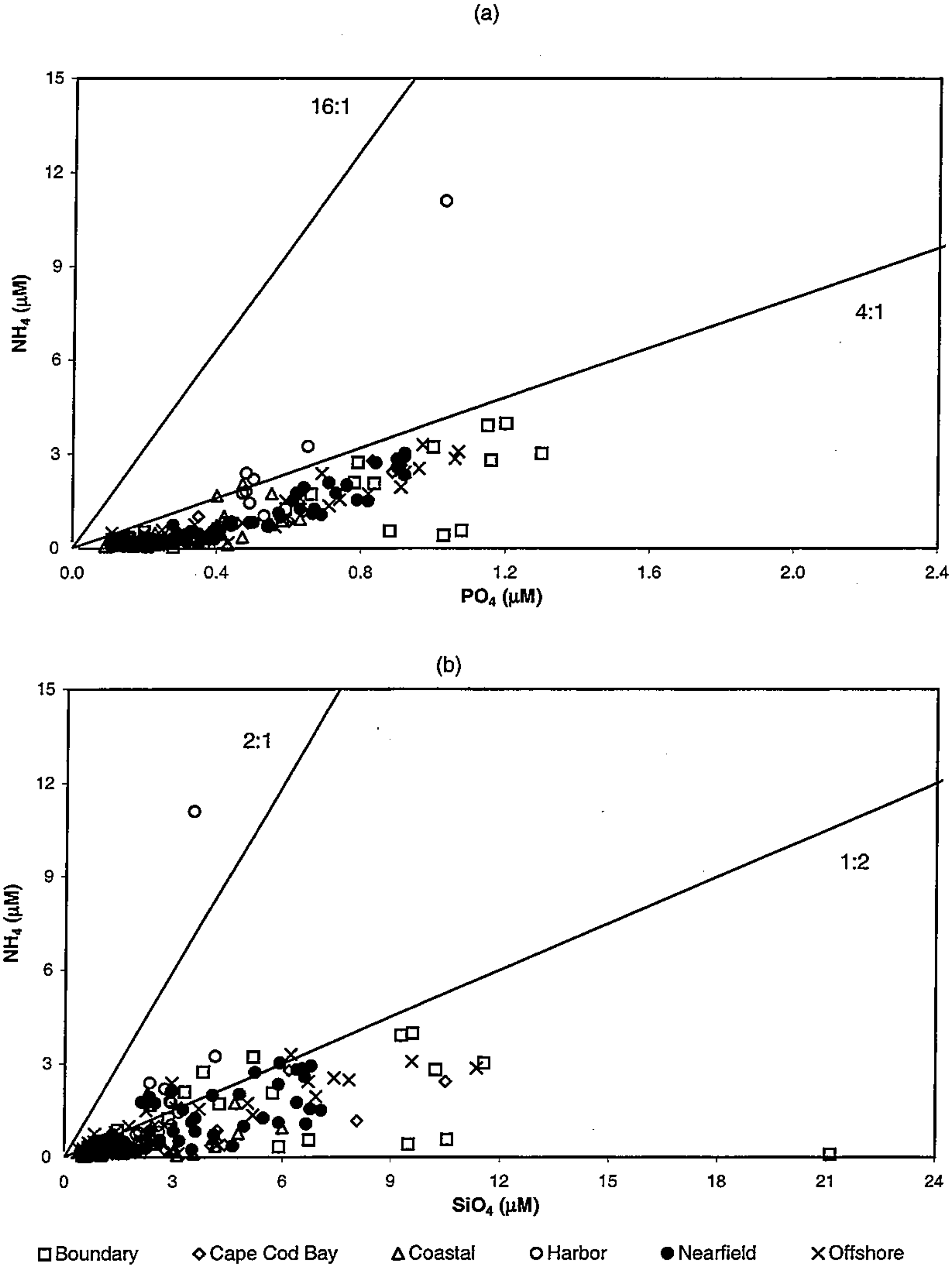


FIGURE 4-96

Nutrient vs. nutrient plots for farfield survey W9707, (Jun 97)

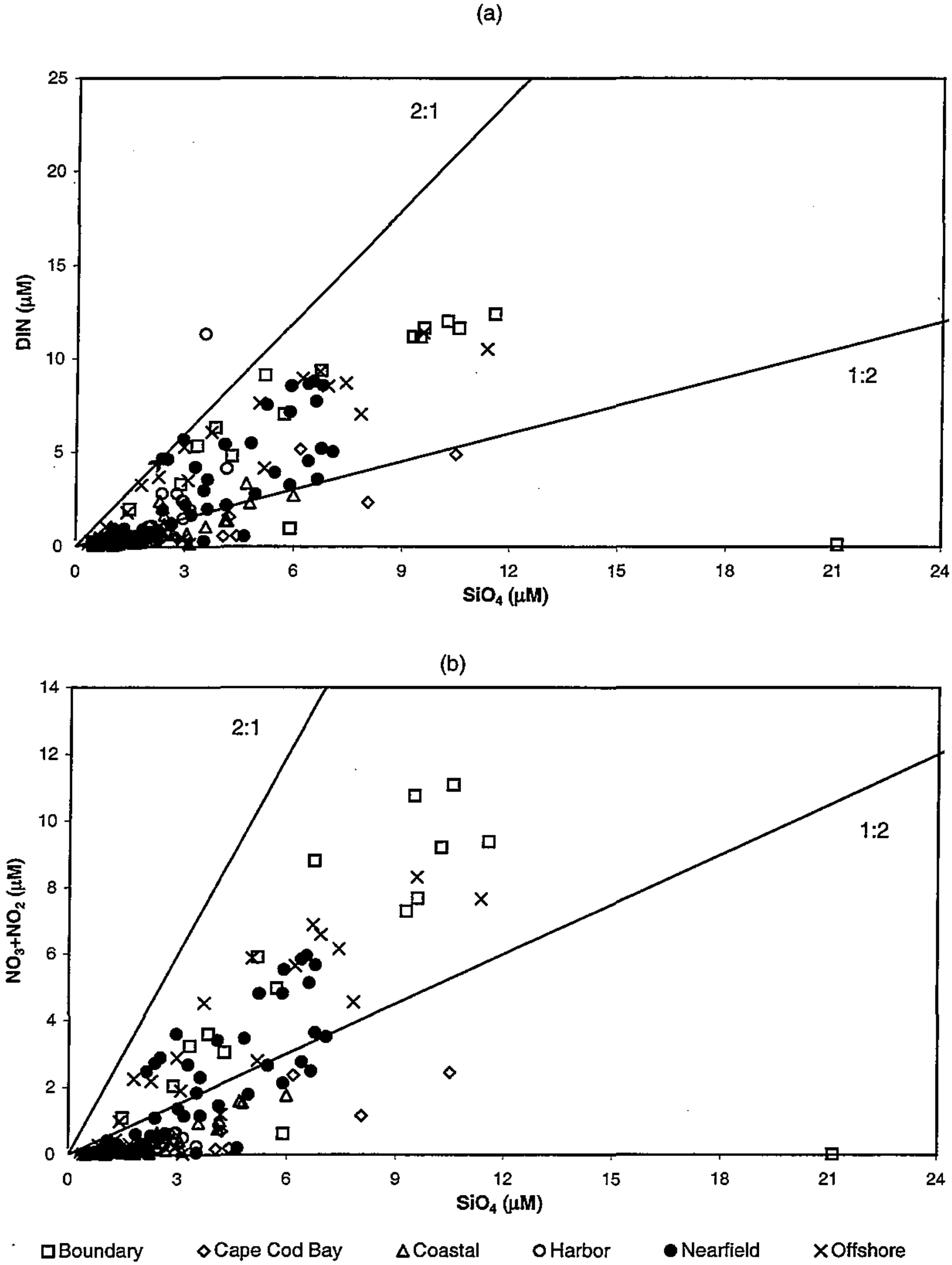


FIGURE 4-97

Nutrient vs. nutrient plots for farfield survey W9707, (Jun 97)

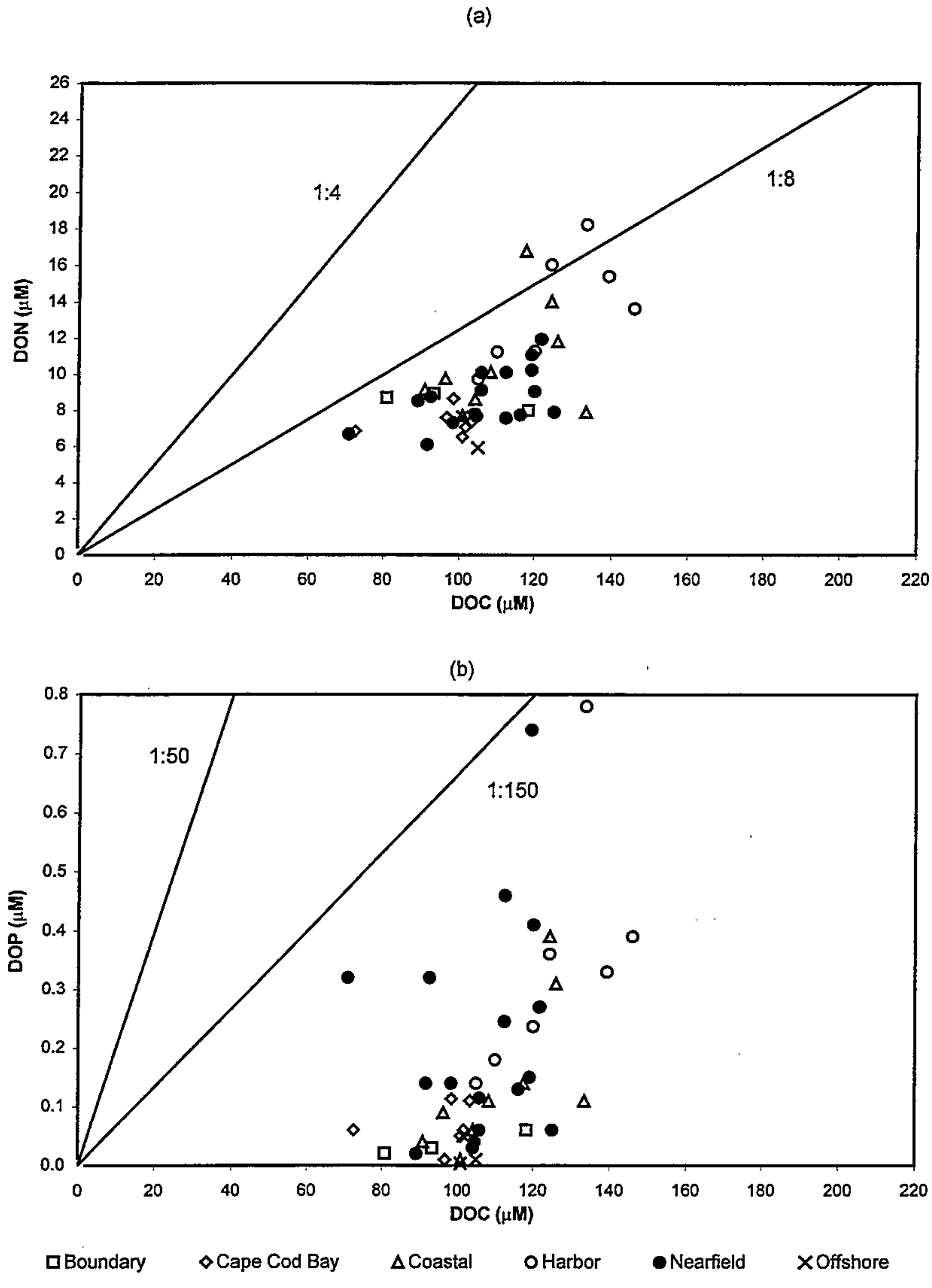


FIGURE 4-98
Nutrient vs. nutrient plots for farfield survey W9707, (Jun 97)

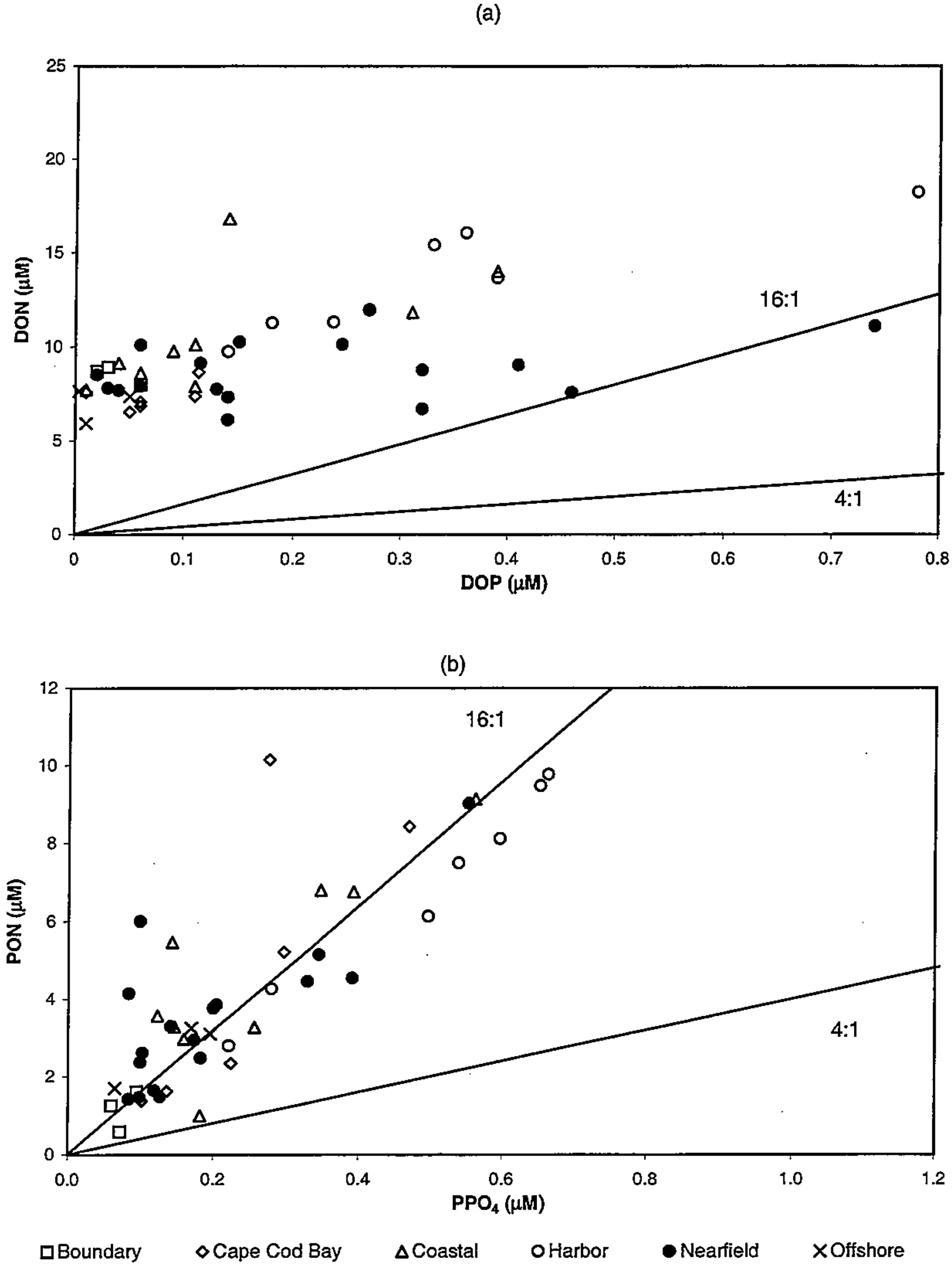


FIGURE 4-99
Nutrient vs. nutrient plots for farfield survey W9707, (Jun 97)

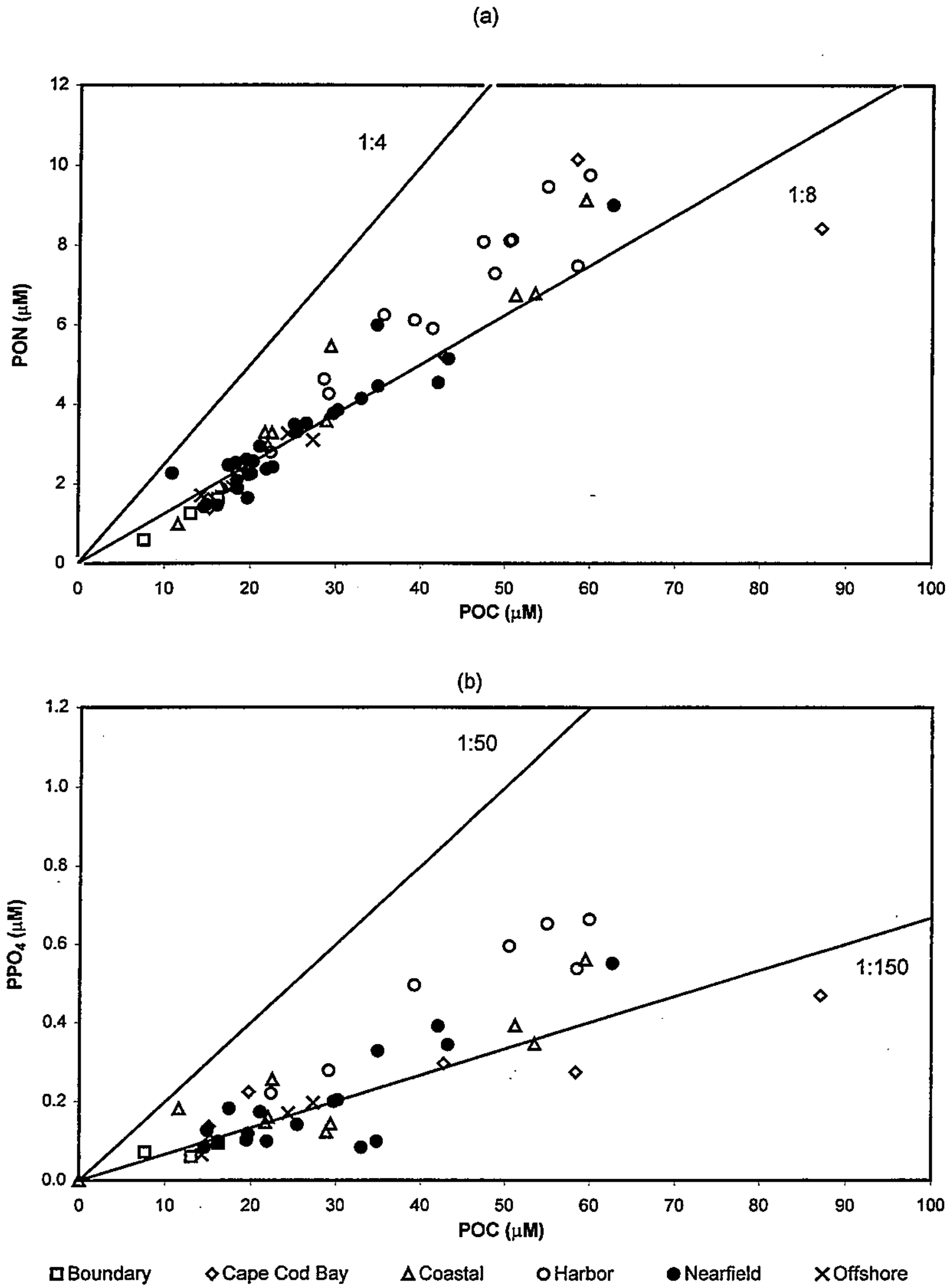


FIGURE 4-100

Nutrient vs. nutrient plots for farfield survey W9707, (Jun 97)

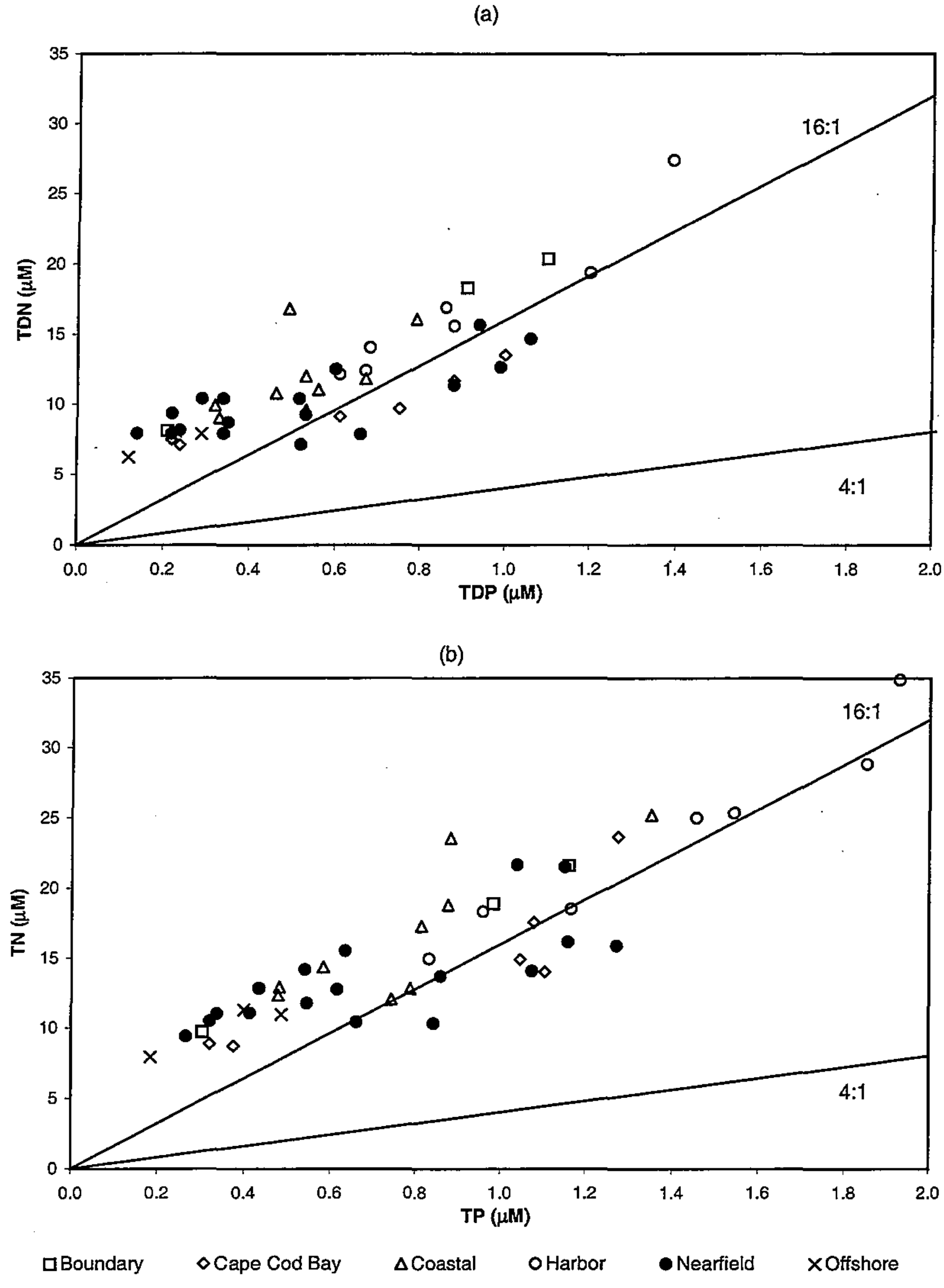


FIGURE 4-101
Nutrient vs. nutrient plots for farfield survey W9707, (Jun 97)

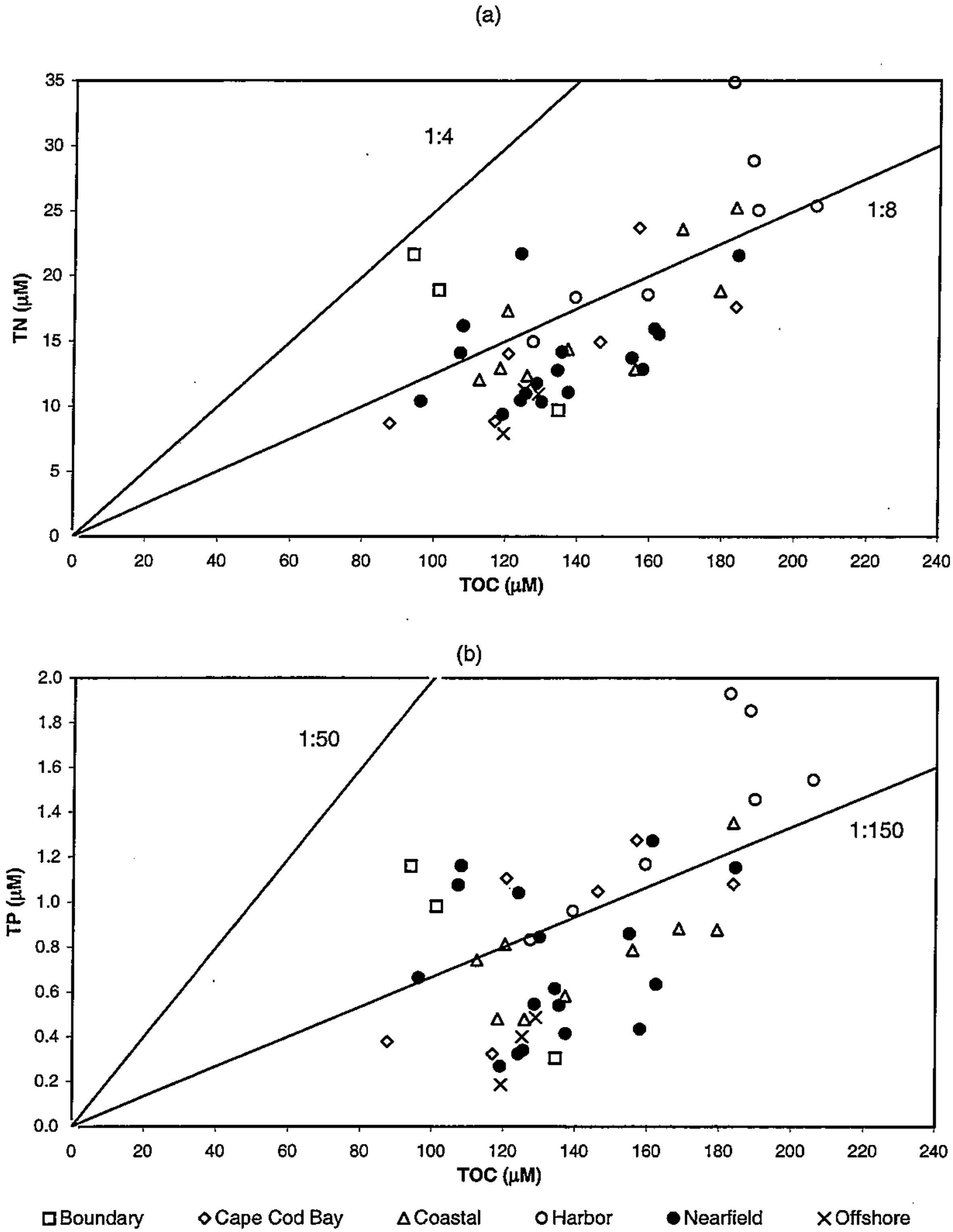


FIGURE 4-102
Depth vs. nutrient plots for farfield survey W9707, (Jun 97)

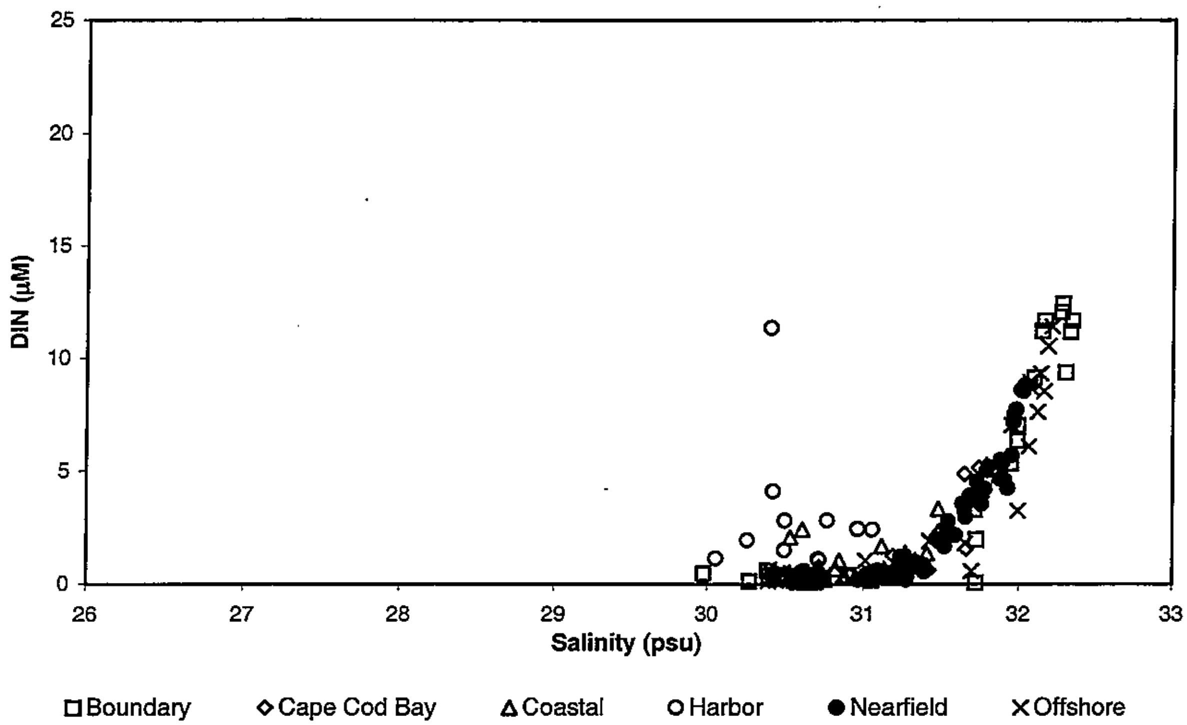


FIGURE 4-103
Nutrient vs. salinity plots for farfield survey W9707, (Jun 97)

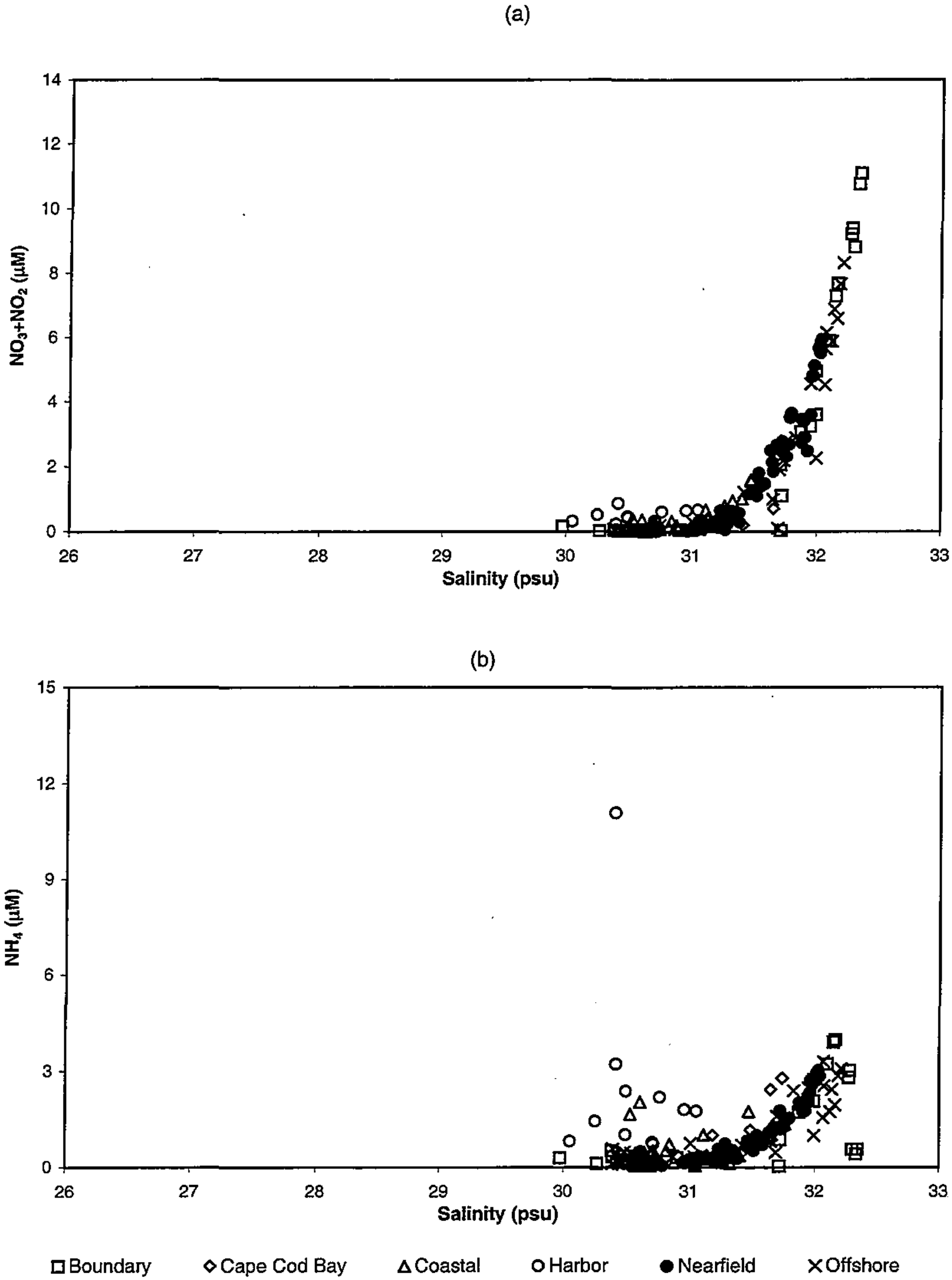
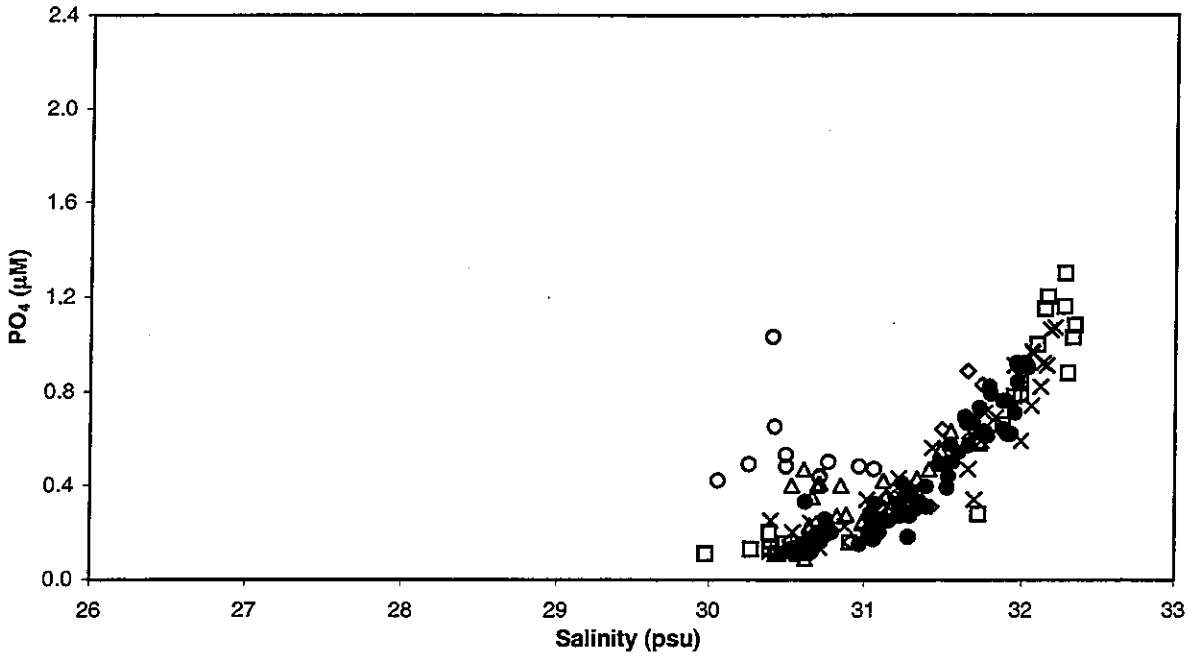


FIGURE 4-104

Nutrient vs. salinity plots for farfield survey W9707, (Jun 97)

(a)



(b)

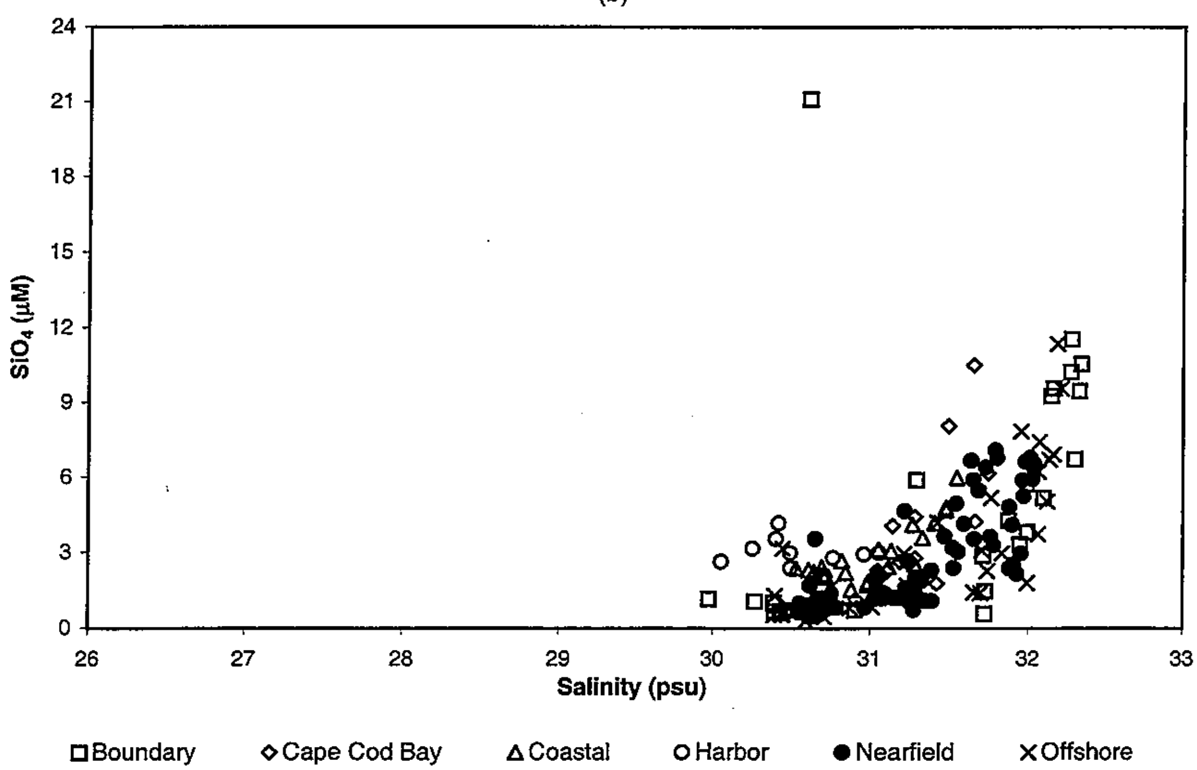


FIGURE 4-105
Nutrient vs. salinity plots for farfield survey W9707, (Jun 97)

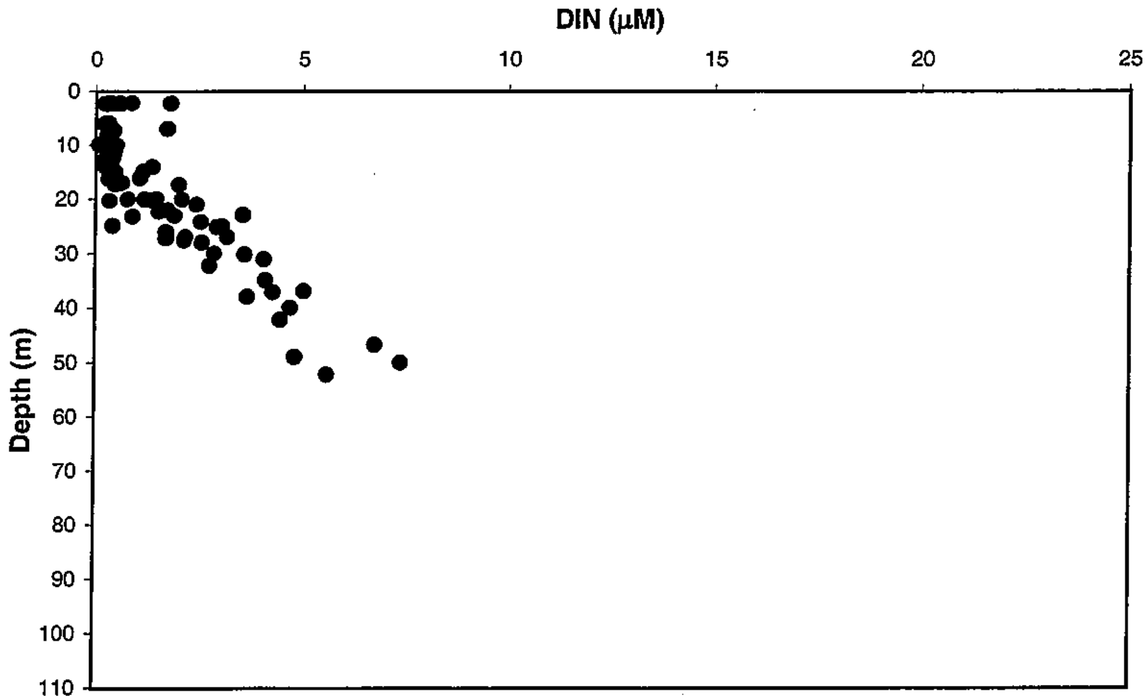
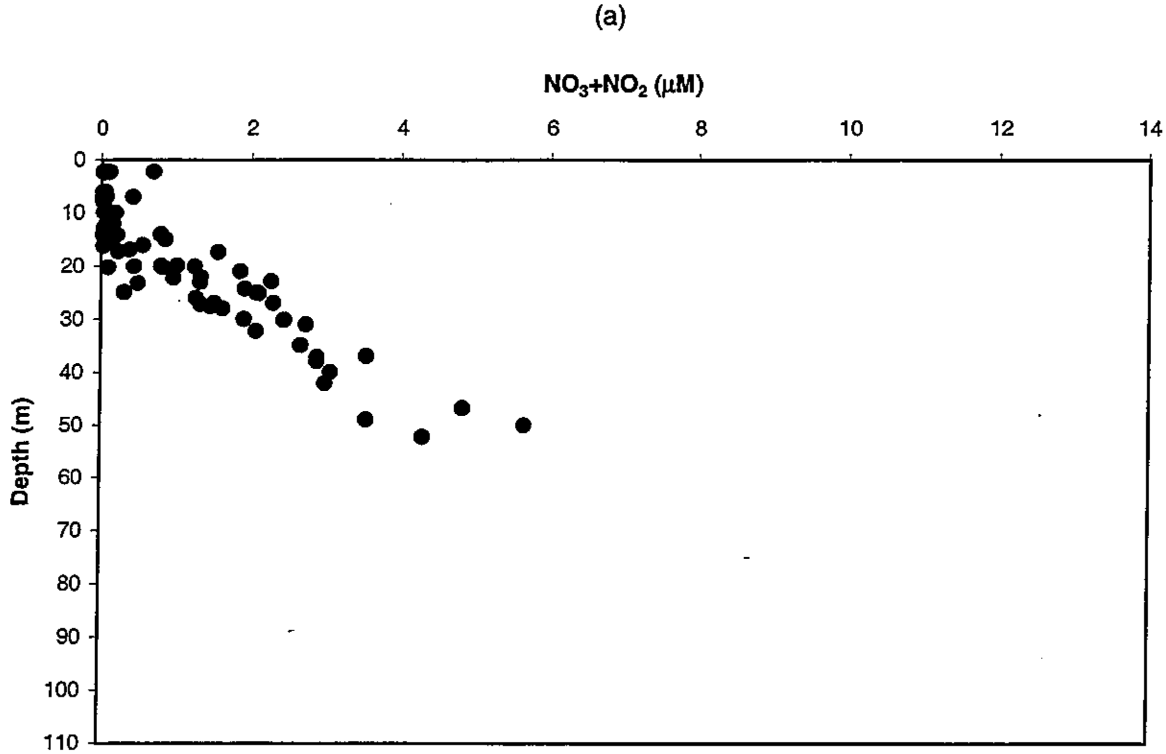


FIGURE 4-106
Depth vs. nutrient plots for nearfield survey W9708, (Jul 97)



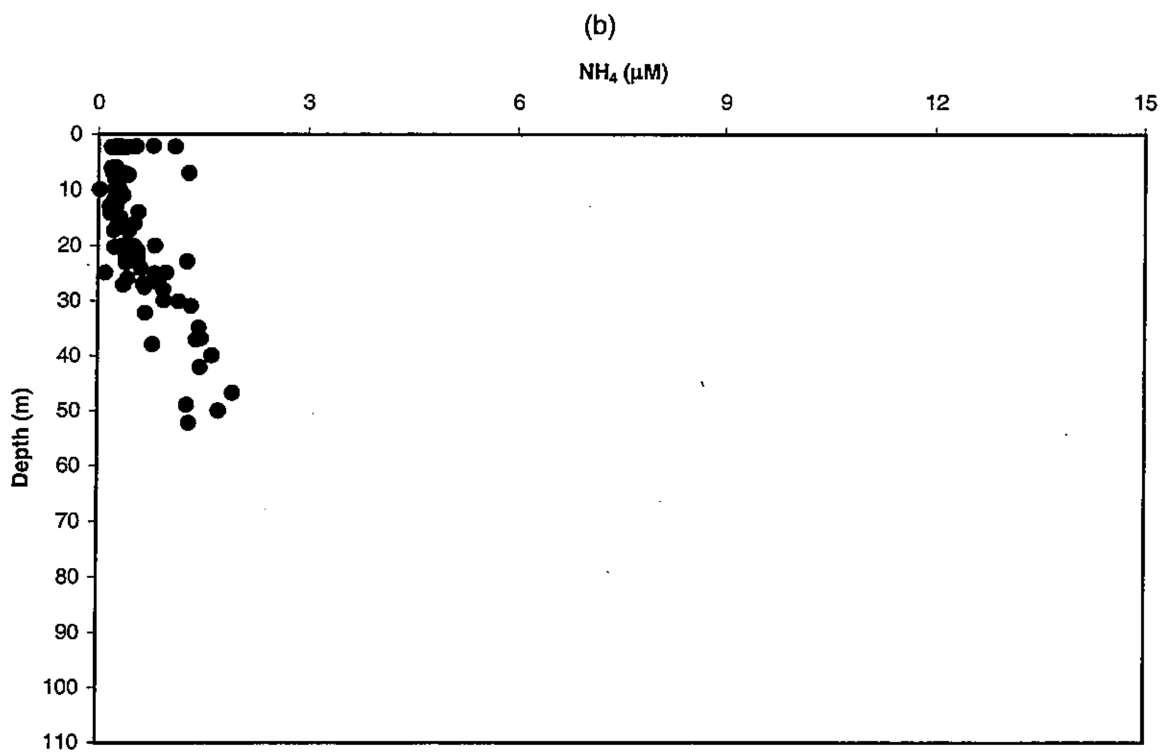
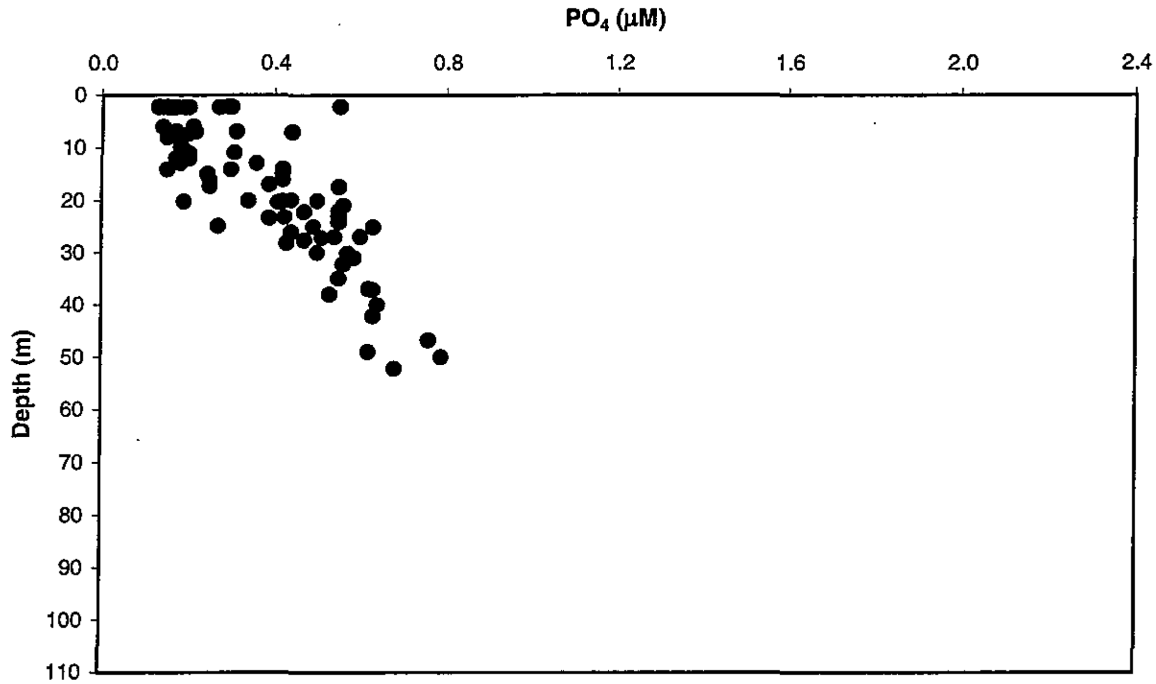


FIGURE 4-107
Depth vs. nutrient plots for nearfield survey W9708, (Jul 97)

(a)



(b)

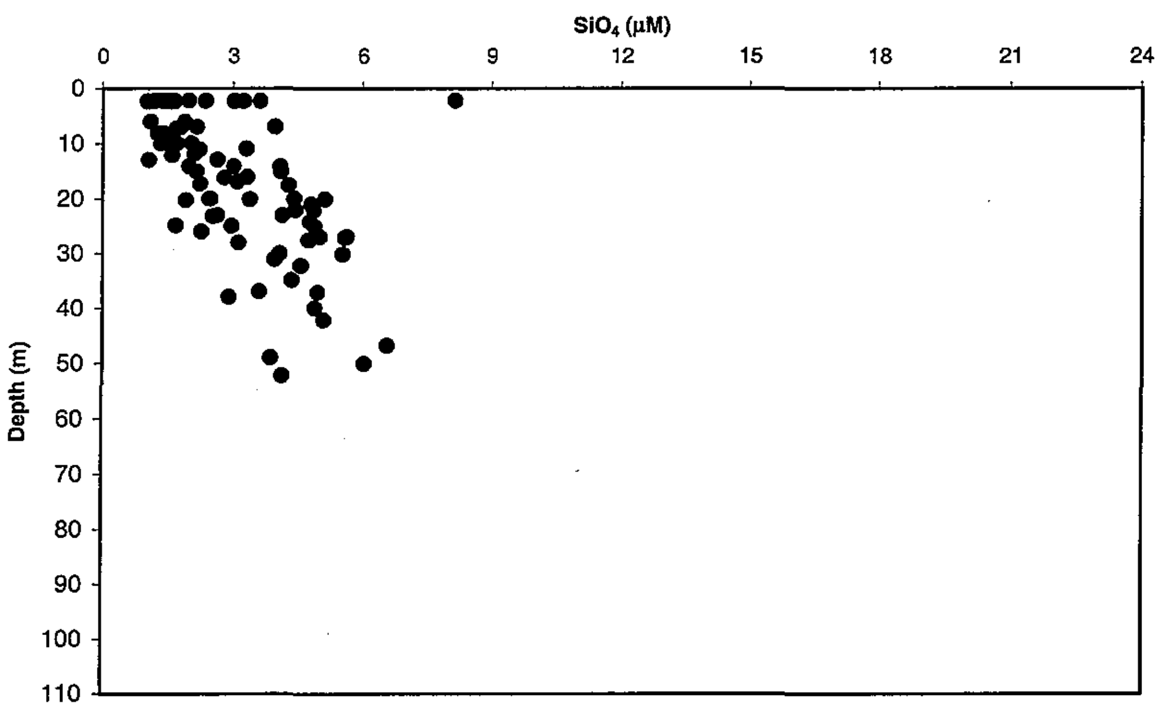
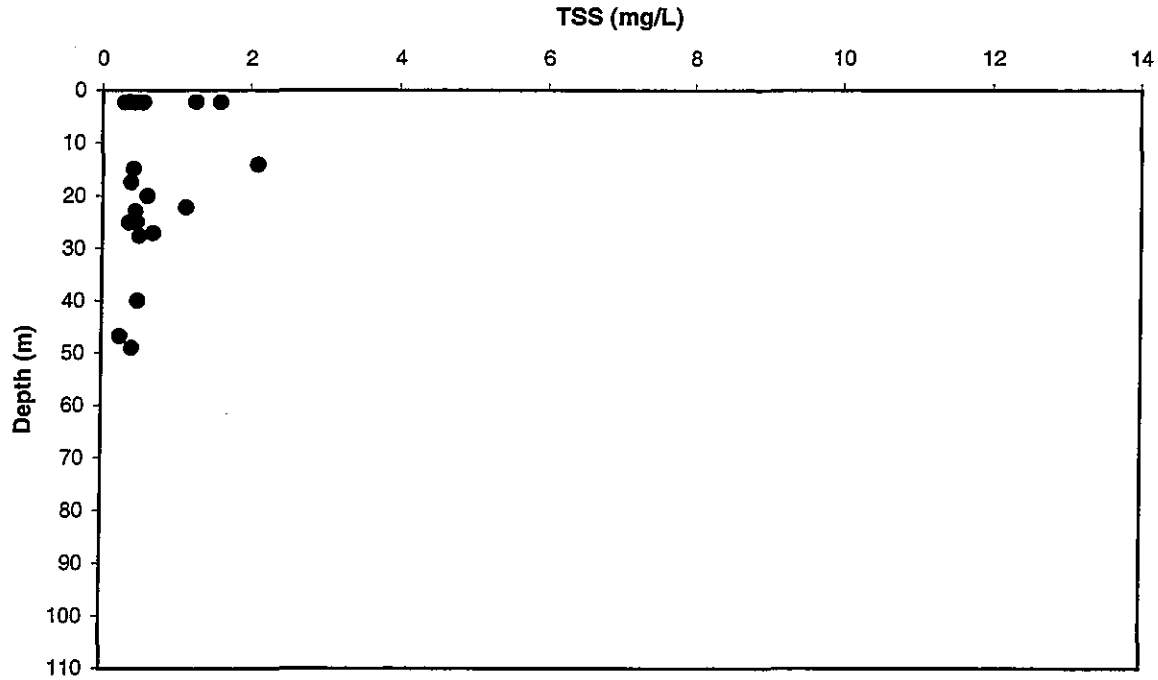


FIGURE 4-108

Depth vs. nutrient plots for nearfield survey W9708, (Jul 97)

(a)



(b)

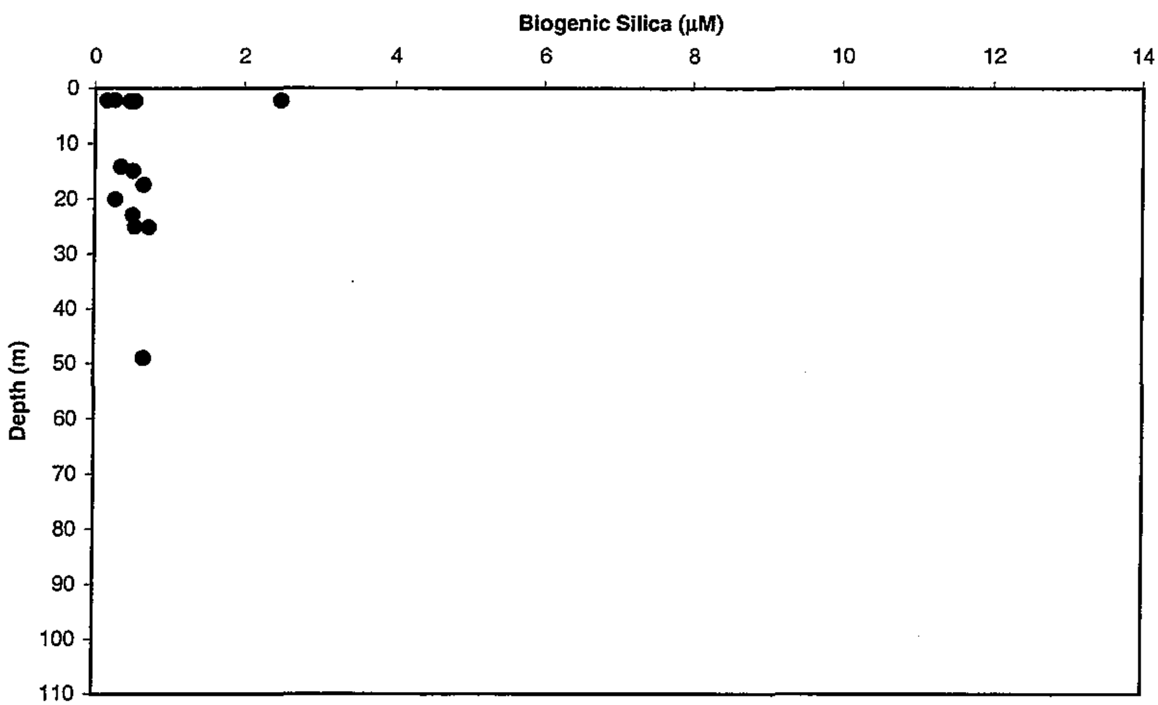


FIGURE 4-109

Depth vs. nutrient plots for nearfield survey W9708, (Jul 97)

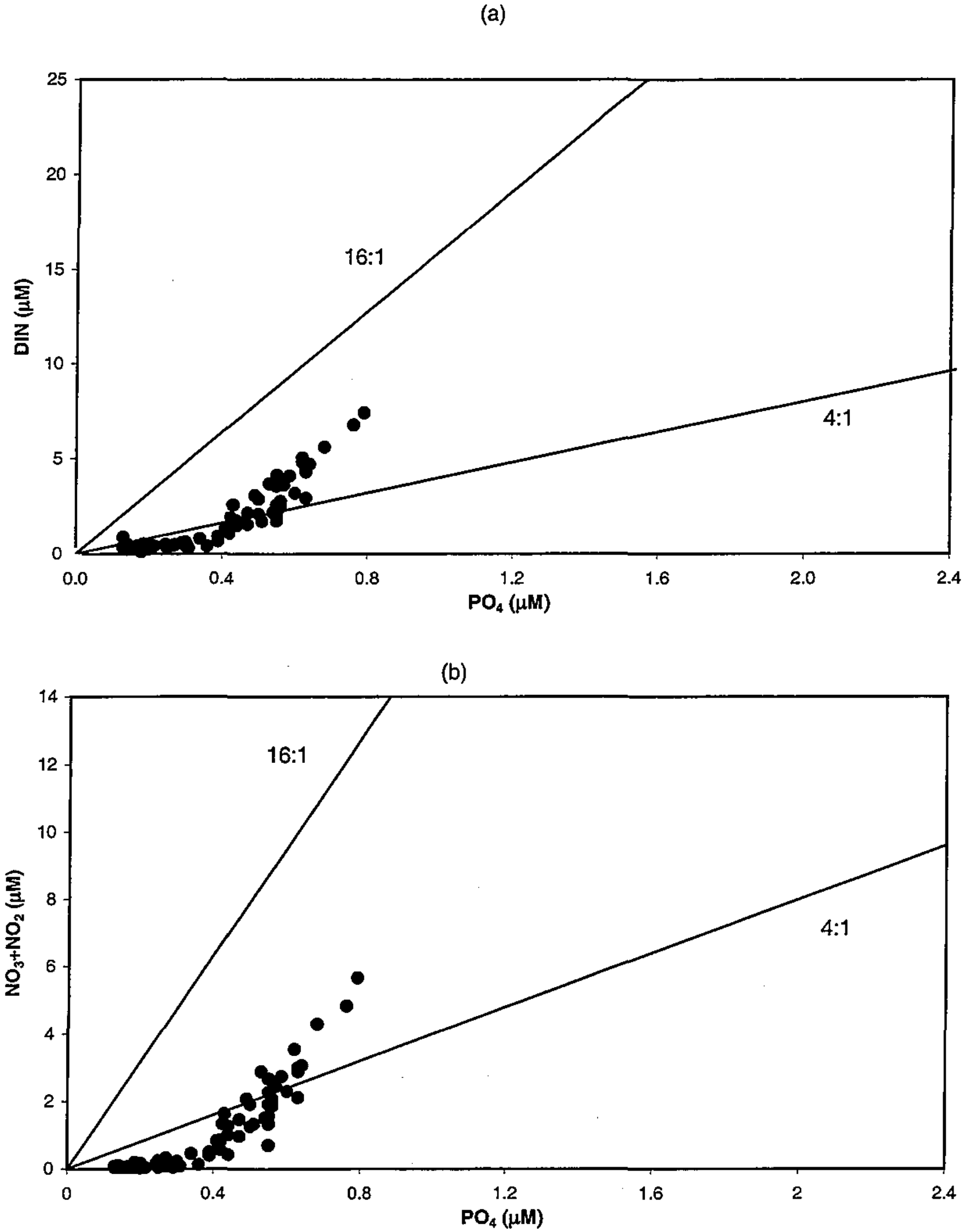


FIGURE 4-110
Nutrient vs. nutrient plots for nearfield survey W9708, (Jul 97)

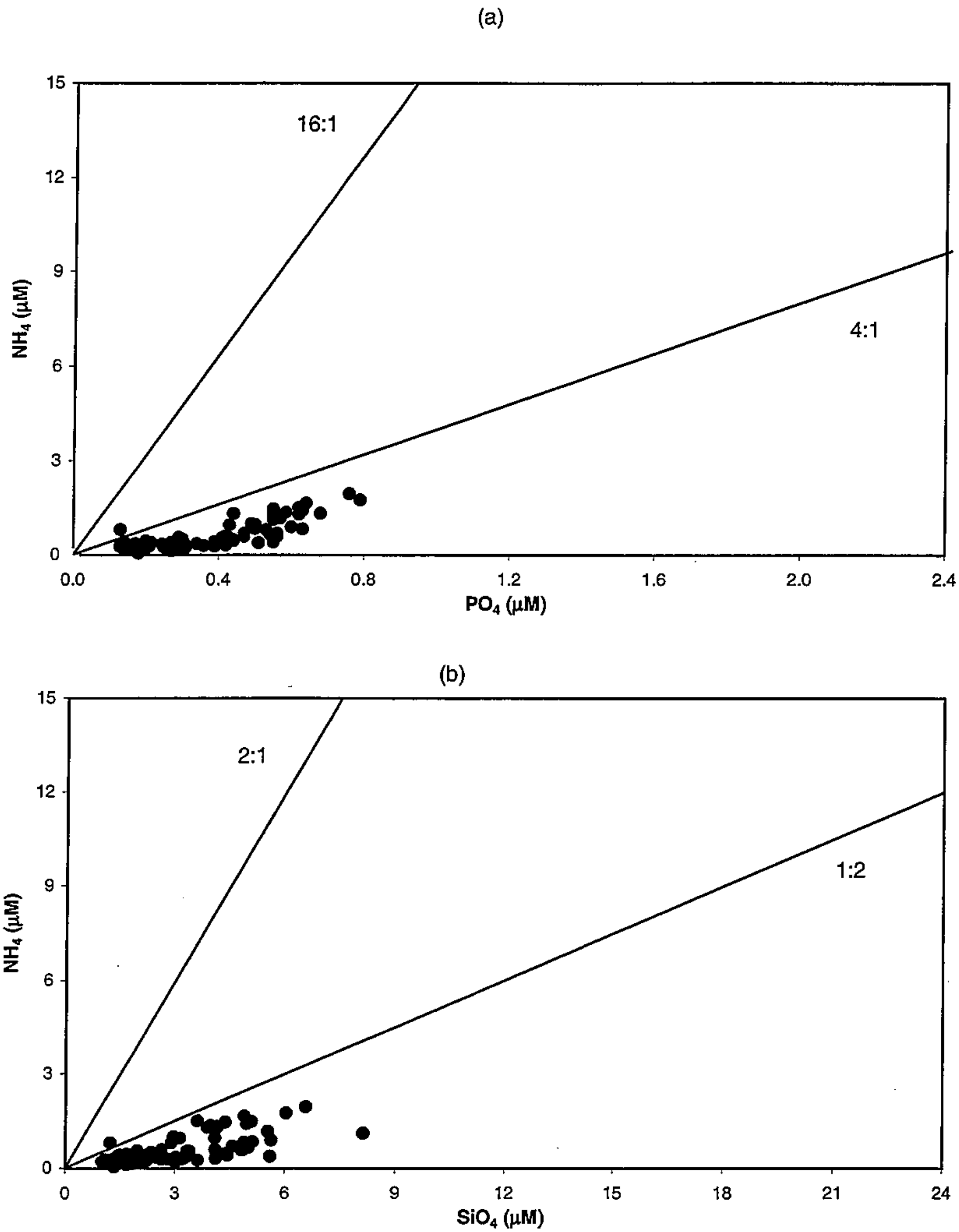
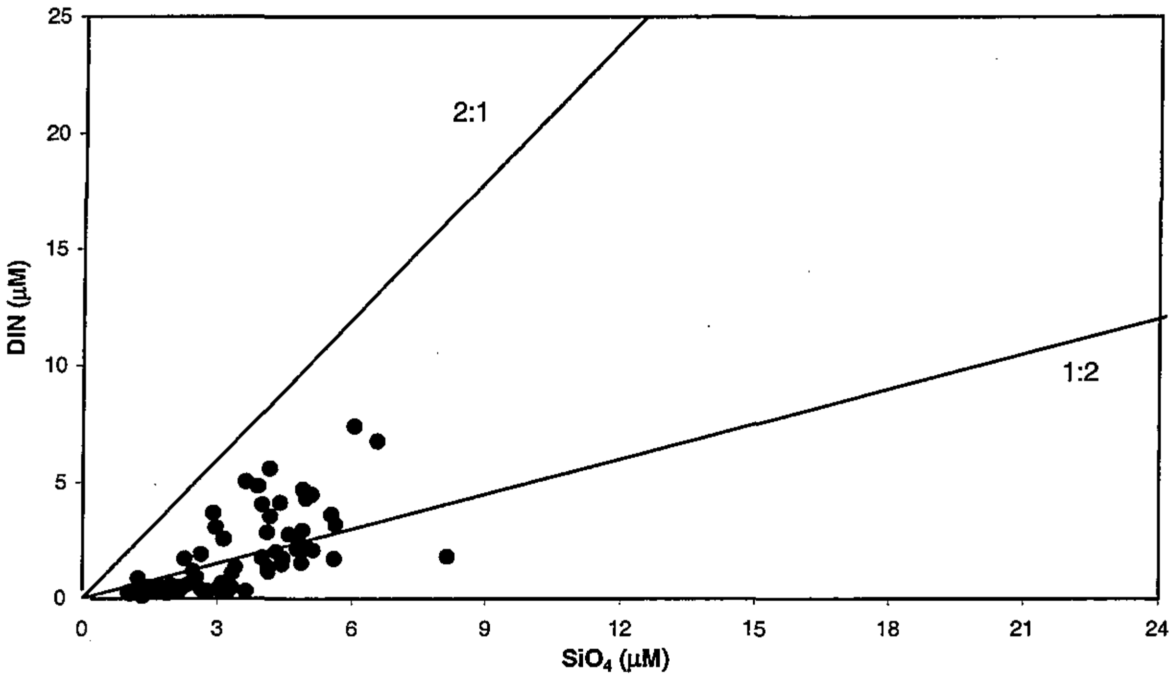


FIGURE 4-111

Nutrient vs. nutrient plots for nearfield survey W9708, (Jul 97)

(a)



(b)

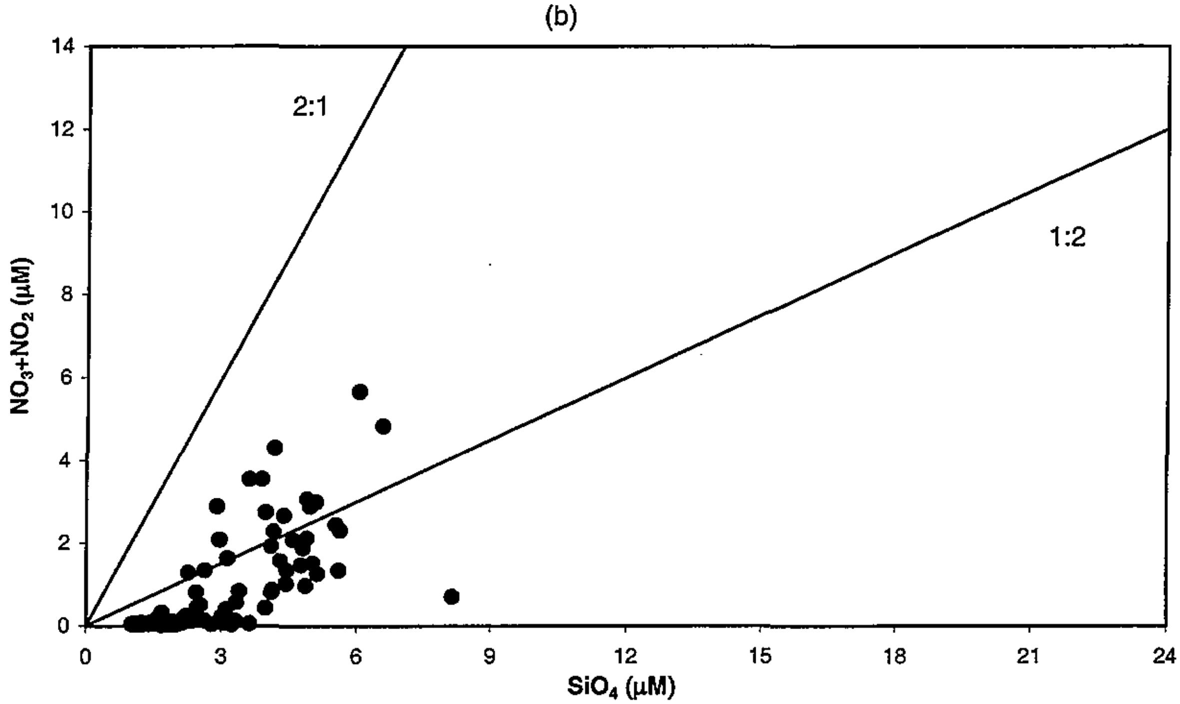
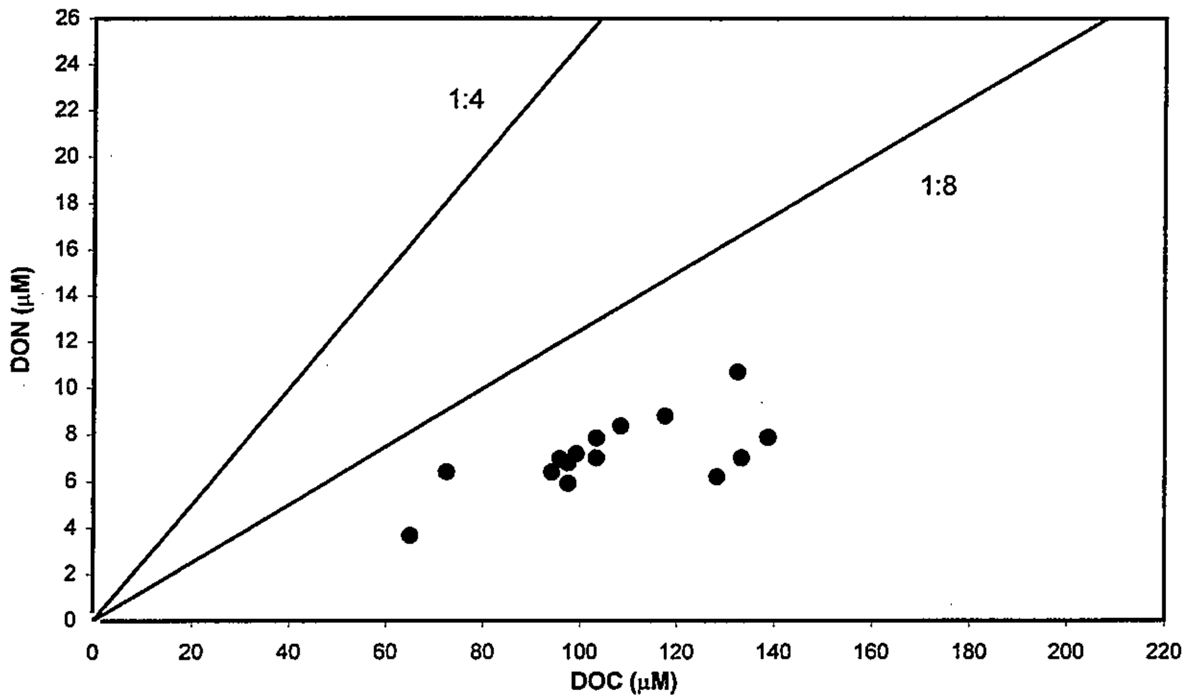


FIGURE 4-112

Nutrient vs. nutrient plots for nearfield survey W9708, (Jul 97)

(a)



(b)

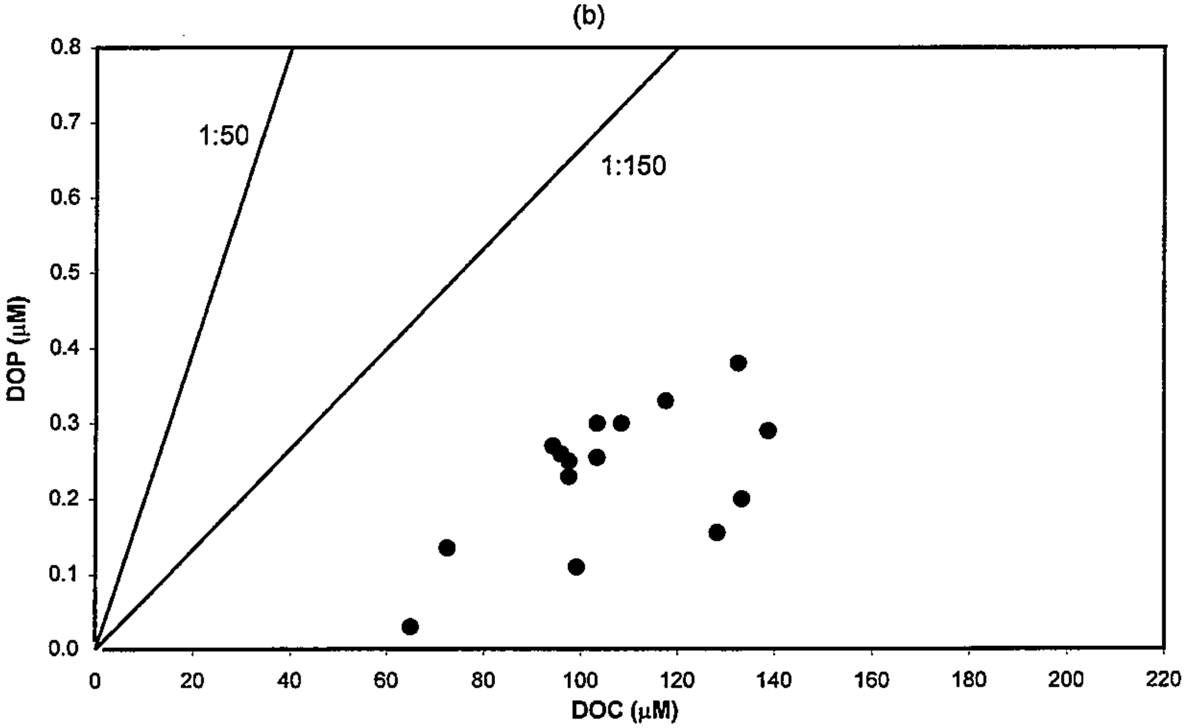


FIGURE 4-113
Nutrient vs. nutrient plots for nearfield survey W9708, (Jul 97)

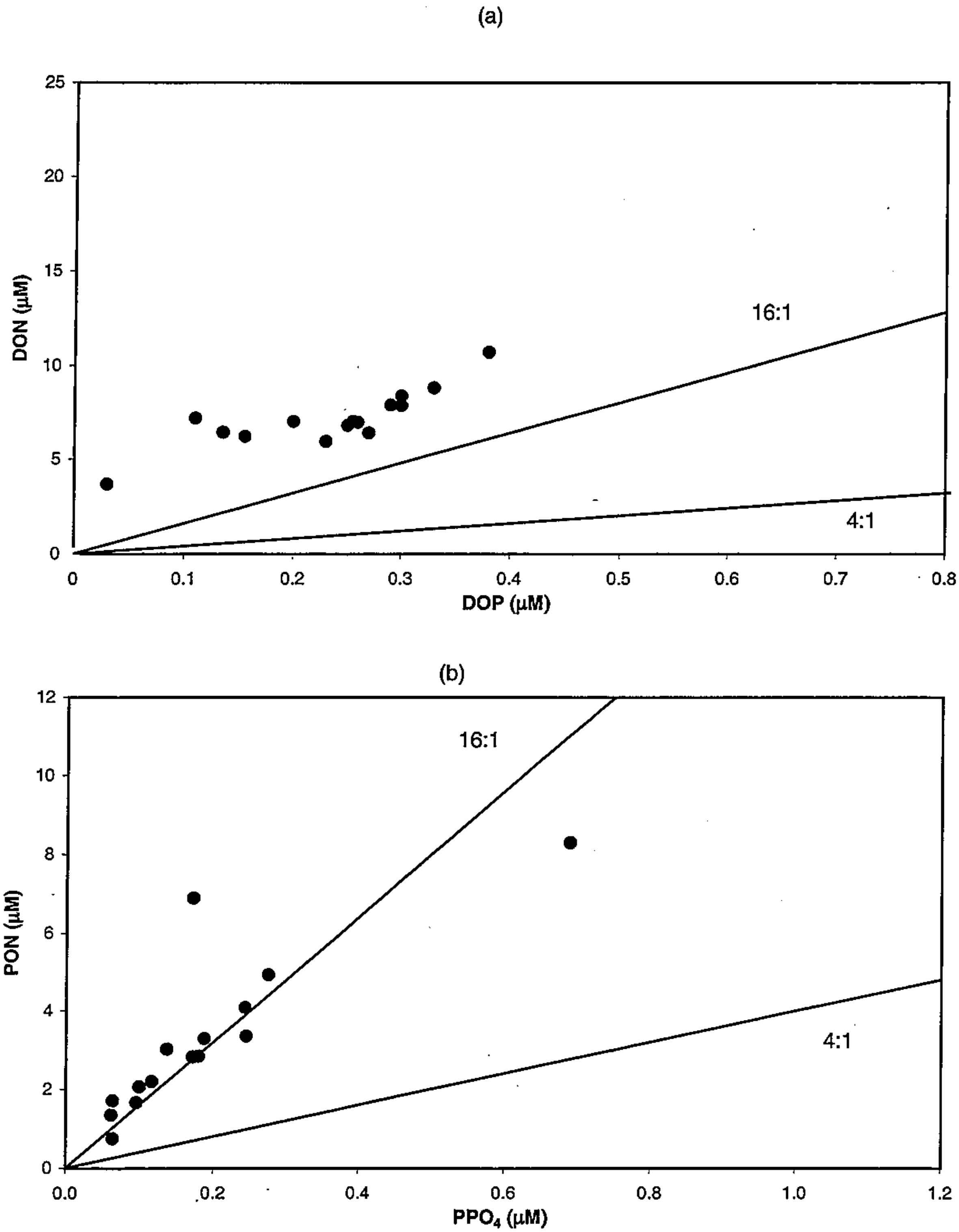


FIGURE 4-114
Nutrient vs. nutrient plots for nearfield survey W9708, (Jul 97)

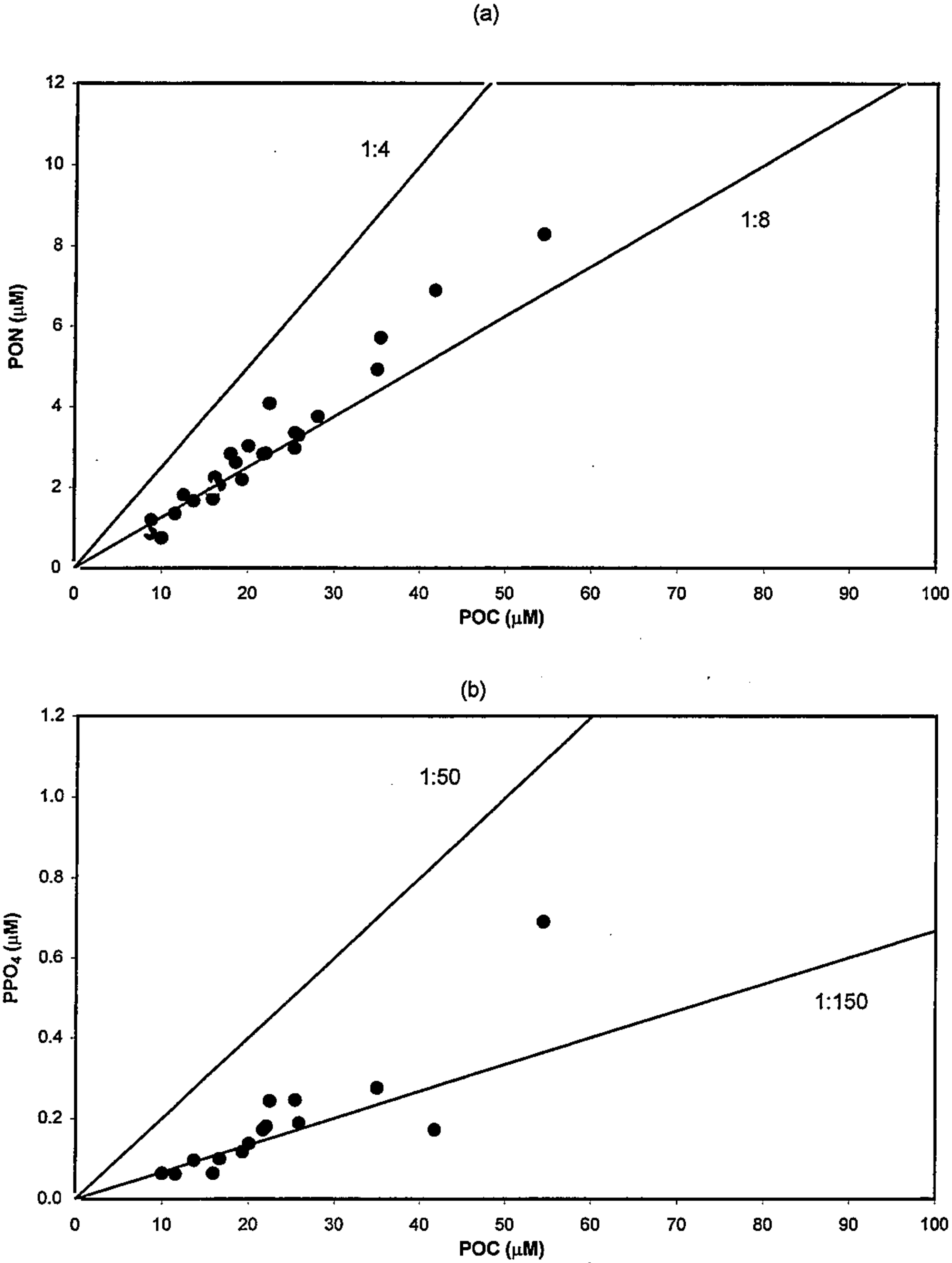
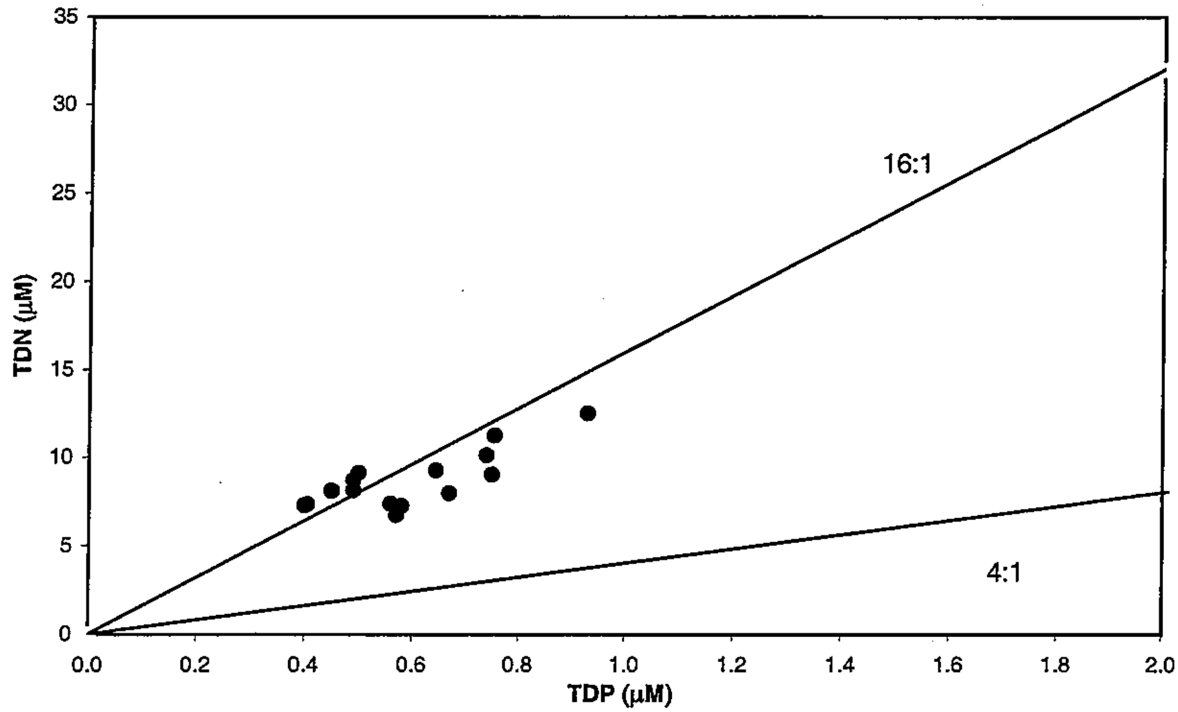


FIGURE 4-115
Nutrient vs. nutrient plots for nearfield survey W9708, (Jul 97)

(a)



(b)

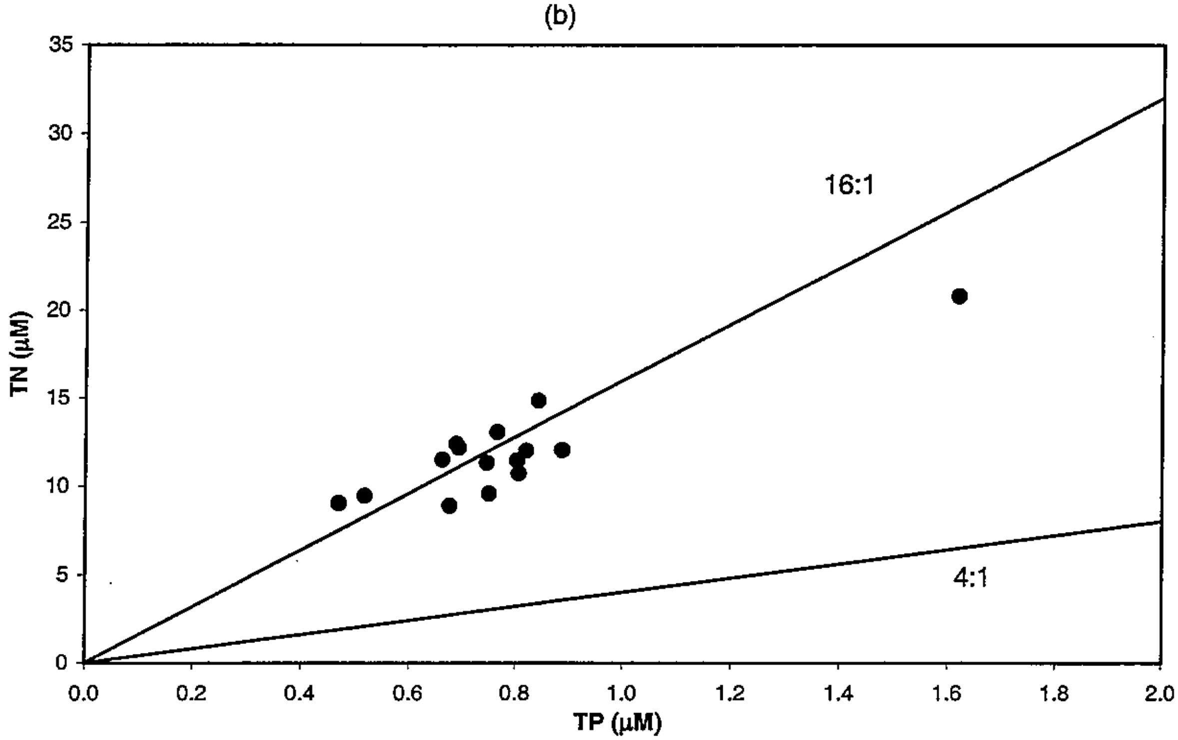
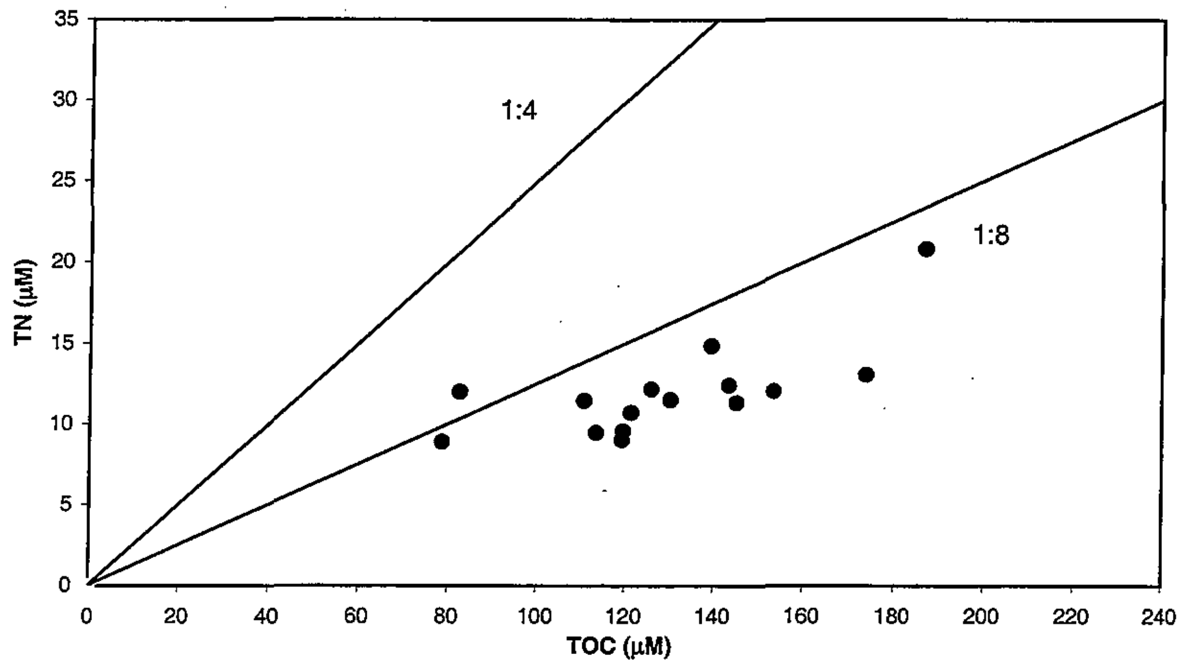


FIGURE 4-116
Nutrient vs. nutrient plots for nearfield survey W9708, (Jul 97)

(a)



(b)

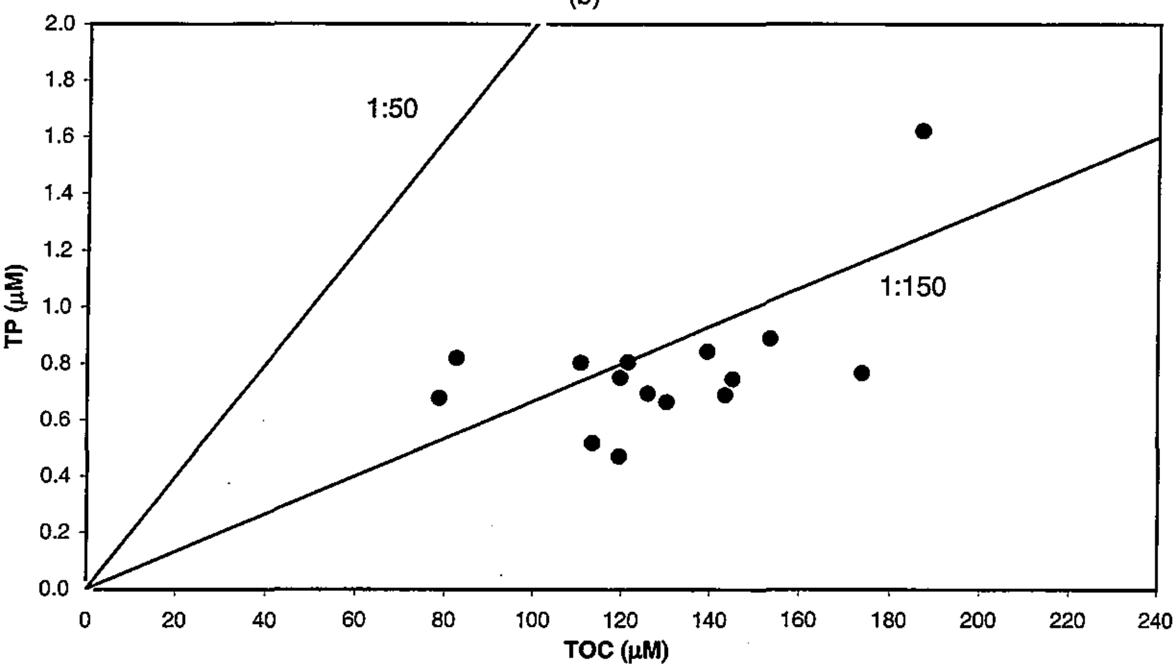


FIGURE 4-117

Depth vs. nutrient plots for nearfield survey W9708, (Jul 97)

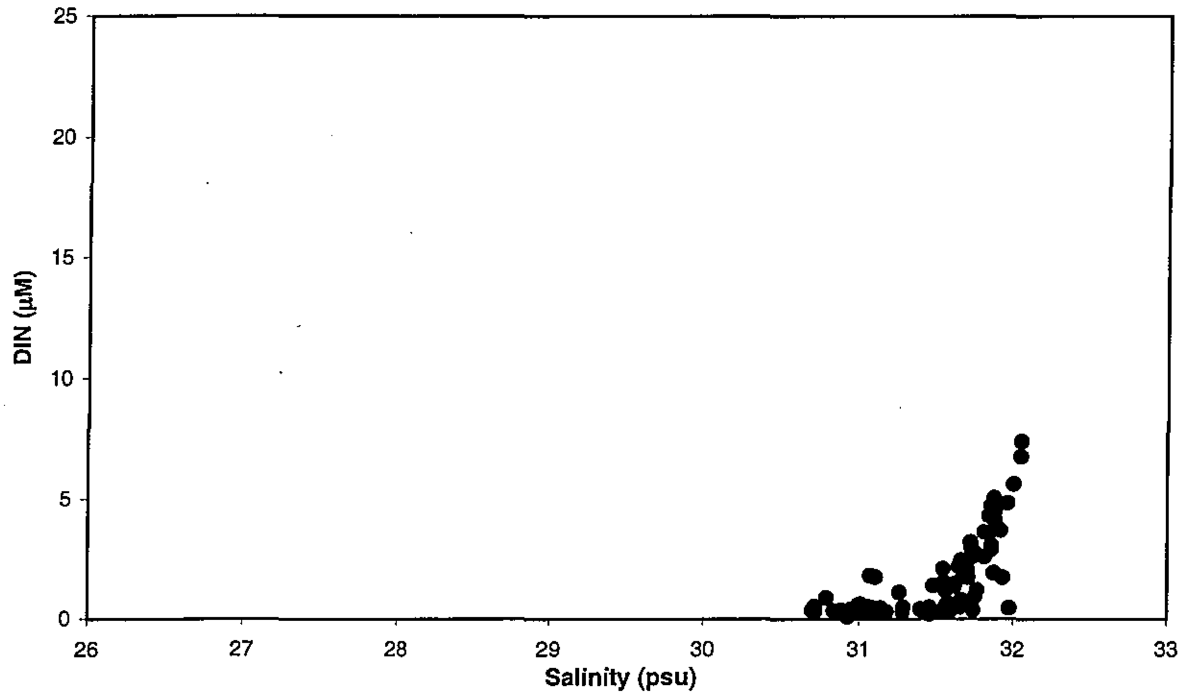


FIGURE 4-118
Nutrient vs. salinity plots for nearfield survey W9708, (Jul 97)

(a)

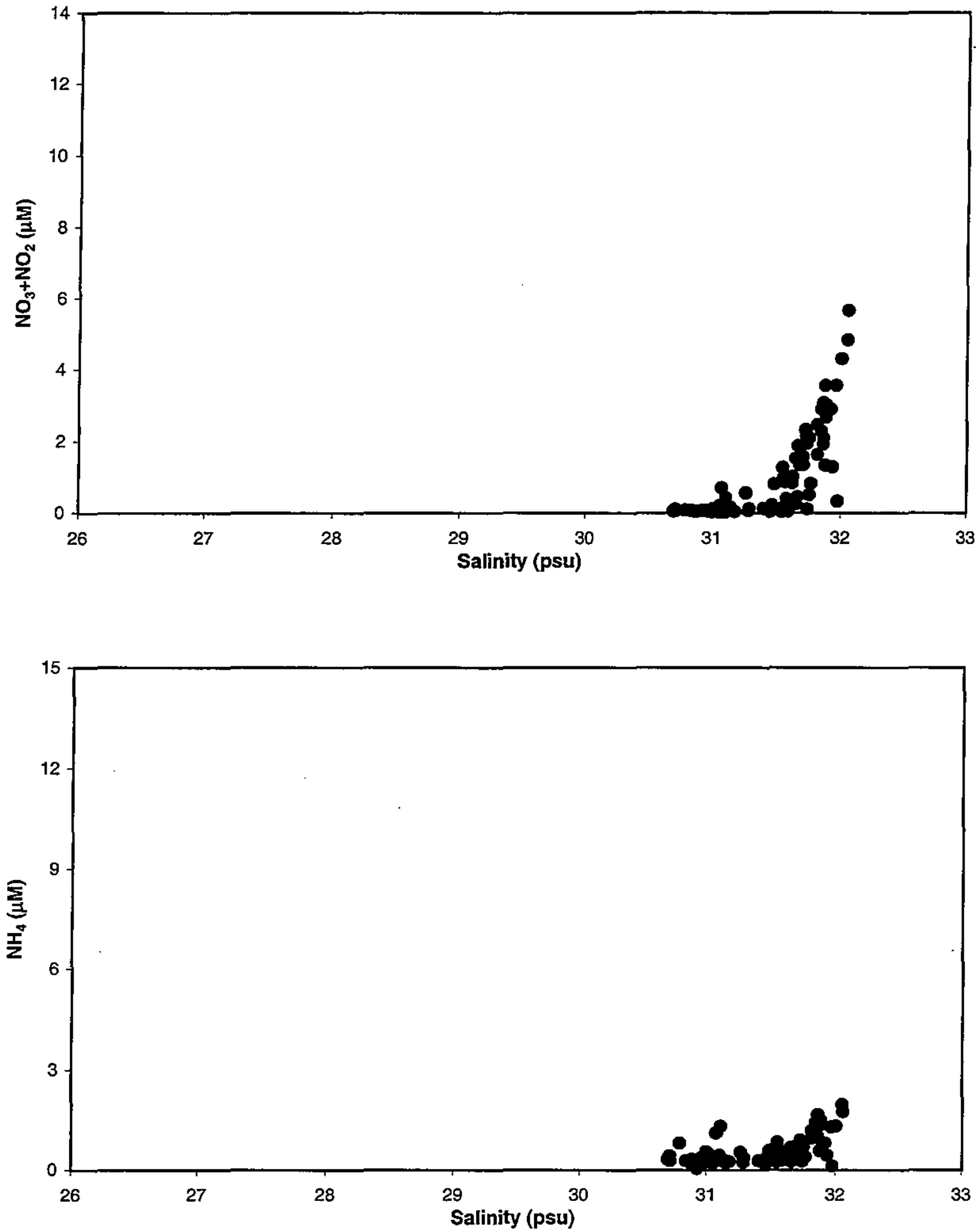
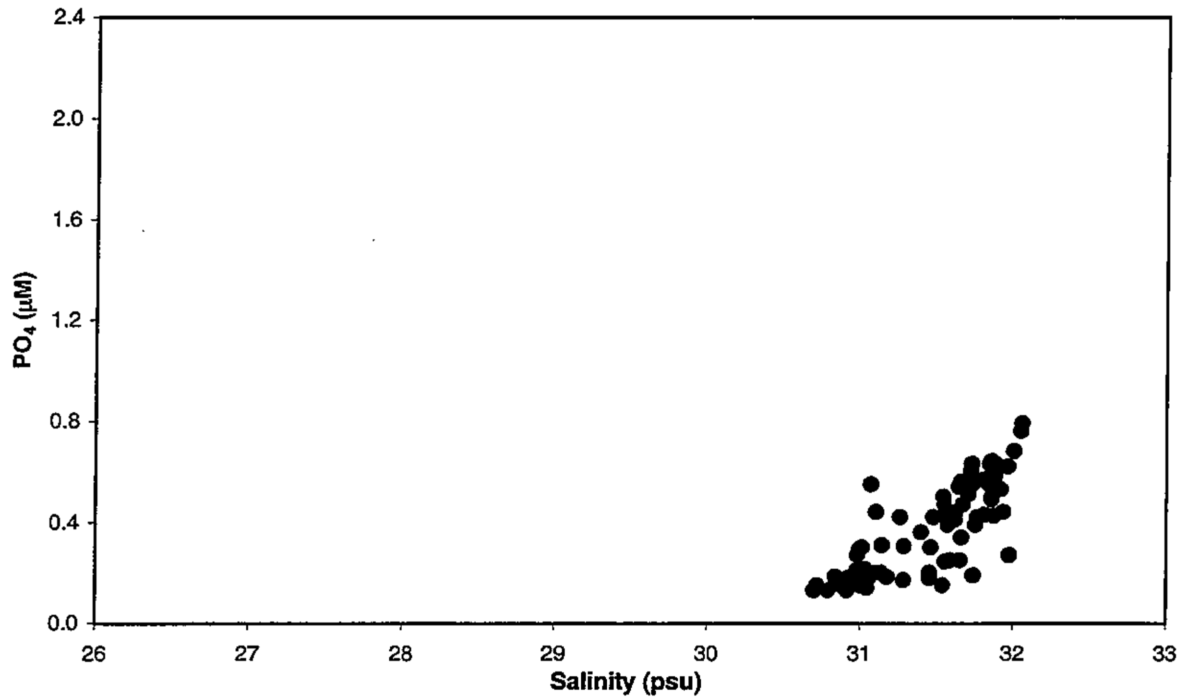


FIGURE 4-119

Nutrient vs. salinity plots for nearfield survey W9708, (Jul 97)

(a)



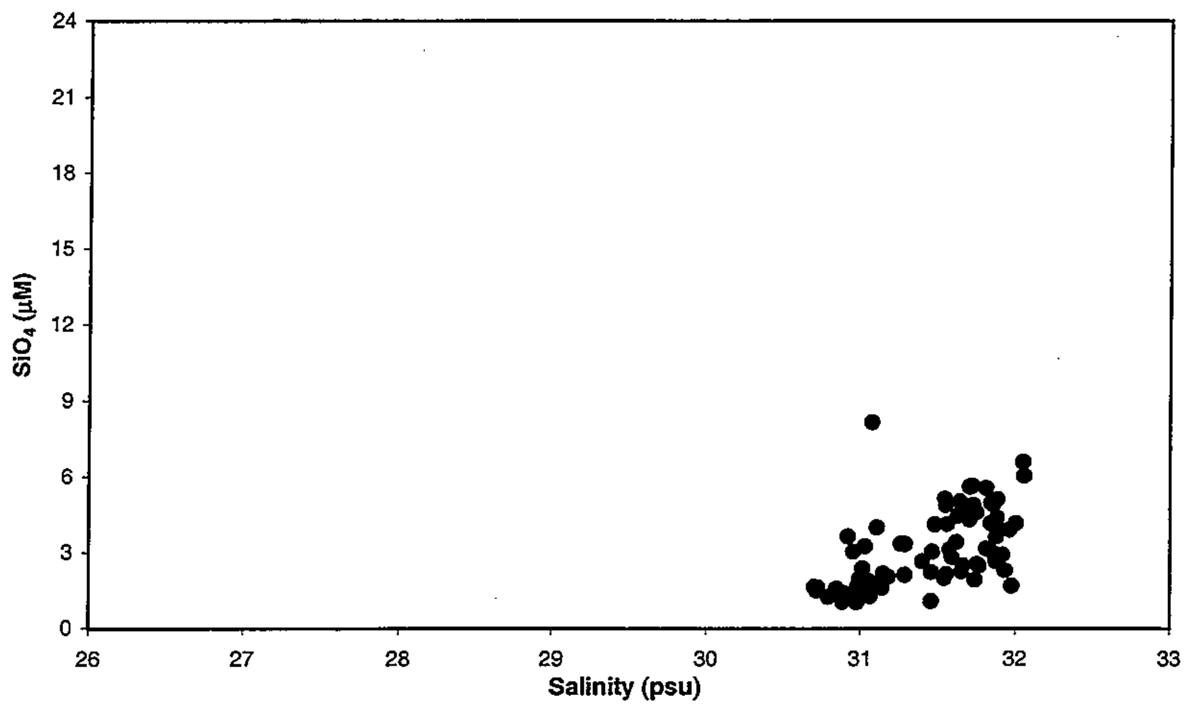


FIGURE 4-120
Nutrient vs. salinity plots for nearfield survey W9708, (Jul 97)

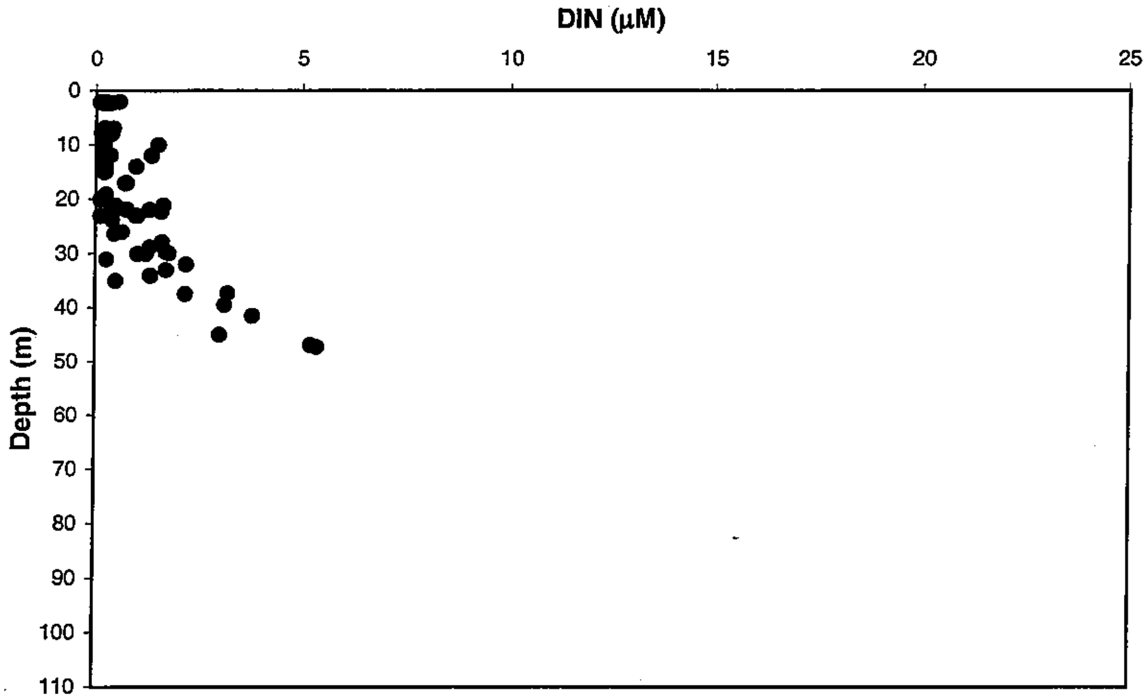


FIGURE 4-121
Depth vs. nutrient plots for nearfield survey W9709, (Jul 97)

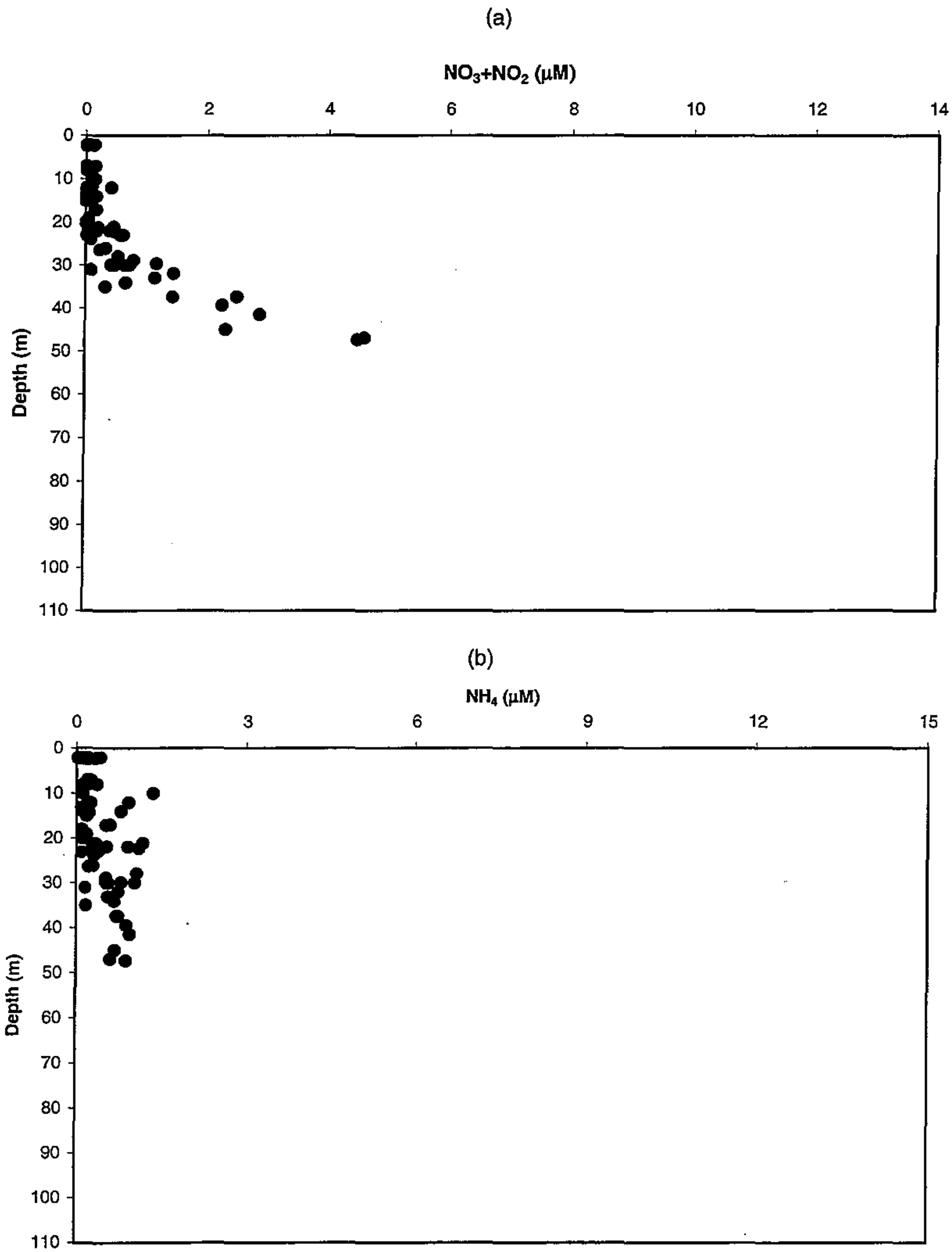
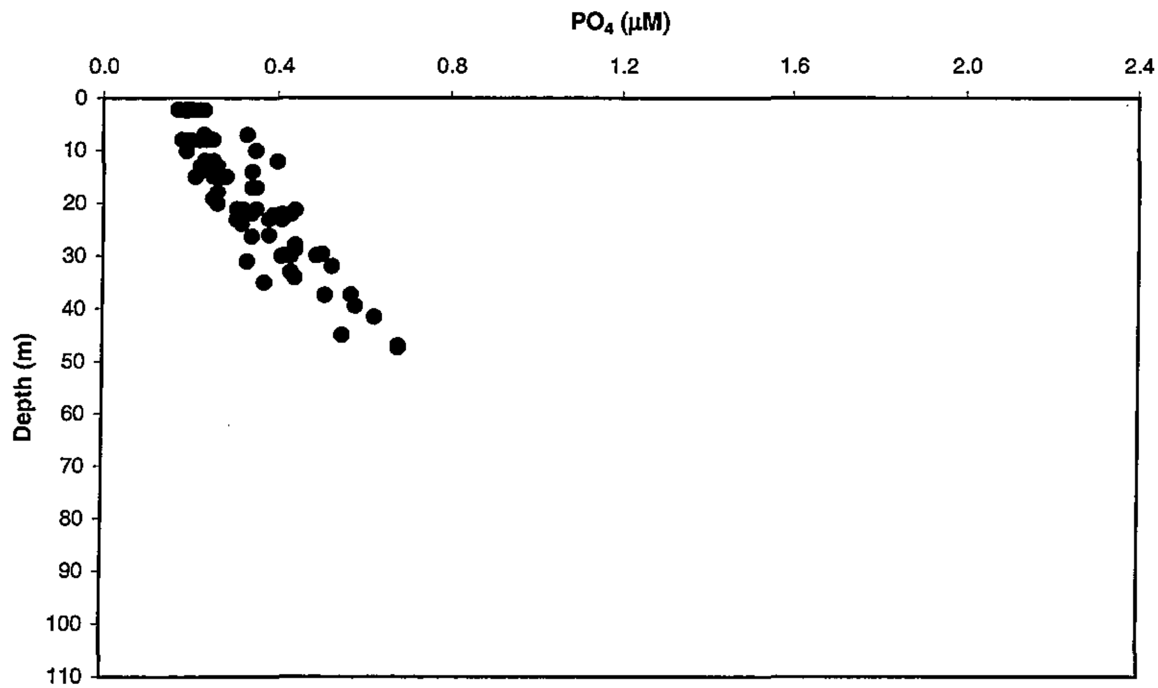


FIGURE 4-122
Depth vs. nutrient plots for nearfield survey W9709, (Jul 97)

(a)



(b)

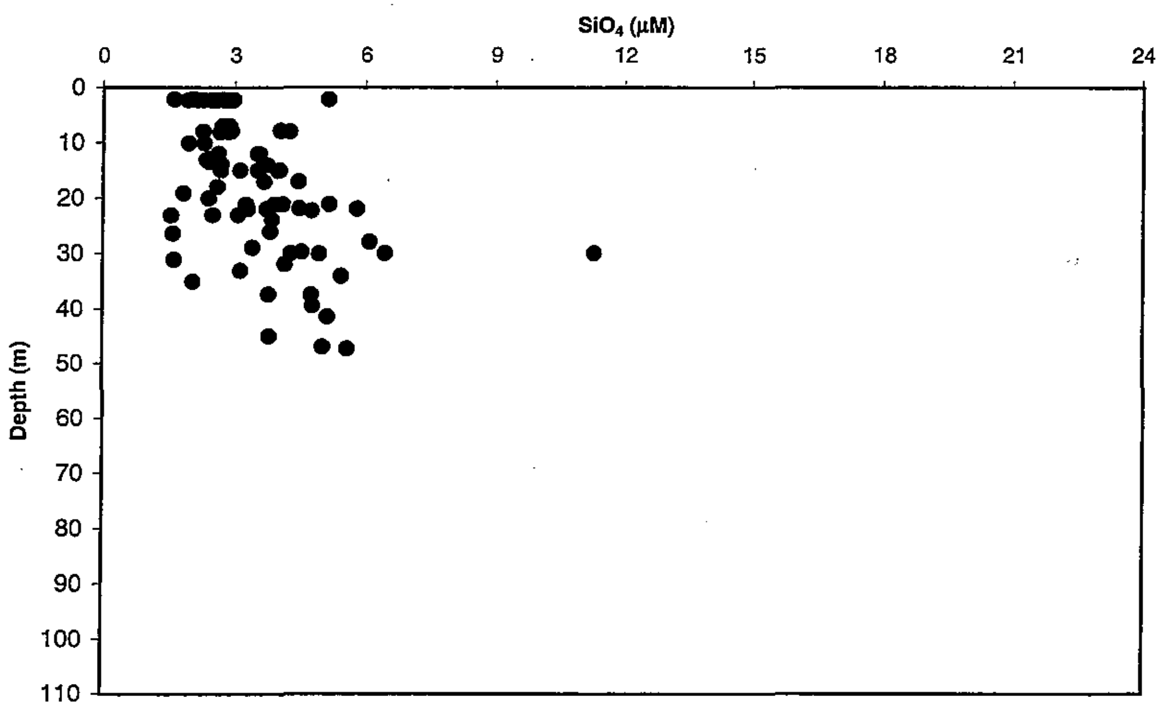
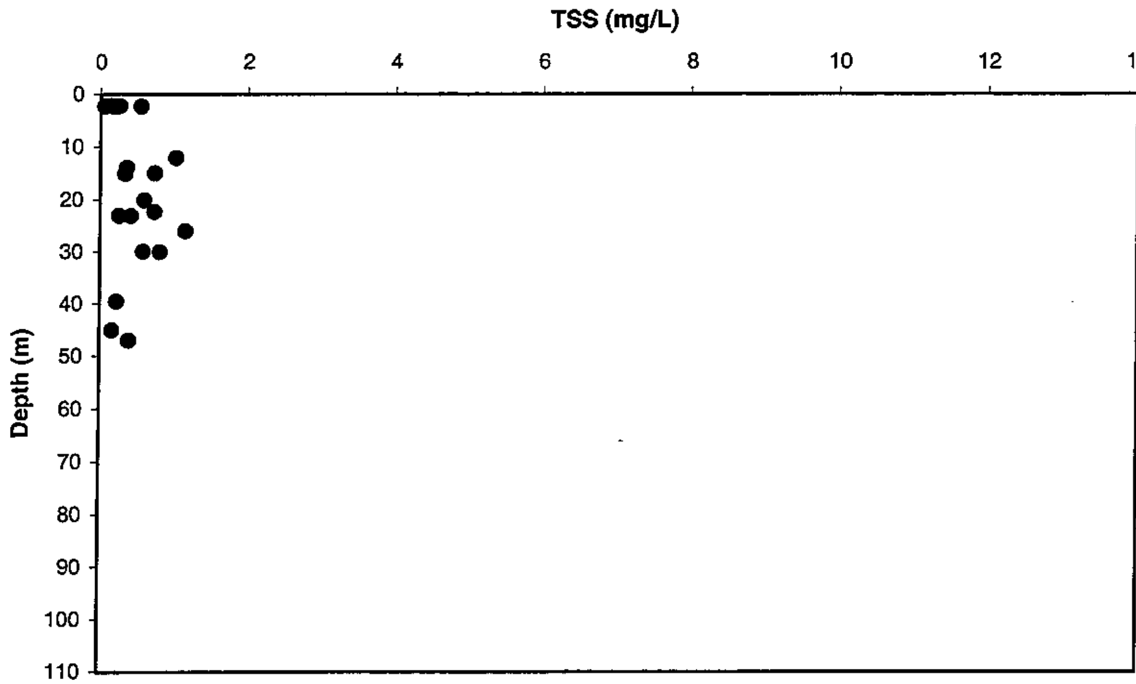


FIGURE 4-123

Depth vs. nutrient plots for nearfield survey W9709, (Jul 97)

(a)



(b)

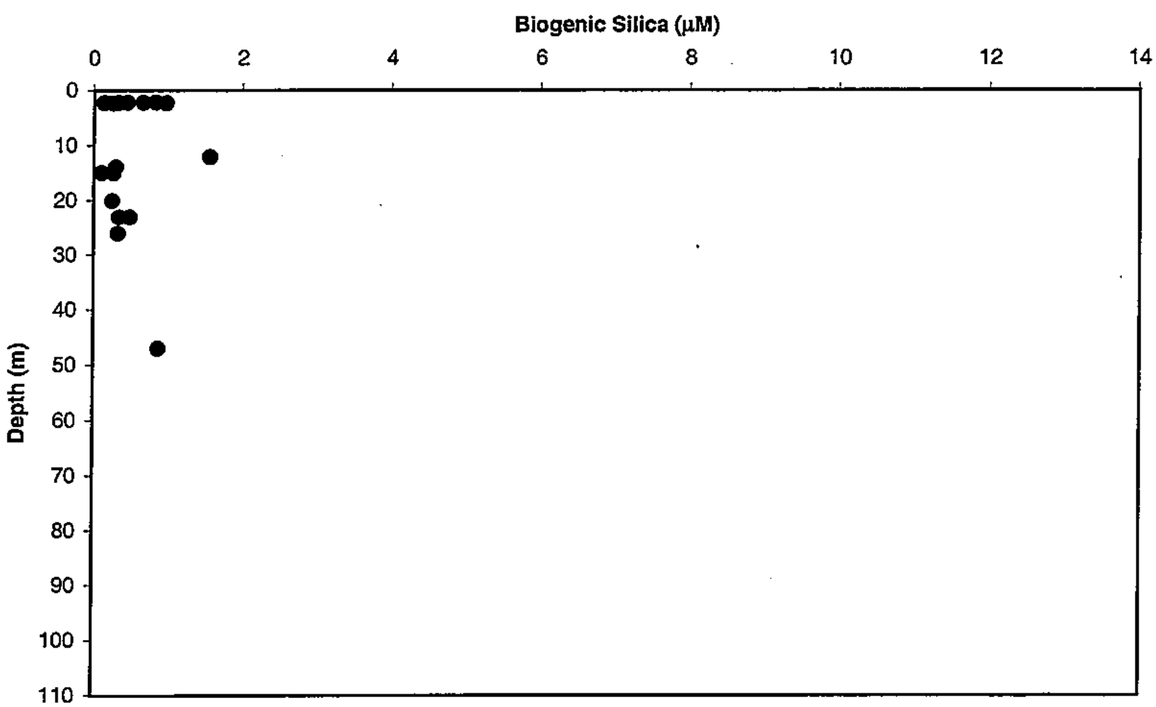


FIGURE 4-124
Depth vs. nutrient plots for nearfield survey W9709, (Jul 97)

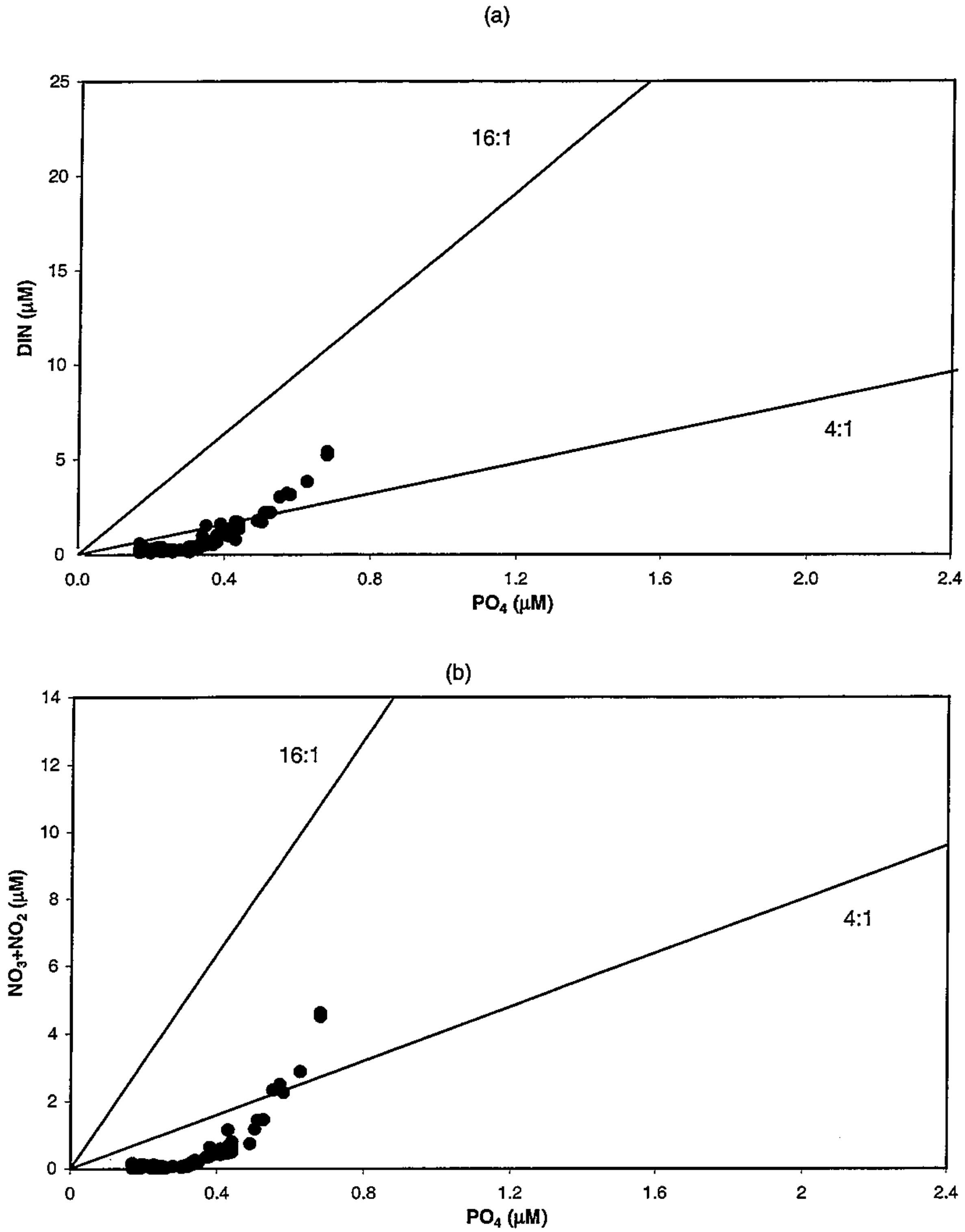


FIGURE 4-125
Nutrient vs. nutrient plots for nearfield survey W9709, (Jul 97)

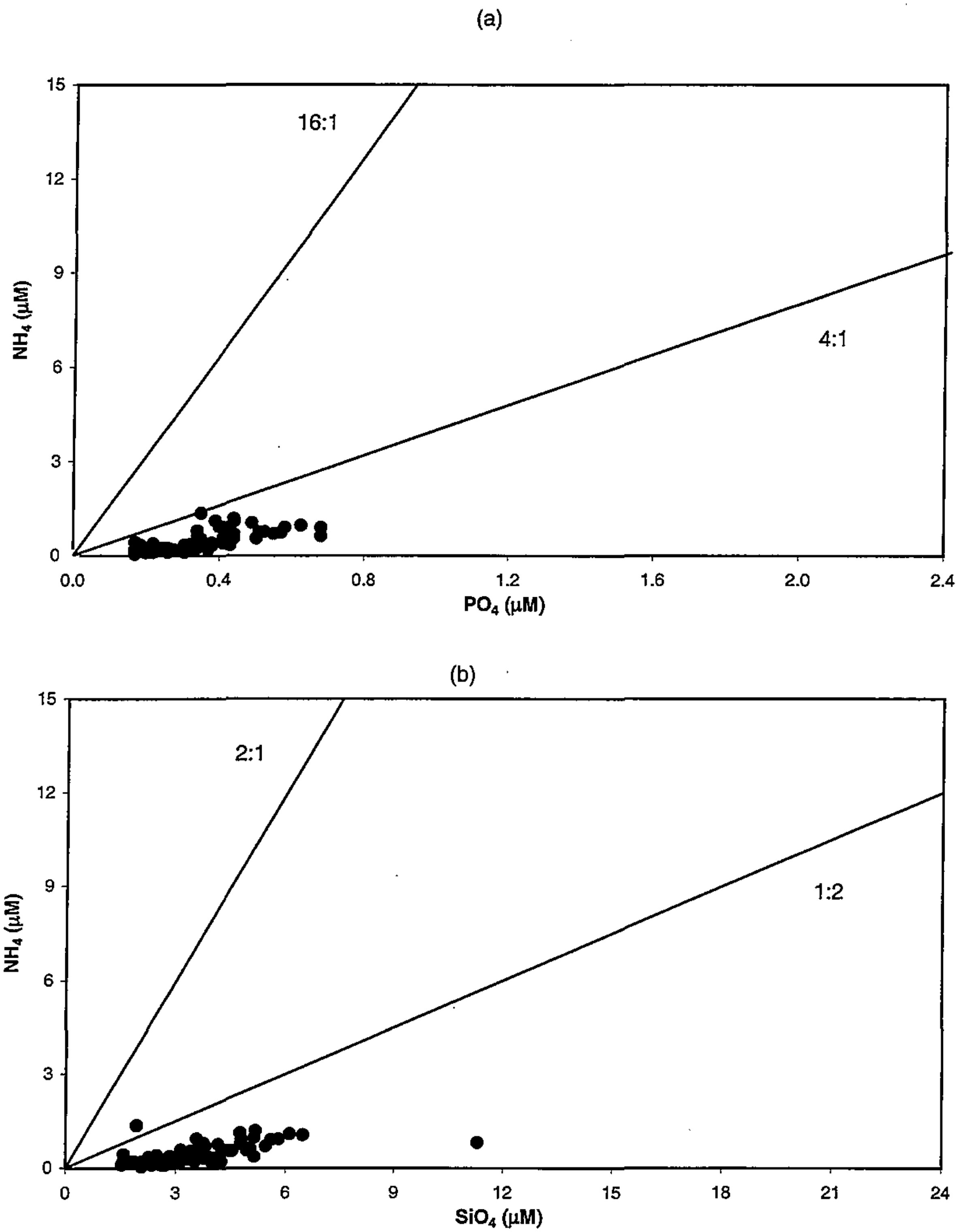
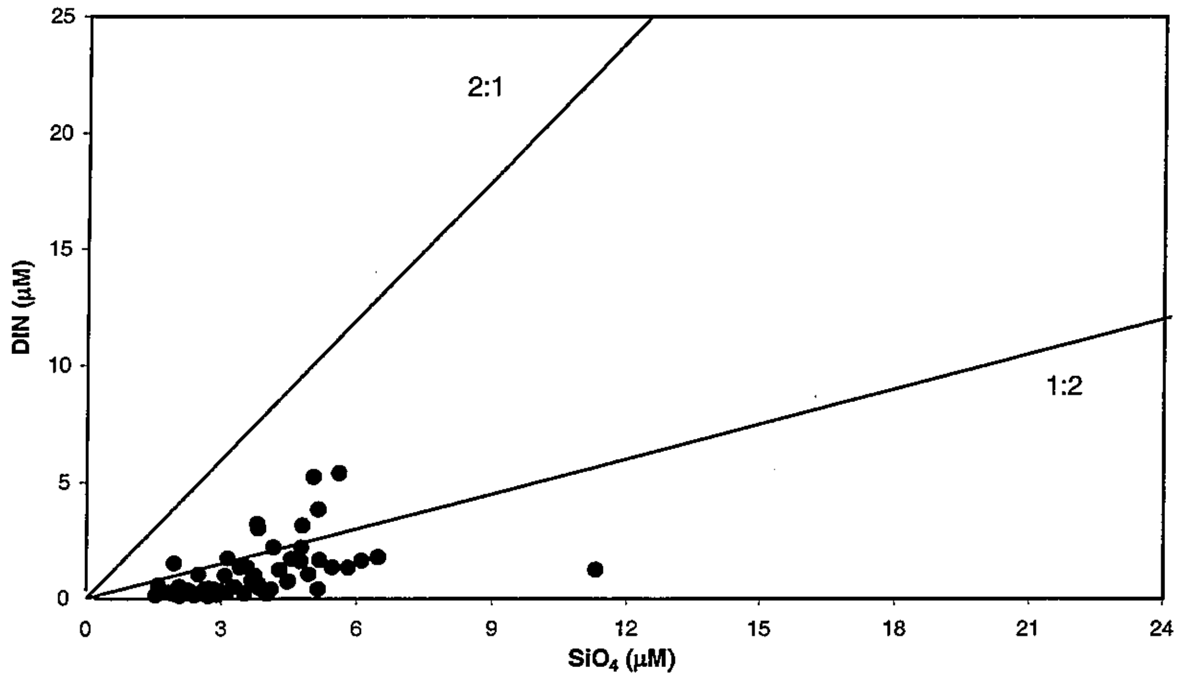


FIGURE 4-126
Nutrient vs. nutrient plots for nearfield survey W9709, (Jul 97)

(a)



(b)

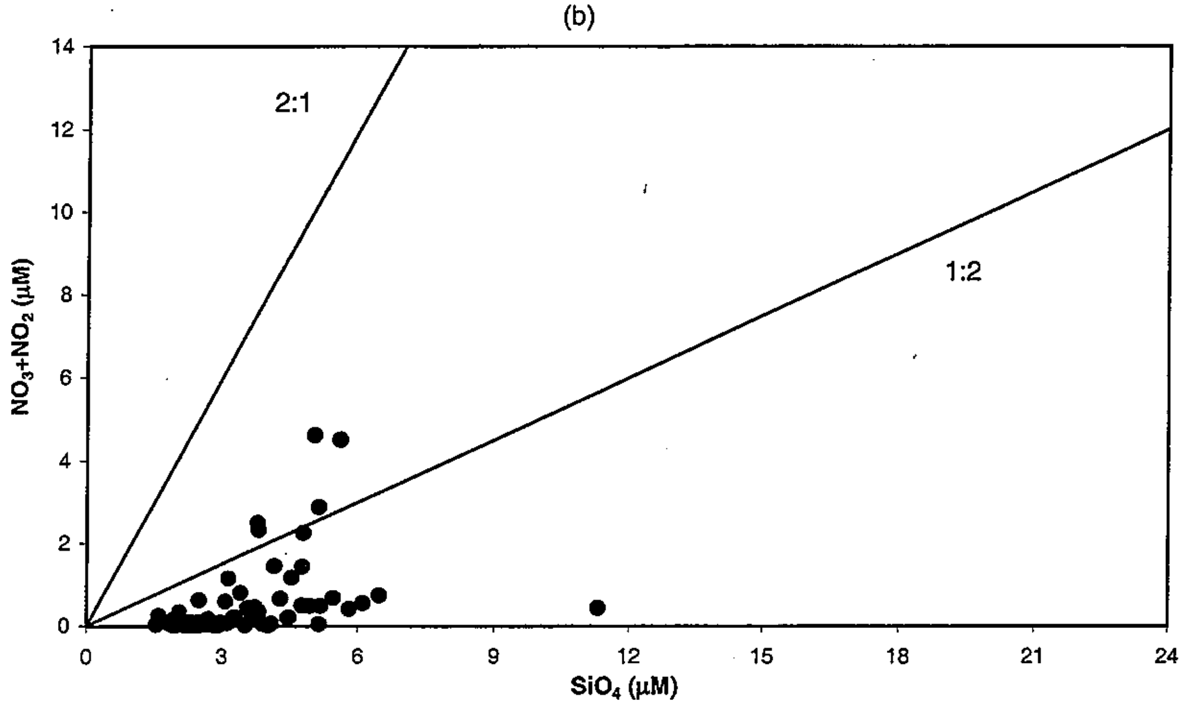


FIGURE 4-127

Nutrient vs. nutrient plots for nearfield survey W9709, (Jul 97)

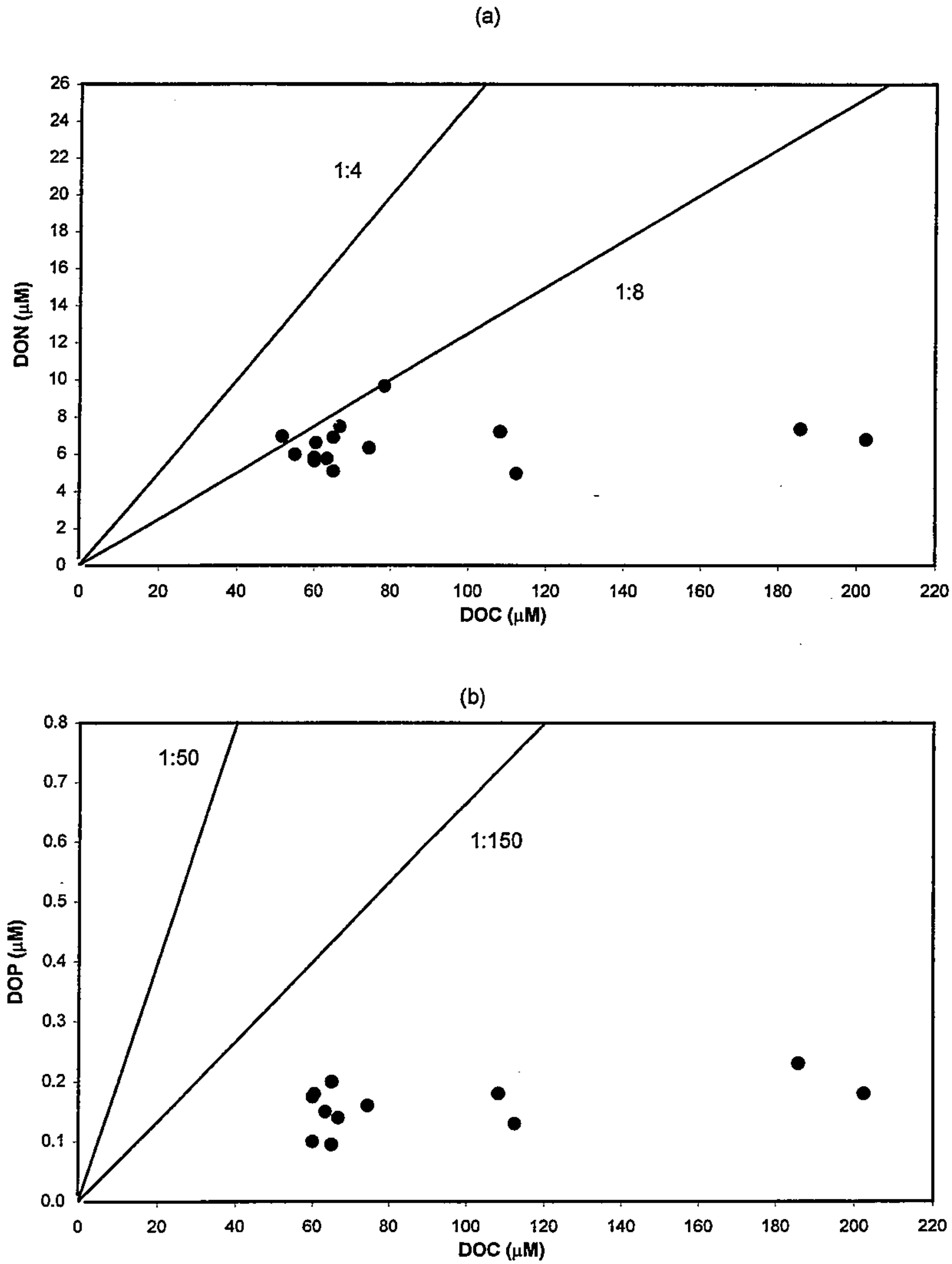


FIGURE 4-128

Nutrient vs. nutrient plots for nearfield survey W9709, (Jul 97)

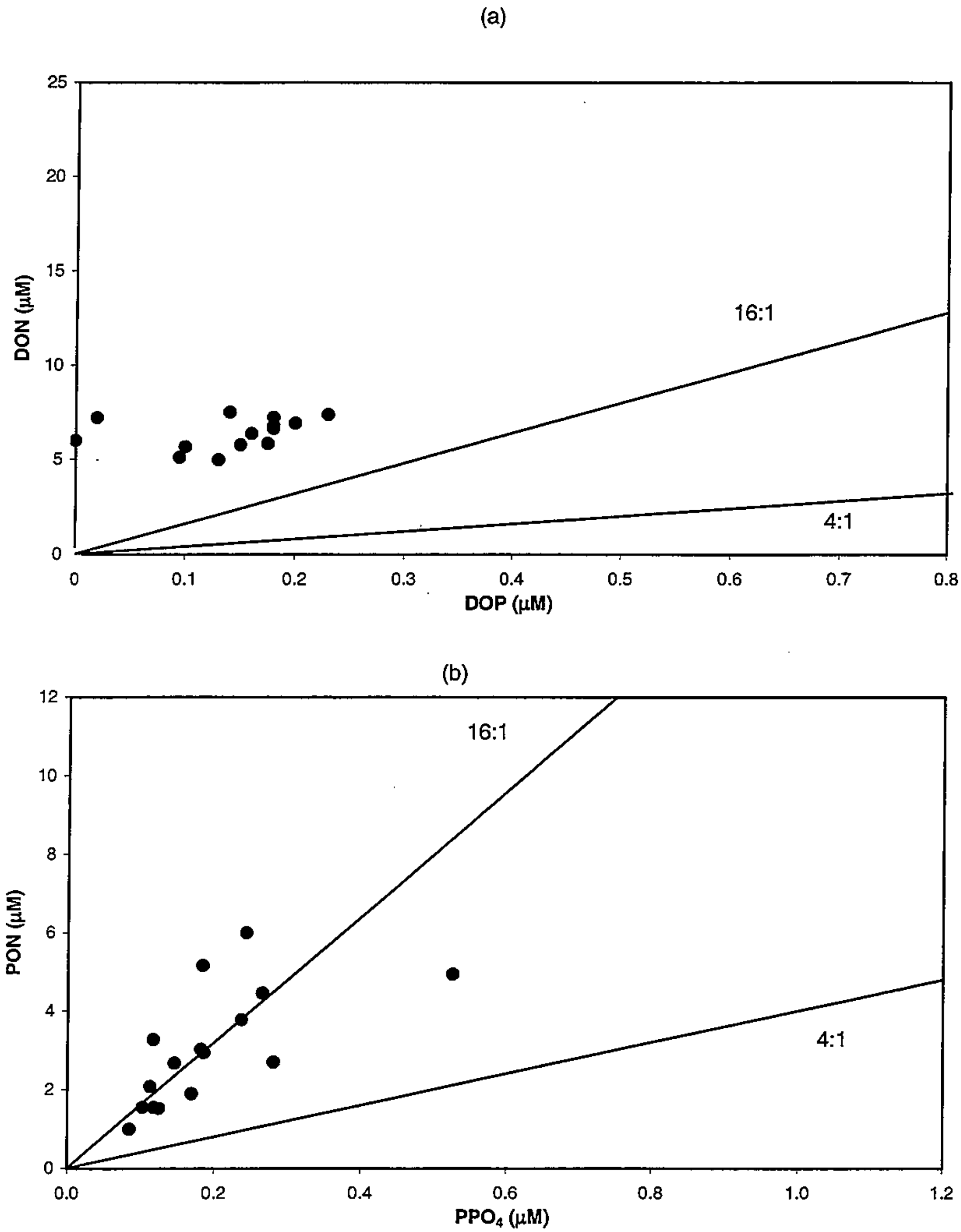
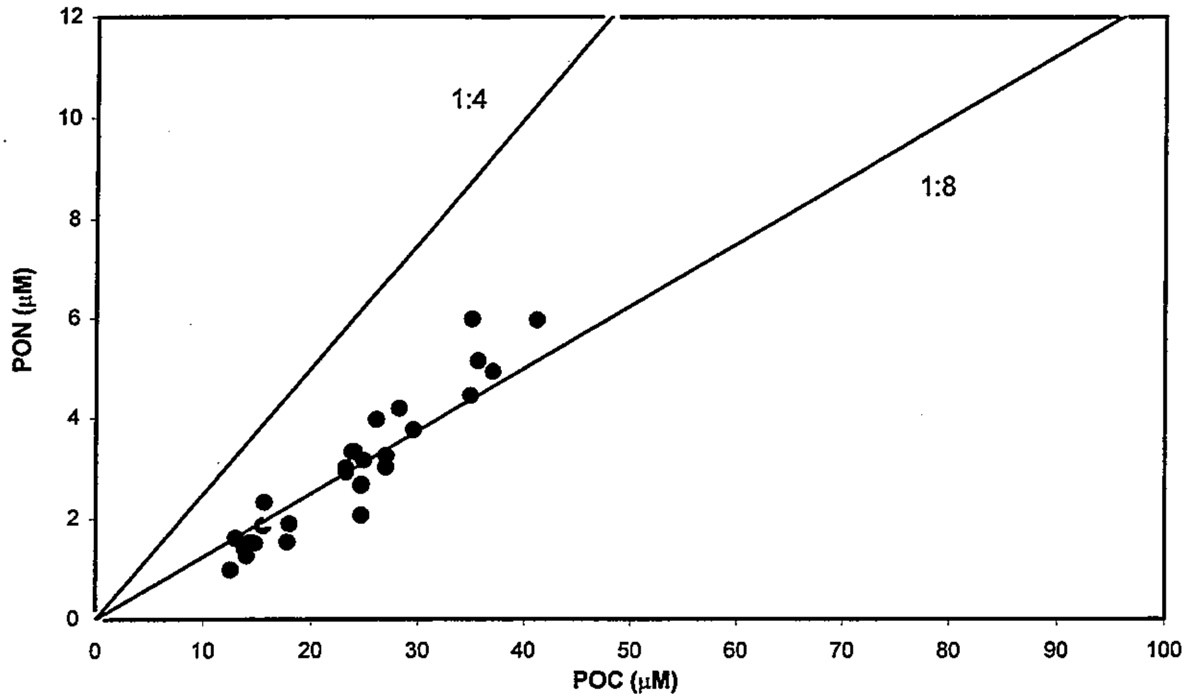


FIGURE 4-129
Nutrient vs. nutrient plots for nearfield survey W9709, (Jul 97)

(a)



(b)

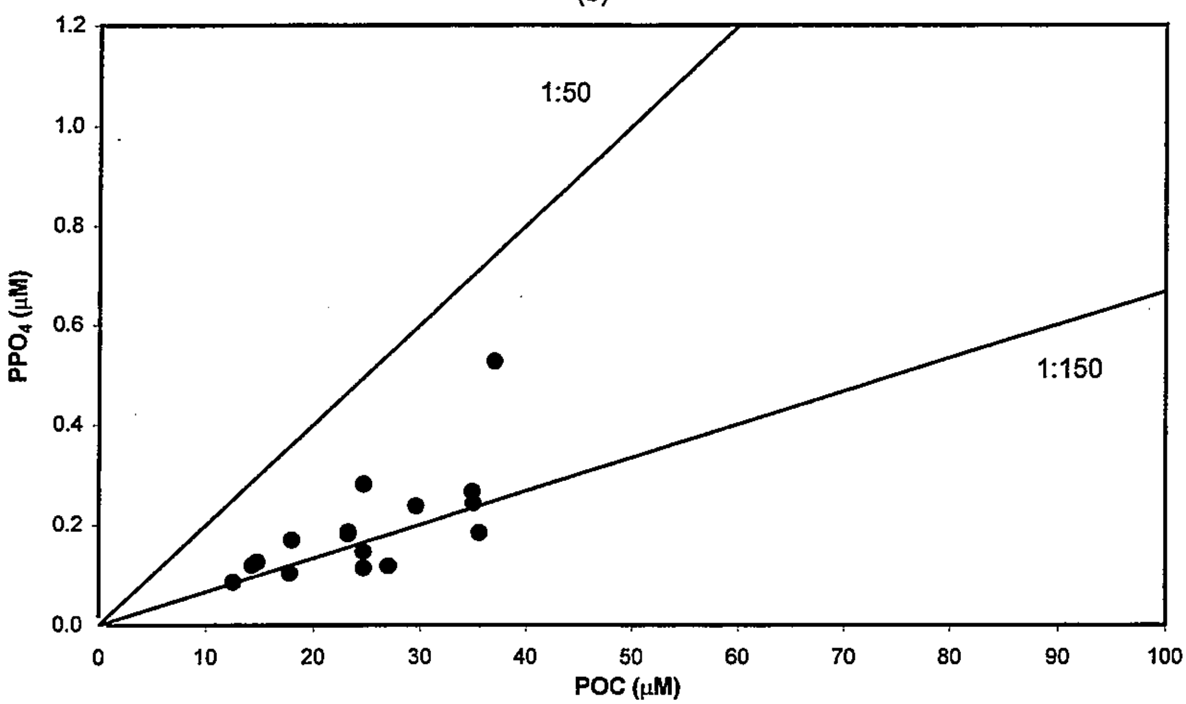
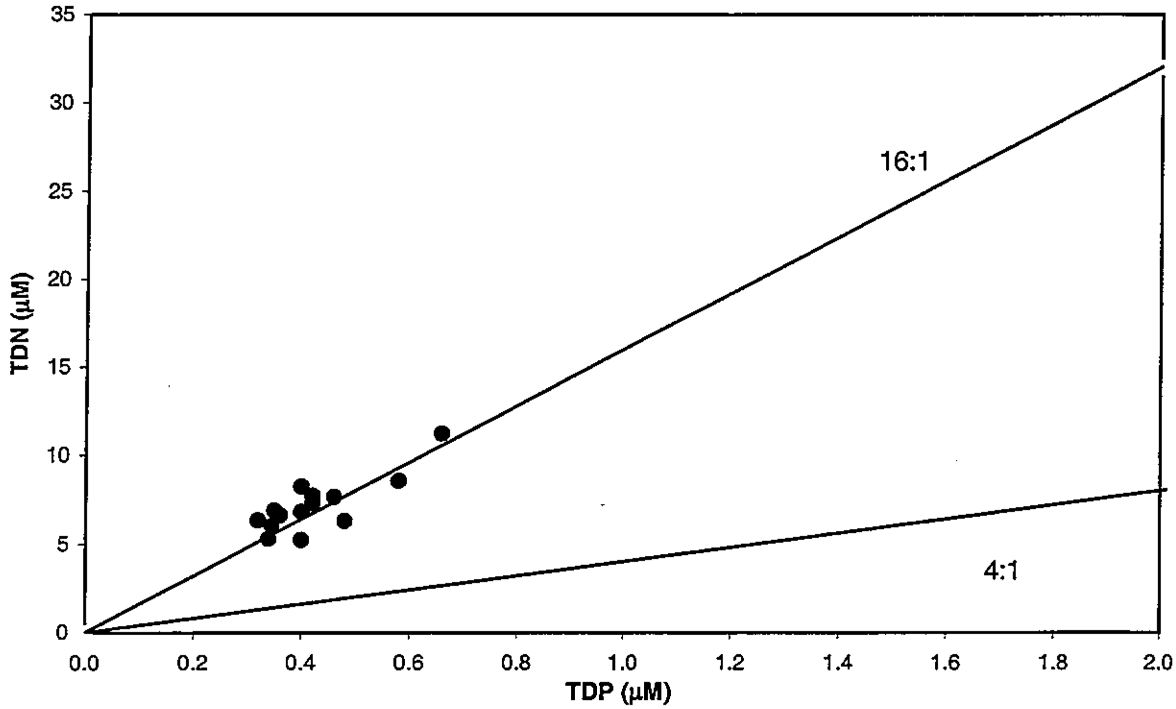


FIGURE 4-130

Nutrient vs. nutrient plots for nearfield survey W9709, (Jul 97)

(a)



(b)

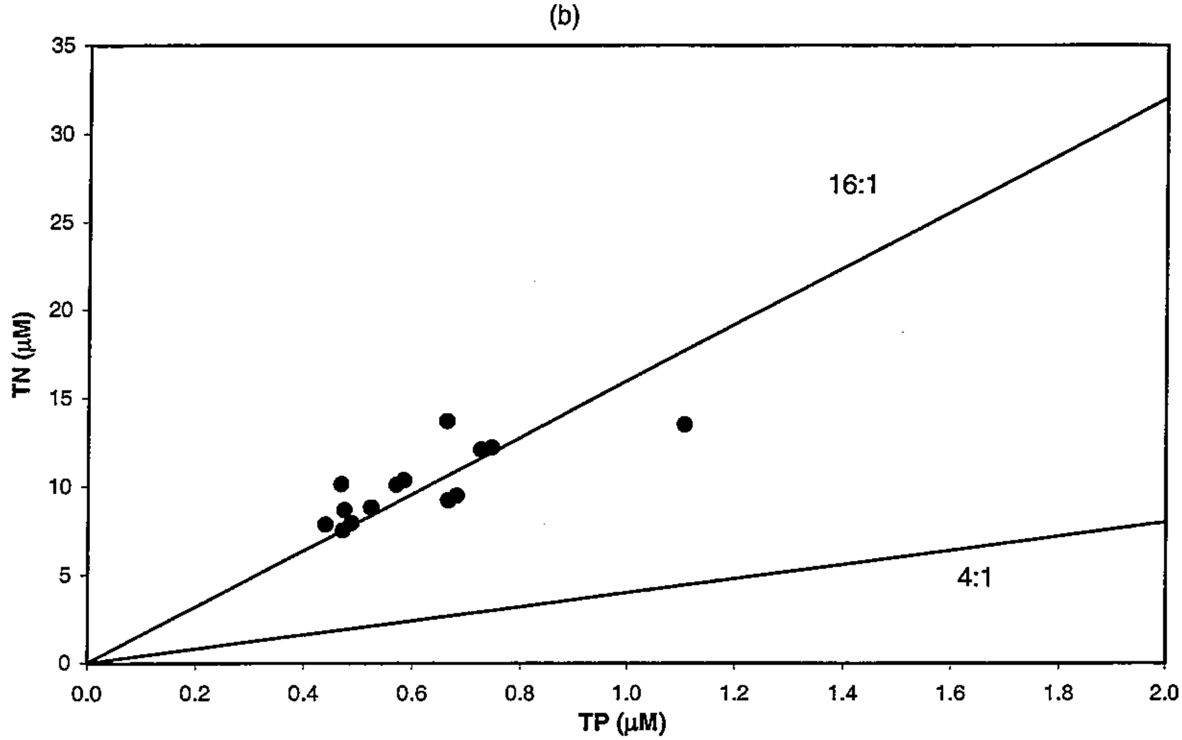
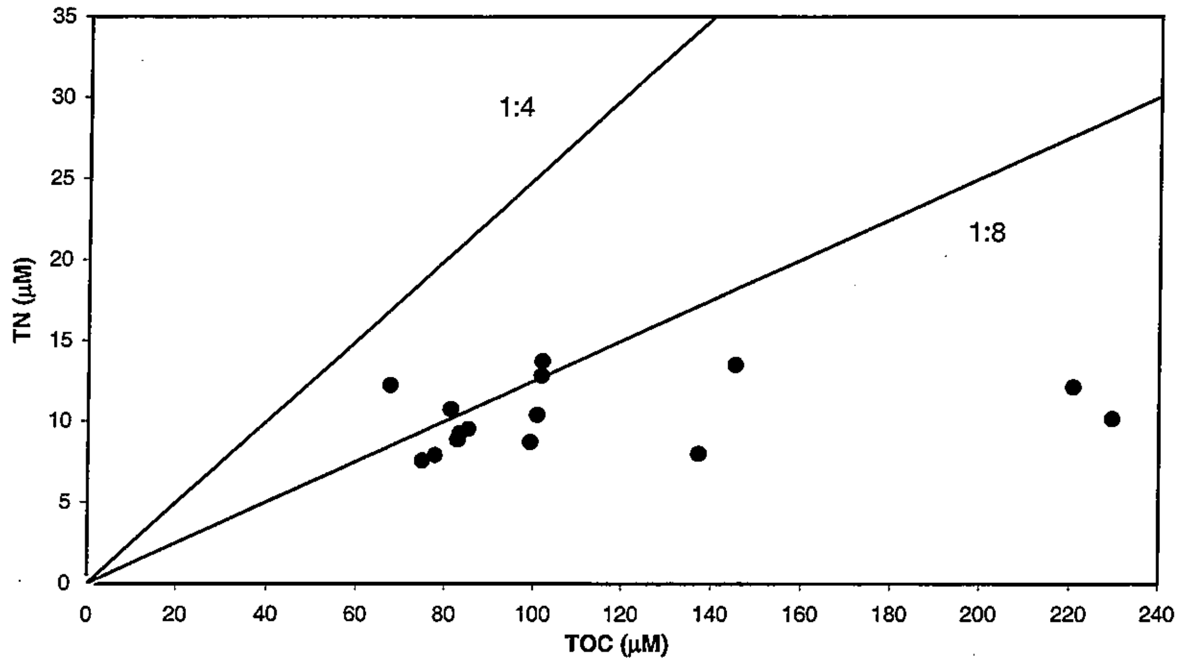


FIGURE 4-131

Nutrient vs. nutrient plots for nearfield survey W9709, (Jul 97)

(a)



(b)

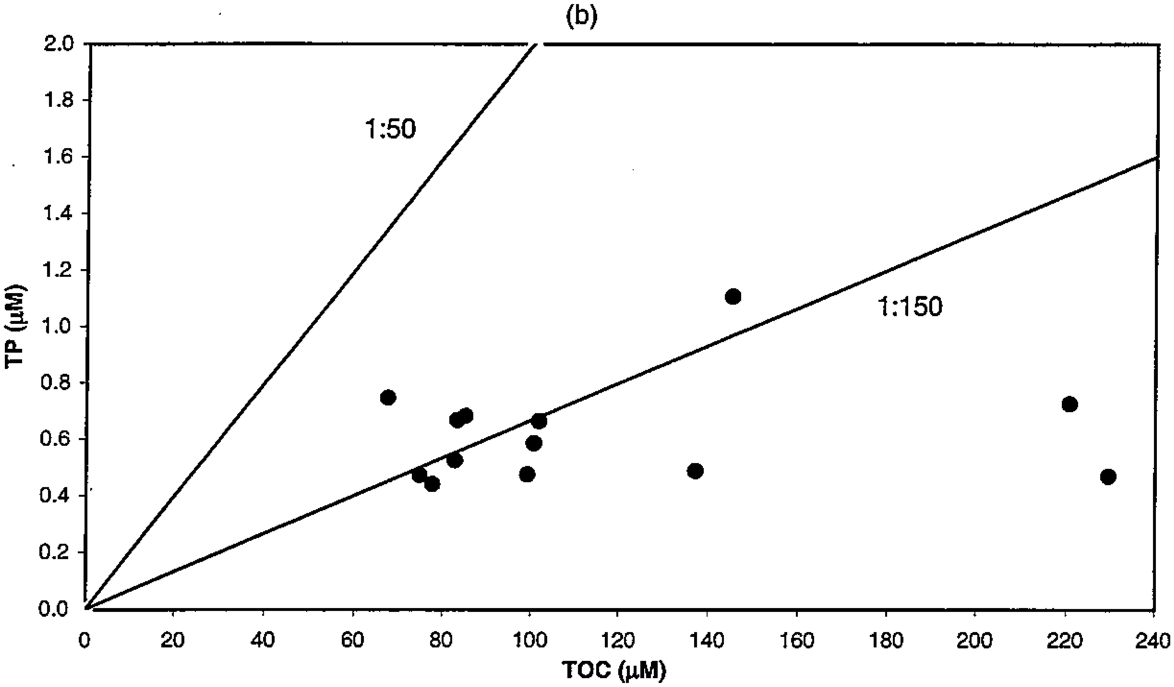


FIGURE 4-132
Depth vs. nutrient plots for nearfield survey W9709, (Jul 97)

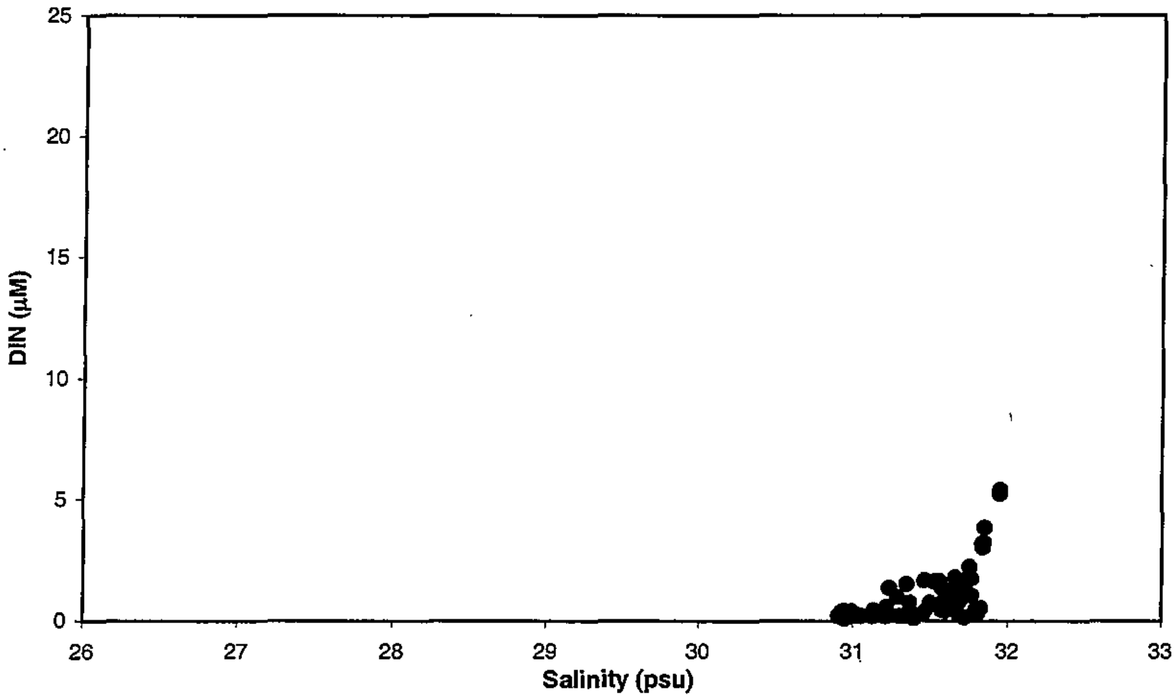


FIGURE 4-133
Nutrient vs. salinity plots for nearfield survey W9709, (Jul 97)

(a)

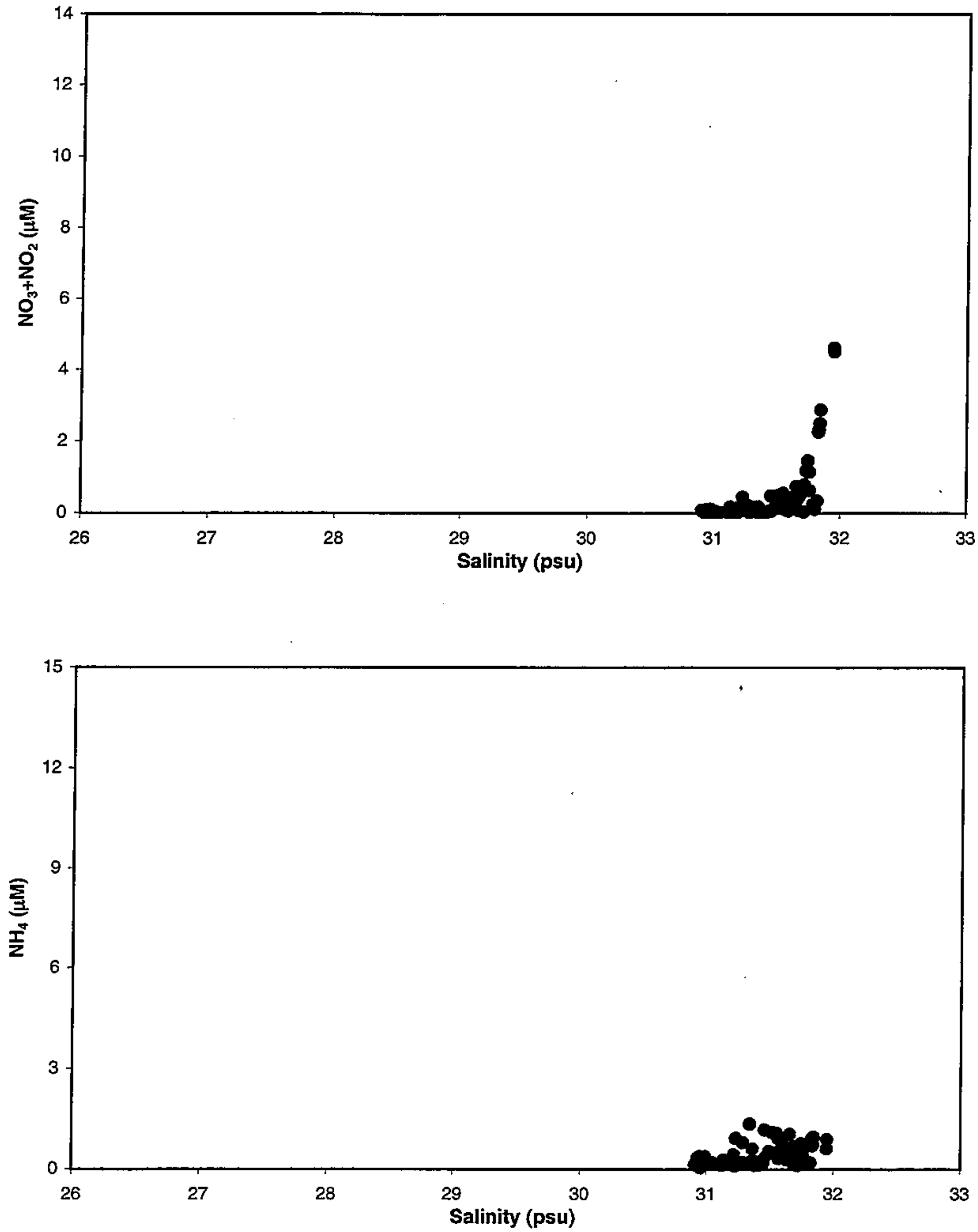


FIGURE 4-134
Nutrient vs. salinity plots for nearfield survey W9709, (Jul 97)

(a)

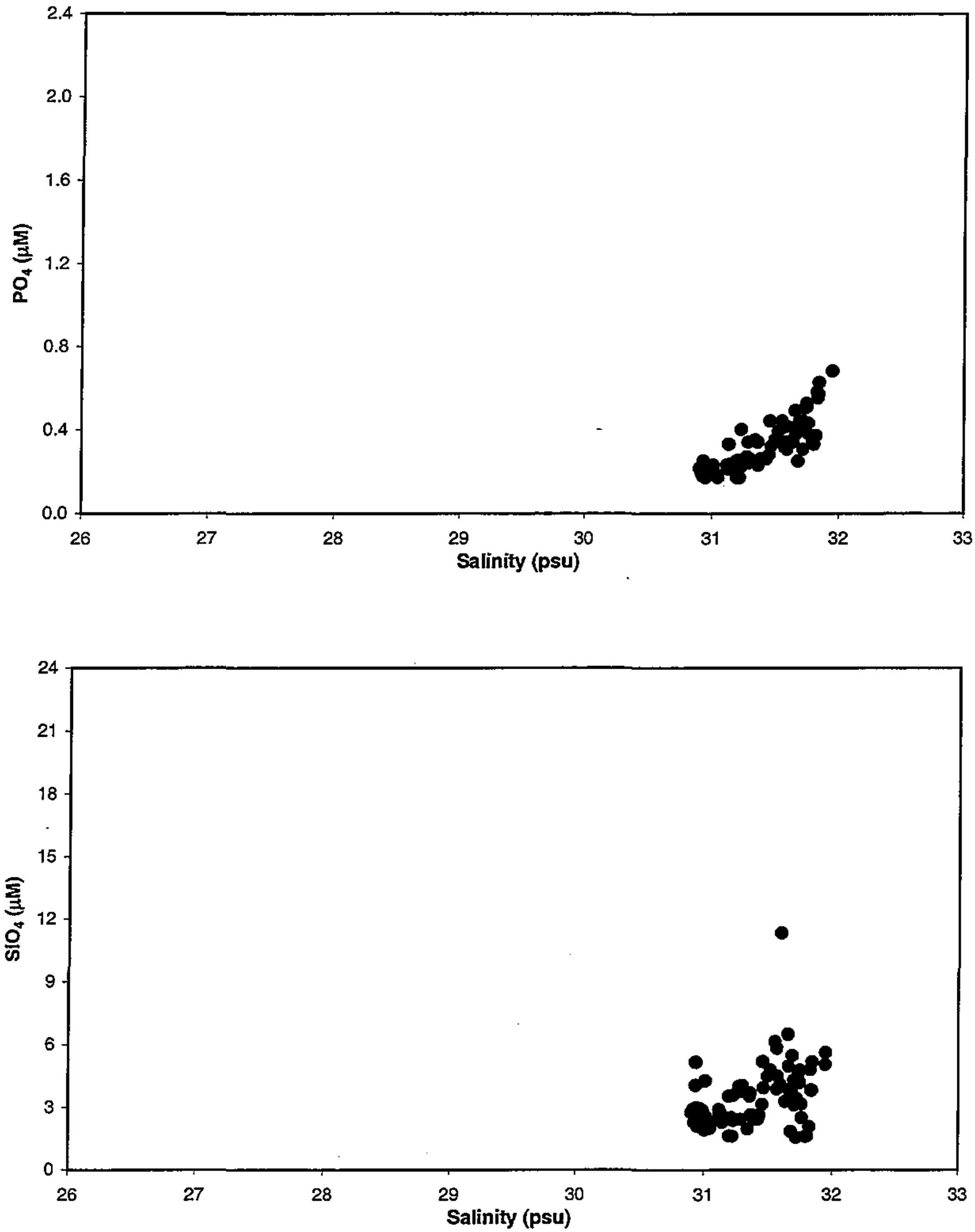


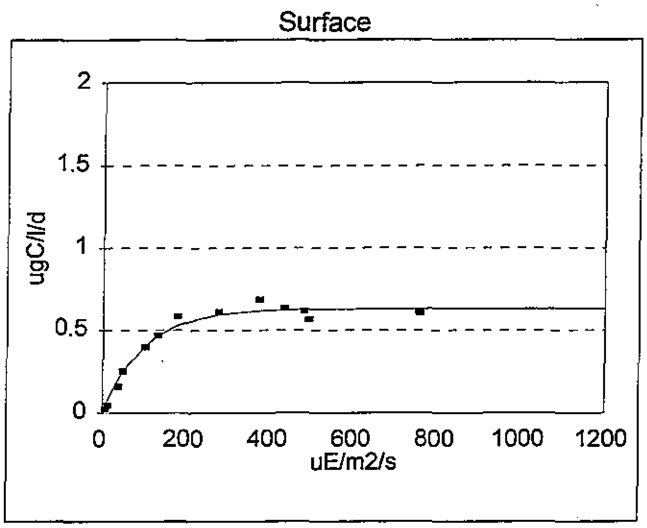
FIGURE 4-135
Nutrient vs. salinity plots for nearfield survey W9709, (Jul 97)

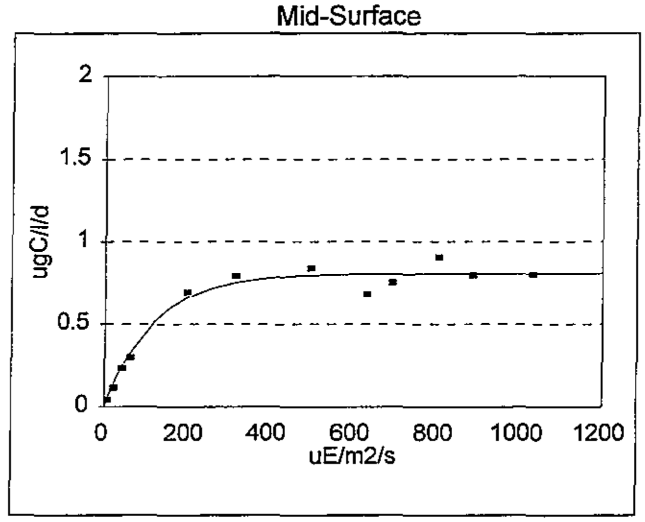
APPENDIX D

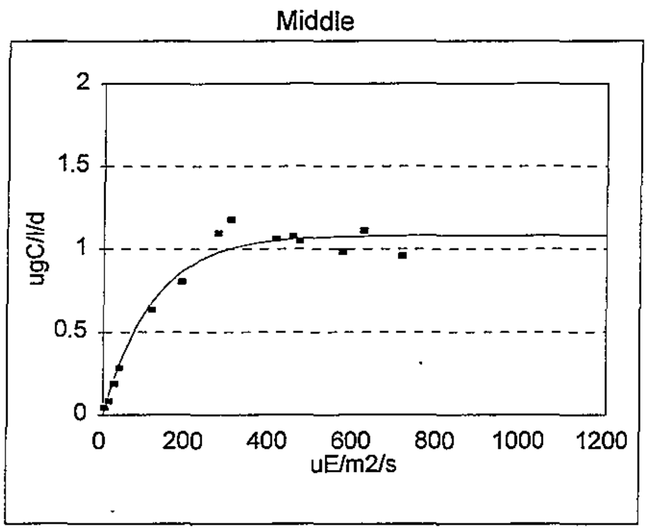
Photosynthesis-Irradiance (P-I) Curves

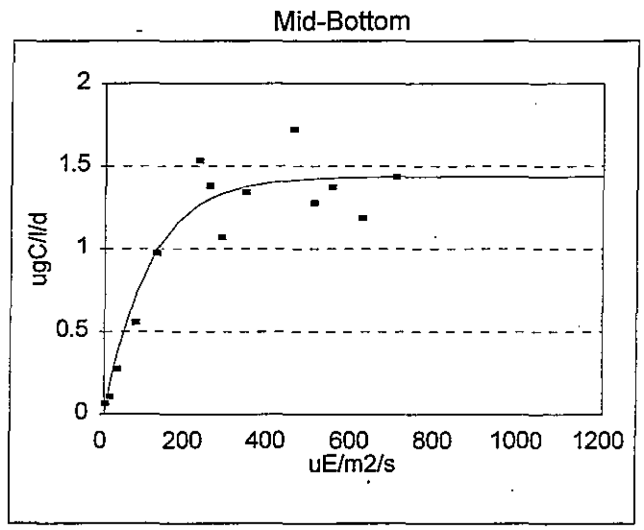
Productivity calculations utilized light attenuation data from a CTD-mounted 4π sensor and incident light time-series data from an on-deck 2π irradiance sensor (Combined Work/Quality Assurance Project Plan for Water Quality Monitoring, ENSR, 1996). After collection of the productivity samples, they were incubated in a temperature-controlled incubator. The resulting photosynthesis ($mgC/m^3/h$) versus light irradiance ($\mu E/m^2/s$, P-I) curves are comprehensively presented in this appendix. These data were used to determine hourly production at intervals throughout the day for each sampling depth.

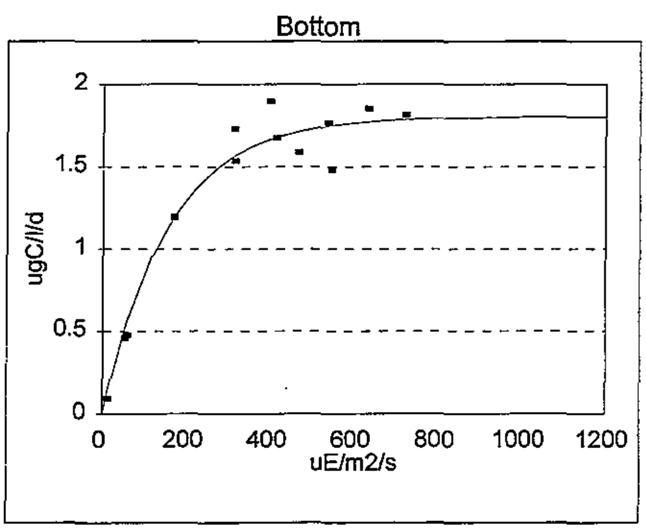
W9701 **Station F23**





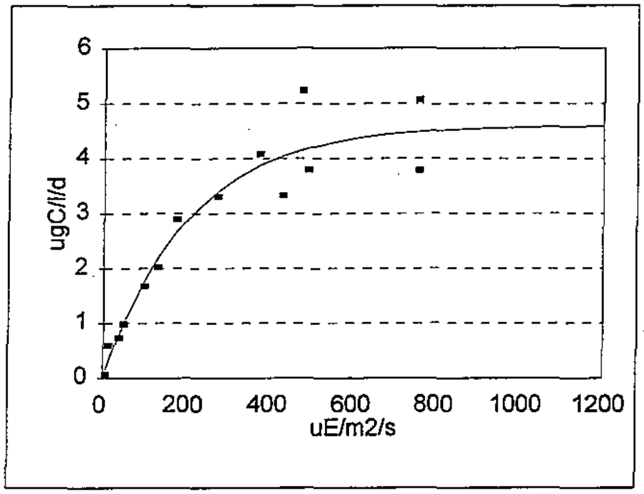






W9701 **Station N04**

Surface



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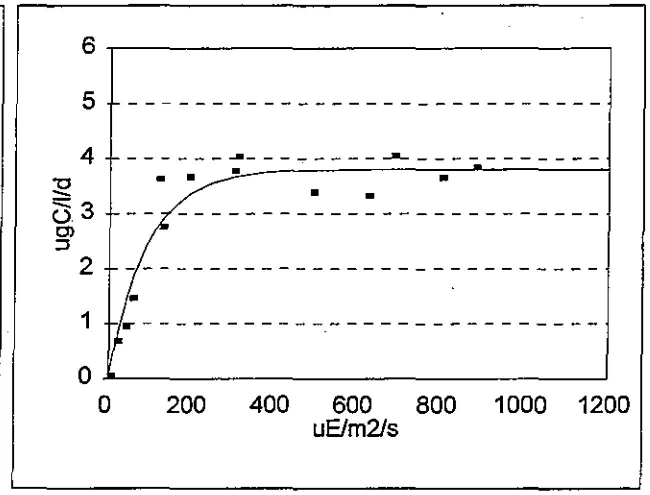

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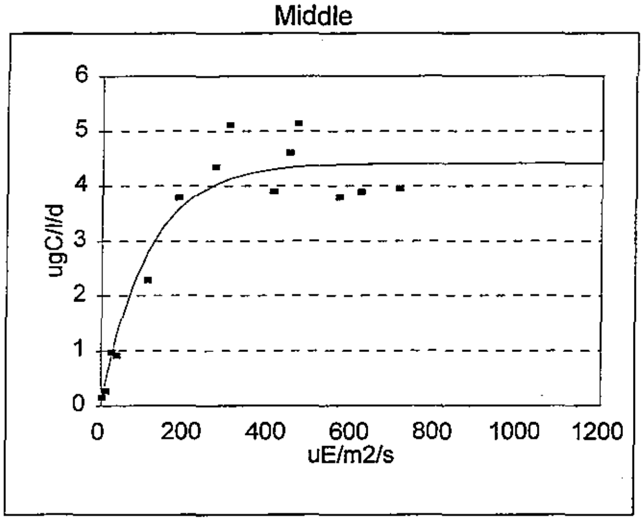
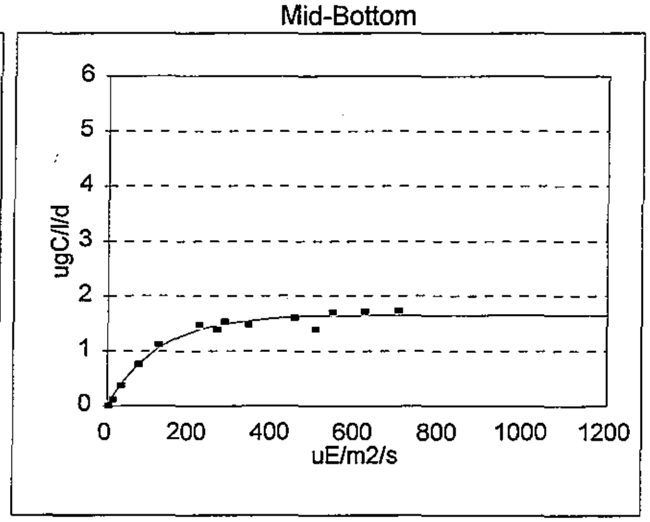


Mid-Bottom



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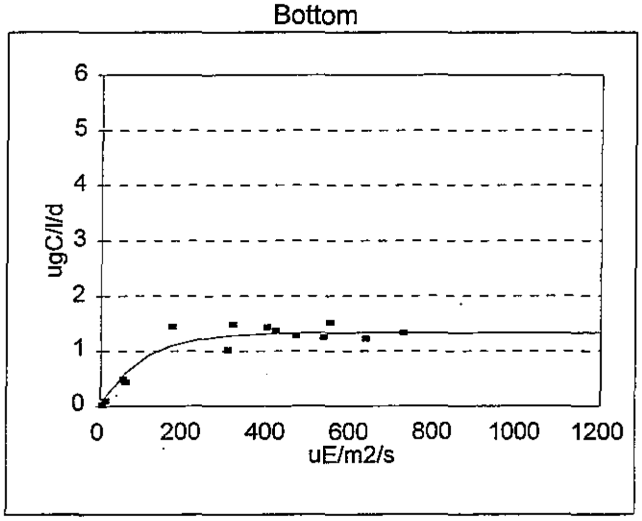
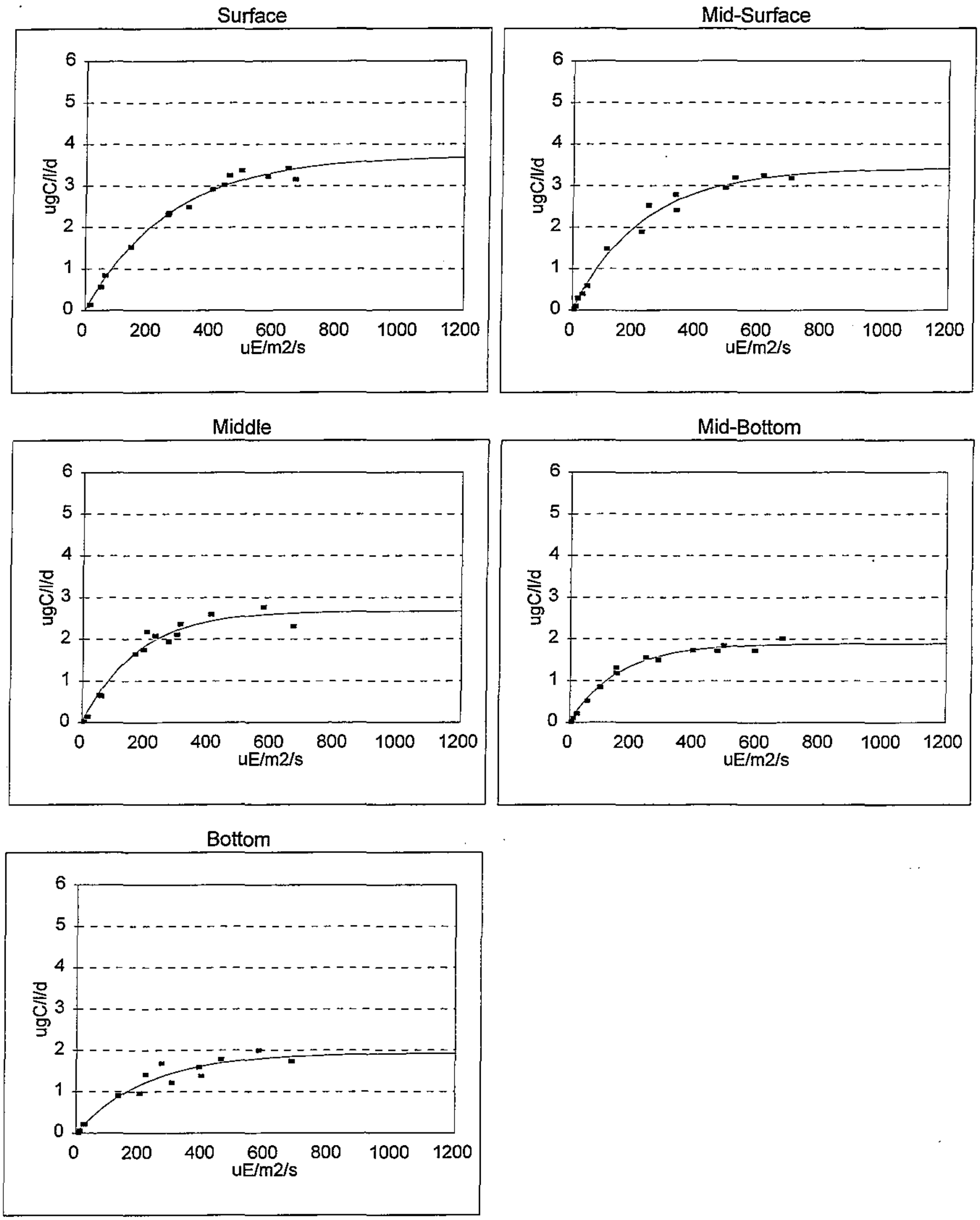
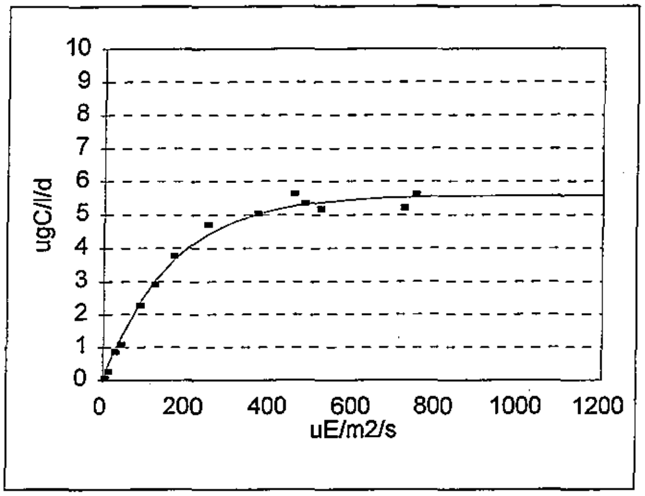


W9701 Station N18



W9702 Station F23

Surface



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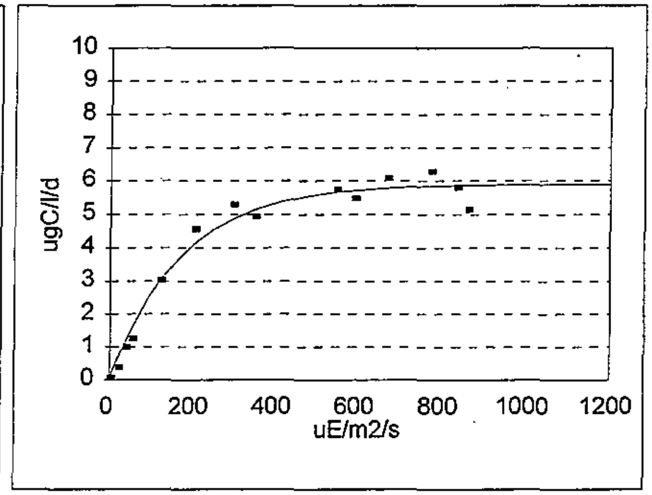

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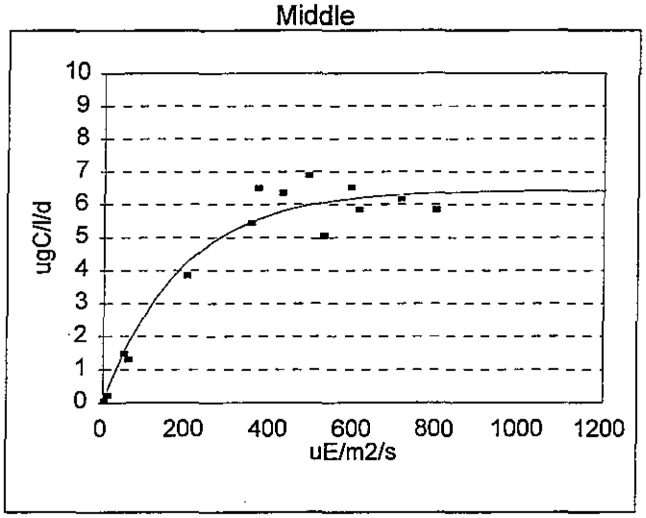

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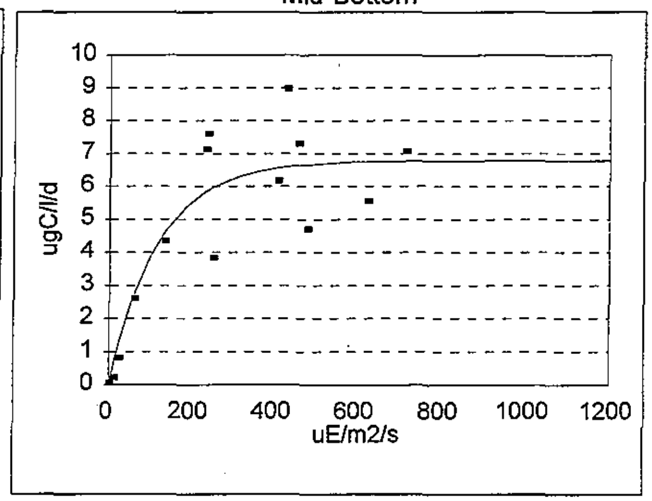

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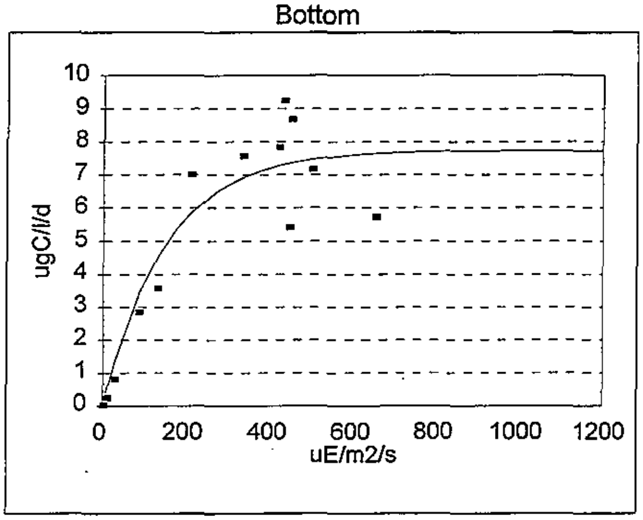

W9702 Station N04

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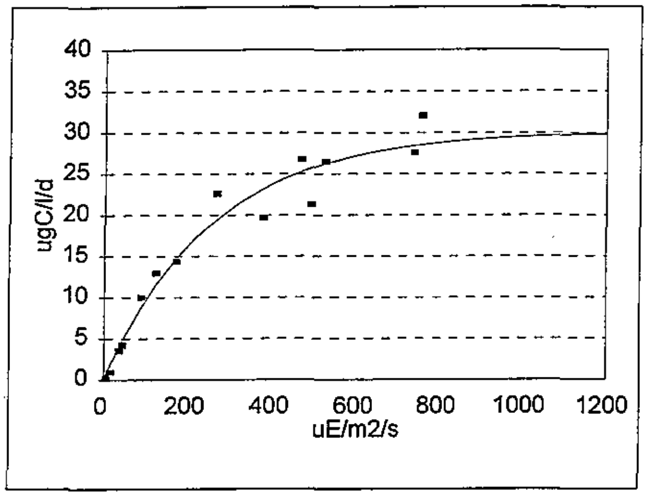

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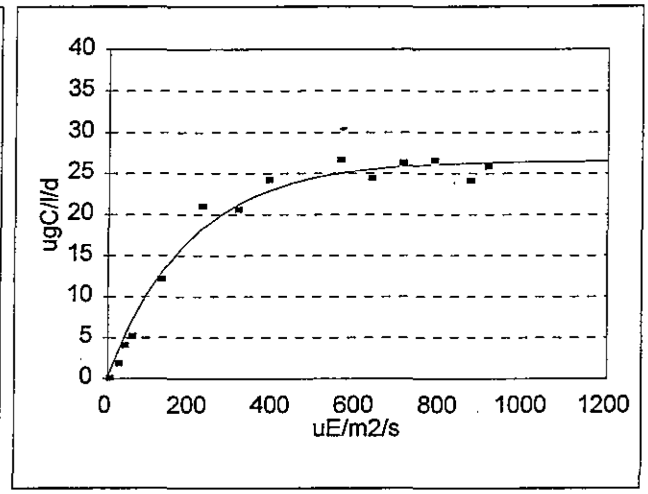

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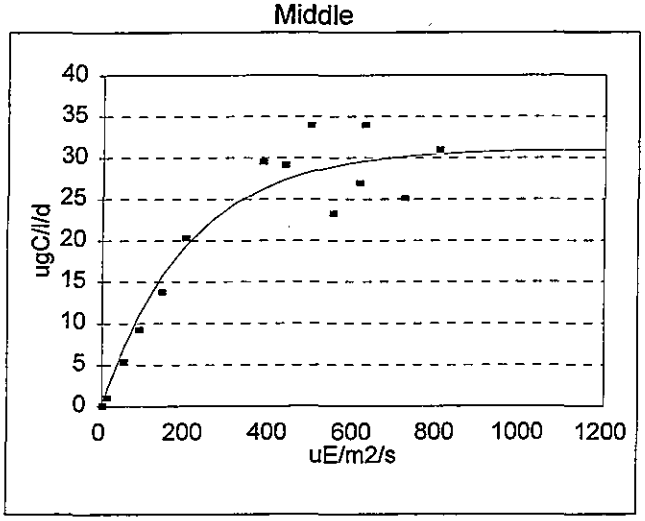

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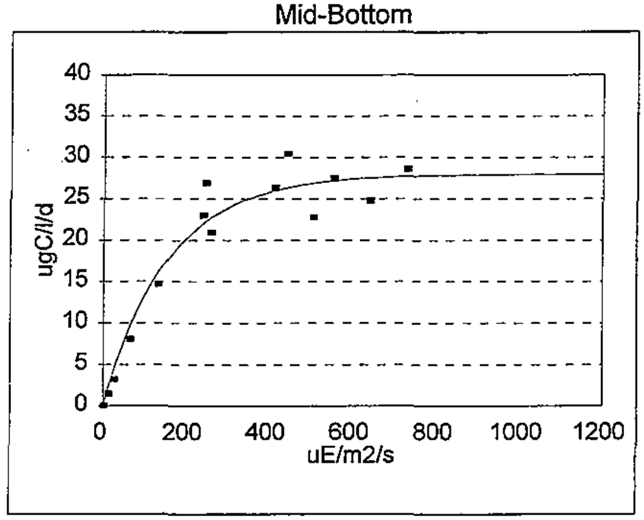

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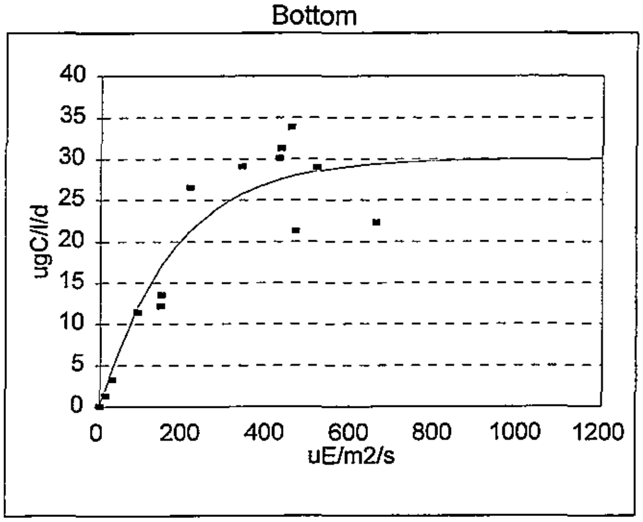
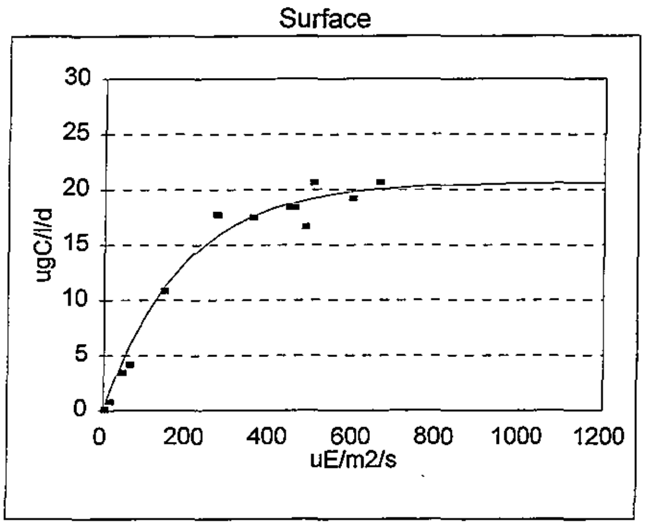
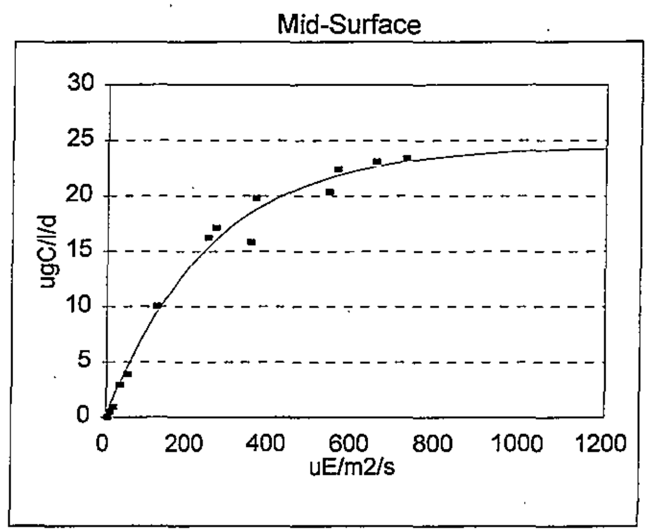
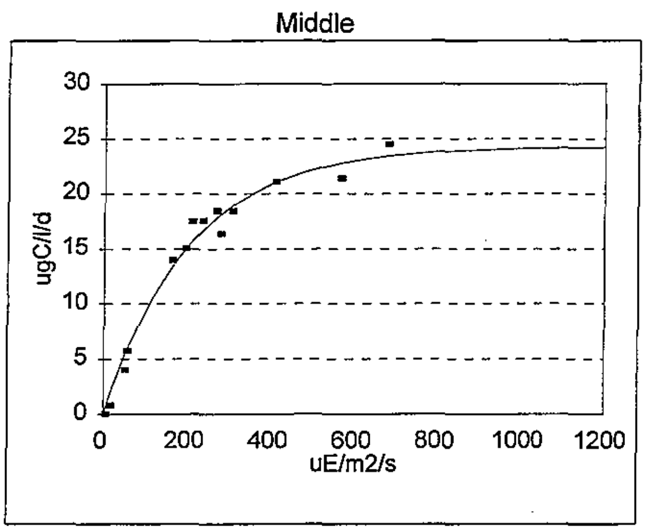
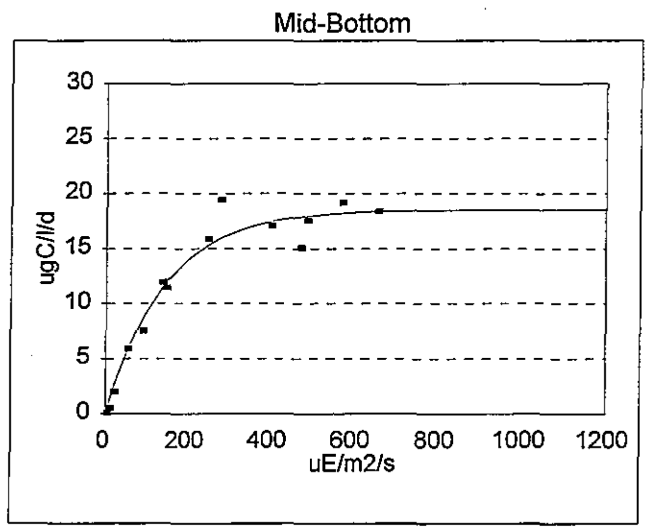


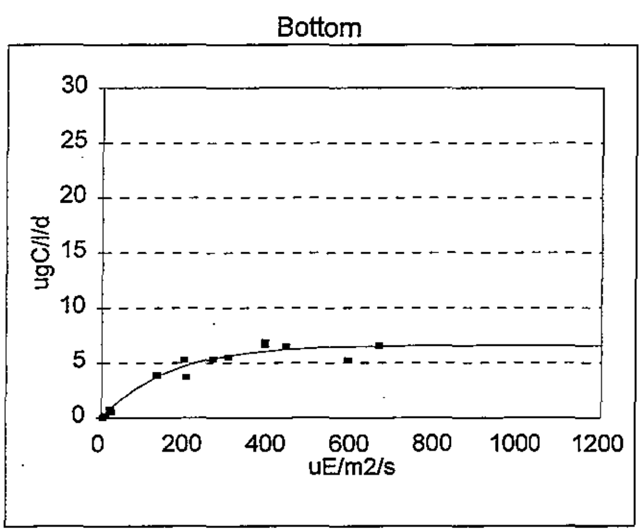
W9702 Station N18





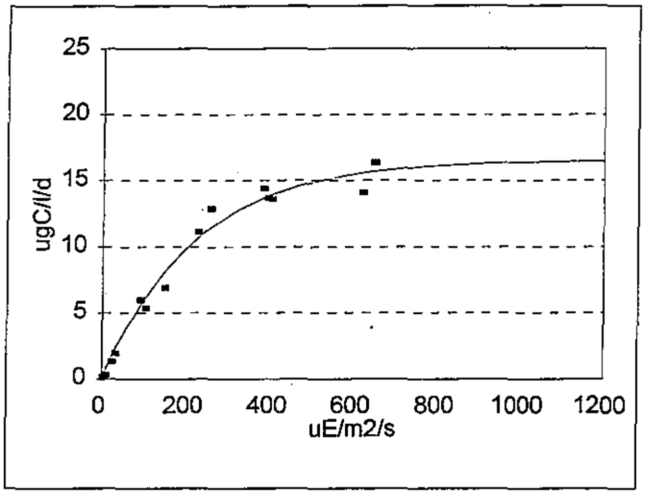






W9703 Station N04

Surface



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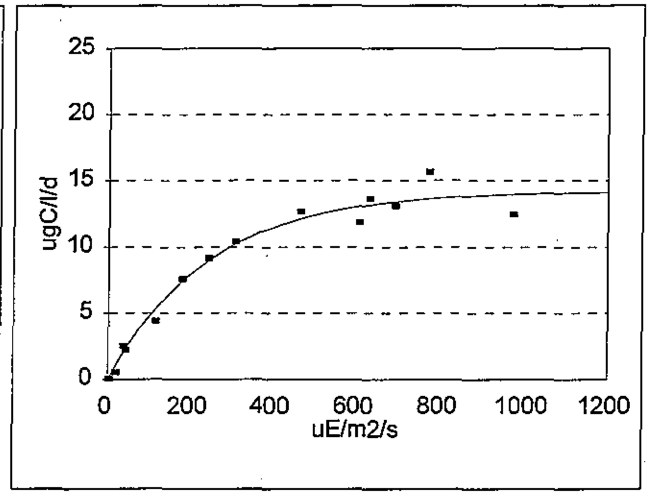

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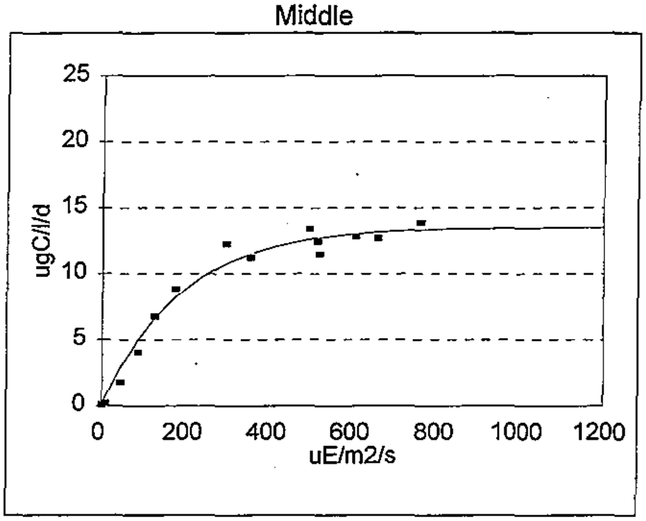

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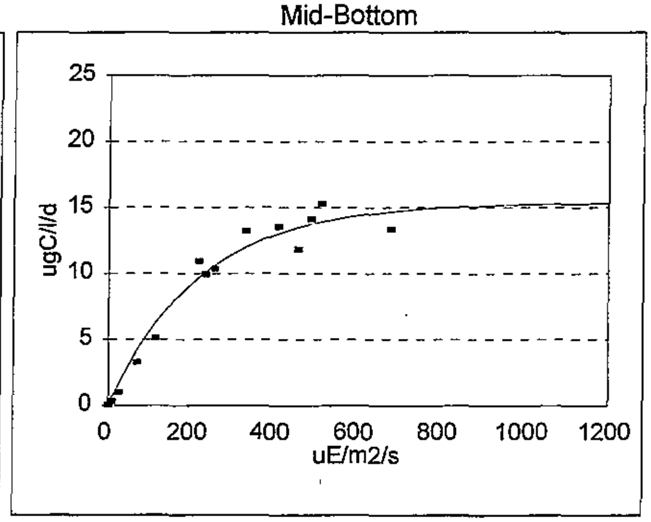

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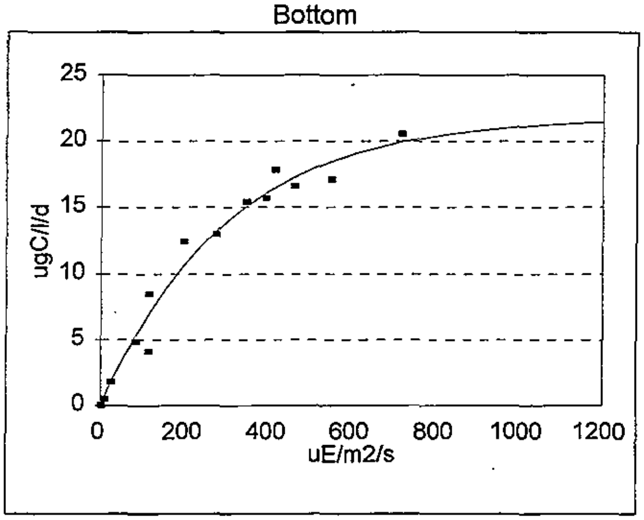
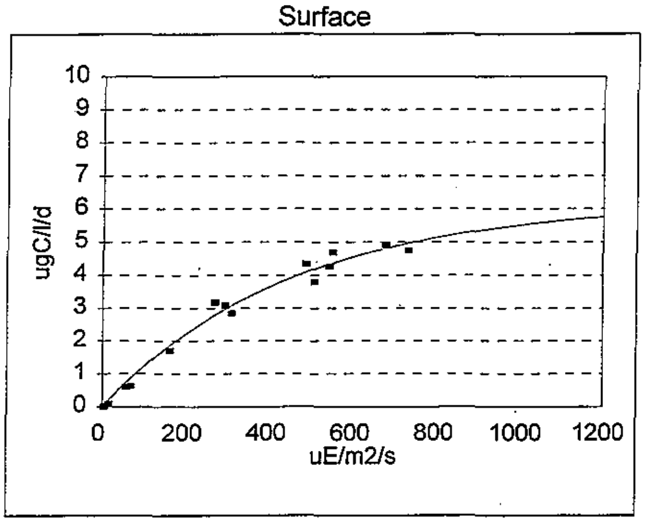
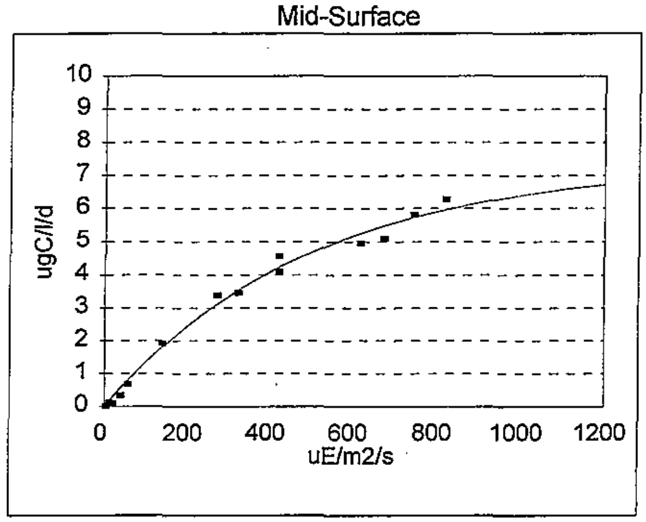
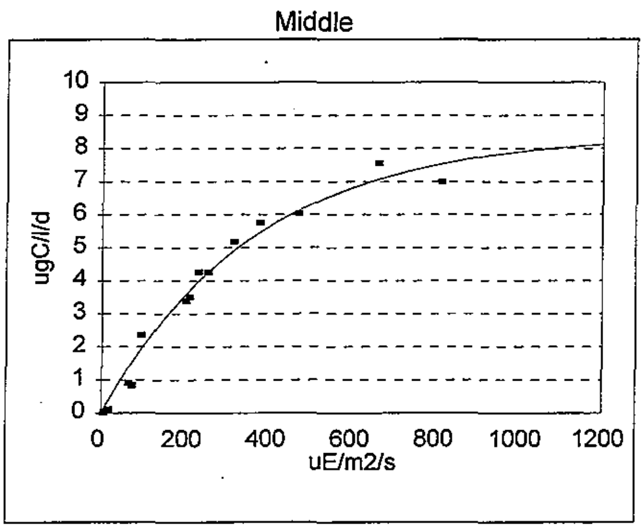
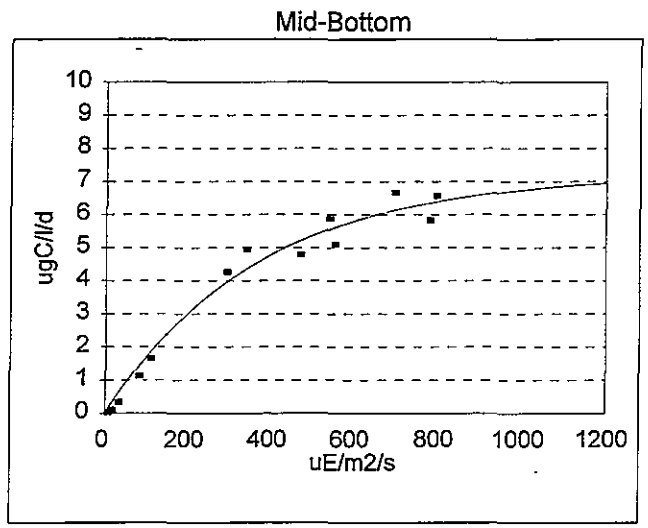


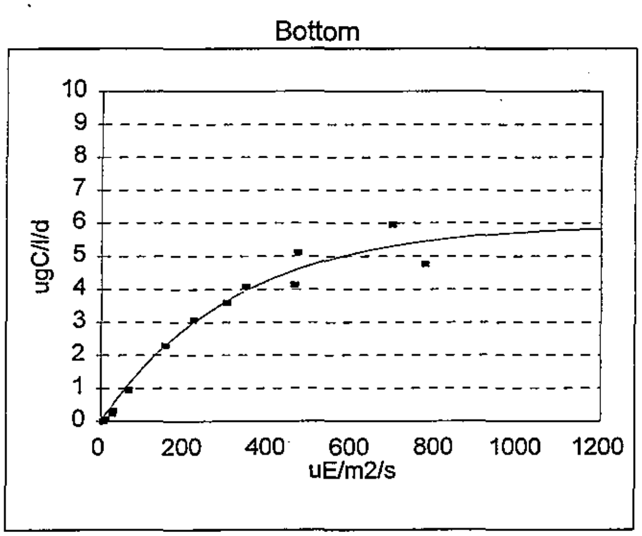
W9703 **Station N18**





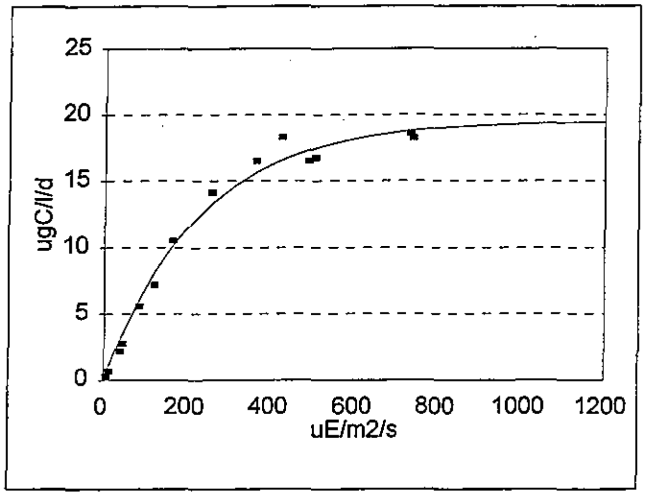




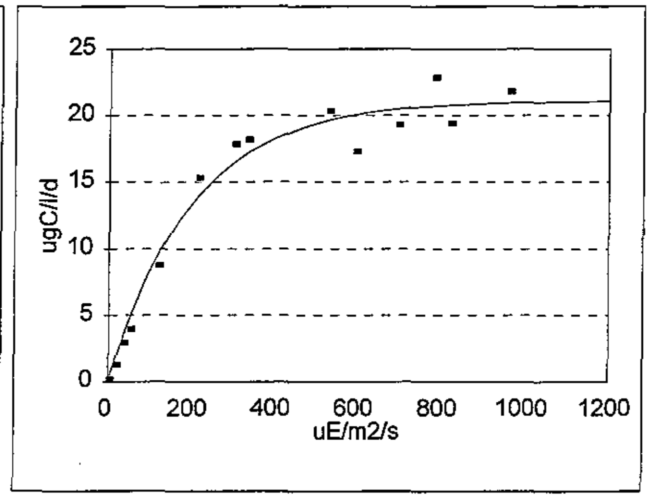


W9704 **Station F23**

Surface



Mid-Surface



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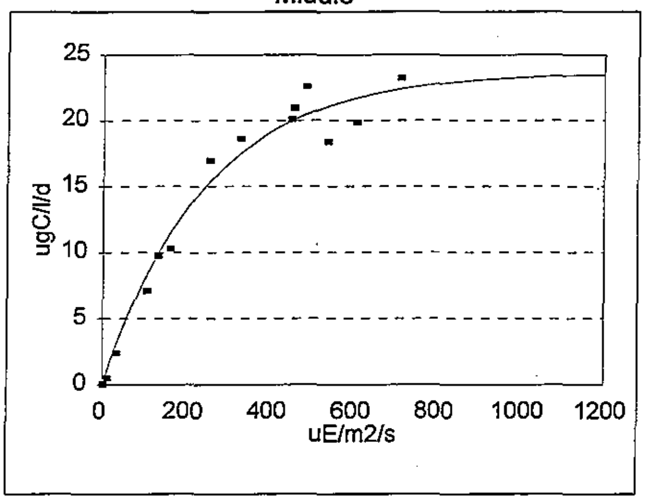
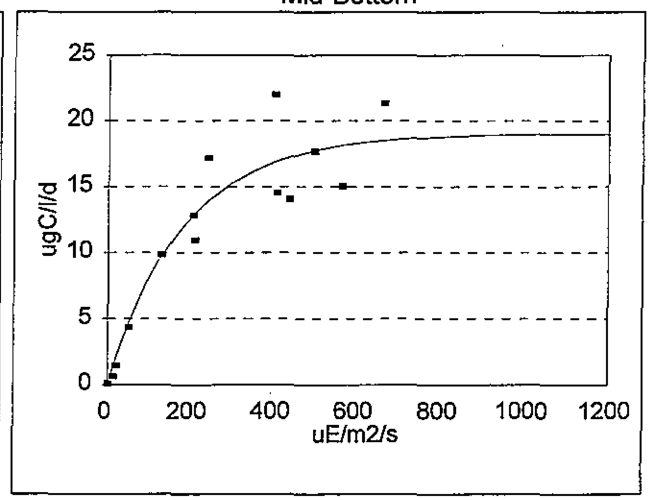


Mid-Bottom



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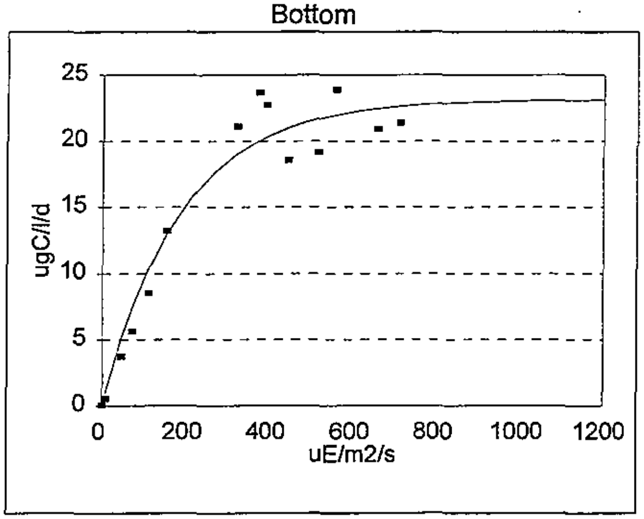
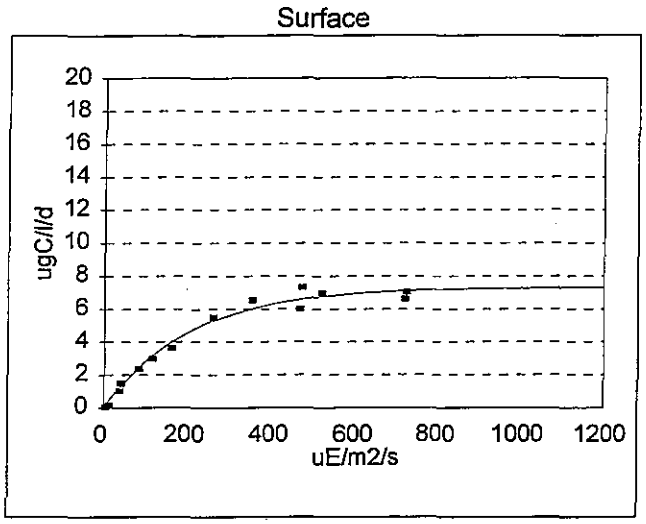
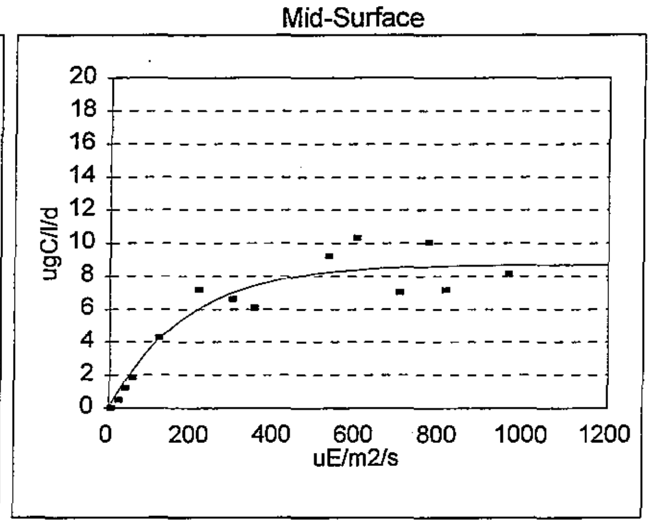
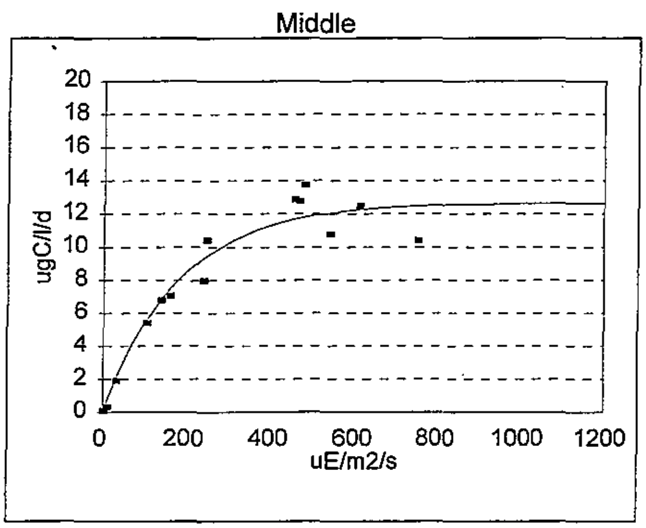
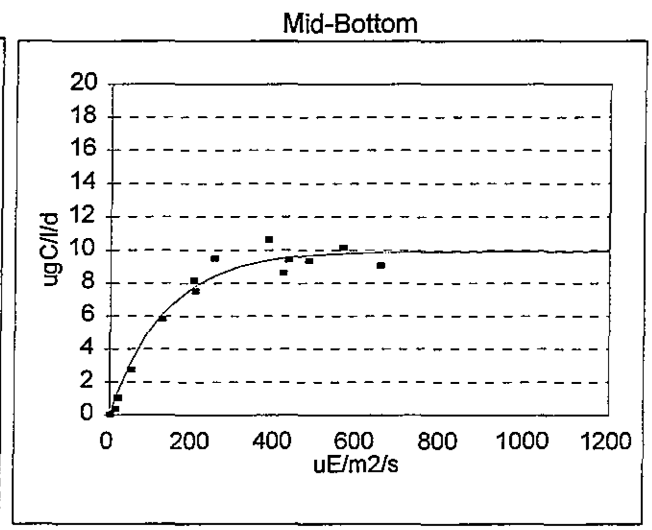


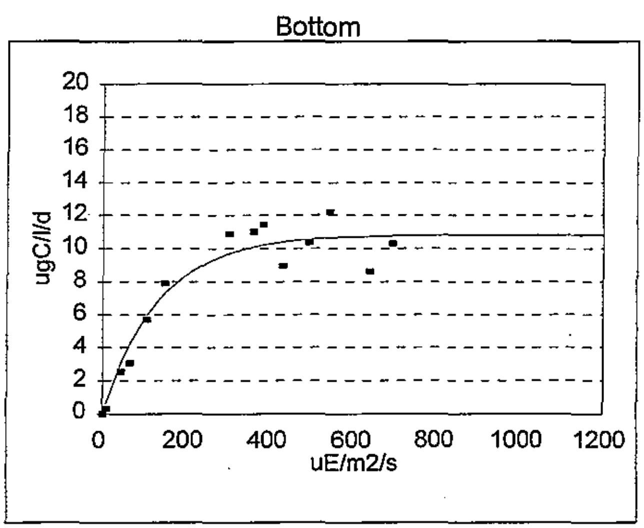
W9704 Station N04





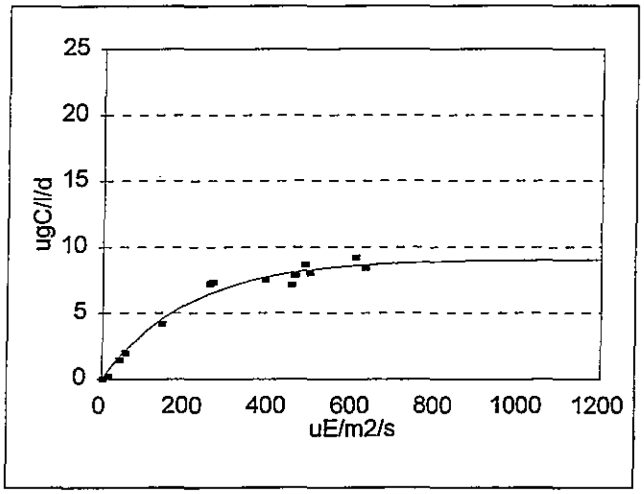






W9704 Station N18

Surface



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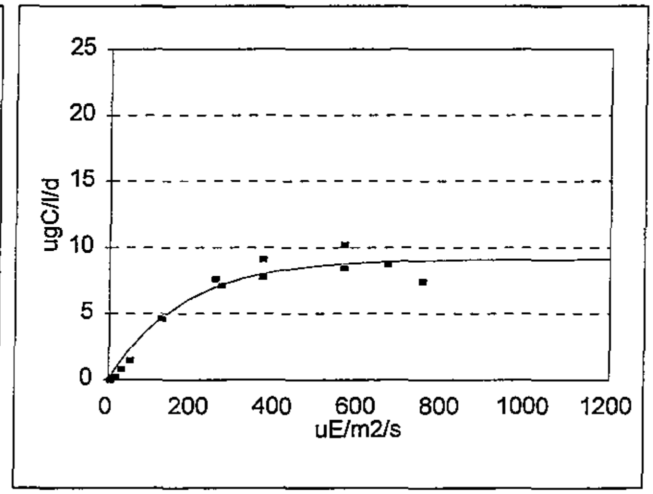

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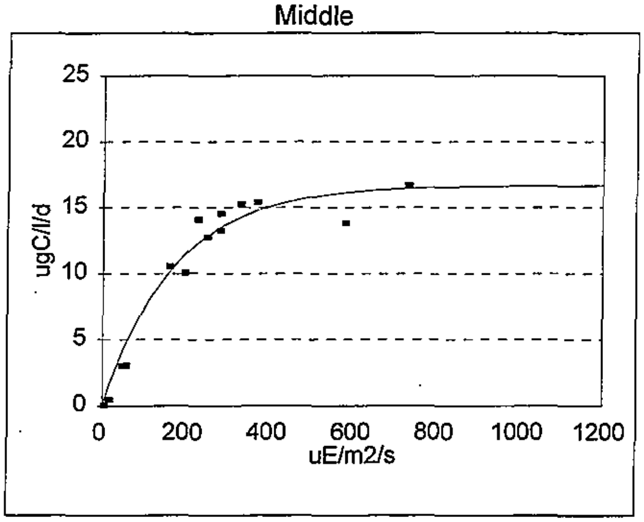

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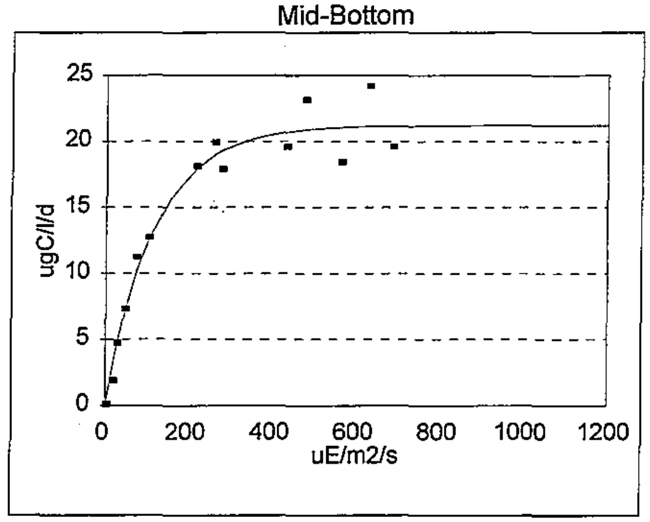

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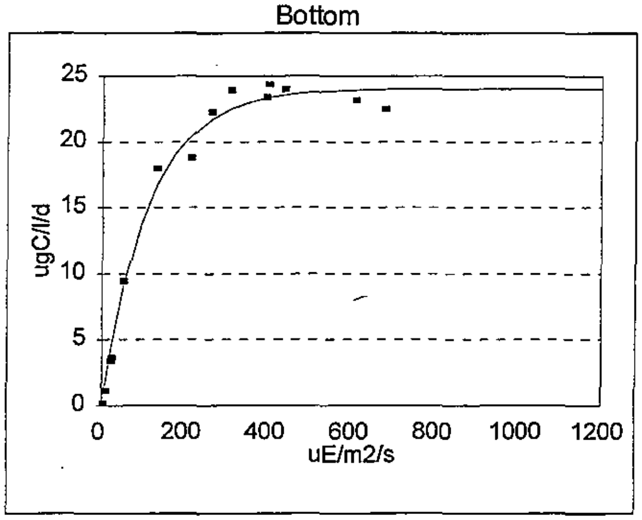
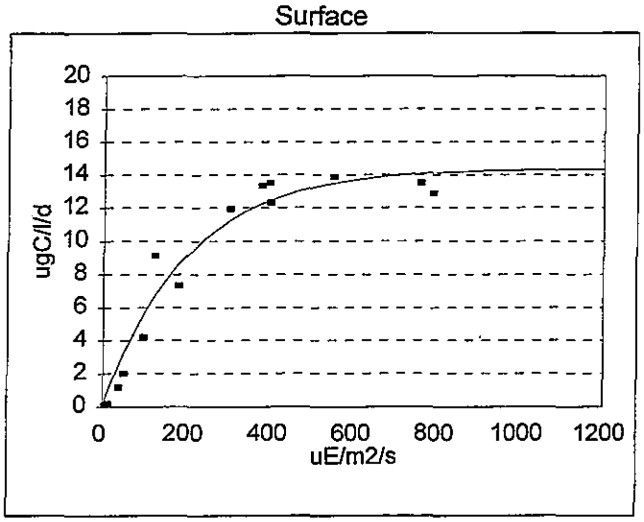
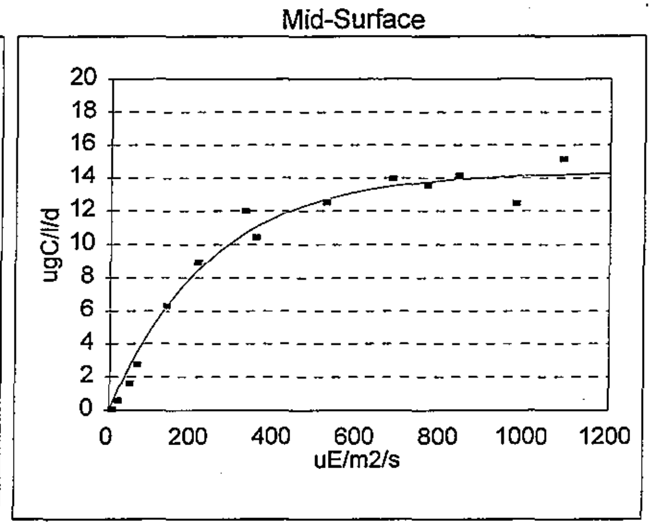
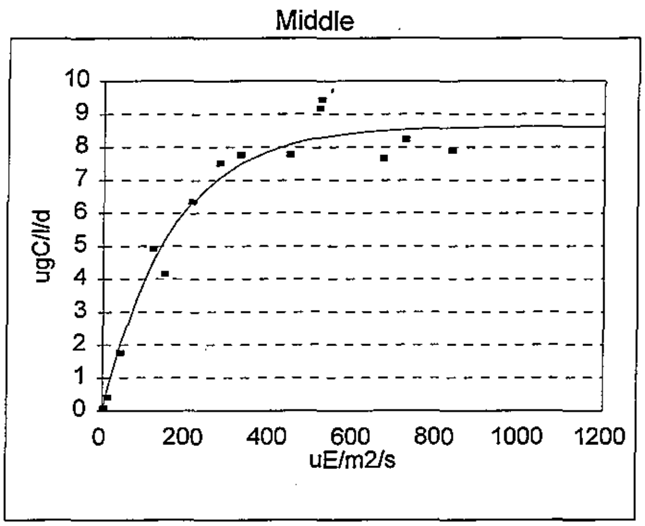
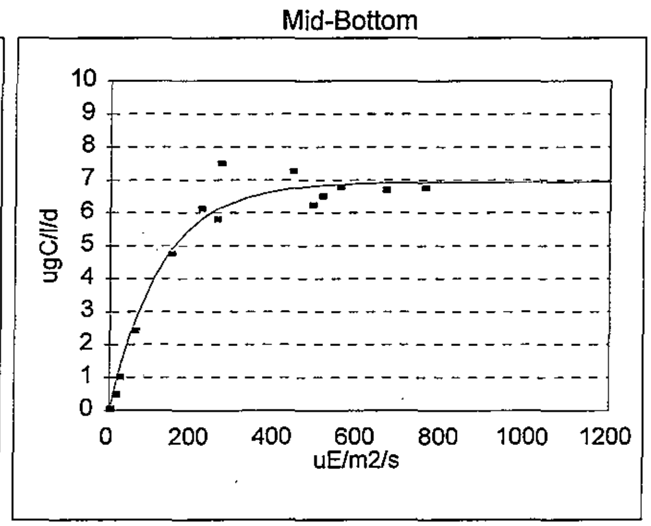


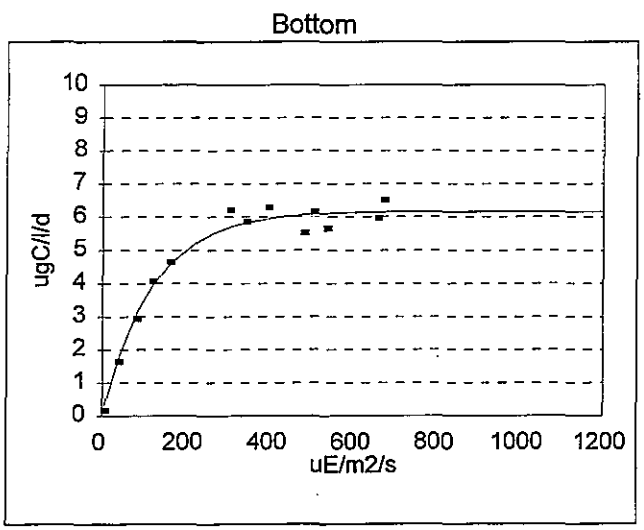
W9705 Station N04





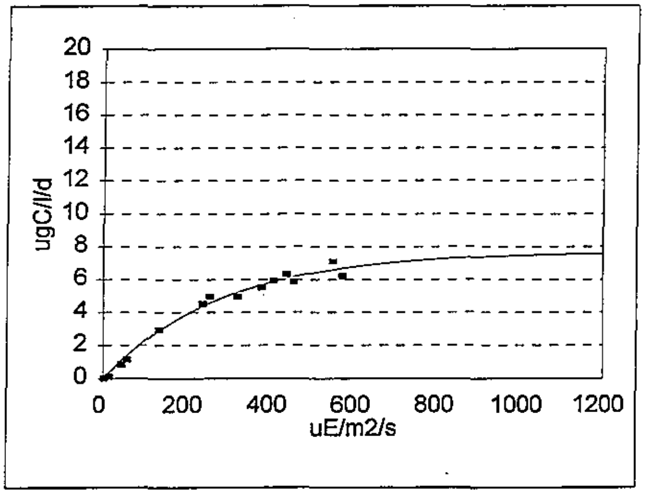




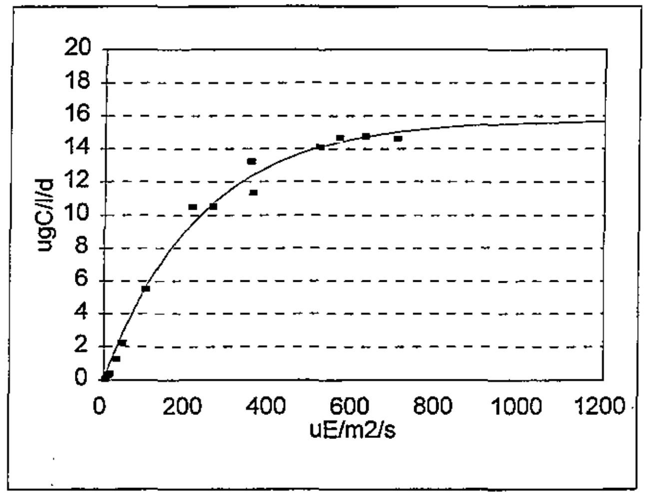


W9705 Station N18

Surface



Mid-Surface



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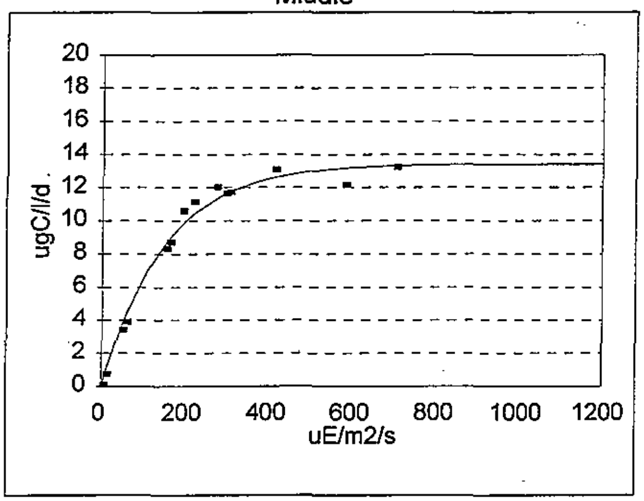
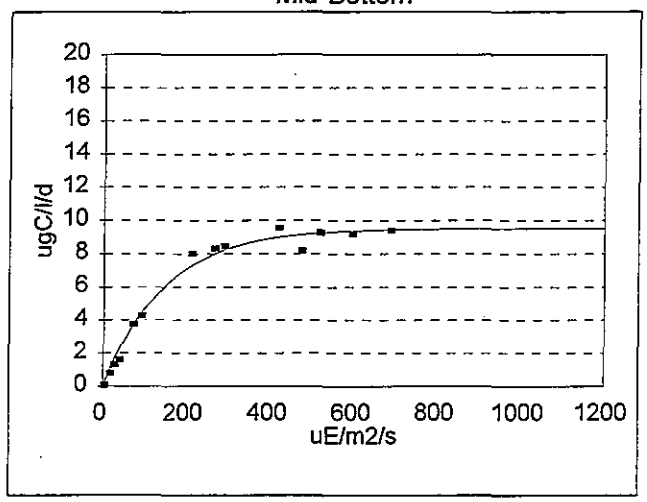


Mid-Bottom



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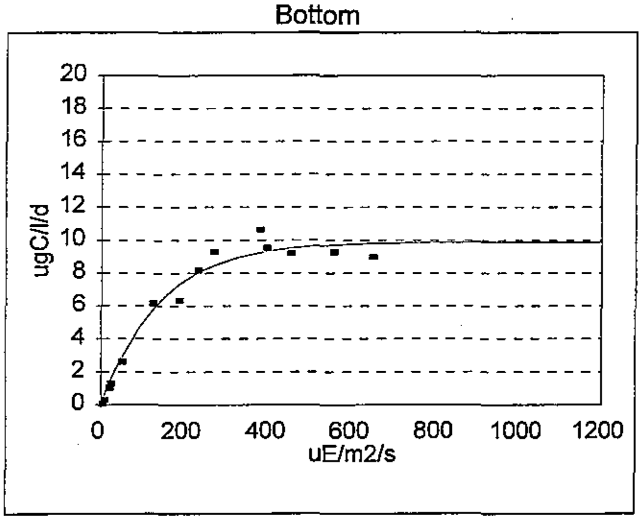
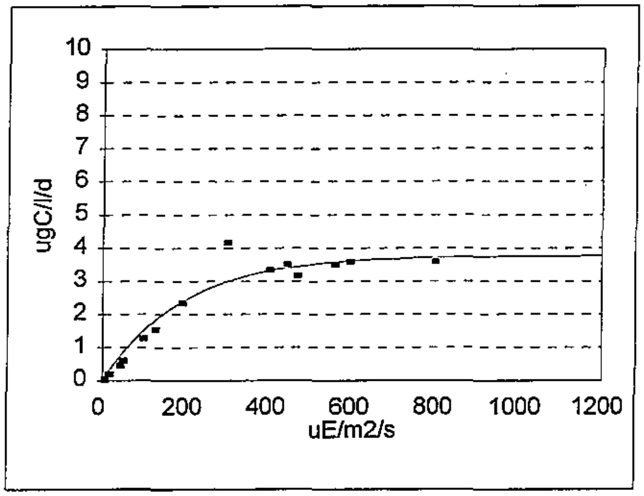
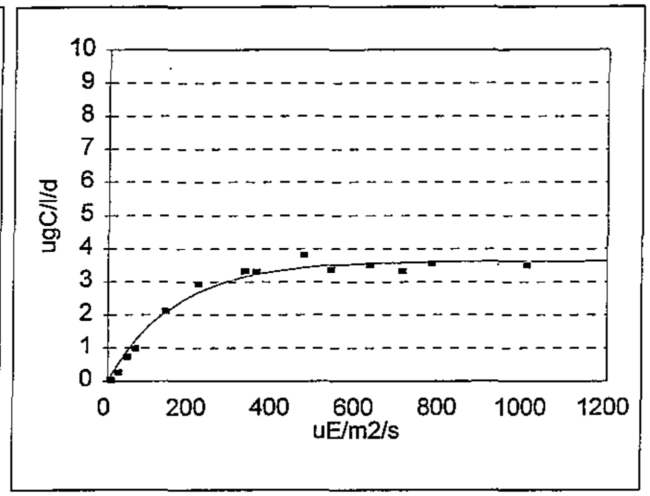


W9706 Station N04

Surface



Mid-Surface



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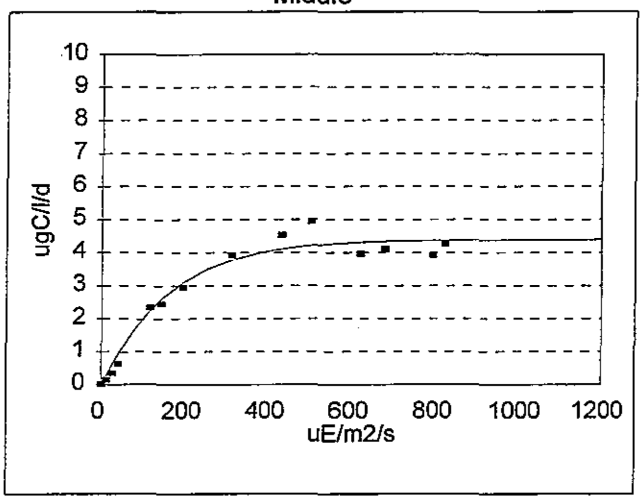

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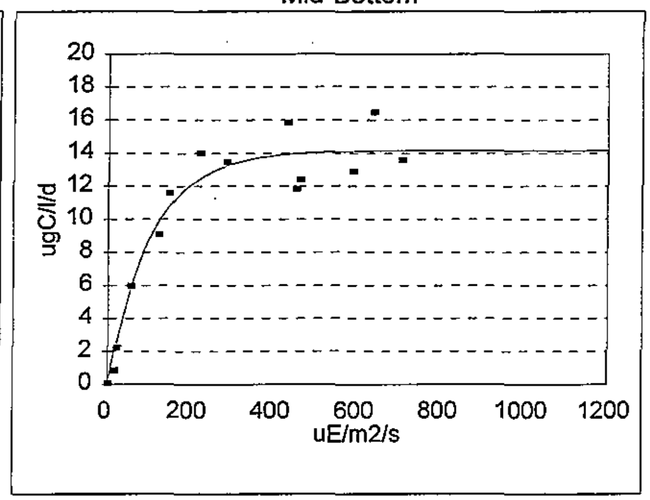

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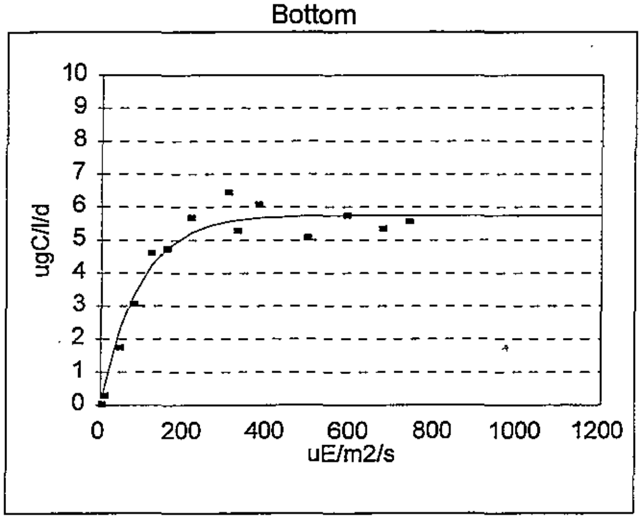
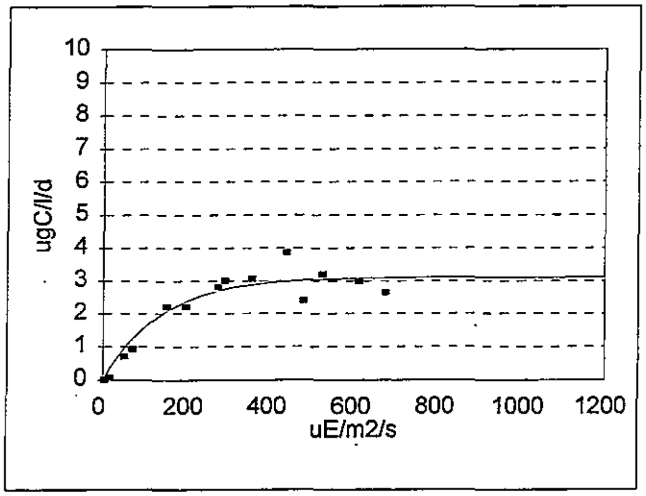


W9706 **Station N18**

Surface



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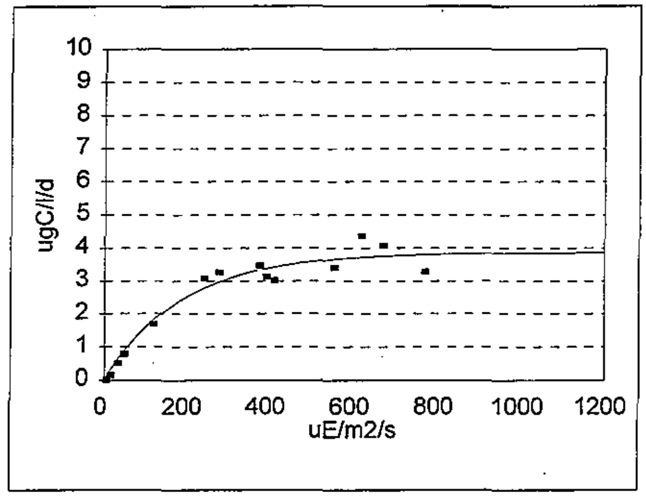

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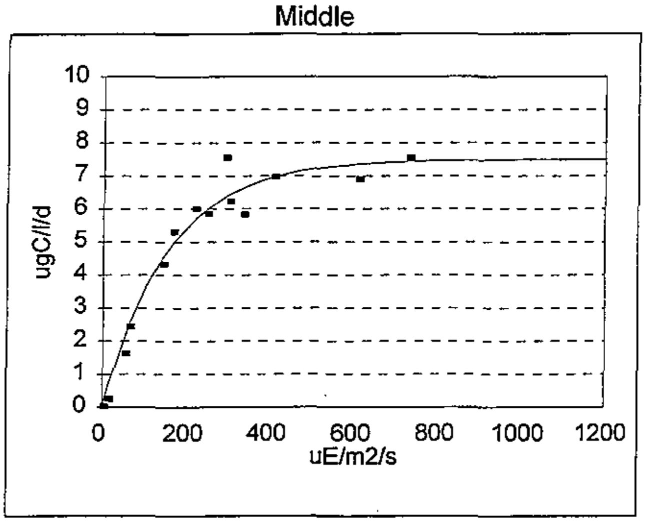

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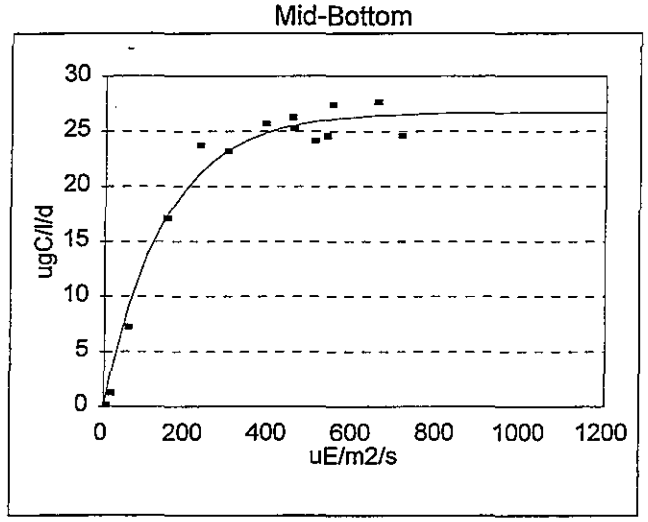

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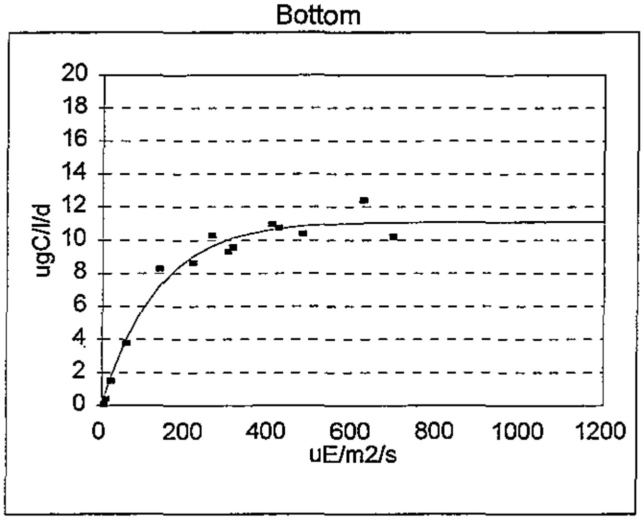
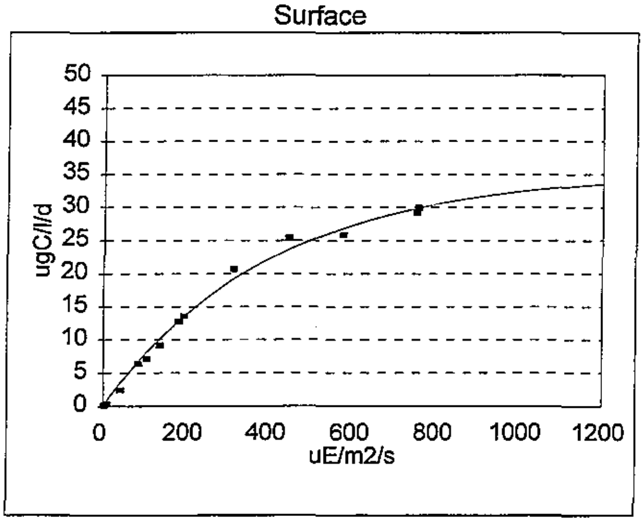
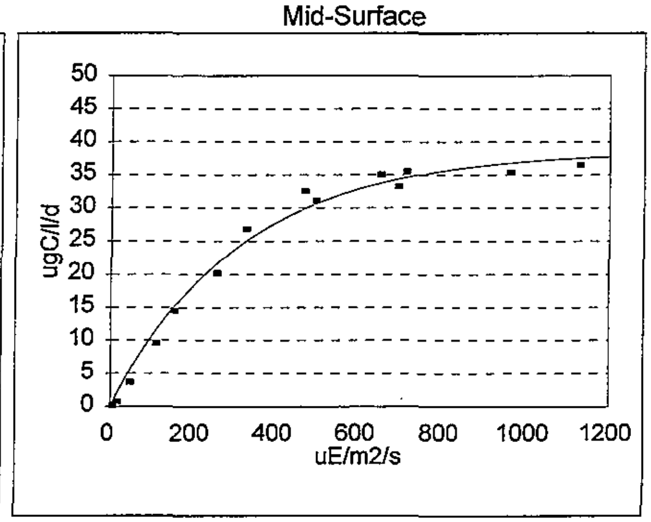
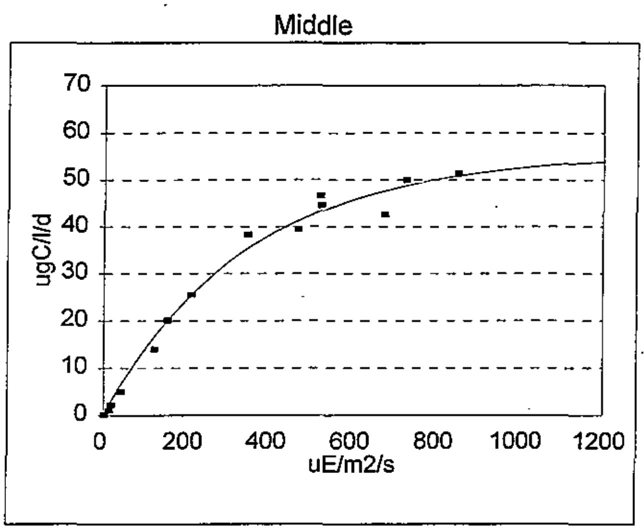
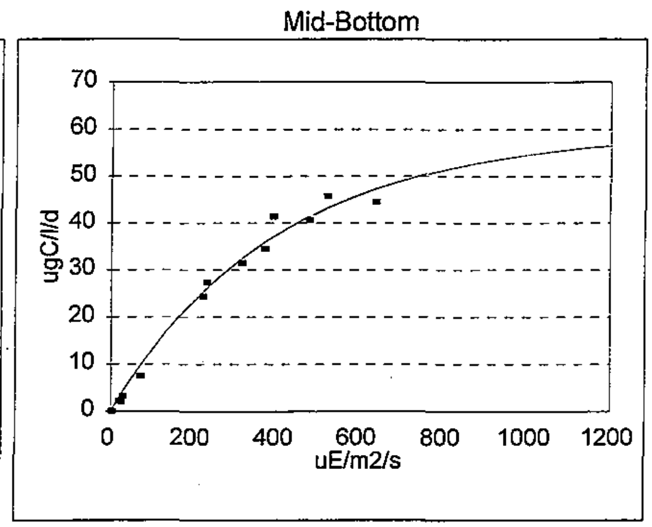


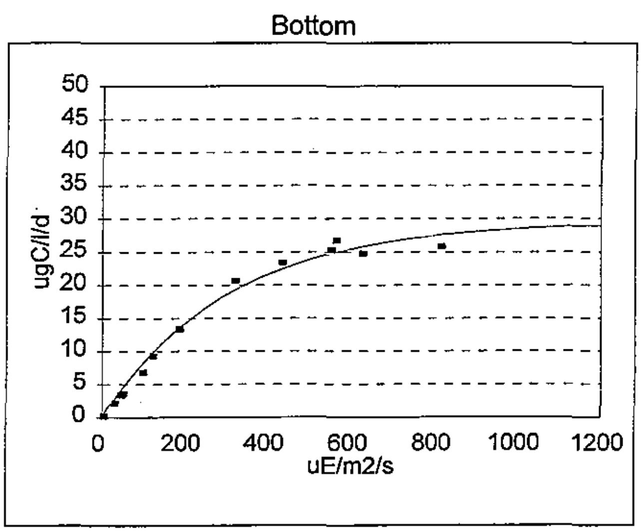
W9707 Station F23











W9707 Station N04

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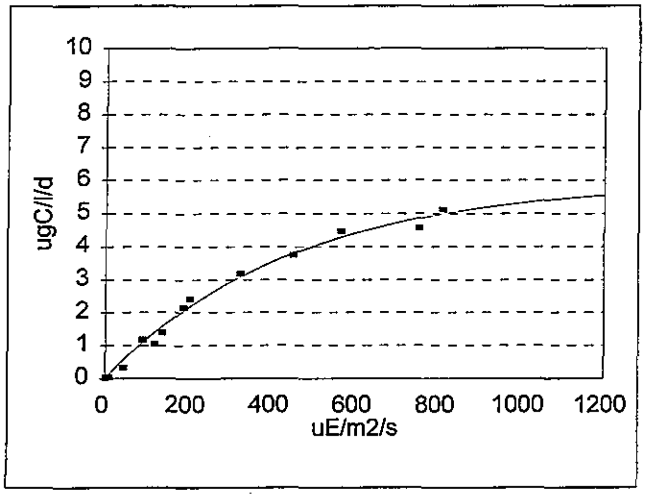

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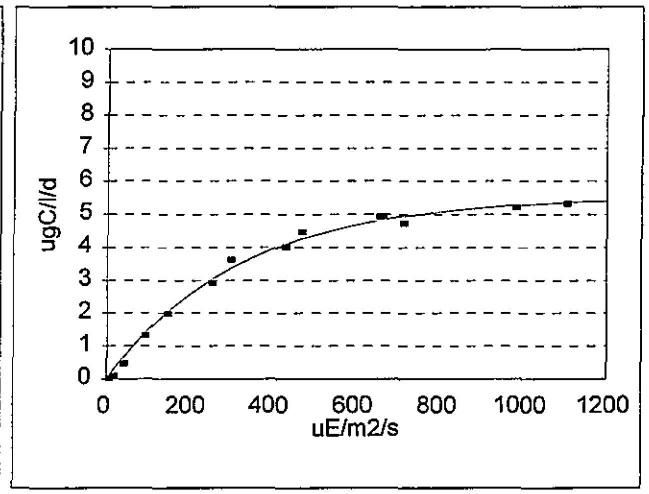

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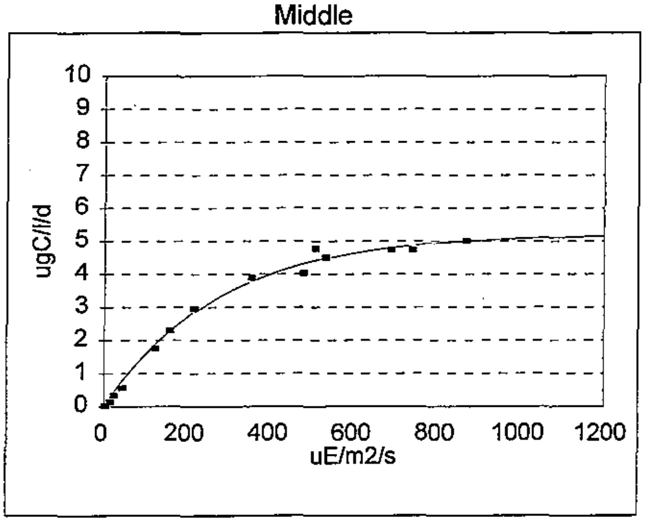
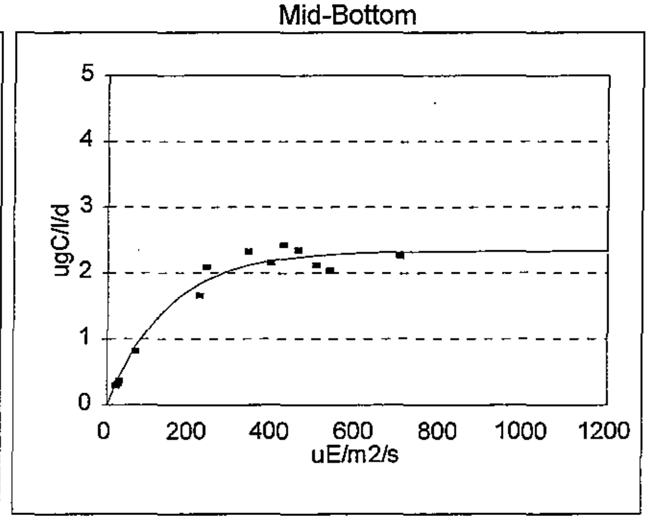


Mid-Bottom



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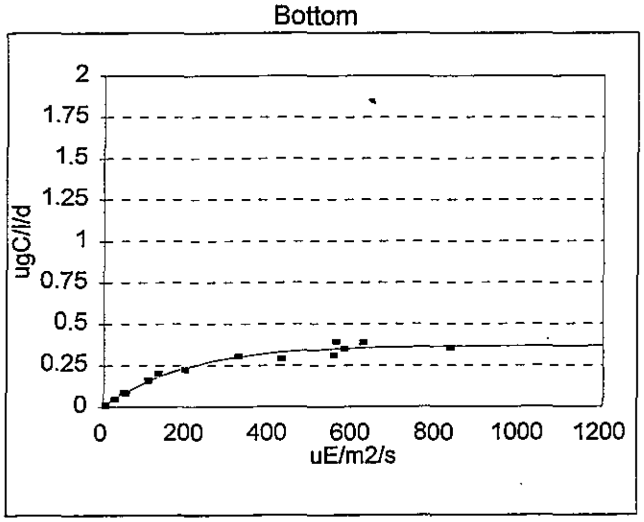

W9707 **Station N18**

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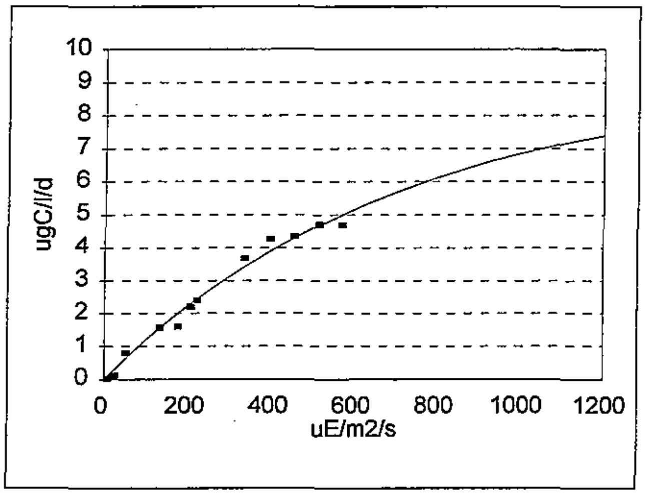

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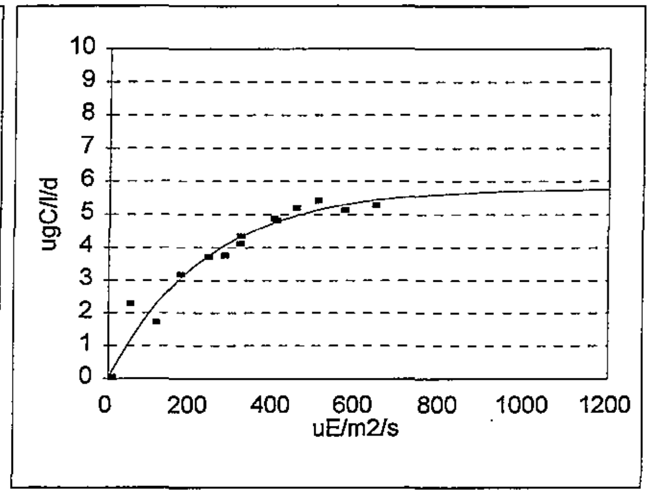

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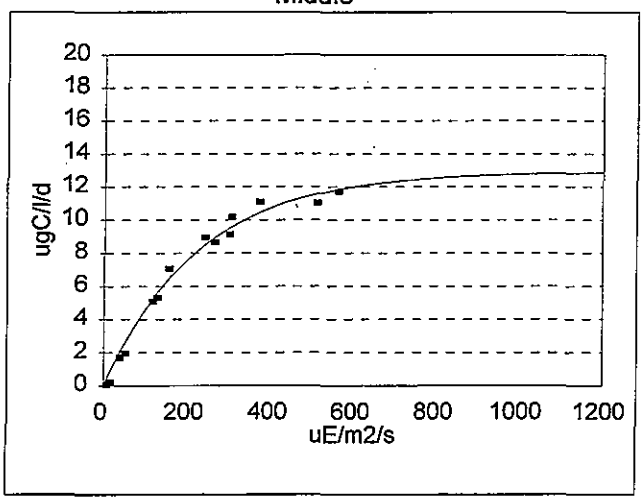

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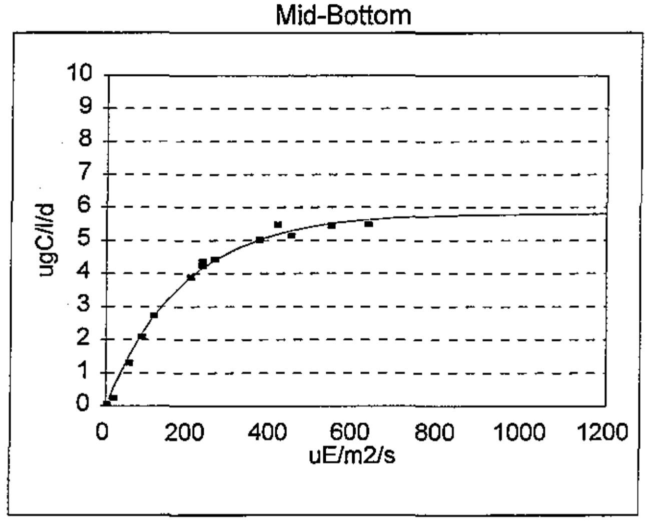

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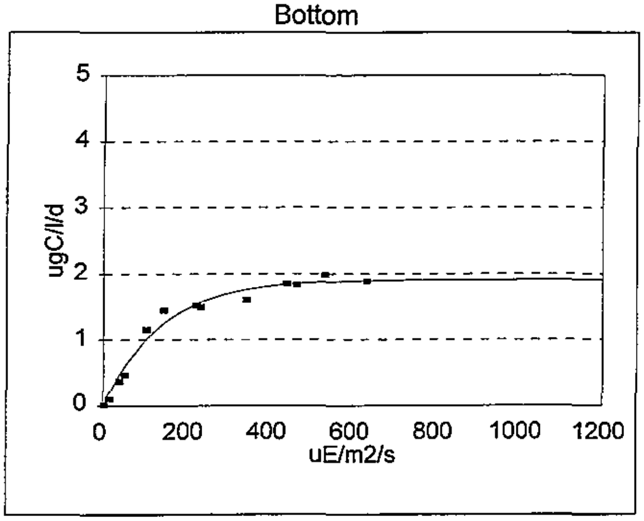
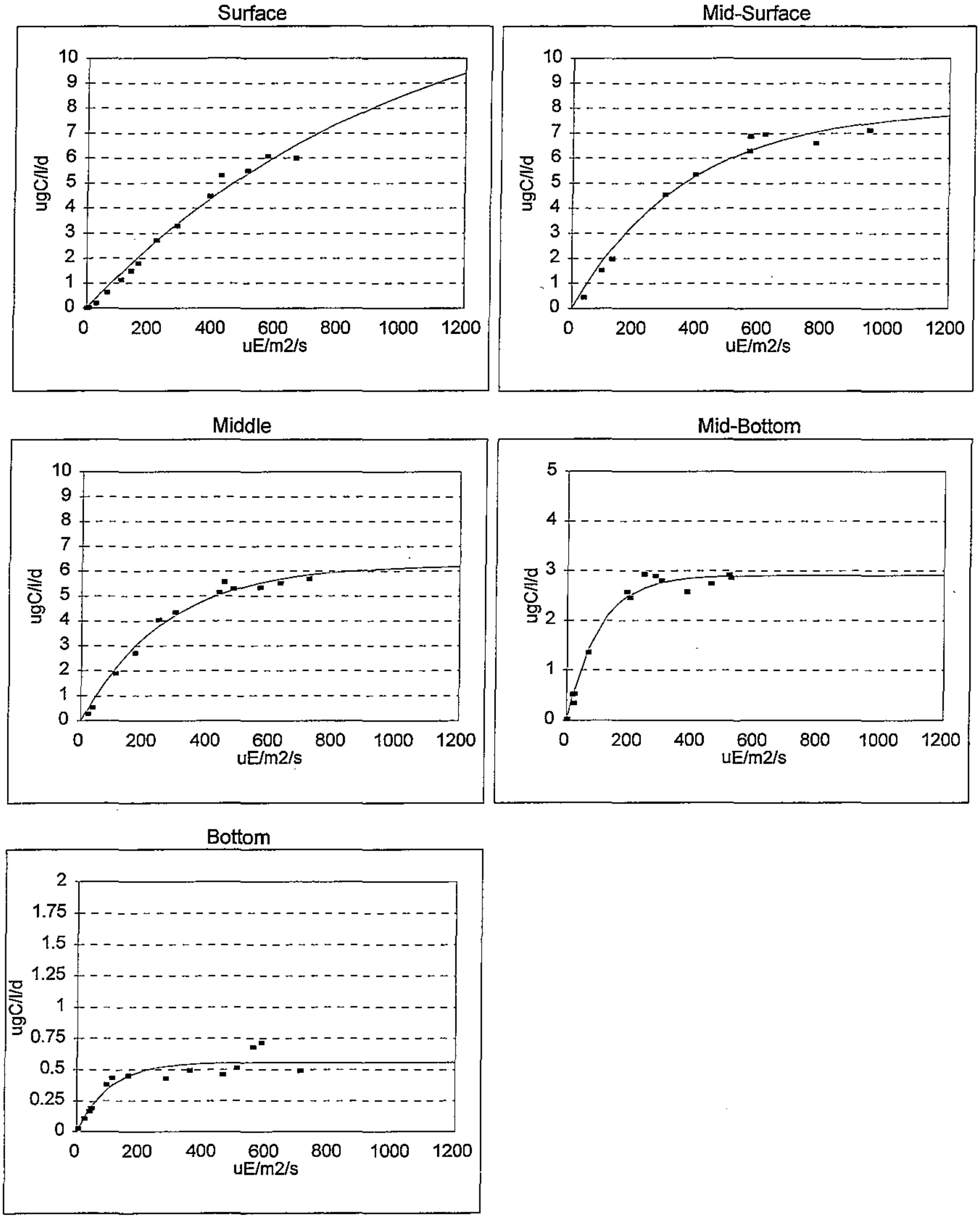


W9708 Station N04



W9708 Station N18

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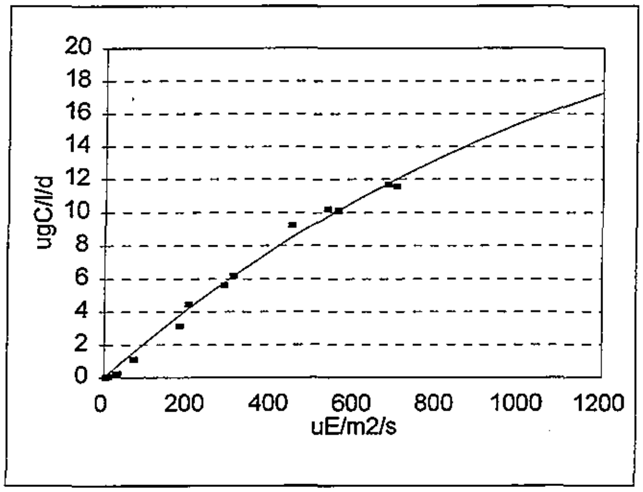

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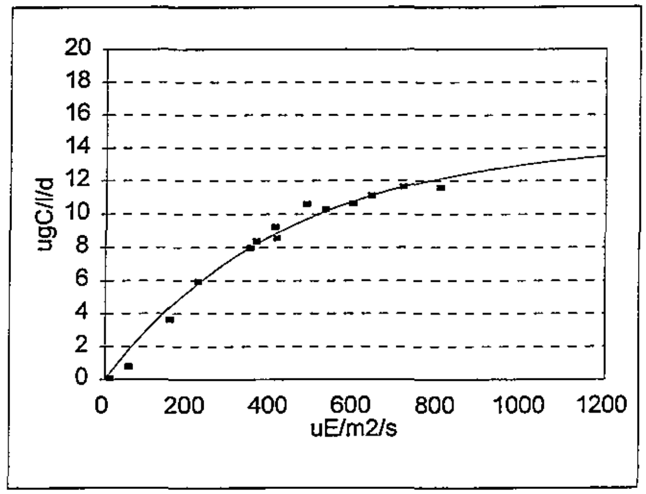

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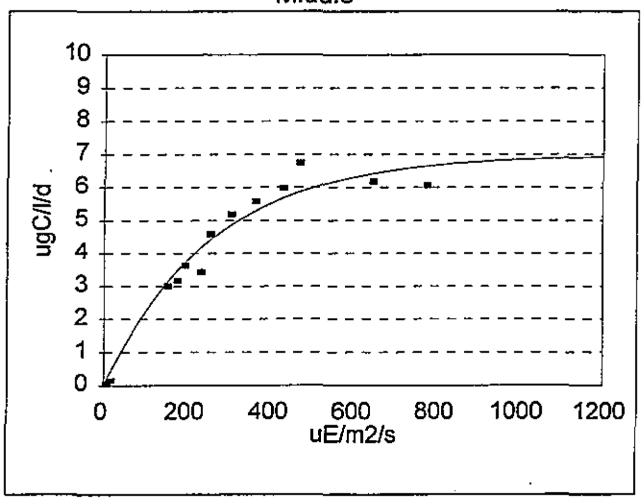

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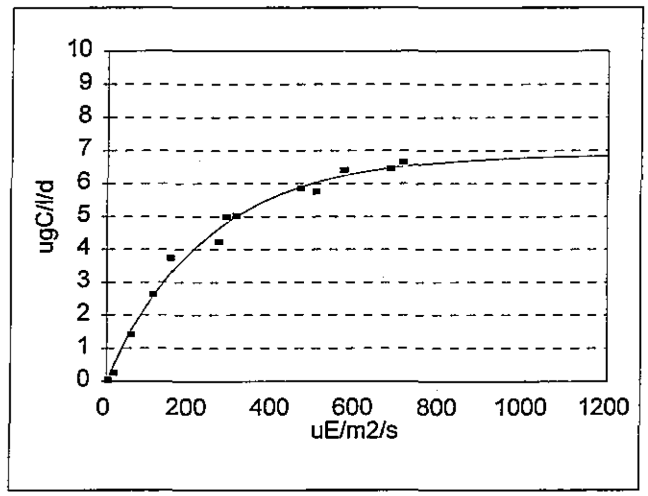

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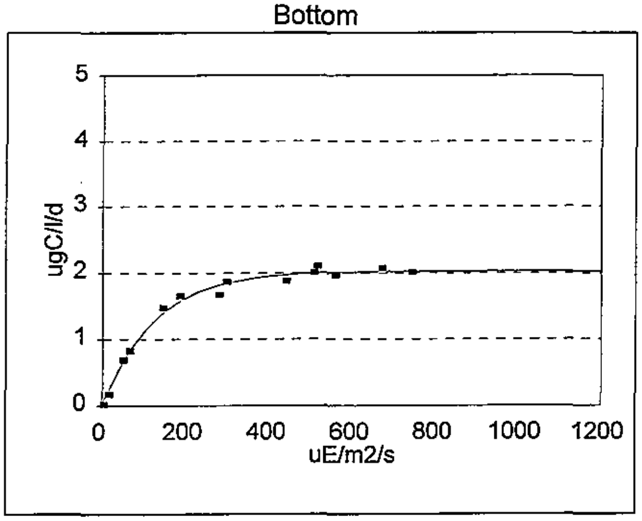
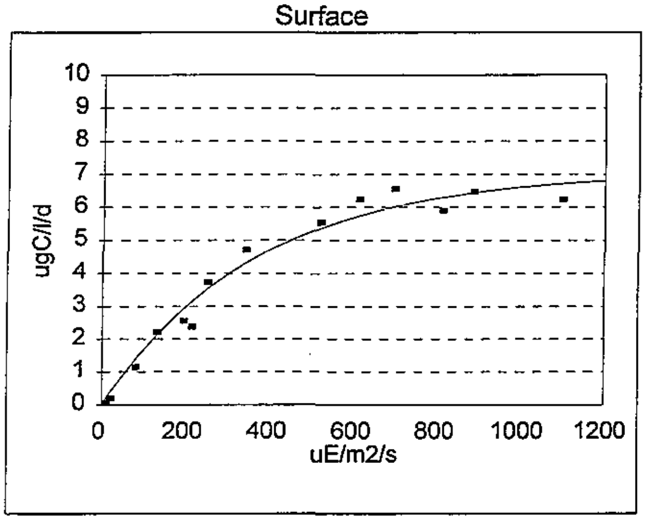
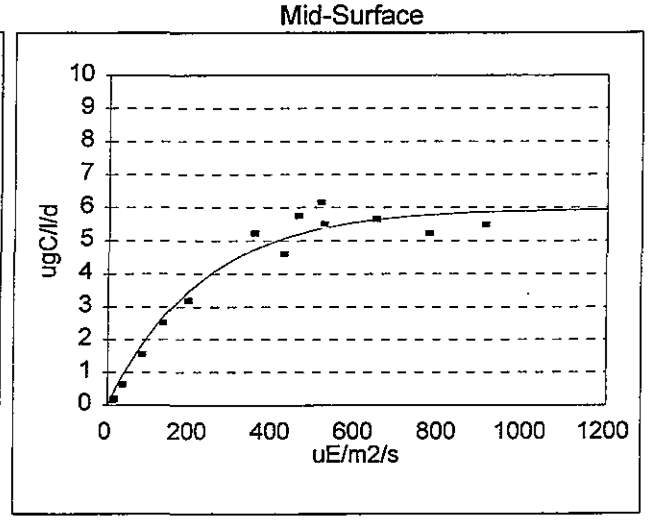
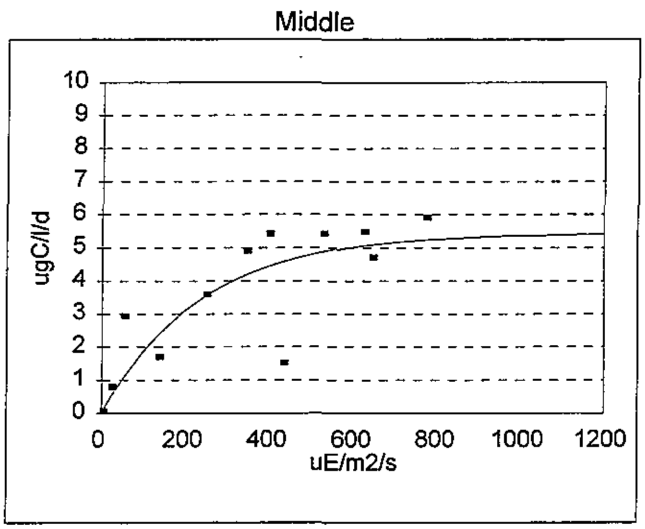
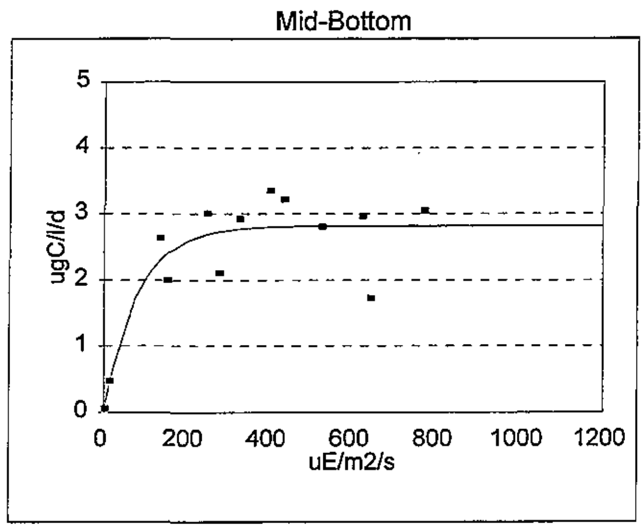


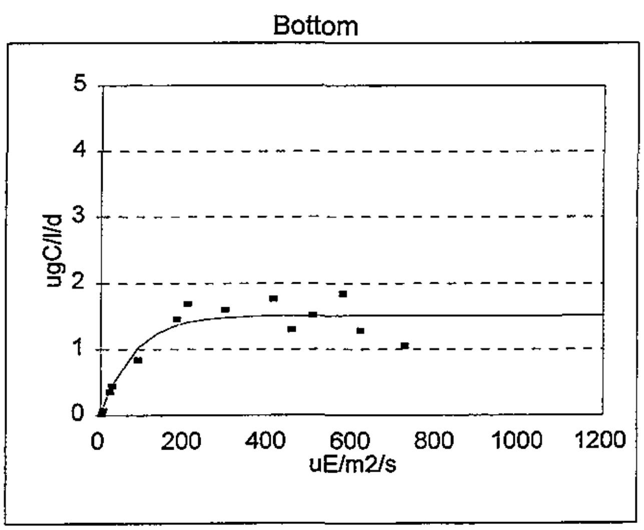
W9709 Station N04





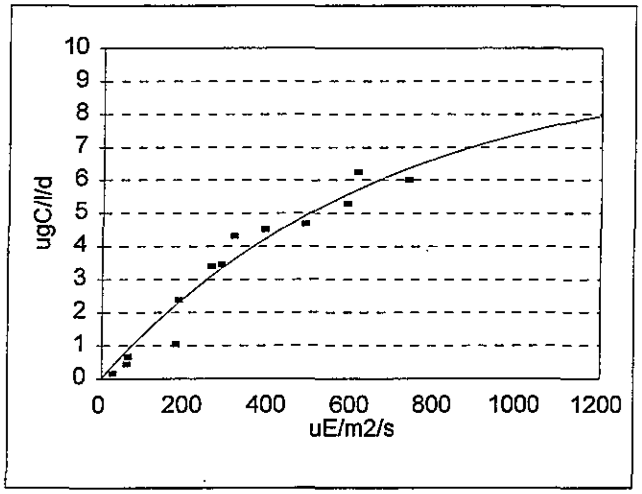






W9709 Station N18

Surface



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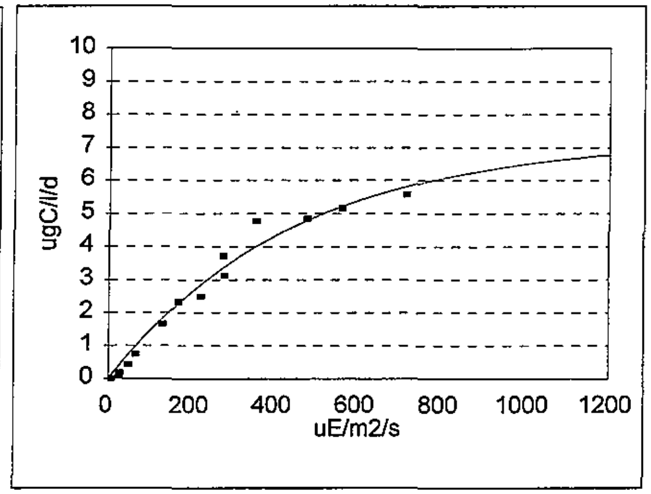

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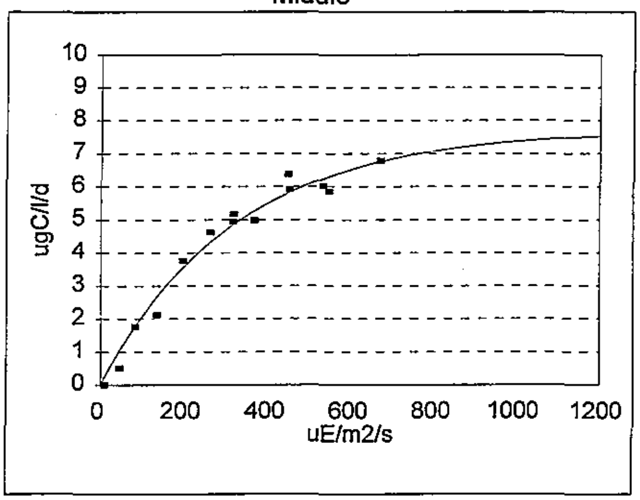
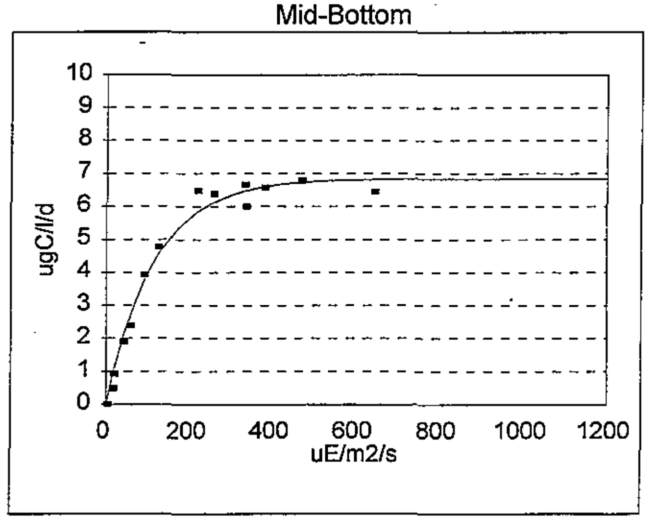


Mid-Bottom



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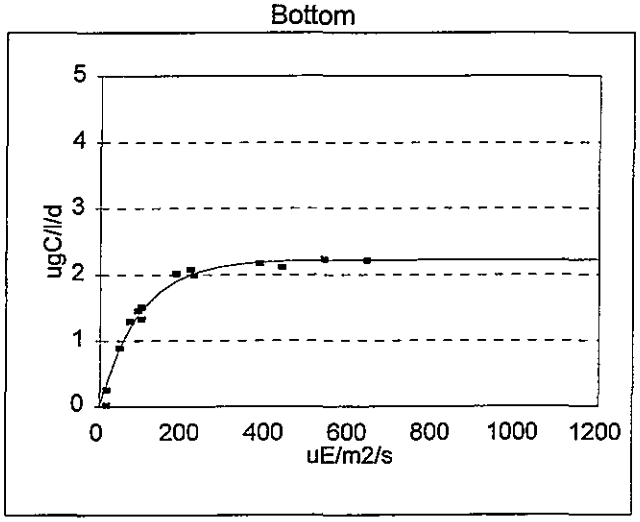

APPENDIX E-1

ABUNDANCE OF PREVALENT SPECIES IN WHOLE WATER SURFACE SAMPLES

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, February 4 - 7, 1997 (W9701)

Species	Group	Parameter	Station Cast													
			F23	F30	F31	F13	F24	F25	N04	N16	1N18	3N18	F06	F27	F01	F02
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6Cells/L					0.03		0.05			0.04	0.03	0.04	0.05	
		%					16		9			6	5	7	7	
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	10^6Cells/L							0.03		0.03		0.05	0.05		
		%							6		7		9	9		
RHIZOSOLENIA DELICATULA	CD	10^6Cells/L											0.05		0.04	0.06
		%											8		6	10
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6Cells/L	0.29	0.33	0.26	0.33	0.63	0.34	0.38		0.30	0.59	0.36	0.36	0.54	0.42
		%	82	84	83	85	160	79	71		75	84	61	69	77	72
Group Definitions:	CD	Centric Diatom														
	DF	Dinoflagellate														
	MF	Microflagellate														
	O	Other														
	PD	Pennate Diatom														

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, February 25 - 28, 1997 (W9702)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CHOANOFLAGELLATE SPP.	MF	10^6Cells/L	0.05	0.05		0.04		0.02							
		%	12	10		6		6							
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6Cells/L		0.04									0.03		
		%		8									6		
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	10^6Cells/L											0.03		
		%											6		
PHAEOCYSTIS POUCHETII	HP	10^6Cells/L							0.03		0.05			3.13	4.61
		%							6		7			81	83
THALASSIOSIRA GRAVIDA	CD	10^6Cells/L	0.03	0.04	0.05	0.12	0.09	0.04	0.22	0.11	0.15		0.10		
		%	8	9	11	17	19	9	42	19	23		21		
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6Cells/L	0.27	0.31	0.33	0.47	0.32	0.30	0.23	0.40	0.40	0.36	0.23	0.38	0.57
		%	65	65	73	67	64	73	44	68	60	83	50	10	10
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	O	Other													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, March 18, 1997 (W9703)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	10^6Cells/L									0.04				
		%									6				
PHAEOCYSTIS POUCHETII	HP	10^6Cells/L							0.40		0.18				
		%							40		27				
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6Cells/L							0.38		0.34				
		%							38		51				
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	O	Other													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, March 31 - April 6, 1997 (W9704)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
BLUE GREEN TRICHOME SPP.	CY	10^6 cells/L		0.31											
		%		18											
CHAETOCEROS SP#1 DIAM <10 MICRONS	CD	10^6 cells/L	0.28	0.16		0.06									
		%	10	10		9									
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	10^6 cells/L			0.10		0.27	0.10	0.14	0.41	0.12		0.07		
		%			7		9	6	8	7	9		5		
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6 cells/L		0.33											
		%		20											
PHAEOCYSTIS POUCHETII	HP	10^6 cells/L	2.09	0.34	0.34	0.38	1.33	0.50	1.00	4.24	0.65	0.79	0.20	3.35	0.98
		%	74	20	26	54	45	33	54	78	48	59	16	71	53
THALASSIONEMA NITZSCHIOIDES	PD	10^6 cells/L		0.11											
		%		7											
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L	0.24	0.16	0.59	0.10	1.03	0.72	0.51	0.47	0.47	0.46	0.81	1.17	0.83
		%	9	9	44	14	35	48	27	9	35	35	62	25	45

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, April 23, 1997 (W9705)

Species	Group	Parameter	Wholewater Phytoplankton	
			N04 Surface	N18 Surface
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	10^6 cells/L	0.11	
		%	7	
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6 cells/L	0.10	0.12
		%	6	9
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	10^6 cells/L	0.10	0.10
		%	6	7
PHAEOCYSTIS POUCHETII	HP	10^6 cells/L	0.66	0.59
		%	44	41
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L	0.29	0.35
		%	19	25
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, May 13, 1997 (W9706)

Species	Group	Parameter	Wholewater Phytoplankton	
			N04 Surface	N18 Surface
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	10^6 cells/L		0.05
		%		6
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR			0.07
				8
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF		0.04	0.07
			7	8
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L	0.39	0.47
		%	67	55
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, June 17 - 20, 197 (W9707)

Species	Group	Parameter	Station Cast F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CHAETOCEROS SP#1 DIAM <10 MICRONS	CD	10^6cells/l						0.45			0.95				
		%						8			10				
CRYPTOMONAS SP#1 LENGTH <10 MICRONS	CR	10^6cells/l	0.11		0.08			0.38			1.06	0.45		0.07	
		%	11		7			7			11	6		9	
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6cells/l	0.10	0.05	0.06	0.06	0.48	0.84	0.20		1.05	0.93		0.08	
		%	11	6	6	7	12	15	6		11	13		9	
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	10^6cells/l	0.10	0.06		0.04								0.07	0.08
		%	10	6		5								8	8
RHIZOSOLENIA DELICATULA	CD	10^6cells/l							0.20						
		%							6						
RHIZOSOLENIA FRAGILISSIMA	CD	10^6cells/l				0.04	0.33	0.35	0.37				0.05		0.06
		%				5	9	6	11				5		6
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6cells/l	0.57	0.74	0.91	0.62	2.17	3.09	1.84	1.09	5.52	4.91	0.70	0.55	0.76
		%	59	81	83	72	57	53	54	83	58	70	74	65	75

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, July 1, 1997 (W9708)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
RHIZOSOLENIA FRAGILISSIMA	CD	10^6cells/l													0.52
		%													22
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6cells/l											1.27		1.45
		%											86		61
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	HP	Haptophyte													
	CR	Cryophyte													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Whole Water Phytoplankton, July 22, 1997 (W9709)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CRYPTOMONAS SP#1 LENGTH <10 MICRONS	CRYPTOPHYTES	10^6cells/l											0.06		0.05
		%											10		6
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CRYPTOPHYTES	10^6cells/l											0.04		
		%											7		
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	ICROFLAGELLATE	10^6cells/l											0.49		0.73
		%											76		85

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

APPENDIX E-2

ABUNDANCE OF PREVALENT SPECIES IN WHOLE WATER CHLOROPHYLL *a* MAXIMUM SAMPLES

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, February 4 - 7, 1997 (W9701)

Species	Group	Parameter	Station Cast													
			F23	F30	F31	F13	F24	F25	N04	N16	1N18	3N18	F06	F27	F01	F02
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6Cells/L	0.03	0.04		0.02	0.02		0.03			0.05			0.06	
		%	7	12		6	6		7			9			8	
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	10^6Cells/L							0.04		0.06	0.04	0.04	0.02		
		%							9		12	6	8	6		
RHIZOSOLENIA DELICATULA	CD	10^6Cells/L											0.04		0.07	0.07
		%											9		10	13
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6Cells/L	0.31	0.27	0.23	0.24	0.32	0.31	0.33		0.34	0.43	0.31	0.20	0.52	0.38
		%	82	75	78	81	80	81	72		77	76	63	72	70	70

Group Definitions:	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	O	Other
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, February 25 - 28, 1997 (W9702)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
AGMENELLUM SPP.	CY	10^6Cells/L			0.07										
		%			6										
BLUE GREEN TRICHOME SPP.	CY	10^6Cells/L			0.52										
		%			42										
CHOANOFLAGELLATE SPP.	MF	10^6Cells/L	0.03	0.04	0.11					0.05					
		%	9	8	9					8					
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6Cells/L		0.04						0.08					
		%		9						14					
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	10^6Cells/L											0.02		
		%											5		
PHAEOCYSTIS POUCHETII	HP	10^6Cells/L							0.02				0.02	3.10	5.74
		%							6				8	81	89
THALASSIOSIRA GRAVIDA	CD	10^6Cells/L	0.03	0.05		0.09	0.12	0.04	0.17	0.07	0.20		0.04		
		%	9	11		11	29	9	41	12	31		13		
UNID. MICRO-PHYTOFLAG.LENGTH <10 MICRONS	MF	10^6Cells/L	0.26	0.32	0.35	0.63	0.25	0.30	0.19	0.33	0.35	0.33	0.20	0.40	0.45
		%	68	66	28	77	61	71	46	58	56	86	63	10	7
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	O	Other													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, March 18, 1997 (W9703)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	10^6Cells/L							0.28		0.03				
		%							20		6				
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	10^6Cells/L									0.03				
		%									5				
PHAEOCYSTIS POUCHETII	HP	10^6Cells/L							0.67		0.16				
		%							49		30				
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6Cells/L							0.20		0.27				
		%							14		49				

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	O	Other
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, March 31 - April 6, 1997 (W9704)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CHAETOCEROS SP#1 DIAM <10 MICRONS	CD	10^6 cells/L	0.24	0.16	0.14		0.29								
		%	9	12	9		9								
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	10^6 cells/L	0.25		0.16	0.09	0.41	0.15		0.53	0.44		0.28		
		%	9		11	6	13	11		6	10		18		
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6 cells/L		0.18											
		%		14											
PHAEOCYSTIS POUCHETII	HP	10^6 cells/L	1.18	0.52	0.45	0.74	1.59	0.47	2.98	7.72	2.40	5.60	0.48	3.49	14.94
		%	43	39	30	51	50	34	72	80	55	80	31	76	68
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L	0.79	0.22	0.59	0.52	0.73	0.59	0.94	0.83	0.94	1.01	0.63	0.84	6.86
		%	29	17	39	36	23	42	23	9	22	15	40	18	31

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, April 23, 1997 (W9705)

Species	Group	Parameter	Whole Water Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
PHAEOCYSTIS POUCHETII	HP	10^6 cells/L	1.62	2.56
		%	66	74
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L	0.66	0.74
		%	27	21
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll a Maximum Sample
Whole Water Phytoplankton, May 13, 1997 (W9706)

Species	Group	Parameter	Whole Water Phytoplankton N04 Chl *a* Max	Whole Water Phytoplankton N18 Chl *a* Max
CHAETOCEROS SP#1 DIAM <10 MICRONS	CD	10^6 cells/L	1.16	0.82
		%	28	27
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	10^6 cells/L	0.88	0.97
		%	21	32
THALASSIOSIRA GRAVIDA	CR	10^6 cells/L	0.26	
		%	6	
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L	1.60	0.84
		%	38	28
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, June 17 - 20, 1997 (W9707)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CHAETOCEROS SP#1 DIAM <10 MICRONS	CD	10^6 cells/L		0.18				0.50				
		%		6				7				
CRYPTOMONAS SP#1 LENGTH <10 MICRONS	CR	10^6 cells/L		0.18				0.68		0.02	0.05	
		%		6				9		7	7	
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6 cells/L	0.06	0.24	0.14	0.24		0.81		0.04	0.05	
		%	7	9	10	7		11		12	7	
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	10^6 cells/L					0.02					0.07
		%					9					6
RHIZOSOLENIA FRAGILISSIMA	CD	10^6 cells/L			0.09	0.45			0.27			0.09
		%			7	14			6			8
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L	0.70	1.71	0.82	1.65	0.20	5.00	3.57	0.23	0.57	0.74
		%	79	60	59	51	80	66	79	67	81	64
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, July 8, 1997 (W9708)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CRYPTOMONAS SP#1 LENGTH <10 MICRONS	CR	10^6 cells/L								0.09		
		%								13		
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6 cells/L								0.10		
		%								15		
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L								0.44		
		%								63		
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, July 22, 1997 (W9709)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CRYPTOMONAS SP#1 LENGTH <10 MICRONS	CR	10^6 cells/L								0.14		
		%								17		
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	10^6 cells/L								0.04		
		%								5		
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	10^6 cells/L								0.57		0.64
		%								69		89

Group Definitions:	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

APPENDIX F-1

ABUNDANCE OF PREVALENT SPECIES IN SCREENED SURFACE SAMPLES

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, February 4 - 7, 1997 (W9701)

Species	Group	Parameter	Station Cast													
			F23	F30	F31	F13	F24	F25	N04	N16	1N18	3N18	F06	F27	F01	F02
CERATIUM FUSUS	DF	10^6cells/L				1.80E-06	1.38E-05	1.70E-06			1.35E-05	1.02E-05			1.43E-05	
		%				9	7	5			11	6			10	
CERATIUM LINEATUM	DF	10^6cells/L				1.20E-06										
		%				6										
CERATIUM LONGIPES	DF	10^6cells/L	3.70E-06	3.00E-06		1.20E-06		2.40E-06			1.25E-05	1.02E-05			1.61E-05	
		%	6	11		6		7			11	6			12	
CERATIUM MACROCEROS	DF	10^6cells/L														
		%														
CERATIUM TRIPOS	DF	10^6cells/L	2.92E-05	6.00E-06	3.02E-05	7.70E-06	5.46E-05	2.10E-05	1.63E-04		5.90E-05	5.43E-05		1.31E-04	6.49E-05	
		%	47	23	19	41	26	65	7		50	34		17	47	
DINOPHYSIS NORVEGICA	DF	10^6cells/L													2.98E-05	
		%													22	
NITZSCHIA PUNGENS	PD	10^6cells/L	2.38E-05	1.45E-05	1.22E-04	7.10E-06	1.11E-04	6.60E-06	8.53E-04		2.45E-05	6.63E-05		5.27E-04		
		%	39	55	77	37	53	20	37		21	41		70		
PHAEOCYSTIS POUCHETII	HP	10^6cells/L							1.19E-03			1.35E-05	1.21E+00	6.60E-05		9.23E-02
		%							52			8	100	9		100

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	O	Other
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, February 25 - 28, 1997 (W9702)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CERATIUM FUSUS	DF	10^6cells/L							5.78E-05		1.74E-05				
		%							7		7				
CERATIUM LONGIPES	DF	10^6cells/L							0.00006		0.00002				
		%							7		10				
CERATIUM TRIPOS	DF	10^6cells/L	5.10E-05	2.10E-06	2.03E-05	2.13E-05	3.05E-05		2.87E-04	5.12E-05	1.05E-04		1.63E-04		
		%	38	6	18	11	13		34	17	42		18		
NITZSCHIA PUNGENS	PD	10^6cells/L	4.29E-05	5.20E-06	1.62E-05	1.03E-05	6.30E-05		2.36E-04	2.06E-05			5.76E-04		
		%	32	14	14	5	27		28	7			64		
PHAEOCYSTIS POUCHETII	HP	10^6cells/L			3.06E-05		2.76E-05	4.05E-04				1.28E-02		5.19E+00	2.83E+00
		%			27		12	87				99		100	100
PROTOPERIDINIUM SP.#1 10-30W 10-40L	DF	10^6cells/L	2.51E-05	2.62E-05	3.29E-05	1.42E-04	8.15E-05	2.52E-05	1.88E-04	1.86E-04	8.58E-05		6.04E-05		
		%	19	72	29	73	35	5	22	62	35		7		
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	O	Other													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, March 18, 1997 (W9703)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
PHAEOCYSTIS POUCHETI	HP	10^6cells/L							3.83E-01		5.05E-02				
		%							100		99				
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	O	Other													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, March 31 - April 6, 1997 (W9704)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
PHAEOCYSTIS POUCHETII	HP	10^6 cells/L	8.59E-01	3.98E-01	2.01E-01	1.15E+00	1.57E+00	5.74E-01	6.29E-01	3.70E+00	5.97E-01	6.03E-01	5.41E-03	1.45E+00	1.02E+00
		%	100	100	100	100	100	100	100	100	100	100	96	100	100
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	HP	Haptophyte													
	CR	Cryophyte													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, April 23, 1997 (W9705)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Surface	N18 Surface
PHAEOCYSTIS POUCHETII	HP	10^6 cells/L	1.13E-01	1.55E-01
		%	99	99
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, May 13, 1997 (W9706)

Species	Group	Parameter	Screened Phytoplankton N04 Surface	Screened Phytoplankton N18 Surface
CERATIUM FUSUS	DF	10^6 cells/L	4.69E-05	2.21E-05
		%	16	5
CERATIUM LINEATUM	DF	10^6 cells/L	1.66E-05	
		%	6	
CERATIUM LONGIPES	DF	10^6 cells/L	1.25E-04	2.14E-04
		%	44	51
CERATIUM TRIPOS	DF	10^6 cells/L	5.77E-05	1.35E-04
		%	20	32
DINOPHYSIS NORVEGICA	DF	10^6 cells/L	1.74E-05	
		%	6	
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, June 17 - 20, 1997 (W9707)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM FUSUS	DF	10^6 cells/L	4.01E-04	2.35E-04	5.07E-05	2.86E-04	3.48E-04	2.34E-04	4.60E-04	2.64E-04	4.82E-05	8.01E-05	1.26E-04	1.09E-04	4.30E-04
		%	48	11	6	21	22	13	39	29	17	17	19	11	29
CERATIUM LINEATUM	DF	10^6 cells/L		1.79E-04					8.74E-05						
		%		8					7						
CERATIUM LONGIPES	DF	10^6 cells/L	1.76E-04	1.25E-03	5.83E-04	4.21E-04	3.62E-04	2.56E-04	2.78E-04	3.80E-04	4.64E-05	1.06E-04	2.98E-04	3.92E-04	5.86E-04
		%	21	58	71	31	23	14	24	42	16	23	44	39	40
CERATIUM TRIPOS	DF	10^6 cells/L	1.38E-04	4.09E-04	1.39E-04	4.39E-04	2.00E-04	2.08E-04	1.40E-04	1.74E-04	2.91E-05	6.30E-05	6.40E-05	3.18E-04	1.13E-04
		%	16	19	17	32	13	12	12	19	10	14	9	32	8
DINOPHYSIS NORVEGICA	DF	10^6 cells/L				1.42E-04	4.99E-04	9.82E-04	7.82E-05		1.02E-04	1.56E-04			
		%				10	32	54	7		36	34			
DINOPHYSIS PUNCTATA	DF	10^6 cells/L								8.00E-05			1.80E-04	1.66E-04	2.71E-04
		%								9			26	17	19
PROTOPERIDINIUM SP.#1 10-30W 10-40L	DF	10^6 cells/L									3.09E-05				
		%									11				

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, July 8, 1997 (W9708)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM FUSUS	DF	10^6 cells/L											8.80E-05		1.35E-04
		%											14		13
CERATIUM LONGIPES	DF	10^6 cells/L											2.79E-04		0.00
		%											44		23
CERATIUM TRIPOS	DF	10^6 cells/L											2.62E-04		5.28E-04
		%											41		52

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Surface Sample
Screened Phytoplankton, July 22, 1997 (W9709)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	10^6 cells/L											2.82E-04		4.70E-04
		%											82		93
CERATIUM TRIPOS	DF	10^6 cells/L											4.37E-05		0.00
		%											13		7

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

APPENDIX F-2

ABUNDANCE OF PREVALENT SPECIES IN SCREENED CHLOROPHYLL *a* MAXIMUM SAMPLES

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, February 4 - 7, 1997 (W9701)

Species	Group	Parameter	Station Cast													
			F23	F30	F31	F13	F24	F25	N04	N16	1N18	3N18	F06	F27	F01	F02
CERATIUM FUSUS	DF	10^6cells/L				1.60E-06	8.10E-06	6.70E-06			1.34E-05					
	DF	%				6	5	13			10					
CERATIUM LONGIPES	DF	10^6cells/L		5.60E-06	2.60E-06	2.10E-06		4.60E-06			1.49E-05					
	DF	%		10	8	8		9			11					
CERATIUM TRIPOS	DF	10^6cells/L	3.91E-05	2.47E-05	1.42E-05	1.14E-05	3.60E-05	3.22E-05	7.75E-05		5.28E-05	4.25E-05		1.82E-04		
	DF	%	66	45	45	46	24	64	14		40	17		6		
DINOPHYSIS NORVEGICA	DF	10^6cells/L	4.70E-06			1.60E-06										
	DF	%	8			6										
NITZSCHIA PUNGENS	PD	10^6cells/L	7.40E-06	2.12E-05	1.05E-05	6.70E-06	9.28E-05	2.80E-06	3.81E-04		4.61E-05	1.08E-04		2.78E-03		
	PD	%	13	39	33	27	62	6	67		35	42		92		
PHAEOCYSTIS POUCHETII	HP	10^6cells/L							8.00E-05			7.50E-05	4.29E-03		3.59E-02	1.14E-02
	HP	%							14			29	96		100	99
Group Definitions:	CD	Centric Diatom														
	DF	Dinoflagellate														
	MF	Microflagellate														
	O	Other														
	PD	Pennate Diatom														

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, February 25 - 28, 1997 (W9702)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CERATIUM FUSUS	DF	10^6cells/L		1.10E-05	4.30E-06	9.80E-06	1.54E-05	1.06E-05			2.80E-05				
		%		8	6	5	5	7			9				
CERATIUM LONGIPES	DF	10^6cells/L			5.80E-06		1.54E-05			4.28E-05	2.30E-05				
		%			8		5			5	8				
CERATIUM TRIPOS	DF	10^6cells/L		2.96E-05	2.69E-05	2.03E-05	6.57E-05	5.78E-05	2.62E-04	1.74E-04	7.78E-05		2.47E-04		
		%		22	39	10	22	39	17	21	26		18		
NITZSCHIA PUNGENS	PD	10^6cells/L		1.35E-05		1.89E-05	1.12E-04		9.88E-04	4.55E-04	1.61E-05		9.90E-04		
		%		10		10	38		65	54	5		71		
PHAEOCYSTIS POUCHETII	HP	10^6cells/L	3.83E-04								4.10E-05	4.59E-02		2.55E+00	2.58E+00
		%	87								14	100		100	100
PROTOPERIDINIUM SP.#1 10-30W 10-40L	DF	10^6cells/L		6.85E-05	2.78E-05	1.32E-04	7.51E-05	6.04E-05	9.92E-05	1.05E-04	9.86E-05				
		%		51	40	68	25	40	7	13	32				
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	O	Other													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, March 18, 1997 (W9703)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CERATIUM TRIPOS	DF	10^6cells/L									9.32E-05				
		%									6				
NITZSCHIA PUNGENS	PD	10^6cells/L									1.68E-04				
		%									10				
PHAEOCYSTIS POUCHETII	HP	10^6cells/L							2.37E-01		1.24E-03				
		%							99		75				

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	O	Other
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, March 31 - April 6, 1997 (W9704)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
PHAEOCYSTIS POUCHETII	HP	10^6 cells/L	1.51E+00	7.79E-01	7.19E-01	4.25E-01	7.36E-01	7.88E-01	1.23E+00	2.57E+00	1.21E+00	4.23E+00	4.93E-01	3.27E+00	3.82E+00
		%	100	100	100	100	100	100	100	100	100	100	100	100	100
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	HP	Haptophyte													
	CR	Cryophyte													
	PD	Pennate Diatom													

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, April 23, 1997 (W9705)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
PHAEOCYSTIS POUCHETII	HP	10^6 cells/L	7.04E-01	1.24E+00
		%	100	100

Group Definitions:	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, May 13, 1997 (W9706)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
CERATIUM FUSUS	DF	10^6 cells/L		9.11E-05
		%		13
CERATIUM LINEATUM	DF	10^6 cells/L	6.63E-05	
		%	16	
CERATIUM LONGIPES	DF	10^6 cells/L	1.22E-04	1.66E-04
		%	29	24
CERATIUM TRIPOS	DF	10^6 cells/L	8.86E-05	1.62E-04
		%	21	23
DINOPHYSIS NORVEGICA	DF	10^6 cells/L		8.53E-05
		%		12
NITZSCHIA PUNGENS	PD	10^6 cells/L	2.89E-05	9.05E-05
		%	7	13
PROTOPERIDINIUM DEPRESSUM	DF	10^6 cells/L	7.34E-05	
		%	18	
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, June 17 - 20, 1997 (W9707)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM FUSUS	DF	10^6 cells/L		7.49E-05		4.47E-04		4.37E-05	2.28E-04	4.18E-04	1.84E-04	2.28E-04
		%		11		36		12	21	7	5	10
CERATIUM LINEATUM	DF	10^6 cells/L				1.06E-04						
		%				9						
CERATIUM LONGIPES	DF	10^6 cells/L	1.01E-03	2.02E-04	5.29E-04	3.01E-04	3.60E-05	6.37E-05	3.66E-04	4.37E-03	2.18E-03	9.59E-04
		%	28	29	30	24	22	17	33	73	61	42
CERATIUM TRIPOS	DF	10^6 cells/L		8.33E-05	1.33E-04	1.60E-04	2.46E-05	5.10E-05	2.06E-04		9.15E-04	5.03E-04
		%		12	8	13	15	14	19		26	22
DINOPHYSIS NORVEGICA	DF	10^6 cells/L	2.30E-03	2.02E-04	9.69E-04	9.17E-05	1.14E-05	1.16E-04	2.32E-04	8.49E-04	2.64E-04	5.13E-04
		%	64	29	55	7	7	31	21	14	7	22
DINOPHYSIS PUNCTATA	DF	10^6 cells/L					9.00E-06	1.91E-05				
		%					6	5				
PROTOPERIDINIUM SP.#1 10-30W 10-40L	DF	10^6 cells/L		6.22E-05			2.64E-05	2.64E-05				
		%		9			16	7				
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	10^6 cells/L					2.94E-05					
		%					18					
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, July 8, 1997 (W9708)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	10^6 cells/L								2.89E-03		
		%								92		
CERATIUM TRIPOS	DF	10^6 cells/L								2.03E-04		
		%								6		
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

Abundance of Prevalent Species (> 5% Total Count) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, July 22, 1997 (W9709)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	10^6 cells/L								6.19E-03		1.38E-03
		%								100		92
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

APPENDIX G

ZOOPLANKTON SPECIES DATA

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, February 4 - 7, 1997 (W9701)

Species		Life Stage	Group	Parameter	F23	F30	F31	F13	F24	F25	N04	N16	N18a	N18b	F06	F27	F01	F02
					Station Cast													
CENTROPAGES SPP.			C	ind/m3														
				%														
CIRRIPEDE SPP.		N	B	ind/m3		958.85	163.01											
				%		10	5											
COPEPOD SPP.		N	C	ind/m3	3246.17	4314.82	1314.24	2255.14	14277.53	1590.18	39335.63		9806.19	15257.50	23465.01	5946.79	21228.31	14082.50
				%	53	43	43	53	62	43	69		49	64	48	61	53	48
GASTROPODA;MOLLUSCA			OZ	ind/m3												1235.70		
				%												13		
MICROSETELLA NORVEGICA			C	ind/m3									1462.80					
				%									7					
OIKOPLEURA DIOICA			OZ	ind/m3											5245			
				%											11			
OITHONA SIMILIS	CLAUS	C	C	ind/m3	769.46	1472.52	387.14	216.40	3789.04	294.48	7696.10		2763.07	6018.23	12146.59	1197.08	9777.89	7310.00
				%	12	15	13	5	16	8	13		14	25	25	12	24	25
OITHONA SIMILIS	CLAUS	F	C	ind/m3	312.59				1702.32						2898.62		3087.75	2580.00
				%	5				7						6		8	9
POLYCHAETE SPP.		L	OZ	ind/m3		1096												
				%		11												
PSEUDOCALANUS NEWMANI		C	C	ind/m3	480.91		733.53	2938.52		647.85			1300.27		2484.53			
				%	8		24	69		17			6		5			

Life Stage Definitions:			Group Definitions:	
	C	Copepodite stages I-V		B
	F	Copepoda adult female		C
	L	Larva		OZ
	M	Copepoda adult male		
	N	Nauplii		
	T	Trochophore (larval stage of polychaete)		
	Y	Cypris Larva of Barnacle		

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, February 25 - 28, 1997 (W9702)

Species	Life Stage	Group	Parameter	Station Cast F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CIRRIPEDE SPP.	N	B	ind/m3	2192.59	6511.03	4905.73	5760.00	2777.46	22599.16	948.90	4912.94	3191.23				
			%	21	26	29	45	24	60	6	25	16				
COPEPOD SPP.	N	C	ind/m3	4852.94	14077.90	5456.37	2713.39	2900.00	4867.51	7496.28	4699.33	6259.73	4836.00	13824.66	10015.11	2472.01
			%	47	55	32	21	25	13	47	24	31	30	56	46	40
GASTROPODA;MOLLUSCA		OZ	ind/m3											3495.89		
			%											14		
OIKOPLEURA DIOICA		OZ	ind/m3							996.34						
			%							6						
OITHONA SIMILIS CLAUS	C	C	ind/m3			1551.81	1475.70	2491.55		4981.70	4485.73	6075.62	5146.00	4926.03	3808.56	1977.61
			%			9	11	22		31	23	30	32	20	17	32
OITHONA SIMILIS CLAUS	F	C	ind/m3										868			405
			%										5			6
POLYCHAETE SPP.	L	OZ	ind/m3						3754.94							
			%						10							
POLYCHAETE SPP.	T	OZ	ind/m3	672.40												
			%	7												
PSEUDOCALANUS NEWMANI	C	C	ind/m3			1051.23		735.21					2046.00		3103.27	719.13
			%			6		6					13		14	12

Life Stage Definitions:

- C Copepodite stages I-V
- F Copepoda adult female
- L Larva
- M Copepoda adult male
- N Nauplii
- T Trochophore (larval stage of polychaete)
- Y Cypris Larva of Barnacle

Group Definitions:

- B
- C
- OZ

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, March 18, 1997 (W9703)

Species	Life Stage	Group	Parameter	Station Cast F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CIRRIPEDE SPP.	N	B	ind/m3									1482.77				
			%									5				
COPEPOD SPP.	N	C	ind/m3							8993.31		8261.16				
			%							43		31				
GASTROPODA;MOLLUSCA		OZ	ind/m3							3925.65		5719.26				
			%							19		21				
OITHONA SIMILIS CLAUS	C	C	ind/m3							4211.15		5931.09				
			%							20		22				

Life Stage Definitions:
- C Copepodite stages I-V
- F Copepoda adult female
- L Larva
- M Copepoda adult male
- N Nauplii
- T Trochophore (larval stage of polychaete)
- Y Cypris Larva of Barnacle

Group Definitions:
- B
- C
- OZ

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, March 31 - April 6, 1997 (W9704)

Species		Life Stage	Group	Parameter	Station Cast F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
COPEPOD SPP.		N	C	ind/m3	4295.35	17759.16	9917.65	12781.89	5986.52	11548.48	13122.95	6455.85	24298.43	19376.15	32059.81	10379.67	7610.48
				%	40	47	40	39	47	39	36	39	34	40	47	46	40
COPEPOD SPP.			C	ind/m3	704.16												
				%	7												
GASTROPODA;MOLLUSCA		L	OZ	ind/m3				5865.66		7129.93	4285.05	3021.89	30960.90	14144.59	12919.63	2801.87	
				%				18		24	12	18	44	29	19	12	
OIKOPLEURA DIOICA			OZ	ind/m3							3347.69				5502.80		
				%							9				8		
OITHONA SIMILIS	CLAUS	C	C	ind/m3	985.82	5137.87	3206.46	4377.36	1402.25	2811.80	6427.57	1510.94	8099.48	6200.37	6699.07	3183.95	2264.28
				%	9	14	13	13	11	9	18	9	11	13	10	14	12
OITHONA SIMILIS	CLAUS	F	C	ind/m3			1640.51		862.92		2142.52						
				%			7		7		6						
POLYCHAETE SPP.		L	OZ	ind/m3	1267.48	1898.78	1565.95		701.12								
				%	12	5	6		5								
POLYCHAETE SPP.		T	OZ	ind/m3		2792.32											
				%		7											
PSEUDOCALANUS NEWMANI		C	C	ind/m3	915.40		1416.81									1146.22	5660.69
				%	9		6									5	30

Life Stage Definitions:

C	Copepodite stages I-V
F	Copepoda adult female
L	Larva
M	Copepoda adult male
N	Nauplii
T	Trochophore (larval stage of polychaete)
Y	Cypris Larva of Barnacle

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, April 23, 1997 (W9705)

Species	Life Stage	Group	Parameter	Station Cast												
				F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
COPEPOD SPP.	N	C	ind/m3							11343.87		16036.04				
			%							38		35				
GASTROPODA;MOLLUSCA	L	OZ	ind/m3							1922.69		6666.67				
			%							6		14				
OITHONA SIMILIS CLAUS	C	C	ind/m3							5768.07		9909.91				
			%							19		21				
OITHONA SIMILIS CLAUS	F	C	ind/m3							1922.69						
			%							6						
PSEUDOCALANUS NEWMANI	C	C	ind/m3							2114.96						
			%							7						

Life Stage Definitions:

C	Copepodite stages I-V
F	Copepoda adult female
L	Larva
M	Copepoda adult male
N	Nauplii
T	Trochophore (larval stage of polychaete)
Y	Cypris Larva of Barnacle

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, May 13, 1997 (W9706)

Species	Life Stage	Group	Parameter	Station Cast F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
BIVALVIA SPP.	L	OZ	ind/m3							3800.48		2880.67				
			%							7		11				
COPEPOD SPP.	N	C	ind/m3							19762.47		10461.38				
			%							36		41				
GASTROPODA;MOLLUSCA	L	OZ	ind/m3							3610.45		1667.76				
			%							7		7				
OIKOPLEURA DIOICA		OZ	ind/m3									1516.14				
			%									6				
OITHONA SIMILIS CLAUS	C	C	ind/m3							12921.62		3411.32				
			%							24		13				

Life Stage Definitions:		
	C	Copepodite stages I-V
	F	Copepoda adult female
	L	Larva
	M	Copepoda adult male
	N	Nauplii
	T	Trochophore (larval stage of polychaete)
	Y	Cypris Larva of Barnacle

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, June 17 - 20, 1997 (W9707)

Species	Life Stage	Group	Parameter	Station Cast F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
ACARTIA HUDSONICA	C	C	ind/m^3									17036.12				
			%									15				
BIVALVIA SPP.	L	OZ	ind/m^3	10244.69	7929.86	10848.93	41221.45		3704.92		7761.13		5724.22	22297.77	37207.94	30375.31
			%	27	16	11	30		6		8		6	25	36	27
CENTROPAGES SPP.		C	ind/m^3											4546.15		
			%											5		
COPEPOD SPP.	N	C	ind/m^3	8519.27	21540.82	39262.80	18533.67	18542.64	22822.29	45520.61	51677.75	50106.24	36134.16	31823.04	34107.28	34678.48
			%	22	42	39	13	42	38	46	52	43	37	35	33	31
EURYTEMORA HERDMANI	C	C	ind/m^3					3708.53				9353.16	6081.99			
			%					8				8	6			
EVADNE SPP.		OZ	ind/m^3							9345.29						
			%							9						
GASTROPODA;MOLLUSCA	L	OZ	ind/m^3	2803.81								9687.21	7155.28			
			%	7								8	7			
MICROSETELLA NORVEGICA		C	ind/m^3	2803.81												
			%	7												
OITHONA SIMILIS CLAUS	C	C	ind/m^3	4637.07	5444.38	11193.34	7030.01	3280.62	5779.67	9345.29	10600.56			10607.68	9689.57	10125.11
			%	12	11	11	5	8	10	9	11			12	9	9
PSEUDOCALANUS NEWMANI	C	C	ind/m^3	2480.29	3669.04	18425.96	27161.42		3260.33		12304.23			7143.95	8914.40	8100.08
			%	6	7	18	20		5		12			8	9	7
TEMORA LONGICORNIS	C	C	ind/m^3	3666.52	3905.75	5166.16	28439.60	3423.26	9632.79				10375.16		5426.16	17212.68
			%	10	8	5	20	8	16				11		5	15

Life Stage Definitions:
- C Copepodite stages I-V
- F Copepoda adult female
- L Larva
- M Copepoda adult male
- N Nauplii
- T Trochophore (larval stage of polychaete)
- Y Cypris Larva of Barnacle

Group Definitions:
- B Barnacle
- C Copepod
- OZ Other Zooplankton

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, July 8, 1997 (W9708)

Species	Life Stage	Group	Parameter	F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
				Station Cast												
COPEPOD SPP.	N	C	ind/m^3											59484.25		44581.46
			%											56		49
OITHONA SIMILIS CLAUS	C	C	ind/m^3											16800.89		14860.49
			%											16		16
PSEUDOCALANUS NEWMANI	C	C	ind/m^3											7946.37		6811.06
			%											7		8
TEMORA LONGICORNIS	C	C	ind/m^3													6811.06
			%													8

Life Stage Definitions:

C	Copepodite stages I-V
F	Copepoda adult female
L	Larva
M	Copepoda adult male
N	Nauplii
T	Trochophore (larval stage of polychaete)
Y	Cypris Larva of Barnacle

Group Definitions:

B	Barnacle
C	Copepod
OZ	Other Zooplankton

Abundance of Prevalent Species (> 5% Total Count)
Zooplankton, July 22, 1997 (W9709)

Species	Life Stage	Group	Parameter	Station Cast F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
BIVALVIA SPP.	L	OZ	ind/m^3											16781.52		
			%											16		
CALANUS FINMARCHICUS	C	C	ind/m^3													2662.00
			%													6
COPEPOD SPP.	N	C	ind/m^3											39639.11		20086.00
			%											39		44
OITHONA SIMILIS CLAUS	C	C	ind/m^3											15334.84		13310.00
			%											15		29
PSEUDOCALANUS NEWMANI	C	C	ind/m^3											13888.16		2299.00
			%											14		5

Life Stage Definitions:
- C Copepodite stages I-V
- F Copepoda adult female
- L Larva
- M Copepoda adult male
- N Nauplii
- T Trochophore (larval stage of polychaete)
- Y Cypris Larva of Barnacle

Group Definitions:
- B Barnacle
- C Copepod
- OZ Other Zooplankton

APPENDIX H-1

ORGANIC CARBON CONTENT OF PREVALENT SPECIES IN WHOLE WATER SURFACE SAMPLES

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, February 4 - 7, 1997 (W9701)

Species	Group	Parameter	Station Cast														
			F23	F30	F31	F13	F24	F25	N04	N10	N16	N18a	N18b	F27	F06	F01	F02
CERATIUM LONGIPES	DF	µg/L		4.63					4.63					4.63	4.63		
		%		28					13					16	12		
CORETHRON CRIOPHILUM	CD	µg/L														2.88	
		%														7	
COSCINODISCUS SP#3 DIAM >100 MICRONS	CD	µg/L							5.73								
		%							16								
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	µg/L			0.53	0.67	1.37		1.96			0.80	1.80			2.02	
		%			6	6	10		5			5	9			5	
CYLINDROTHECA CLOSTERIUM	PD	µg/L				0.58											
		%				5											
DITYLUM BRIGHTWELLII	CD	µg/L							3.27					1.63			
		%							9					5			
GUINARDIA FLACCIDA	CD	µg/L														4.32	
		%														11	
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	µg/L	1.21		0.81	1.16	1.77	2.07	3.44			3.24	2.63	4.96	5.48		2.53
		%	11		9	10	13	15	9			22	13	17	14		7
PLEUROSIGMA ANGULATUM	PD	µg/L															1.83
		%															5
RHIZOSOLENIA DELICATULA	CD	µg/L													10.45	10.02	13.25
		%													28	26	36
RHIZOSOLENIA IMBRICATA	CD	µg/L												1.94			
		%												7			
RHIZOSOLENIA SETIGERA	CD	µg/L															3.95
		%															11
THALASSIOSIRA GRAVIDA	CD	µg/L							5.07				1.04				
		%							14				5				
THALASSIOSIRA SP#2 DIAM >20 MICRONS	CD	µg/L			0.62			1.00				0.75					
		%			7			7				5					
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	µg/L	6.11	6.85	5.46	6.77	6.35	7.07	7.91			6.35	12.31	7.42	7.52	11.29	8.65
		%	56	42	59	61	47	51	22			43	59	25	19	29	24
UNID. MICRO-PHYTOFLAG LENGTH >10 MICRONS	MF	µg/L	1.15	1.54		1.15	1.15	0.77				1.15			3.07		
		%	11	9		10	9	6				8			8		

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, February 25 - 28, 1997 (W9702)

Species	Group	Parameter	Station Cast													
			F23	F30	F31	F13	F24	F25	N04	N10	N16	N18	F27	F06	F01	F02
BIDDULPHIA SPP.	CD	µg/L						6.87								
		%						23								
CERATIUM LONGIPES	DF	µg/L							4.63		4.63		15.45			9.27
		%							5		8		22			11
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	µg/L					2.40						5.59		4.80	4.80
		%					5						8		8	6
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	µg/L		1.59												
		%		6												
FRAGILARIA SP#2 LENGTH 30-60 MICRONS	PD	µg/L													4.53	
		%													7	
GUINARDIA FLACCIDA	CD	µg/L													4.32	4.32
		%													7	5
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	µg/L	1.37		0.76									1.87	3.34	8.70
		%	6		6									13	5	11
PLEUROSIGMA ANGULATUM	PD	µg/L			0.92									0.92		
		%			7									7		
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	µg/L										7.82	4.34			5.21
		%										11	6			6
RHIZOSOLENIA DELICATULA	CD	µg/L													27.71	14.50
		%													45	18
THALASSIOSIRA GRAVIDA	CD	µg/L	10.59	13.12	1.02	37.78	29.08	11.48	70.09		35.21	48.47	31.32	0.75		
		%	49	50	8	67	61	39	82		62	69	44	5		
THALASSIOSIRA SP#2 DIAM >20 MICRONS	CD	µg/L			0.75											
		%			6											
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	µg/L	5.52	6.51	6.77	9.77	6.60	6.35	4.82		8.35	8.25	4.89	7.53	8.00	11.80
		%	25	25	52	17	14	22	6		15	12	7	54	13	15
UNID. MICRO-PHYTOFLAG LENGTH >10 MICRONS	MF	µg/L			0.77											
		%			6											
Group Definitions:	CD	Centric Diatom														
	DF	Dinoflagellate														
	MF	Microflagellate														
	HP	Haptophyte														
	CR	Cryophyte														
	PD	Pennate Diatom														

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, March 18, 1997 (W9703)

Species	Group	Parameter	Wholewater Phytoplankton	
			N04 Surface	N18 Surface
CERATIUM LONGIPES	DF	ug/L		4.63
		%		11
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L	12.15	12.79
		%	25	32
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L	4.50	3.39
		%	9	8
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	ug/L	5.21	2.61
		%	11	6
THALASSIOSIRA GRAVIDA	CD	ug/L	12.98	3.43
		%	27	8
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L	7.93	7.02
		%	16	17
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, March 31 - April 6, 1997 (W9704)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
BLUE GREEN TRICHOME SPP.	CY	ug/L		6.40											
		%		9											
CERATIUM LONGIPES	DF	ug/L						4.63	17.38		9.27	4.63	5.79		
		%						6	17		12	20	8		
CHAETOCEROS CRINITUS C. CURVISETUM	CD	ug/L			6.79										
		%			8										
CHAETOCEROS DECIPIENS	CD	ug/L			17.55			6.67							
		%			19			8							
CHAETOCEROS SP#1 DIAM <10 MICRONS	CD	ug/L	5.79												
		%	5												
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L	6.74	12.24	32.97	6.74	90.31	32.37	47.95	138.53	39.96	3.84	22.38	15.98	
		%	6	17	37	10	66	40	47	75	50	16	31	23	
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	ug/L		13.76											
		%		19											
FRAGILARIA SP#2 LENGTH 30-60 MICRONS	PD	ug/L										1.22			
		%										5			
GUINARDIA FLACCIDA	CD	ug/L												4.32	
		%												6	
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L										1.37			
		%										6			
GYMNODINIUM SP.#3 41-70UM W 51-70UM L	DF	ug/L												4.04	
		%												6	
PHAEOCYSTIS POUCHETII	HP	ug/L	65.15	10.52		11.82									
		%	59	14		18									
PLEUROSIGMA ANGULATUM	PD	ug/L		4.12											
		%		6											
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	ug/L									7.82				
		%									10				
THALASSIONEMA NITZSCHIOIDES	PD	ug/L		4.69											
		%		6											
THALASSIOSIRA GRAVIDA	CD	ug/L			8.84		13.00	6.26	6.34	21.77			3.91	8.95	
		%			10		10	8	6	12			5	13	
THALASSIOSIRA SP#2 DIAM >20 MICRONS	CD	ug/L	12.55	7.30		5.25									
		%	11	10		8									
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L			12.31		21.45	14.97	10.53	9.77	9.77	9.64	16.68	24.36	17.26
		%			14		16	18	10	5	12	41	23	35	81

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, April 23, 1997 (W9705)

Species	Group	Parameter	Wholewater Phytoplankton	
			N04 Surface	N18 Surface
CERATIUM LONGIPES	DF	ug/L	11.58	55.61
		%	13	49
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L	35.96	6.07
		%	40	5
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L	10.37	10.75
		%	11	9
PROROCENTRUM MINIMUM	DF	ug/L	4.53	6.96
		%	5	6
THALASSIOSIRA GRAVIDA	CD	ug/L	9.32	
		%	10	
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L	6.11	7.28
		%	7	6
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, May 13, 1997 (W9706)

Species	Group	Parameter	Wholewater Phytoplankton N04 Surface	Wholewater Phytoplankton N18 Surface
CERATIUM LONGIPES	DF	ug/L	4.63	8.58
		%	13	13
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L	5.27	16.87
		%	14	25
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L	4.25	7.12
		%	12	10
RHIZOSOLENIA FRAGILISSIMA	CD	ug/L		5.80
		%		8
RHIZOSOLENIA IMBRICATA	CD	ug/L		3.60
		%		5
THALASSIOSIRA GRAVIDA	CD	ug/L	4.47	
		%	12	
THALASSIOSIRA SP#2 DIAM >20 MICRONS	CD	ug/L	3.24	
		%	9	
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L	8.04	9.77
		%	22	14
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, June 17 - 20, 1997 (W9707)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATAULINA PELAGICA	CD	ug/L				5.05									
		%				10									
CERATIUM FUSUS	DF	ug/L								2.79					
		%								6					
CERATIUM LONGIPES	DF	ug/L	4.63	4.63	27.80	4.63				4.63			13.90	13.90	4.63
		%	12	14	53	9				10			21	25	8
CHAETOCEROS SP#1 DIAM <10 MICRONS	CD	ug/L									19.76				
		%									6				
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L					23.18	59.14			22.64				
		%					10	17			7				
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	ug/L	4.36	2.11	2.68		19.77	35.05			43.56	38.67		3.17	
		%	11	7	5		8	10			14	15		6	
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L	10.62	6.02		4.80			16.94	6.57	16.01		3.94	7.67	8.70
		%	27	19		9			6	14	5		6	14	15
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	ug/L	2.81												
		%	7												
RHIZOSOLENIA DELICATULA	CD	ug/L							45.83			25.05	7.04		3.41
		%							16			9	11		6
RHIZOSOLENIA FRAGILISSIMA	CD	ug/L				14.40	110.96	115.80	122.06		49.55	42.25	16.43		20.34
		%				28	46	34	43		16	16	25		35
THALASSIOSIRA GRAVIDA	CD	ug/L										24.61			
		%										9			
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L	11.93	15.36	19.04	12.82	45.18	64.21	38.32	22.72	114.84	102.15	14.59	25.38	15.86
		%	30	48	36	25	19	19	13	50	37	39	23	47	27
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	HP	Haptophyte													
	CR	Cryophyte													
	PD	Pennate Diatom													

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, July 8, 1997 (W9708)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	ug/L											13.90		23.17
		%											26		9
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L											4.65		
		%											9		
RHIZOSOLENIA FRAGILISSIMA	CD	ug/L											2.82		172.13
		%											5		65
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L											26.40		30.08
		%											50		11
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	HP	Haptophyte													
	CR	Cryophyte													
	PD	Pennate Diatom													

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Whole Water Phytoplankton, July 22, 1997 (W9709)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	ug/L											9.27		4.63
		%											36		19
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	ug/L											1.86		1.49
		%											7		6
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L											2.23		
		%											9		
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L											10.28		15.10
		%											40		62
UNID. MICRO-PHYTOFLAG LENGTH >10 MICRONS	MF	ug/L													1.54
		%													6
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	HP	Haptophyte													
	CR	Cryophyte													
	PD	Pennate Diatom													

APPENDIX H-2

ORGANIC CARBON CONTENT OF PREVALENT SPECIES IN WHOLE WATER CHLOROPHYLL *a* MAXIMUM SAMPLES

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, February 4 - 7, 1997 (W9701)

Species	Group	Parameter	Station Cast														
			F23	F30	F31	F13	F24	F25	N04	N10	N16	N18a	N18b	F27	F06	F01	F02
CERATIUM LONGIPES	DF	µg/L					4.63							9.27	9.27		
		%					27							39	21		
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	µg/L													2.40		3.52
		%													5		9
CORETHRON CRIOPHILUM	CD	µg/L						1.44						1.44		4.31	
		%						10						6		9	
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	µg/L	1.16	1.80		0.71	1.04		1.37			1.00	2.10			2.41	
		%	9	17		8	6		7			7	11			5	
CYLINDROTHECA CLOSTERIUM	PD	µg/L					1.01		1.23			1.23					
		%					6		6			8					
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	µg/L	1.42	1.26	1.11	0.96	1.67	1.01	4.40			2.83	3.89	1.77	4.45	2.53	2.53
		%	12	12	10	10	10	7	22			19	20	8	10	5	7
PLEUROSIGMA ANGULATUM	PD	µg/L			0.92			0.92								2.75	
		%			9			6								6	
RHIZOSOLENIA DELICATULA	CD	µg/L													9.91	16.45	15.99
		%													22	35	41
RHIZOSOLENIA IMBRICATA	CD	µg/L															1.94
		%															5
RHIZOSOLENIA SETIGERA	CD	µg/L	0.66		0.66											3.30	
		%	5		6											7	
THALASSIOSIRA GRAVIDA	CD	µg/L							1.19								
		%							6								
THALASSIOSIRA SP#2 DIAM >20 MICRONS	CD	µg/L		0.62			1.00					1.00	1.12				
		%		6			6					7	6				
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	µg/L	6.51	5.52	4.89	5.01	6.60	6.43	6.94			7.07	8.88	4.25	6.51	10.79	7.93
		%	53	51	46	54	38	43	35			47	45	18	15	23	20
UNID. MICRO-PHYTOFLAG LENGTH >10 MICRONS	MF	µg/L	0.77		0.77	1.15		1.54				0.77					
		%	6		7	12		10				5					

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, February 25 - 28, 1997 (W9702)

Species	Group	Parameter	Station Cast													
			F23	F30	F31	F13	F24	F25	N04	N10	N16	N18	F27	F06	F01	F02
BLUE GREEN TRICHOME SPP.	CY	µg/L			10.78											
		%			21											
CERATIUM FUSUS	DF	µg/L												1.39		
		%												9		
CERATIUM LONGIPES	DF	µg/L		4.63			4.63				4.63	4.63				
		%		13			8				11	5				
CORETHRON CRIOPHILUM	CD	µg/L											1.44			
		%											6			
COSCINODISCUS SP#2 DIAM 40-100 MICRONS	CD	µg/L							3.68							
		%							5							
COSCINODISCUS SP#3 DIAM >100 MICRONS	CD	µg/L			13.43	5.73										34.40
		%			26	11										37
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	µg/L		1.82							3.29					
		%		5							8					
GUINARDIA FLACCIDA	CD	µg/L														8.64
		%														9
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	µg/L						1.52					1.77	0.81	5.36	8.60
		%						6					7	5	9	9
PLEUROSIGMA ANGULATUM	PD	µg/L	1.83													
		%	8													
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	µg/L										5.21		2.61		
		%										6		17		
RHIZOSOLENIA DELICATULA	CD	µg/L													33.26	18.76
		%													54	20
THALASSIOSIRA GRAVIDA	CD	µg/L	10.69	17.30		28.63	38.28	12.23	53.44		22.37	62.64	13.12	1.04		
		%	45	48		53	68	49	79		51	71	54	7		
THALASSIOSIRA SP#1 DIAM <20 MICRONS	CD	µg/L			2.93											
		%			6											
THALASSIOSIRA SP#2 DIAM >20 MICRONS	CD	µg/L			7.30			1.87								
		%			14			7								
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	µg/L	5.46	6.60	7.28	13.20	5.20	6.35	4.01		6.85	7.36	4.06	6.77	8.25	9.26
		%	23	18	14	24	9	25	6		16	8	17	44	13	10
UNID. MICRO-PHYTOFLAG LENGTH >10 MICRONS	MF	µg/L												1.15		
		%												7		

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, March 18, 1997 (W9703)

Species	Group	Parameter	Wholewater Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
CERATIUM FUSUS	DF	ug/L		1.39
		%		5
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L	94.31	11.03
		%	74	40
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L		3.03
		%		11
THALASSIOSIRA GRAVIDA	CD	ug/L	16.62	3.88
		%	13	14
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L		5.52
		%		20
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, March 31 - April 6, 1997 (W9704)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CERATIUM LONGIPES	DF	ug/L				9.27			9.27		13.24	18.54	23.17		
		%				14			13		6	19	13		
CHAETOCEROS SP#1 DIAM <10 MICRONS	CD	ug/L		3.39											
		%		6											
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L	85.51	10.08	53.81	28.97	139.86	50.08	23.02	180.62	148.65	42.09	95.11	17.58	
		%	59	17	62	43	78	63	32	35	67	43	54	27	
COSCINODISCUS SP#3 DIAM >100 MICRONS	CD	ug/L				5.73							22		
		%				8							12		
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	ug/L		7.59											
		%		13											
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L							4.55					4.25	
		%							6					7	
GYMNODINIUM SP.#3 41-70UM W 51-70UM L	DF	ug/L							4.04						
		%							6						
PHAEOCYSTIS POUCHETII	HP	ug/L		16.18						240.09					
		%		27						47					
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	ug/L												5.21	
		%												8	
THALASSIOSIRA GRAVIDA	CD	ug/L	22.74		8.76	5.67	9.69	5.52		49.61	16.19		10.25	9.25	
		%	16		10	8	5	7		10	7		8	14	
THALASSIOSIRA SP#2 DIAM >20 MICRONS	CD	ug/L		5.61											
		%		9											
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L	16.37	4.57	12.18	10.91	15.23	12.18	19.54		19.54	21.07	13.07	17.55	143
		%	11	8	14	16	9	15	28		9	22	7	27	86
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	HP	Haptophyte													
	CR	Cryophyte													
	PD	Pennate Diatom													

TABLE 12

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll a Maximum Sample Whole Water Phytoplankton, April 23, 1997 (W9705)

Species	Group	Parameter	Wholewater Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
CERATIUM LONGIPES	DF	ug/L		4.63
		%		10
COSCINODISCUS SP#2 DIAM 40-100 MICRONS	CD	ug/L	2.45	
		%	7	
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L	10.87	8.43
		%	30	19
THALASSIOSIRA GRAVIDA	CD	ug/L	5.67	6.86
		%	16	15
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L	13.71	15.35
		%	38	34
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll a Maximum Sample
Whole Water Phytoplankton, Survey W9706

Species	Group	Parameter	Wholewater Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L	297.30	327.67
		%	61	79
THALASSIOSIRA GRAVIDA	CD	ug/L	82.77	
		%	17	
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L	33.25	
		%	7	
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, June 17 - 20, 1997 (W9707)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM FUSUS	DF	ug/L	5.58									
		%	6									
CERATIUM LONGIPES	DF	ug/L	60.24		11.59				23.17	13.90	115.85	11.59
		%	61		11				9	59	87	13
CHAETOCEROS SP#2 DIAM 10-30 MICRONS	CD	ug/L		36.76	8.79			26.64				
		%		25	8			10				
CRYPTOMONAS SP#2 LENGTH >10 MICRONS	CR	ug/L		10.08	5.74			33.61		1.66		
		%		7	6			12		7		
DINOPHYSIS PUNCTATA	DF	ug/L	8.96									
		%	9									
GYMNODINIUM SP.#1 5-20UM W 10-20UM L	DF	ug/L		7.33	6.70	14.41	2.48	16.01		1.62		7.50
		%		5	6	5	27	6		7		9
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	ug/L						21.72				
		%						8				
RHIZOSOLENIA DELICATULA	CD	ug/L		10.13	7.73	27.18			29.31			10.66
		%		7	7	10			11			12
RHIZOSOLENIA FRAGILISSIMA	CD	ug/L		25.82	30.91	150.22		26.08	89.19			30.91
		%		18	30	56		10	34			36
THALASSIOSIRA GRAVIDA	CD	ug/L							14.91			
		%							6			
UNID. CENTRIC DIATOM DIAM 10-30 MICRONS	CD	ug/L					0.67					
		%					7					
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L	14.47	35.53	17.13	34.26	4.07	104.06	74.24	4.82	11.93	15.36
		%	15	25	16	13	44	38	28	20	9	18
UNID. MICRO-PHYTOFLAG LENGTH >10 MICRONS	MF	ug/L					0.96					
		%					10					
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, July 8, 1997 (W9708)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	ug/L								88.04		
		%								82		
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L								9.11		
		%								9		
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Whole Water Phytoplankton, July 22, 1997 (W9709)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	ug/L								176.09		4.63
		%								91		21
UNID. MICRO-PHYTOFLAG LENGTH <10 MICRONS	MF	ug/L								11.80		13.32
		%								6		62
UNID. MICRO-PHYTOFLAG LENGTH >10 MICRONS	MF	ug/L										1.92
		%										9
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

APPENDIX I-1

ORGANIC CARABON CONTENT OF PREVALENT SPECIES IN SCREENED SURFACE SAMPLES

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Screened Phytoplankton, February 4 - 7, 1997 (W9701)

Species	Group	Parameter	Station Cast														
			F23	F30	F31	F13	F24	F25	N04	N10	N16	N18a	N18b	F27	F06	F01	F02
CERATIUM FUSUS	DF	µg/L				0.01	0.04		0.14			0.04	0.03			0.04	
		%				6	6		9			6	5			6	
CERATIUM LONGIPES	DF	µg/L	0.04	0.03		0.01	0.10	0.02	0.12			0.12	0.10	0.06		0.16	
		%	14	35		16	15	13	8			19	18	6		22	
CERATIUM TRIPOS	DF	µg/L	0.22	0.05	0.23	0.06	0.41	0.16	1.24			0.45	0.41	0.99		0.49	0.69
		%	82	53	90	75	65	84	76			70	74	87		69	18
PHAEOCYSTIS POUCHETII	HP	µg/L													37.61		2.87
		%													96		75
PROTOPERIDINIUM DEPRESSUM	DF	µg/L					0.05										
		%					7										

Group Definitions:

Group Definitions:	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Screened Phytoplankton, February 25 - 28, 1997 (W9702)

Species	Group	Parameter	Station Cast													
			F23	F30	F31	F13	F24	F25	N04	N10	N16	N18	F27	F06	F01	F02
CERATIUM FUSUS	DF	µg/L				0.02	0.03	0.01	0.17							
		%				6	7	6	5							
CERATIUM LONGIPES	DF	µg/L		0.01	0.03	0.06	0.06	0.02	0.56		0.10	0.24	0.17			
		%		15	14	17	14	11	18		14	19	11			
CERATIUM TRIPOS	DF	µg/L	0.39	0.02	0.15	0.16	0.23	0.11	2.18		0.39	0.79	1.24	0.17		
		%	83	34	68	44	50	58	70		53	64	77	26		
PHAEOCYSTIS POUCHETII	HP	µg/L						0.01						0.40	161.42	88.04
		%						7						59	99	99
PROTOPERIDINIUM SP.#1 10-30W 10-40L	DF	µg/L		0.02	0.03	0.11	0.06	0.02			0.15	0.07				
		%		45	11	30	14	10			20	5				
PROTOPERIDINIUM SP.#3 76-150W 81-150L	DF	µg/L					0.06	0.01								
		%					13	6								

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample Screened Phytoplankton, March 18, 1997 (W9703)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Surface	N18 Surface
CERATIUM LONGIPES	DF	ug/L		0.24
		%		8
CERATIUM TRIPOS	DF	ug/L	2.33	0.81
		%	15	28
PHAEOCYSTIS POUCHETII	HP	ug/L	11.91	1.57
		%	77	54
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Screened Phytoplankton, March 31 - April 6, 1997 (W9704)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CERATIUM LONGIPES	DF	ug/L							1.56		1.56		0.46		
		%							6		7		27		
CERATIUM TRIPOS	DF	ug/L			0.38				2.52		1.84		0.56		
		%			5				10		8		33		
PHAEOCYSTIS POUCHETII	HP	ug/L	26.71	12.37	6.26	35.62	48.83	17.84	19.55	114.95	18.56	18.77	0.17	45.06	31.63
		%	99	94	89	96	98	91	81	96	81	95	10	96	95
PROTOPERIDINIUM DEPRESSUM	DF	ug/L											0.22		
		%											13		
PROTOPERIDINIUM SP.#3 76-150W 81-150L	DF												0.14		
													9		

Group Definitions:

CD	Centric Diatom
DF	Dinoflagellate
MF	Microflagellate
HP	Haptophyte
CR	Cryophyte
PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Screened Phytoplankton, April 23, 1997 (W9705)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Surface	N18 Surface
CERATIUM LONGIPES	DF	ug/L	4.38	5.30
		%	35	36
CERATIUM TRIPOS	DF	ug/L	3.15	3.54
		%	25	24
PHAEOCYSTIS POUCHETII	HP	ug/L	3.50	4.83
		%	28	33
PROTOPERIDINIUM SP.#3 76-150W 81-150L	DF	ug/L	0.71	
		%	6	
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Screened Phytoplankton, May 13, 1997 (W9706)

Species	Group	Parameter	Screened Phytoplankton N04 Surface	Screened Phytoplankton N18 Surface
CERATIUM FUSUS	DF	ug/L	0.14	
		%	7	
CERATIUM LONGIPES	DF	ug/L	1.22	2.11
		%	64	61
CERATIUM TRIPOS	DF	ug/L	0.44	1.02
		%	23	30
PROTOPERIDINIUM DEPRESSUM	DF	ug/L		0.21
		%		6
PROTOPERIDINIUM SP.#3 76-150W 81-150L	DF	ug/L		
		%		
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Screened Phytoplankton, June 17 - 20, 1997 (W9707)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM FUSUS	DF	ug/L	1.19			0.85	1.03	0.69	1.36	0.78	0.14	0.24	0.37		1.27
		%	29			10	16	14	24	13	15	13	9		15
CERATIUM LONGIPES	DF	ug/L	1.73	12.31	5.73	4.14	3.56	2.52	2.74	3.74	0.46	1.05	2.93	3.86	5.76
		%	42	72	82	49	55	49	49	63	48	56	74	57	69
CERATIUM TRIPOS	DF	ug/L	1.05	3.10	1.06	3.33	1.51	1.58	1.06	1.32	0.22	0.48	0.49	2.41	0.86
		%	25	18	15	40	23	31	19	22	23	25	12	36	10
PROTOPERIDINIUM SP.#3 76-150W 81-150L	DF	ug/L									0.05				
		%									5				

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Screened Phytoplankton, July 8, 1997 (W9708)

Species	Group	Parameter	Station Cast												
			F01	F02	F06	F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM FUSUS	DF	ug/L											0.26		0.40
		%											5		6
CERATIUM LONGIPES	DF	ug/L											2.75		2.31
		%											55		34
CERATIUM TRIPOS	DF	ug/L											1.99		4.00
		%											40		58

Group Definitions:	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Surface Sample
Screened Phytoplankton, July 22, 1997 (W9709)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Surface	N18 Surface
CERATIUM LONGIPES	DF	ug/L	2.77	4.63
		%	88	94
CERATIUM TRIPOS	DF	ug/L	0.33	0.26
		%	10	5
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

APPENDIX I-2

ORGANIC CARABON CONTENT OF PREVALENT SPECIES IN SCREENED CHLOROPHYLL *a* MAXIMUM SAMPLES

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, February 4 - 7, 1997 (W9701)

Species	Group	Parameter	Station Cast														
			F23	F30	F31	F13	F24	F25	N04	N10	N16	N18a	N18b	F27	F06	F01	F02
CERATIUM FUSUS	DF	µg/L					0.02	0.02	0.05			0.04	0.04		0.11		0.07
		%					6	6	7			7	9		10		7
CERATIUM LONGIPES	DF	µg/L	0.02	0.06	0.03	0.02	0.07	0.05	0.07			0.15	0.06	0.12	0.07	0.13	0.12
		%	7	22	15	17	18	14	9			25	14	7	7	8	12
CERATIUM TRIPOS	DF	µg/L	0.30	0.19	0.11	0.09	0.27	0.24	0.59			0.40	0.32	1.38	0.72	0.32	0.41
		%	89	75	64	74	72	78	80			67	71	79	64	19	39
NITZSCHIA PUNGENS	PD	µg/L												0.14			
		%												8			
PHAEOCYSTIS POUCHETII	HP	µg/L													0.13	1.12	0.35
		%													12	68	34
PROTOPERIDINIUM DEPRESSUM	DF	µg/L			0.03												0.07
		%			15												7
Group Definitions:	CD	Centric Diatom															
	DF	Dinoflagellate															
	MF	Microflagellate															
	HP	Haptophyte															
	CR	Cryophyte															
	PD	Pennate Diatom															

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, February 25 - 28, 1997 (W9702)

Species	Group	Parameter	Station Cast													
			F23	F30	F31	F13	F24	F25	N04	N10	N16	N18	F27	F06	F01	F02
CERATIUM FUSUS	DF	µg/L		0.03		0.03	0.05	0.03	0.22		0.10	0.08				
		%		9		8	6	5	7		5	8				
CERATIUM LONGIPES	DF	µg/L	0.02	0.03	0.06	0.08	0.15	0.07	0.70		0.42	0.23	0.13			
		%	9	9	19	22	19	11	22		20	21	6			
CERATIUM TRIPOS	DF	µg/L	0.11	0.22	0.20	0.15	0.50	0.44	1.98		1.32	0.59	1.87	0.31		
		%	59	63	68	41	63	73	63		64	56	83	16		
PHAEOCYSTIS POUCHETII	HP	µg/L	0.01											1.43	79.35	80.20
		%	6											74	100	99
PROTOPERIDINIUM SP.#1 10-30W 10-40L	DF	µg/L	0.01	0.05	0.02	0.10	0.06	0.05				0.08				
		%	7	15	7	27	7	8				7				
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	µg/L	0.02													
		%	11													
PROTOPERIDINIUM SP.#3 76-150W 81-150L	DF	µg/L										0.06				
		%										6				

Group Definitions:		
	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample Screened Phytoplankton, March 18, 1997 (W9703)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
CERATIUM FUSUS	DF	ug/L		0.08
		%		6
CERATIUM LONGIPES	DF	ug/L	1.12	0.22
		%	9	17
CERATIUM TRIPOS	DF	ug/L	2.69	0.71
		%	22	56
PHAEOCYSTIS POUCHETII	HP	ug/L	7.38	
		%	60	
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	ug/L		0.10
		%		8
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, March 31 - April 6, 1997 (W9704)

Species	Group	Parameter	Station Cast												
			F23	F30	F31	F13	F24	F25	N04	N16	N18	F06	F27	F01	F02
CERATIUM LONGIPES	DF	ug/L				0.86									
		%				6									
CERATIUM TRIPOS	DF	ug/L							2.62				1.93		
		%							6				10		
PHAEOCYSTIS POUCHETII	HP	ug/L	46.93	24.24	22.35	13.20	22.89	24.50	38.12	80.03	37.57	131.50	15.34	101.60	118.69
		%	100	95	97	87	98	95	89	96	95	98	82	98	99
Group Definitions:	CD	Centric Diatom													
	DF	Dinoflagellate													
	MF	Microflagellate													
	HP	Haptophyte													
	CR	Cryophyte													
	PD	Pennate Diatom													

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, April 23, 1997 (W9705)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
CERATIUM TRIPOS	DF	ug/L	1.52	2.42
		%	6	6
PHAEOCYSTIS POUCHETII	HP	ug/L	21.89	38.70
		%	90	89
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample Screened Phytoplankton, May 13, 1997 (W9706)

Species	Group	Parameter	Screened Phytoplankton	
			N04 Chl *a* Max	N18 Chl *a* Max
CERATIUM FUSUS	DF	ug/L		0.27
		%		7
CERATIUM LONGIPES	DF	ug/L	1.19	1.64
		%	21	40
CERATIUM TRIPOS	DF	ug/L	0.67	1.23
		%	12	30
PROTOPERIDINIUM DEPRESSUM	DF	ug/L	3.54	0.59
		%	63	14
PROTOPERIDINIUM SP.#3 76-150W 81-150L	DF	ug/L		0.22
		%		5
Group Definitions:	CD	Centric Diatom		
	DF	Dinoflagellate		
	MF	Microflagellate		
	HP	Haptophyte		
	CR	Cryophyte		
	PD	Pennate Diatom		

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, June 17 - 20, 1997 (W9707)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM FUSUS	DF	ug/L		0.22		1.32		0.13	0.67			
		%		7		21		10	11			
CERATIUM LONGIPES	DF	ug/L	9.91	1.99	5.20	2.96	0.35	0.63	3.60	42.94	21.48	9.44
		%	87	66	73	47	30	47	59	93	74	66
CERATIUM TRIPOS	DF	ug/L	0.79	0.63	1.01	1.21	0.19	0.39	1.56		6.93	3.81
		%	7	21	14	19	16	29	26		24	27
PROTOPERIDINIUM DEPRESSUM	DF	ug/L				0.45	0.38	0.09				
		%				7	32	7				
PROTOPERIDINIUM SP.#2 31-75W 41-80L	DF	ug/L					0.16					
		%					14					
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, July 8, 1997 (W9708)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	ug/L								28.46		
		%								93		
CERATIUM TRIPOS	DF	ug/L								1.54		
		%								5		
Group Definitions:	CD	Centric Diatom										
	DF	Dinoflagellate										
	MF	Microflagellate										
	HP	Haptophyte										
	CR	Cryophyte										
	PD	Pennate Diatom										

Organic Carbon Content of Prevalent Species (> 5% Total Carbon) in Chlorophyll *a* Maximum Sample
Screened Phytoplankton, July 22, 1997 (W9709)

Species	Group	Parameter	Station Cast									
			F13	F23	F24	F25	F27	F30	F31	N04	N16	N18
CERATIUM LONGIPES	DF	ug/L								60.85		13.59
		%								100		94

Group Definitions:	CD	Centric Diatom
	DF	Dinoflagellate
	MF	Microflagellate
	HP	Haptophyte
	CR	Cryophyte
	PD	Pennate Diatom

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