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THE PHYSICAL OCEANOGRAPHY OFF THE CENTRAL CALIFORNIA COAST DURING MARCH AND MAY-JUNE 1993: A SUMMARY OF CTD DATA FROM PELAGIC YOUNG-OF-THE-YEAR ROCKFISH SURVEYS

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

NOAA Technical Memorandum NMFS

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THE PHYSICAL OCEANOGRAPHY OFF THE CENTRAL CALIFORNIA COAST DURING MARCH AND MAY-JUNE 1993: A SUMMARY OF CTD DATA FROM PELAGIC YOUNG-OF-THE-YEAR ROCKFISH SURVEYS

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ABSTRACT

Hydrographic conditions during a 12-day period in early March 1993 in the area bounded by Cypress Pt. (36°35'N) and Salt Pt. (38°35'N), California, from the coast to approximately 400 km offshore are summarized in a series of horizontal maps and vertical transects. In addition, hydrographic conditions, during three periods of approximately ten days each from mid-May through mid-June 1993 in the coastal ocean bounded by Cypress Pt. (36°35'N) and Pt. Reyes, California (38°10'N), and from the coast to about 75 km offshore, are also summarized. A total of 89 conductivity-temperature-depth (CTD) casts were obtained during the DAVID STARR JORDAN Cruise DSJ9304, while 255 standard casts were taken during Cruise DSJ9307 over the course of three consecutive sweeps of the region. Data products contained in this report include (1) a master list of CTD stations during each cruise; (2) surface meteorological time series from the region's four National Data Buoy Center (NDBC) meteorological buoys; (3) horizontal maps of temperature, salinity, and density (sigma-theta [σ_θ]) at depths of 2 m, 10 m, 30 m, 100 m, 200 m, 300 m, and 500 m; (4) temperature, salinity and σ_θ along four cross-shelf vertical transects; and (5) dynamic height topography (0/500 m) in the survey region.

INTRODUCTION

In recent years, attempts have been made to integrate the studies of fisheries biologists investigating the recruitment problem (Sissenwine 1984; Rothschild 1986) with those of physical oceanographers studying coastal circulation patterns. This development is due to the widely held perception that spatial and temporal variations in hydrodynamics, on a wide range of scales, have a direct influence on the retention of young-of-the-year in areas favorable for their growth and survival (e.g., Sinclair 1988). This realization has fostered the development of interdisciplinary studies in the area of recruitment fisheries oceanography (Wooster 1988; Office of Oceanic and Atmospheric Research 1989[1]).

Along the central California coast, rockfishes of the genus *Sebastes* are a major component of the west coast groundfish fishery (Gunderson and Sample 1980), with annual landings from 1984-92 averaging 39,463 MT yr^{-1} (Pacific Fishery Management Council 1993). Current management of the rockfish fishery is based largely on analyses of catch-at-age data. Such models are usually poorly constrained in the absence of other information (Deriso et al. 1985). Auxiliary data, such as an independent recruitment index, have the potential to assist in the management of this fishery.

Research conducted at the Southwest Fisheries Science Center's (SWFSC) Tiburon Laboratory since 1983 has attempted to develop a recruitment index for rockfish. Data obtained during annual juvenile rockfish surveys have provided information regarding distributional and abundance patterns of young-of-the-year pelagic juveniles in the area between Monterey Bay and Pt. Reyes (latitude 36°30'-38°10'N) (Wyllie Echeverria et al. 1990). Results of this research show a complex pattern in the spatial distribution of pre-recruits of a variety of commercially significant species (e.g., widow rockfish, *S. entomelas*; chilipepper, *S. goodei*; yellowtail rockfish, *S. flavidus*; bocaccio, *S. paucispinis*; and shortbelly rockfish, *S. jordani*). Moreover, extreme interannual fluctuations in abundance have occurred, with combined stratified mean catches per haul ranging from 0.3-55.0 juvenile rockfish/tow (Adams 1992[2]).

Field studies have shown that the survey region is hydrodynamically complex. The California Current provides the backdrop for large-scale, seasonal circulation patterns (Hickey 1979). Coastal upwelling also occurs regionally for most of the year, especially from April to September (Huyer 1983). On the mesoscale (10-100 km), irregularities in the coastline interact with the wind stress field (Kelly 1985), resulting in turbulent jets, eddies and upwelling filaments, all of which are common features along the central California coast (Mooers and Robinson 1984; Flament et al. 1985; Njoku et al. 1985; Rosenfeld et al. 1994). Moreover, wind-driven fluctuations in coastal flow (Chelton et al. 1988) and freshwater discharge from San Francisco Bay (Applied Environmental Science Division[3]) add further complexity to the circulation regime.

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[1]Office of Oceanic and Atmospheric Research. 1989. Program Development Plan for the NOAA Recruitment Fisheries Oceanography Program. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Washington, D.C., 28 p.

[2]Adams, P. B. (editor). 1992. Progress in rockfish recruitment studies. SWFSC Admin. Rep. T-92-01, 63 p., unpublished report.

[3]Applied Environmental Science Division. Final Report, California Seabird Ecology Study. Volume II, Satellite Data Analysis. Science Applications International Corporation, Monterey, California.

Realizing that a basic description of the physical environment is necessary to better understand the distribution and abundance of young-of-the-year rockfish, collection of conductivity-temperature-depth (CTD) data was initiated in 1987 as part of the Tiburon Laboratory's annual juvenile rockfish surveys. In the spirit of Wooster (1988), the staff of the SWFSC Pacific Fisheries Environmental Group subsequently developed an interest in analyzing the CTD data and were enlisted in this recruitment fisheries oceanography study. Ultimately, it is our goal to determine and forecast the manner in which rockfish year-class strength is affected by variations in the physical environment.

This report summarizes results obtained from the CTD data collected in 1993. Due to the large quantity of data analyzed and the extensive array of results presented herein, we make little attempt to provide detailed interpretations of our findings. Reports covering the juvenile rockfish surveys of 1988 (DSJ8804 and DSJ8806) and 1989 (DSJ8904) have been published (Schwing et al. 1990; Johnson et al. 1992). A companion volume (Schwing and Ralston 1990[4]) contains individual traces of temperature, salinity, and sigma-t (σ_t, a representation of water density) plotted against depth for each CTD cast conducted in 1989. Additional reports covering late larval and juvenile rockfish surveys during 1992 (Sakuma et al. 1994) and 1994 are currently in preparation. Further scientific analysis of these data, and their linkages to fisheries recruitment, will be compiled in future peer-reviewed scientific publications (e.g., Schwing et al. 1991).

MATERIALS AND METHODS

Meteorological Data

Meteorological data were obtained for selected sites in the juvenile rockfish survey region. These sites include the region's four National Data Buoy Center (NDBC) moored buoys: 46013 (Bodega Bay; 38.2°N, 123.3°W), 46026 (Farallones; 37.8°N, 122.7°W), 46012 (Half Moon Bay; 37.4°N, 122.7°W) and 46042 (Monterey Bay; 36.8°N, 122.4°W) (Appendix 3). Daily averages of several surface meteorological parameters, including air and sea temperature, east and north wind components, and barometric pressure, were calculated for the time period that includes the 1993 late larval and juvenile rockfish surveys. Plots of several of these products are provided in this report to aid in the interpretation of results and to suggest possible atmospheric-oceanic interactions (Appendix 4).

Juvenile Rockfish Survey Design

Annual cruises aboard the NOAA Research Vessel (R/V) DAVID STARR JORDAN (DSJ) began in 1983 and have been conducted during late spring (April-June), a time when most pelagic-stage juvenile rockfishes are identifiable as to species, but prior to their settling to nearshore and benthic habitats. Throughout this time, a standard haul consisted of a 15-minute nighttime tow of a large midwater trawl set to a depth of 30 m. Additional tows were made at other depths (i.e., 10 and 100 m) as allowed by constraints imposed by time and bottom bathymetry.

In 1986, the sampling design was altered to permit three consecutive "sweeps" through a study area bounded by Cypress Pt. (36°35'N) and Pt. Reyes (38°10'N), California, and from the coast to about 75 km offshore. Trawls are now conducted at five or six stations along a transect each night; each sweep is composed of seven transects. Starting in 1987, a CTD cast was conducted at each trawl station occupied. In addition, daytime

[4]Schwing, F. B., and S. Ralston. 1990. Individual cast data for CTD stations conducted during cruise DSJ8904 (May 14-June 13, 1989). SWFSC Admin. Rep. PFEG-91-01, 7 p. + figs., unpublished report.

activities were restructured to permit sampling of a new grid of standard CTD stations (Appendix 3). Standard CTD stations were specific locations where CTD casts were scheduled and repeated for each sweep of each cruise. CTD cast locations that were only specific to a particular sweep during a cruise were considered as additional CTD stations. Although each sweep typically lasts approximately ten days (seven nights of scheduled work plus 3 nights of additional discretionary sampling), adverse weather conditions can extend the completion date of a sweep. Logistical constraints can also restrict the number of casts completed. Discretionary sampling typically was focused on specific bathymetric features, such as Cordell Bank or Pioneer Canyon, or devoted to the intense study of oceanic features or processes that may be key to successful recruitment. CTD casts conducted during discretionary sampling were considered additional stations and not included in the grid of standard CTD stations.

Late Larval Rockfish Survey Design

In early March of 1993, a 5 m^2 Methot Isaacs Kidd (MIK) net (Methot 1986) was used to sample late larval stage rockfish in the area bounded by Cypress Pt. (36°35'N) and Salt Pt. (38°35'N) from the coast to approximately 400 km offshore (Appendix 3). Oblique tows were conducted at night to an average depth of 80 meters with a tow duration of approximately 30 minutes. Deeper tows were occasionally done to an average depth of 150 meters with a tow duration of approximately 55 minutes. Due to time constraints imposed by the travel distance between tow stations, a CTD cast was done only at every other station with additional CTDs dropped during the day throughout the survey area (Appendix 3).

Collection of CTD Data at Sea

All CTD data from the 1993 rockfish surveys presented in this report were collected with two Sea-Bird Electronics, Inc., SEACAT-SBE-19 profilers[5]. These particular units were both rated to a depth of 600 m and contained 256K of memory. Four data channels were used to record pressure (0.05% of full scale range [50-5,000 psia]), temperature (0.01 °C from -5 to +35 °C), and conductivity (0.001 S/m from 0 to 7 S/m) at a baud rate of 9,600. Dual casts using both units yielded similar profile data for temperature and salinity. Both profilers have been recalibrated annually by Sea-Bird Electronics, Inc., prior to their use aboard ship.

During deployment, the vessel was brought to a dead stop and the profiler was attached to a hydrographic winch cable. The profiler was then switched on and suspended underwater at the surface for a period of two minutes to allow the conductivity and temperature sensors to equilibrate. The rate of descent was 45 m/minute to a depth 10 m off the bottom if water depths were less than 500 m. Otherwise the profiler was lowered to a maximum depth of 500 m. Only data collected on the downcast were ultimately preserved for analysis. During the cast, certain collection information was recorded on data sheets, including (1) the date, (2) time, (3) a profiler-assigned cast number, (4) a cruise-specific consecutive index number, (5) the trawl station number (when appropriate), (6) latitude, (7) longitude, (8) bucket temperature (temperature [°C] of a bucket sample of surface water using a mercury thermometer, and (9) bottom depth in meters. Position fixes were obtained using the Global Positioning System (GPS). All collection information recorded on the data sheets was eventually entered into a data file (####.LST where #### is the four-digit cruise number) on a personal computer.

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[5]Sea-Bird Electronics, Inc., 1808 - 136th Place NE, Bellevue, Washington 98005 USA. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Data collected from a short series of casts (usually no more than 5-7) were periodically uploaded to a personal computer on board the vessel. During this step, each cast was stored as a separate file and named using the convention C####&&&.HEX, where #### is the four-digit cruise number and &&& is the three-digit consecutive index number. After uploading, the profiler was reinitialized and the *.HEX files on the personal computer were backed up on diskette.

An additional source of hydrographic data was the vessel's Sea-Bird Electronics, Inc., thermosalinometer (TS) unit, which provided a continuous data stream of surface temperature and salinity. These data were stored on diskette and transferred to a personal computer on board the vessel for further processing, analysis, and comparison with and verification of CTD observations. Position fixes for the TS unit were based on GPS.

Data Processing

The first step in data processing was to convert the uploaded CTD *.HEX files to ASCII files. This was accomplished using programs supplied by Sea-Bird Electronics, Inc., in SEASOFT menu-driven release Version 4.011[6]. All *.HEX files were batch-processed through the SEASOFT modules DATCNV, FILTER, ALIGNCTD, LOOPEDIT, BINAVG, and DERIVE (see Appendix 1 for data settings) and output as ASCII files using SAS macros (SAS 1988[7]). All data were averaged into two-meter depth bins and subsequently transferred to a SUN file server.

Each CTD ASCII file was manually edited to remove large outliers (i.e., data spikes) in salinity and/or density, which sometimes occurred near the surface and at the thermocline. Comparisons were made between CTD temperature and salinity from the two-meter depth bin, TS temperature and salinity, and bucket temperature at each CTD station using a simple regression to check for data outliers and any blatant calibration problems (Appendix 5).

Processed hydrographic data were summarized, by sweep, in a series of horizontal maps and vertical transects, and are presented in this report. Although additional CTD casts were completed during DSJ9307, only casts from the grid of standard CTD stations and only those casts which provided a relatively continuous sampling track within a specific sweep were included in the data summary for the horizontal maps (Appendix 6). This was done in an attempt to generate a relatively synoptic representation of each individual sweep and to spatially standardize hydrographic comparisons among sweeps. Vertical transects from the three sweeps of DSJ9307 were also spatially standardized (Appendix 7). However, the Farallones transect line was less synoptic than the Pt. Reyes, Pescadero, and Davenport lines, because casts were combined over a 2- to 3-day time period instead of the more usual 24-hour period. In addition, the Farallones transect line does not follow a straight course, which may lead to some distortion of the vertical transect contours nearshore. All contouring of CTD data for horizontal maps and vertical transects was done using SURFER Version 4.0 graphics software[8], which estimates values throughout a specified region based on the available data. Kriging was

[6]CTD Data Acquisition software, SEASOFT Version 4.011, July 1992, Sea-Bird Electronics, Inc., 1808 - 1336th Place NE, Bellevue, Washington 98005, USA.

[7]SAS Institutes Inc., SAS Circle Box 8000, Cary, North Carolina 27512. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

[8]SURFER Version 4, Golden Software, Inc., 809 14th Street, Golden, Colorado 80402. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

selected as the optimal interpolation method used for the algorithm grid (Cressie 1991). Horizontal and vertical contours were post-processed using FREELANCE Version 4.0 graphics software[9].

The TS raw data were edited to provide a nearly continuous sampling track for DSJ9304 and for each sweep of DSJ9307. However, there appeared to be a consistent offset between salinity recorded by the TS and salinity recorded by the CTD at 2-m depth for each cruise (Appendix 5). Because the CTD was calibrated annually by the manufacturer, and because problems occurred with the TS unit during DSJ9304 and in the past during DSJ9203, TS salinity values were considered less reliable and, when necessary, were adjusted using the regression comparison with the CTD. That is, $TS' = \alpha + \beta(TS)$, where TS' is the adjusted thermosalinometer value (either temperature or salinity), TS is the unadjusted value, and α and β are the intercept and slope parameters of the regression of two-meter CTD data (temperature or salinity) on the corresponding TS value. The TS' data were then contoured using SURFER and post-processed using FREELANCE.

Dynamic height was calculated for stations occupied during DSJ9307. CTD casts that did not reach a maximum depth of 480 m were not included in this analysis. Of the remaining casts, many did not quite reach 500 m and the data were projected to this level. This was accomplished by a linear extrapolation of temperature and salinity values, based on the last 20 m of *in situ* data. For example, if the recorded data only went to 494 m, a line was fit to the data over the range 474-494 m. The fitted line was then used to extrapolate values to a depth of 500 m. All the data were then spline interpolated at 2-m intervals to remove any missing values, which were very few. Next, specific volume anomalies were calculated using the IES-80 density algorithm (UNESCO 1983) at the 0-, 10-, 20-, 30-, 50-, 75-, 100-, 125-, 150-, 200-, 250-, 300-, 400-, and 500-m levels. Finally, dynamic height anomalies were calculated by numerically integrating specific volumes over the appropriate depth range; for the 0 db surface, this integration was over all depth levels. The dynamic height topography of the 0 db surface relative to the 500 db surface for the three sweeps of DSJ9307 were contoured using SURFER Version 5.01 (Windows version), after the data were gridded by Kriging. Dynamic heights for casts conducted during DSJ9304 were output from the DERIVE module of SEASOFT Version 4.201 and these data were gridded in SURFER Version 4.0 and post-processed using FREELANCE. A 0.01 contour interval was chosen for all maps.

To date, no attempt has been made to calculate vertical sections of geostrophic velocity because the large number of shallow stations during the juvenile rockfish surveys necessitates the extrapolation of isopycnals into the shore, a procedure that is subject to great uncertainty. In addition, recent studies (Berryman 1989; Tisch 1990) suggest that geostrophic velocities calculated for stations spaced closer than the internal Rossby radius frequently feature alternating current bands of reversed flow, which are thought to be associated with inertial currents. The Rossby radius in the survey region is generally about 10-20 km, which is similar to the typical station spacing of the rockfish surveys. We are presently investigating the method that best determines geostrophic velocities from dynamic heights, based on closely spaced shallow water stations, before attempting to calculate the geostrophic velocity field during these surveys.

[9]Lotus FREELANCE Graphics for DOS, Lotus Development Corporation, 55 Cambridge Parkway, Cambridge, Massachusetts 02142. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

RESULTS

Data Products

Below are a few brief comments on each of the data products contained in this report in the order that they appear.

Appendix 1: Data Settings for SEASOFT Modules

Listed are the settings of the SEASOFT modules DATCNV, FILTER, ALIGNCTD, LOOPEDIT, BINAVG, and DERIVE used to process the *.HEX files.

Appendix 2: Lists of CTD Stations Summarized from Cruises DSJ9304 and DSJ9307

The station lists include, from left to right, CTD cast number (only acceptable casts included), date, local military time, latitude and longitude (degrees, minutes), and station bottom depth. Cruise DSJ9304 (March 2-March 13) includes 89 stations (casts 1-122). Cruise DSJ9307, Sweep 1 (May 13-May 20) includes 91 standard stations (casts 1-96), Sweep 2 (May 21-May 28) includes 96 standard stations (casts 100-199), and Sweep 3 (June 3-10) includes 68 standard stations (casts 246-318).

Appendix 3: CTD Stations and Bathymetric Maps of Survey Region with Locations of the NDBC Buoys

The locations of the CTD stations for DSJ9304 and the standard CTD stations for DSJ9307 along with the locations of the NDBC buoys, the place names, and the bottom bathymetry of the survey areas are shown.

Appendix 4: Meteorological Time Series

Meteorological time series are presented for the four NDBC buoys as described above. The first figure in this section summarizes the daily average wind speed (m/s) and direction (relative to true north) at these stations, in stick vector form, for the period January through June 1993. Vectors point in the direction toward which the wind was blowing; an arrow pointing toward the top of the page represents a northward-directed wind.

The following figures show scalar time series of sea surface temperature, or SST (°C); air temperature (°C); the north-south component of wind speed (m/s), a crude indicator of upwelling-favorable wind; and barometric pressure (millibars) at each meteorological station for the first 180 calendar days of 1992. A positive wind value denotes a northward-directed wind component. The survey periods for DSJ9304 and DSJ9307 (divided by sweep) are shaded in all time series plots.

Appendix 5: Regression Comparisons of CTD, TS, and Bucket

The plots presented show comparisons between CTD, TS, and bucket temperatures and CTD and TS salinities. The solid lines represent the lines of equality in order to show how the different data varied from each other. The regression statistics for each comparison were as follows:

DSJ9304:

CTD temperature versus TS temperature,
CTDtemp. = TStemp. x 0.9989 - 0.0163
R^2 = 0.9935

CTD temperature versus bucket temperature,
CTDtemp. = buckettemp. x 1.0001 - 0.0673
R^2 = 0.9510

TS temperature versus bucket temperature,
TStemp. = buckettemp. x 1.0124 - 0.1871
R^2 = 0.9741

CTD salinity versus TS salinity,
CTDsal. = TSsal. x 0.9358 + 2.1917
R^2 = 0.8119

DSJ9307: CTD temperature versus TS temperature,
CTDtemp. = TStemp. x 1.0099 - 0.2059
R^2 = 0.9950
CTD temperature versus bucket temperature,
CTDtemp. = buckettemp. x 1.0026 - 0.1204
R^2 = 0.9851
TS temperature versus bucket temperature,
TStemp. = buckettemp. x 0.9935 + 0.0765
R^2 = 0.9921
CTD salinity versus TS salinity,
CTDsal. = TSsal. x 0.9331 + 2.3528
R^2 = 0.9640

Appendix 6: Horizontal Maps of CTD and TS

a) Maps of TS temperature and salinity

Maps of surface temperature (°C) and salinity (ppt) obtained from the vessel's TS continuous profiling unit are presented for DSJ9304 and for each sweep of DSJ9307. The TS maps are located in front of the corresponding horizontal map for the CTD at 2 m. The contour intervals are 0.2°C for temperature and 0.1 ppt for salinity. They are included to provide some verification of hydrographic spatial patterns inferred from the CTD data. The 2-m CTD and surface TS maps display good quantitative agreement, despite the fact that the data used to generate each were collected by different instrument packages.

b) Maps of CTD temperature, salinity and density, by depth

Horizontal maps of temperature (°C), salinity (ppt) and density (sigma-theta [σ_θ]) (kg/m^3) are presented at depths of 2 m, 10 m, 30 m, 100 m, 200 m, 300 m, and 500 m. The locations of the CTD casts used in generating the horizontal contours are shown by a + symbol. The 2-m depth was selected to represent surface conditions. The 10-m depth was selected to represent near-surface conditions because (1) the quality of data in the first few meters below the surface was not acceptable at some stations, and (2) localized, ephemeral conditions, related to factors such as strong surface heating and low vertical mixing that did not reflect the realistic, longer-term conditions of the region, were generally confined to the upper 5 m (refer to footnote 4). The 30-m depth was contoured to coincide with the standard midwater trawl depth during the surveys. The contour intervals are 0.2°C, 0.1 ppt and 0.1 kg/m^3, respectively for depths 2-100 m. For the 200- to 500-m depths, the contour intervals were lowered to 0.1°C, 0.02 ppt, and 0.02 kg/m^3.

Appendix 7: Vertical Transects

Vertical transects of temperature, salinity and density are presented for four cross-shelf transects off Salt Pt., Pt. Reyes, Pescadero, and Davenport for DSJ9304 and off Pt. Reyes, the Farallones, Pescadero, and Davenport for DSJ9307. Station maps denote the location of each transect and the offshore extent of stations used to generate plots for each sweep. The locations of CTD casts used in generating the vertical transects are shown by an ↑. The contour intervals are 0.5°C for temperature, 0.1 ppt for salinity, and 0.2 kg/m^3 for density.

Appendix 8: Dynamic Height Topography

Horizontal maps of dynamic height (0/500 m) are presented for DSJ9304 and the three sweeps of DSJ9307. The locations of the CTD casts used in generating the horizontal contours are shown by a + symbol.

Synopsis of Hydrographic Conditions

Conditions during the 1993 surveys off central California are best characterized as a continuation of the ENSO that developed in 1992. Temperature remained warm and salinity low relative to long-term spring and summer means. Temperature throughout the water column (i.e., to 500 m) during DSJ9304 (March) was cooler than for a similar period in 1992 (Sakuma et al. 1994), but remained substantially warmer than the region's long-term average of the CalCOFI data base (Lynn 1967; Lynn et al. 1982). Visually, the ambient salinity in the survey area was very similar to that in 1992, and anomalously low relative to the CalCOFI climatology. A notable difference in the near-surface salinity in 1993 was a low-saline (<32.5 ppt) plume extending west-southwest from the Golden Gate. The plume was apparent to about 10-20 m depth. In contrast to the previous year, no strong Davidson Current signature was seen (Sakuma et al. 1994); nor was there the strong near-surface front seen during the DSJ9203 survey. However, the DSJ9304 temperature and salinity fields below the upper mixed layer featured strong lateral gradients and an unusually complex mesoscale structure, when compared to 1992 and other late winter surveys. A particularly strong front meandered approximately parallel to the coast near 125°W at 50- to 300-m depth, separating the warm, less saline offshore water from cooler, more saline water over the continental slope. Wind forcing during early 1993 varied greatly on scales of one to a few days, typical of conditions prior to the spring transition.

The mean temperature and salinity for DSJ9307 (May-June) reflect the continuation of the ENSO-like conditions noted in 1992, and are characteristic of other recent ENSOs (i.e., 1983, 1986) (Figure 1). The general pattern of near-surface temperature and salinity during May-June 1993 was similar to the CalCOFI spring climatology (Lynn 1967), although the distribution suggested an onshore displacement of California Current water, similar to that seen in 1992 (Sakuma et al. 1994), as well as during the 1940-41 and 1982-83 ENSO events (Simpson 1984, 1992). Coastal temperature and salinity during Sweep 1 reflected coastal upwelling patterns, albeit anomalously warmer and less saline than typical springtime conditions. However, nearshore conditions during Sweeps 2 and 3 returned to the even higher temperatures and lower salinities noted in the previous year. Unusually fresh water (<32.5 ppt) in the upper 100 m, even relative to DSJ9206, was seen in the northwest corner of the survey area during Sweep 1. Warm temperatures corresponded to the lower salinities. This water type appeared to extend south and onshore during Sweeps 2 and 3, resulting in a strong front that extended parallel to shore throughout the entire survey. The unusually low salinities observed in the offshore portion of the survey region account for the low average salinities in the upper water column for the entire 1993 sampling period (Figure 1). Wind forcing during DSJ9307 was strongly downwelling-favorable through the first two sweeps, then upwelling-favorable during the third sweep. This could have contributed to the anomalously warm, fresh conditions observed during the cruise, through a combination of reduced or no coastal upwelling and shoreward advection of offshore (California Current) water.

The maps of dynamic topography in Appendix 8 represent surface geostrophic flow, relative to 500 m, as parallel to lines of equal height, such that higher dynamic heights are on the right facing downstream, and closer-spaced contours denote higher velocities. The dynamic topography based on the density structure during DSJ9304 and DSJ9307 suggests a circulation that is highly variable in time and space, superimposed on a generally southward flow with maximum velocity in the outer portion of the survey area. Numerous dynamic eddy-like features appear in each sweep. Of particular interest is the surface flow field during Sweep 2 of DSJ9307, dominated by a pair of eddies in the northern half of the survey. A cyclonic eddy, with a corresponding cool, saline core centered about 37.5°N, 123.6°W, lies adjacent to an anticyclonic warm, fresh eddy centered near 37.25°N, 123.2°W. These circulation features are apparent in the hydrography to 200 m. The net effect is an implied baroclinic northward flow, an extremely unusual occurrence after the spring transition. It is more likely that these features occurred in association with a southward barotropic flow typical of summer. By Sweep 3, it appears the eddy pair had weakened slightly and translated southward along the slope, with southward flow returning to the region west of 123°W.

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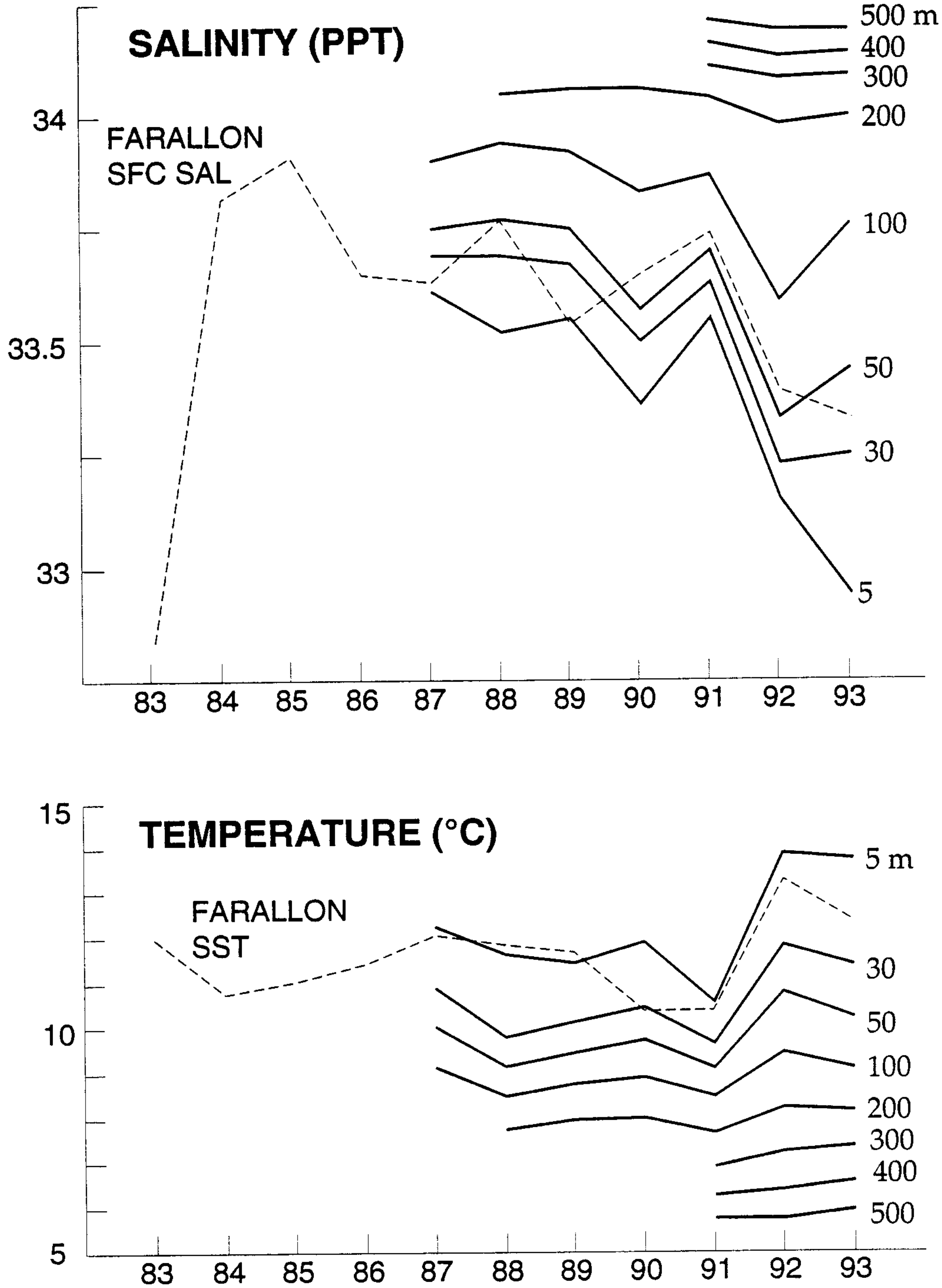


Figure 1. Time series of mean temperature and salinity from May-June rockfish surveys 1987-93, at 5, 30, 50, 100, 200, 300, 400, and 500 m. Means for depths greater than 200 m available from 1991-93 only. Dashed line denotes average of daily measured surface temperatures and salinities for May-June of each year at Farallon Island (1983-93).

APPENDIX 1: DATA SETTINGS FOR SEASOFT MODULES

Module #1: DATCNV

Raw Data File =	depends on cast
Configuration File [.CON] =	depends on cast
Input File [.CON, .DAT, .HEX] Path =	C:\SEASOFT\HEXDATA\
Output Data File Path =	C:\SEASOFT\CNVDATA\
Data Conversion Format =	ASCII
Data Conversion Variables =	<Press Enter to Modify>
Conversion Units	Metric
Column # 0 =	scan number
Column # 1 =	pressure, decibars
Column # 2 =	depth, salt water, meters
Column # 3 =	temperature, deg C
Column # 4 =	conductivity, S/m
Column # 5 =	none
etc.	
Number of Scans to Skip Over =	0

Module #2: FILTER

Input Data File =	depends on cast
Input File [.CNV] Path =	C:\SEASOFT\CNVDATA\
Output Data File Path =	C:\SEASOFT\CNVDATA\
Low Pass Filter A, Time Constant (sec) =	0.500000
Low Pass Filter B, Time Constant (sec) =	0.000000
Variables to Filter =	<Press Enter to Modify>
Filter Type, scan number =	None
Filter Type, pressure, decibars =	None
Filter Type, depth, salt water, meters =	None
Filter Type, temperature, deg C =	None
Filter Type, conductivity, S/m =	Low Pass Filter A
Filter Type, salinity, PSS-78 [PSU]	None
Filter Type, density, sigma-theta, kg^3 =	None
Filter Type, =	None

Module #3: ALIGNCTD

Input Data File =	depends on cast
Input File [.CNV] Path =	C:\SEASOFT\CNVDATA\
Output Data File Path =	C:\SEASOFT\CNVDATA\
Number of Seconds to Advance Cond Relative to Pres =	0.000000
Number of Seconds to Advance Temp Relative to Pres =	0.500000
Number of Seconds to Advance Oxygen Relative to Pres =	0.000000

Module #4: LOOPEDIT

Input Data File =	depends on cast
Input File [.CNV] Path =	C:\SEASOFT\CNVDATA\
Output Data File Path =	C:\SEASOFT\CNVDATA\
Minimum CTD Velocity (m/s) =	0.200000
Exclude Scans Marked Bad in LOOPEDIT =	Yes

Module #5: BINAVG

Input Data File =	depends on cast
Input File [.CNV] Path =	C:\SEASOFT\CNVDATA\
Output Data File Path =	C:\SEASOFT\CNVDATA\
Bin Type =	Depth Bins
Bin Size =	2.000000
Include Number of Scans Per Bin =	Yes
Exclude Scans Markded Bad in BINAVG =	Yes
Number of Scans to Skip Over =	0
Surface Bin Setup Parameters =	<Press Enter to Modify>
Include Surface Bin =	No
Surface Bin Minimum Value =	0.000000
Surface Bin Maximum Value =	0.000000

Module #6: DERIVE

Input Data File =	depends on cast
Input File [.CNV] Path =	C:\SEASOFT\CNVDATA\
Output Data File Path =	C:\SEASOFT\CNVDATA\
Input Variables =	<Press Enter to Display>
Name 0 =	scan number
Name 1 =	pressure, decibars
Name 2 =	depth, salt water, meters
Name 3 =	temperature, deg C
Name 4 =	conductivity, S/m
Name 5 =	salinity, PSS-78 [PSU]
Name 6 =	density, sigma-theta, kg/m^3
Variables to be Derived =	<Press Enter to Modify>
Column # 0 =	salinity, PSS-78 [PSU]
Column # 1 =	density, sigma-theta, kg/m^3
Column # 2 =	dynamic height (for DSJ9403)
Column # 3 =	none
etc.	
Variable Coefficients =	<Press Enter to Modify>
Oxygen Coefficients =	<Press Enter to Modify>

since there is no oxygen meter enter all zeros

Time Window Size for doc/dt (seconds) =	2.00000
Time Window Size for Descent Rate and Accel (seconds) =	2.00000

Directory of C:\SEASOFT

```
.             <DIR>        07-13-92    1:10p
..            <DIR>        07-13-92    1:10p
C9307         <DIR>        07-13-93    1:10p
CNVDATA       <DIR>        09-22-92    7:59a
HEXDATA       <DIR>        09-29-92    9:35a
ASCIIDAT      <DIR>        10-01-92    9:53a
PROGRAMS      <DIR>        10-05-92   11:57a
LSTFILES      <DIR>        10-05-92    1:04p
CTD_CONV BAT           706 10-14-92    1:29p
ROSSUM   EXE         53984 07-09-92    3:06p
SINSTALL BAT           722 07-09-92    4:26p
OXFIT    EXE         21200 12-06-89   12:16p
ALIGNCTD EXE        279944 07-09-92    2:00p
ASCIIOUT EXE        273372 07-09-92    3:05p
BINAVG   EXE        283538 07-09-92    1:58p
CELLTM   EXE        274480 07-09-92    2:54p
CFGTOCON EXE         51440 07-08-92    5:01p
DATCNV   EXE        339876 07-09-92    1:49p
DERIVE   EXE        294598 07-09-92    1:54p
FILTER   EXE        284730 07-09-92    2:56p
LOOPEDIT EXE        274546 07-09-92    1:57p
SEACON   EXE        233414 07-09-92    1:46p
SEAPLOT  EXE        432438 07-09-92    2:48p
SEASAVE  EXE        440816 07-09-92    3:04p
SECTION  EXE        321240 07-09-92    1:51p
SPLIT    EXE        274862 07-09-92    1:55p
STRIP    EXE        276332 07-09-92    1:52p
TRANS    EXE        265132 07-09-92    1:50p
PHFIT    EXE         29834 06-11-92    3:08p
OXSAT    EXE         21086 11-18-85   12:33p
SEAPLOT  CFG            58 10-01-92    9:11a
SEAPLOT  PLT           564 10-01-92    9:11a
TERM19   EXE        281672 07-09-92    8:58a
TMODEM   EXE         30544 06-18-92    5:21p
WILDEDIT EXE        296056 07-09-92    1:56p
SBE$ERR  DAT          3118 03-09-92    4:46p
SBE$HELP DAT          3722 03-09-92    4:49p
SBE$MSG  DAT         12468 03-09-92    4:46p
SEACON   HLP          8719 07-08-92    4:25p
SEASAVE  HLP         18624 07-08-92    4:25p
TERM     HLP         24702 06-02-92    1:25p
GPIB     COM         35627 03-09-92    4:46p
MODE     COM          2345 03-09-92    4:46p
DATCNV   CFG           230 10-15-92    1:23p
FILTER   CFG           198 10-15-92    1:24p
BINAVG   CFG            97 10-15-92    1:24p
LOOPEDIT CFG            66 10-15-92    1:24p
ALIGNCTD CFG            77 10-15-92    1:24p
DERIVE   CFG           251 10-15-92    1:26p
DIRECT   LST             0 10-19-92    2:57p
MODULES  DOC         11098 10-19-92    2:57p
```

APPENDIX 2.1: LIST OF CTD STATIONS SUMMARIZED FROM CRUISE DSJ9304

DSJ9304

CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH(M)
1	02MAR93	1816	36 34.9	122 00.2	126
3	02MAR93	2255	36 34.9	122 38.1	1450
5	03MAR93	0433	36 35.4	123 15.9	3475
6	03MAR93	0724	36 46.9	123 30.0	3475
7	03MAR93	0850	36 47.0	123 42.5	3640
8	03MAR93	1024	36 47.0	123 55.1	3822
9	03MAR93	1156	36 47.0	124 07.6	3600
10	03MAR93	1323	36 47.1	124 20.0	3900
11	03MAR93	1450	36 47.2	124 32.4	4000
12	03MAR93	1620	36 47.0	124 45.0	4200
13	03MAR93	1829	36 34.9	124 50.9	4290
15	04MAR93	0043	36 34.9	124 13.1	4200
17	04MAR93	0609	36 34.8	123 37.6	3168
18	04MAR93	0843	36 47.0	123 18.5	3276
19	04MAR93	1010	36 47.1	123 06.0	3500
20	04MAR93	1128	36 47.0	122 53.5	3000
21	04MAR93	1303	36 47.0	122 41.0	2100
22	04MAR93	1426	36 47.0	122 28.6	2100
23	04MAR93	1550	36 47.0	122 16.0	770
24	04MAR93	1828	37 00.0	122 20.0	95
26	05MAR93	0012	37 00.0	122 58.0	2100
28	05MAR93	0420	37 00.0	123 36.0	3475
29	05MAR93	0701	37 12.0	123 45.1	3650
30	05MAR93	0828	37 12.0	123 57.5	4000
31	05MAR93	0954	37 12.0	124 10.0	5000
33	05MAR93	1453	37 12.0	124 37.6	4050
34	05MAR93	1525	37 12.0	125 00.1	4000
35	05MAR93	1830	37 00.0	125 30.2	4023
37	06MAR93	0005	37 00.1	126 08.0	4500
39	06MAR93	0430	37 00.0	126 46.0	4480
40	06MAR93	0703	37 12.0	126 40.0	4545
41	06MAR93	0828	37 12.0	126 27.4	5000
42	06MAR93	0955	37 12.0	126 15.0	5000
43	06MAR93	1121	37 12.0	126 02.5	4500
44	06MAR93	1250	37 12.0	125 50.0	4200
45	06MAR93	1424	37 12.0	125 37.5	4300
46	06MAR93	1552	37 12.0	125 25.0	4280
47	06MAR93	1837	37 00.0	125 11.3	4200
49	06MAR93	2338	37 00.2	124 32.8	5100
51	07MAR93	0600	37 01.6	123 55.6	3250
52	07MAR93	0824	37 12.1	123 32.5	3000
53	07MAR93	0950	37 12.1	123 19.9	2500
54	07MAR93	1114	37 12.1	123 07.4	1400
55	07MAR93	1226	37 12.0	122 55.0	445
59	07MAR93	1831	37 22.9	122 46.2	94
61	07MAR93	2247	37 23.0	123 24.0	1400
63	08MAR93	0542	37 22.9	124 02.0	3710
72	08MAR93	2100	37 23.0	125 18.0	4700
73	08MAR93	2325	37 23.0	124 59.0	4500
74	09MAR93	0148	37 22.9	124 40.0	4100
75	09MAR93	0412	37 22.9	124 21.0	3970
76	09MAR93	0722	37 34.1	123 52.4	3365
77	09MAR93	0897	37 34.0	123 45.0	4000
78	09MAR93	1010	37 34.0	123 32.4	3900
79	09MAR93	1144	37 34.0	123 20.4	2000
80	09MAR93	1312	37 34.0	123 07.4	900
81	09MAR93	1435	37 34.0	122 55.0	100
83	09MAR93	1830	37 45.0	123 09.1	90

CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH(M)
85	09MAR93	2300	37 45.1	123 47.1	3600
87	10MAR93	0420	37 44.9	124 25.0	3860
88	10MAR93	0644	37 57.0	124 35.1	3945
89	10MAR93	0814	37 57.0	124 47.5	4300
90	10MAR93	0945	37 57.0	124 60.0	4300
91	10MAR93	1118	37 57.0	125 12.4	4500
92	10MAR93	1250	37 57.0	125 25.0	4100
93	10MAR93	1420	37 57.0	125 37.5	4200
94	10MAR93	1618	37 57.0	125 56.3	4400
95	10MAR93	1835	37 44.8	126 00.0	4800
97	10MAR93	2305	37 45.0	125 22.0	4500
99	11MAR93	0325	37 45.1	124 44.0	3900
100	11MAR93	0814	38 10.1	124 38.5	4100
101	11MAR93	0936	38 10.0	124 50.0	4300
102	11MAR93	1104	38 10.0	125 02.5	4200
103	11MAR93	1230	38 10.1	125 15.0	3750
104	11MAR93	1457	38 23.1	124 55.0	3800
105	11MAR93	1621	38 23.0	124 42.5	4200
106	11MAR93	1830	38 35.1	124 42.0	4100
108	11MAR93	2308	38 35.1	124 03.8	3000
110	12MAR93	0513	38 35.1	123 28.0	100
111	12MAR93	0657	38 22.9	123 15.0	92
112	12MAR93	0809	38 23.1	123 27.5	154
113	12MAR93	0928	38 23.0	123 40.1	800
114	12MAR93	1100	38 23.0	123 52.5	2400
115	12MAR93	1224	38 23.0	124 05.1	3300
116	12MAR93	1347	38 23.0	124 17.6	3700
117	12MAR93	1511	38 23.1	124 30.1	3700
118	12MAR93	1835	38 10.1	124 25.9	4200
120	12MAR93	2250	38 10.0	123 48.0	3000
122	13MAR93	0453	38 10.2	123 12.1	100

APPENDIX 2.2: LIST OF CTD STATIONS SUMMARIZED FROM CRUISE DSJ9307

DSJ9307 SWEEP 1

CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH(M)
1	13MAY93	1445	36 44.7	122 02.5	500
3	13MAY93	1625	36 48.9	122 11.0	475
4	13MAY93	1732	36 54.0	122 04.4	48
5	13MAY93	1825	36 53.0	121 55.9	27
6	13MAY93	1924	36 48.8	121 59.6	424
7	13MAY93	2035	36 50.8	121 59.0	78
8	13MAY93	2303	36 45.0	121 53.4	73
9	13MAY93	2339	36 44.4	121 58.6	290
10	14MAY93	0141	36 41.2	121 53.3	78
11	14MAY93	0215	36 38.4	121 51.5	36
12	14MAY93	0455	36 40.0	121 58.7	102
13	14MAY39	0615	36 40.0	122 10.2	1100
14	14MAY93	0705	36 40.0	122 15.2	1600
15	14MAY93	0806	36 40.0	122 21.6	1646
16	14MAY93	0900	36 35.2	122 21.5	2230
17	14MAY93	1020	36 35.0	122 16.1	2290
18	14MAY93	1135	36 34.9	122 06.0	1300
19	14MAY93	1230	36 29.8	122 04.1	830
20	14MAY93	1337	36 30.0	122 09.9	1300
21	14MAY93	1440	36 30.1	122 16.9	1350
22	14MAY93	1532	36 30.0	122 22.4	1580
23	14MAY93	1707	36 30.0	122 35.0	3135
24	15MAY93	MISSING	36 35.0	122 10.5	2200
25	15MAY93	0105	36 33.1	122 01.5	850
26	15MAY93	0209	36 38.8	122 03.0	800
27	15MAY93	0417	36 43.6	122 07.4	1509
28	15MAY93	0557	36 48.3	122 10.4	834
29	15MAY93	0630	36 50.1	122 10.3	324
30	15MAY93	0803	36 52.6	122 22.3	950
31	15MAY93	0931	36 52.6	122 34.6	1600
32	15MAY93	1058	36 52.6	122 47.0	2300
33	15MAY93	1212	36 59.0	122 53.0	1350
34	15MAY93	1328	36 52.4	122 59.3	3000
35	15MAY93	1447	36 59.0	123 05.3	2700
36	15MAY93	1600	37 05.0	122 59.3	1000
37	15MAY93	1727	37 05.0	122 46.9	650
38	15MAY93	1854	37 05.0	122 35.0	115
39	15MAY93	2030	36 58.9	122 35.5	436
40	16MAY93	0041	36 59.0	122 24.6	300
41	16MAY93	0119	36 59.0	122 22.6	125
46	16MAY93	0759	37 10.7	122 40.7	113
47	16MAY93	0913	37 10.8	122 53.0	428
48	16MAY93	1041	37 10.8	123 05.3	865
49	16MAY93	1210	37 10.8	123 17.5	1950
50	16MAY93	1343	37 22.4	123 17.7	1800
51	16MAY93	1510	37 22.3	123 05.2	800
52	16MAY93	1642	37 22.3	122 53.0	195
53	16MAY93	1758	37 22.3	122 40.6	86
54	16MAY93	1907	37 22.3	122 28.4	30
55	16MAY93	2030	37 16.5	122 29.0	50
56	16MAY93	2241	37 15.7	122 32.3	80
57	16MAY93	2325	37 16.5	122 39.1	96
58	17MAY93	0345	37 16.8	122 46.7	130
59	17MAY93	0543	37 17.0	123 01.2	630
60	17MAY93	0749	37 30.8	122 46.8	80
61	17MAY93	0900	37 30.7	122 59.4	218
62	17MAY93	1014	37 30.8	123 11.7	1350
63	17MAY93	1139	37 30.7	123 24.0	2400

CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH(M)
64	17MAY93	1301	37 30.8	123 36.4	3000
65	17MAY93	1416	37 38.4	123 42.4	3330
66	17MAY93	1540	37 46.2	123 36.4	2900
67	17MAY93	1707	37 46.2	123 24.0	1500
68	17MAY93	1830	37 46.2	123 11.6	114
69	17MAY93	2030	37 39.5	123 02.5	105
70	17MAY93	2324	37 41.3	123 13.1	1230
71	18MAY93	0021	37 44.1	123 07.8	91
72	18MAY93	0300	37 53.8	123 20.6	97
73	18MAY93	0530	37 54.8	123 32.0	1830
74	18MAY93	0632	38 01.7	123 30.1	134
75	18MAY93	0751	38 01.6	123 42.4	2560
76	18MAY93	0922	38 01.6	123 54.7	3500
77	18MAY93	1053	38 01.6	124 06.9	3600
78	18MAY93	1207	38 10.1	124 06.8	3600
79	18MAY93	1344	38 18.6	123 54.5	2850
80	18MAY93	1503	38 18.5	123 42.3	1450
81	18MAY93	1622	38 18.5	123 30.0	258
82	18MAY93	1735	38 18.4	123 17.7	108
83	18MAY93	1917	38 10.1	123 27.3	300
84	18MAY93	2030	38 09.9	123 21.9	190
85	19MAY93	0039	38 10.7	123 17.8	123
86	19MAY93	0137	38 09.9	123 10.0	90
87	19MAY93	0343	38 11.1	123 05.7	76
88	19MAY93	0502	38 11.8	123 01.4	60
89	19MAY93	0627	38 01.5	123 05.5	62
90	19MAY93	0750	38 01.6	123 18.0	118
91	19MAY93	2045	37 58.0	122 56.0	53
92	19MAY93	2230	37 55.0	122 51.4	48
93	19MAY93	2358	37 51.0	122 46.0	40
94	20MAY93	0157	37 48.2	122 52.9	57
95	20MAY93	0219	37 42.0	122 54.5	56
96	20MAY93	0542	37 38.5	122 46.1	50

DSJ9307 SWEEP 2

CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH(M)
100	21MAY93	0835	36 54.0	122 17.1	490
101	21MAY93	0930	36 48.9	122 17.1	1500
102	21MAY93	1025	36 49.0	122 11.0	515
103	21MAY93	1123	36 54.0	122 11.0	93
104	21MAY93	1205	36 54.1	122 04.5	58
105	21MAY93	1250	36 48.9	122 05.0	108
106	21MAY93	1330	36 44.5	122 02.4	700
107	21MAY93	1450	36 51.1	121 53.2	54
108	21MAY93	1620	36 53.5	121 59.7	38
109	21MAY93	2035	36 50.7	121 59.0	88
110	21MAY93	2253	36 44.8	121 51.7	58
111	21MAY93	2337	36 44.3	121 58.6	292
112	22MAY93	0134	36 42.8	121 53.0	75
113	22MAY93	0210	36 38.5	121 51.6	36
114	22MAY93	0440	36 39.7	121 55.5	81
115	22MAY93	0600	36 40.1	122 10.0	1100
116	22MAY93	0720	36 46.3	122 16.1	860
117	22MAY93	0835	36 40.0	122 22.3	2300
118	22MAY93	0955	36 46.3	122 28.5	2000

CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH (M)
119	22MAY93	1119	36 40.0	122 34.9	2300
120	22MAY93	1237	36 46.3	122 40.8	2100
121	22MAY93	1403	36 46.3	122 53.0	2550
122	22MAY93	1515	36 40.0	122 47.5	2750
123	22MAY93	1630	36 33.7	122 40.6	2800
124	22MAY93	1756	36 33.7	122 28.3	2750
125	22MAY93	1920	36 33.7	122 16.1	2550
126	22MAY93	2030	36 35.0	122 10.5	3280
127	23MAY93	0056	36 34.0	122 01.1	525
128	23MAY93	0150	36 38.8	122 03.0	850
130	23MAY93	0539	36 45.8	122 07.5	1350
131	23MAY93	0646	36 52.7	122 10.1	100
132	23MAY93	0805	36 52.6	122 22.4	1170
133	23MAY93	0936	36 52.6	122 34.6	1600
134	23MAY93	1105	36 52.5	122 47.3	2300
135	23MAY93	1222	36 52.6	122 59.4	2700
136	23MAY93	1340	36 59.0	123 05.5	2650
137	23MAY93	1458	37 05.0	122 59.3	900
138	23MAY93	1621	37 04.9	122 46.9	690
139	23MAY93	1806	37 05.0	122 34.5	114
140	23MAY93	1937	37 05.0	122 22.4	50
141	23MAY93	2120	36 59.0	122 35.5	433
145	24MAY93	0515	36 57.8	122 12.8	65
146	24MAY93	0615	36 59.0	122 22.6	125
147	24MAY93	0745	37 10.8	122 28.3	68
148	24MAY93	0900	37 10.6	122 40.7	110
149	24MAY93	1015	37 10.7	122 53.0	427
150	24MAY93	1115	37 10.7	123 05.2	846
151	24MAY93	1259	37 16.5	123 11.4	1200
152	24MAY93	1355	37 22.3	123 07.2	851
153	24MAY93	1519	37 22.2	122 53.5	218
154	24MAY93	1632	37 22.3	122 40.6	87
155	24MAY93	1744	37 22.2	122 28.3	40
156	24MAY93	2038	37 16.5	122 29.0	50
157	24MAY93	2239	37 17.9	122 34.8	85
158	24MAY93	2310	37 16.5	122 39.0	96
159	25MAY93	0253	37 17.6	122 49.7	185
160	25MAY93	0433	37 17.8	122 59.7	600
161	25MAY93	0705	37 30.8	122 46.9	80
162	25MAY93	0905	37 30.3	122 58.8	211
163	25MAY93	1024	37 30.8	123 11.4	1350
164	25MAY93	1205	37 30.8	123 23.9	2450
165	25MAY93	1333	37 30.8	123 36.4	3000
166	25MAY93	1447	37 38.8	123 42.5	3300
167	25MAY93	1605	37 46.3	123 36.3	2750
168	25MAY93	1748	37 46.3	123 21.1	1500
169	25MAY93	1930	37 46.3	123 11.6	114
170	25MAY93	2050	37 39.5	123 02.4	104
171	25MAY93	2339	37 41.5	123 11.8	1190
172	26MAY93	0023	37 43.6	123 08.1	107
173	26MAY93	0301	37 54.2	123 20.2	105
174	26MAY93	0510	37 54.0	123 32.5	1000
175	26MAY93	0625	38 01.7	123 30.0	140
176	26MAY93	0749	38 01.6	123 42.5	2550
177	26MAY93	0915	38 01.5	123 54.7	3500
178	26MAY93	1036	38 01.6	124 07.1	3660
179	26MAY93	1152	38 10.0	124 06.9	3620
180	26MAY93	1304	38 18.4	124 06.9	3600
181	26MAY93	1426	38 18.5	123 54.8	2800
182	26MAY93	1553	38 18.6	123 42.4	1450
183	26MAY93	1723	38 18.5	123 30.0	250
184	26MAY93	1852	38 18.5	123 17.7	107

CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH(M)
185	26MAY93	2032	38 10.0	123 22.0	180
186	27MAY93	0032	38 10.9	123 17.6	123
187	27MAY93	0120	38 10.0	123 10.0	90
188	27MAY93	0322	38 11.7	123 04.9	76
189	27MAY93	0435	38 11.5	123 01.1	62
190	27MAY93	0650	38 01.5	123 18.1	120
191	27MAY93	0804	38 01.5	123 05.5	62
192	27MAY93	1353	37 55.9	123 10.0	0
193	27MAY93	1454	37 50.9	123 01.0	80
194	27MAY93	1945	37 55.1	122 51.6	47
195	27MAY93	2045	37 58.0	122 56.4	54
196	27MAY93	2319	37 51.4	122 45.2	35
197	28MAY93	0012	37 47.5	122 52.0	55
198	28MAY93	0156	37 41.8	122 53.3	57
199	28MAY93	0336	37 38.2	122 45.5	51

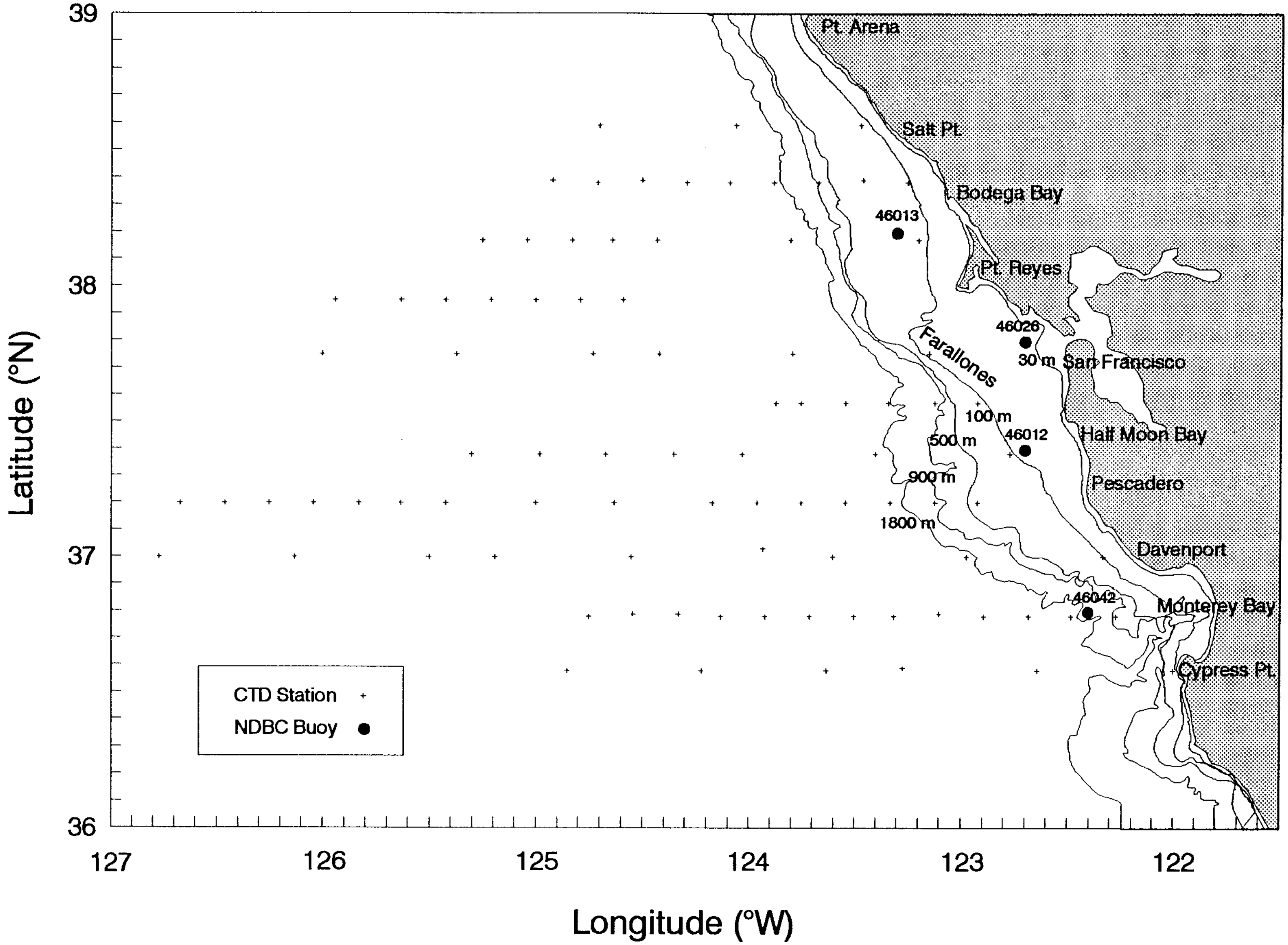
DSJ9307 SWEEP 3

CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH(M)
246	03JUN93	1805	36 53.9	122 04.5	60
247	03JUN93	1846	36 48.9	122 05.0	105
248	03JUN93	1953	36 53.1	121 56.0	36
249	03JUN93	2102	36 50.8	121 59.2	88
250	03JUN93	2318	36 45.1	121 51.3	54
251	04JUN93	0004	36 44.4	121 58.6	320
255	04JUN93	0626	36 39.9	122 10.2	1100
256	04JUN93	0746	36 46.3	122 16.1	840
257	04JUN93	0900	36 40.0	122 22.3	1800
258	04JUN93	1013	36 46.4	122 28.4	2100
259	04JUN93	1130	36 40.1	122 34.6	2300
260	04JUN93	1244	36 46.6	122 40.9	2100
261	04JUN93	1413	36 46.4	122 53.1	2550
262	04JUN93	1530	36 40.0	122 47.0	2880
263	04JUN93	1646	36 33.7	122 40.8	2700
264	04JUN93	1816	36 33.7	122 28.4	2700
265	04JUN93	1949	36 33.7	122 16.2	1600
266	04JUN93	2104	36 34.8	122 10.4	2330
267	05JUN93	0146	36 33.2	122 01.3	850
269	05JUN93	0510	36 40.8	122 05.0	1500
270	05JUN93	0707	36 52.6	122 09.9	100
271	05JUN93	0829	36 52.6	122 22.3	1150
272	05JUN93	1005	36 52.6	122 34.6	1600
273	05JUN93	1143	36 52.7	122 46.9	2300
274	05JUN93	1320	36 52.7	122 59.3	2700
275	05JUN93	1441	36 59.0	123 05.4	2650
276	05JUN93	1552	37 05.0	122 59.3	930
277	05JUN93	1715	37 05.1	122 46.9	650
278	05JUN93	1838	37 05.0	122 34.4	113
279	05JUN93	1946	37 05.0	122 22.2	58
280	05JUN93	2119	36 59.0	122 35.4	426
282	06JUN93	0240	36 58.2	122 20.0	113
283	06JUN93	0320	36 59.0	122 17.4	83
284	06JUN93	0409	36 59.0	122 12.4	43
285	06JUN93	1209	37 22.2	122 28.8	30
287	06JUN93	1455	37 22.2	122 53.0	200
289	06JUN93	1752	37 22.2	123 17.7	1700
290	06JUN93	1908	37 16.5	123 11.4	1200

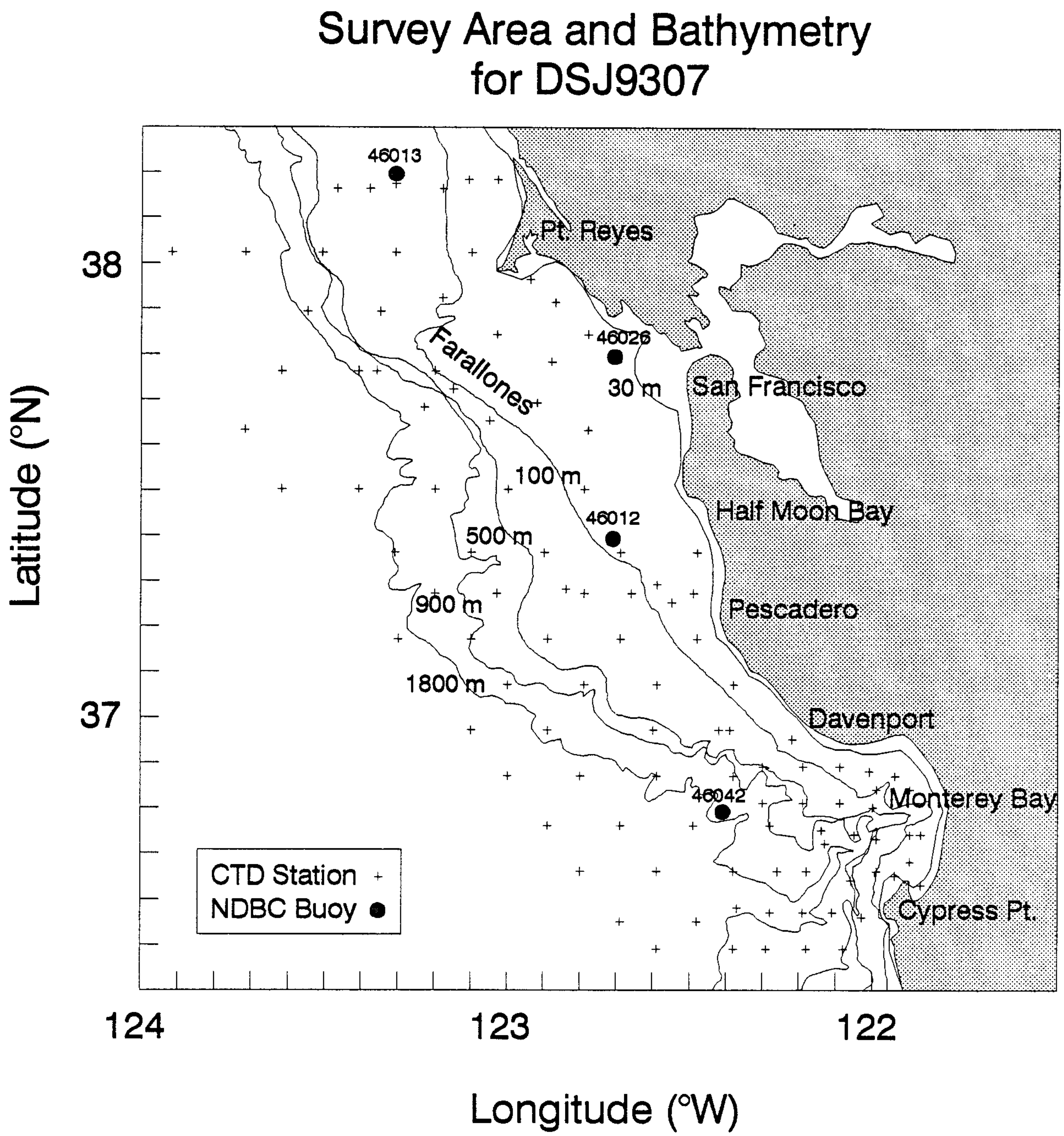
CAST	DATE	TIME	LATITUDE	LONDITUDE	DEPTH(M)
291	06JUN93	2045	37 16.5	122 59.0	523
293	07JUN93	0100	37 16.5	122 39.0	95
294	07JUN93	0244	37 15.6	122 32.2	79
295	07JUN93	0311	37 16.6	122 29.0	50
296	07JUN93	0703	37 30.8	122 47.1	80
297	07JUN93	0820	37 30.8	122 59.3	212
298	07JUN93	0953	37 30.7	123 11.7	1350
299	07JUN93	1120	37 30.8	123 24.0	2400
300	07JUN93	1252	37 30.9	123 36.3	3000
301	07JUN93	1418	37 38.4	123 42.4	3350
302	07JUN93	1543	37 46.2	123 36.4	2700
303	07JUN93	1711	37 46.2	123 24.0	1460
304	07JUN93	1842	37 46.2	123 11.5	112
305	07JUN93	2047	37 39.4	123 02.3	104
306	08JUN93	0016	37 37.4	123 11.4	1100
307	08JUN93	0148	37 44.5	123 08.4	100
308	08JUN93	0555	37 47.6	123 14.4	100
309	09JUN93	2103	37 58.0	122 56.0	52
310	09JUN93	2204	37 54.8	122 51.5	47
311	09JUN93	2253	37 51.0	122 45.9	38
312	10JUN93	0133	37 46.4	122 51.4	54
313	10JUN93	0218	37 42.0	122 54.6	56
314	10JUN93	0418	37 36.3	122 44.8	52
315	10JUN93	1050	38 01.4	123 17.8	118
316	10JUN93	1226	38 01.5	123 30.1	140
317	10JUN93	1412	38 01.7	123 42.5	2400
318	10JUN93	1639	38 10.0	123 46.2	2500

APPENDIX 3.1: DSJ9304 CTD STATIONS AND BATHYMETRIC MAP OF SURVEY REGION WITH LOCATIONS OF THE NDBC BUOYS

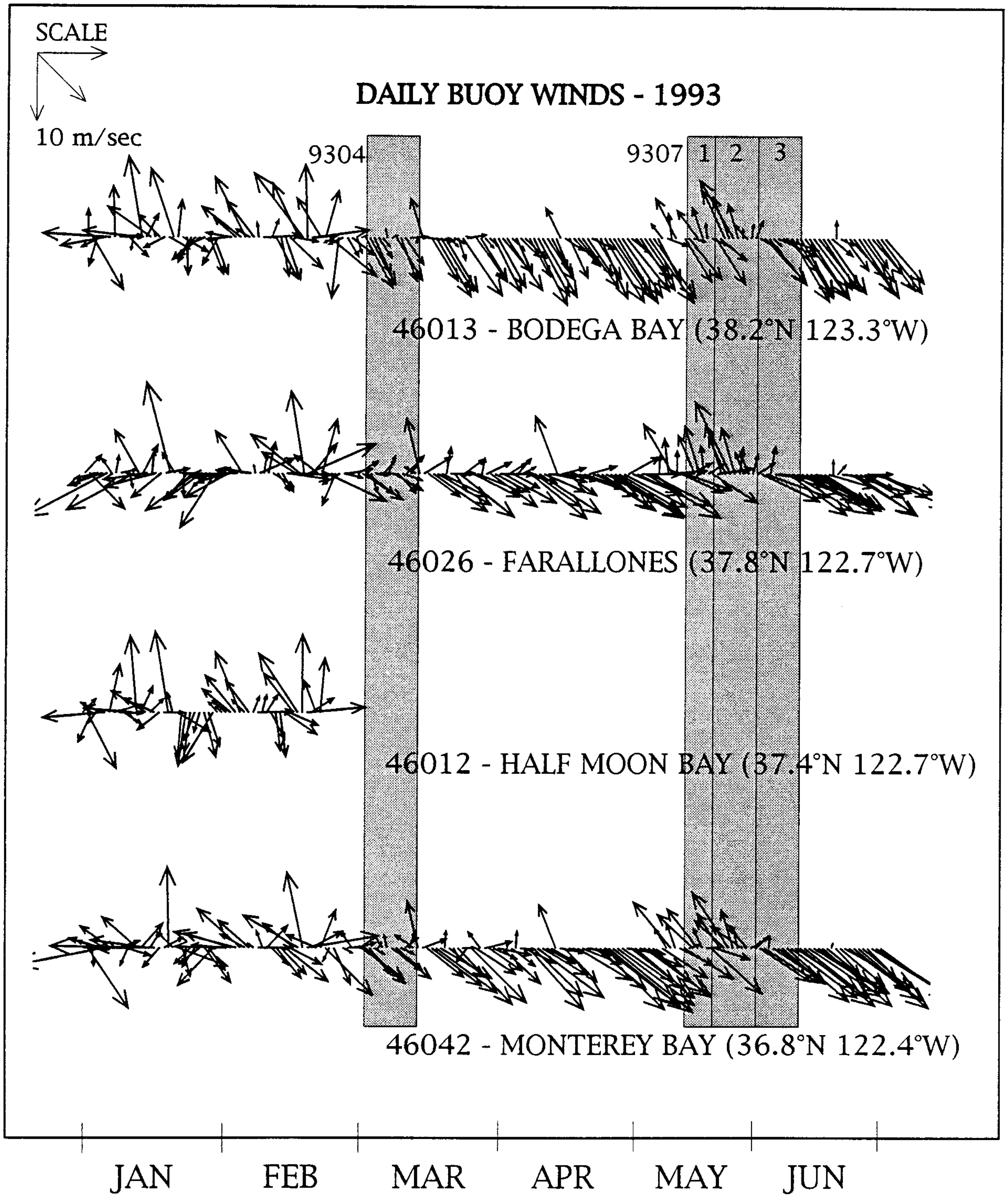
Survey Area and Bathymetry for DSJ9304



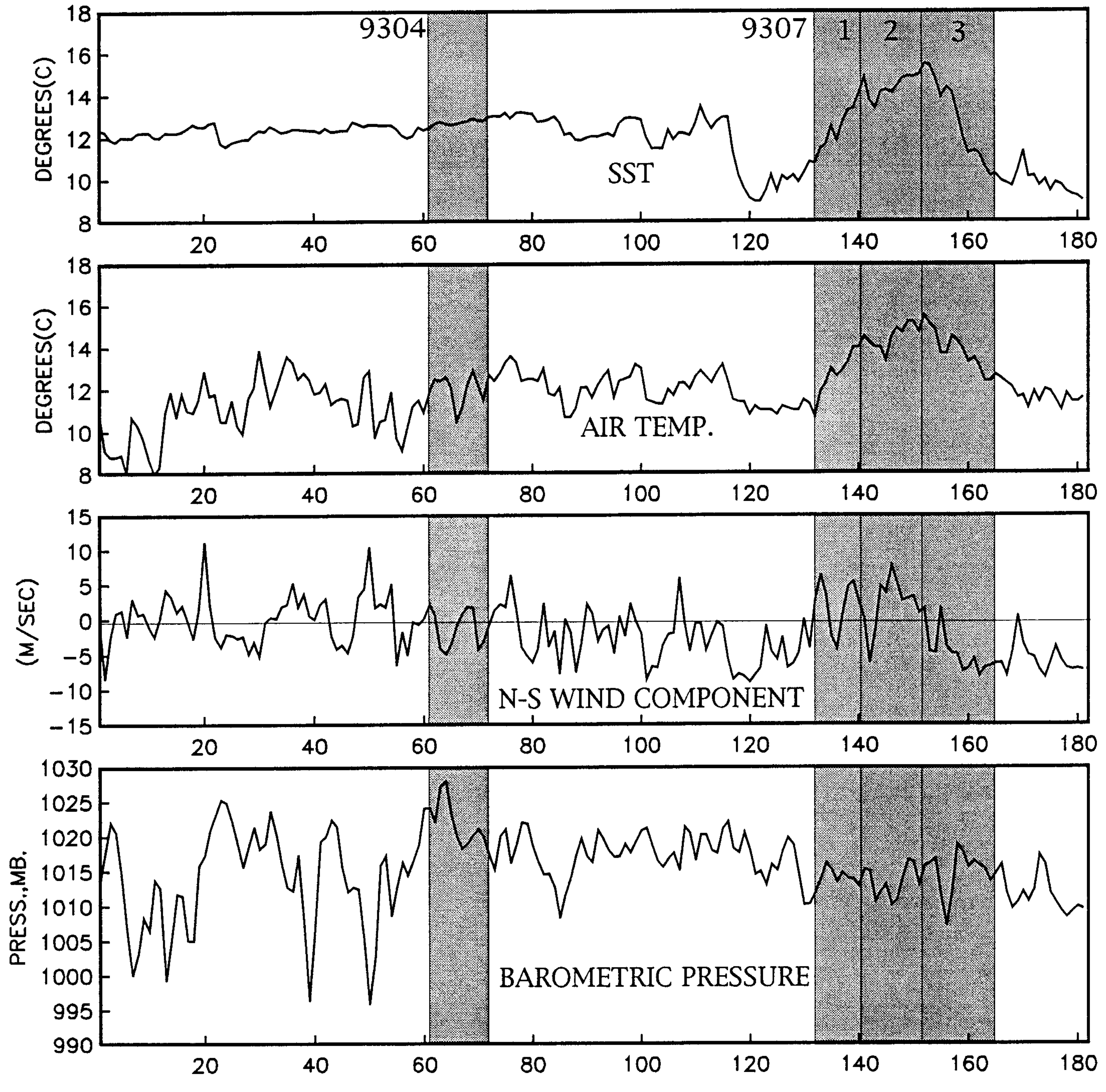
APPENDIX 3.2: DSJ9307 CTD STATIONS AND BATHYMETRIC MAP OF SURVEY REGION WITH LOCATIONS OF THE NDBC BUOYS


Survey Area and Bathymetry
for DSJ9307
46013
Pt. Reyes
46026
Farallones
30 m
San Francisco
100 m
46012
Half Moon Bay
500 m
900 m
Pescadero
1800 m
Davenport
46042
Monterey Bay
Cypress Pt.
CTD Station
NDBC Buoy
38
37
Latitude (°N)
124
123
122
Longitude (°W)

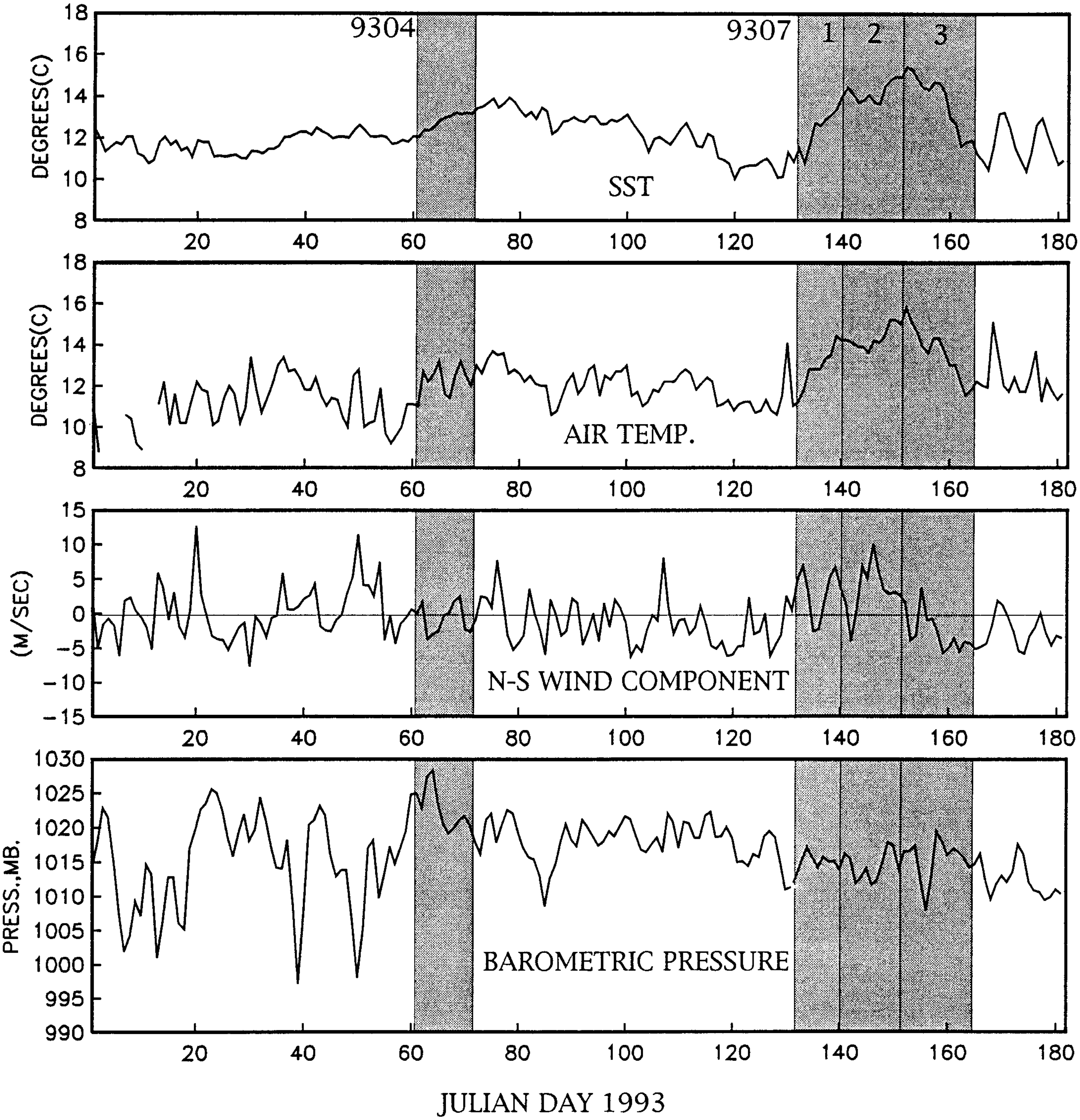
APPENDIX 4: METEOROLOGICAL TIME SERIES


SCALE
10 m/sec
DAILY BUOY WINDS - 1993
9304
9307
1
2
3
46013 - BODEGA BAY (38.2°N 123.3°W)
46026 - FARALLONES (37.8°N 122.7°W)
46012 - HALF MOON BAY (37.4°N 122.7°W)
46042 - MONTEREY BAY (36.8°N 122.4°W)
JAN
FEB
MAR
APR
MAY
JUN

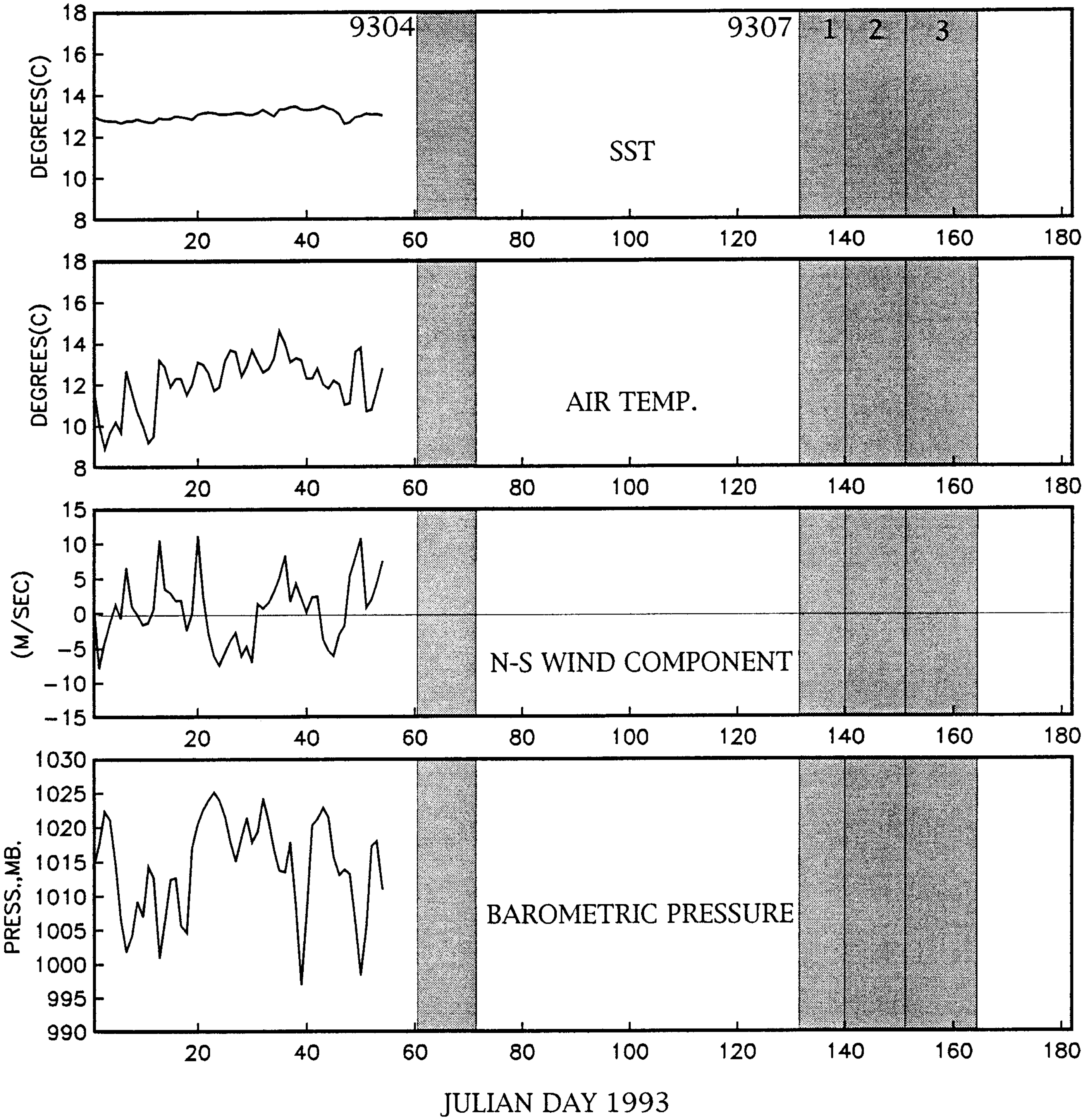
Buoy 46013 - BODEGA BAY (38.2° N, 123.3° W)



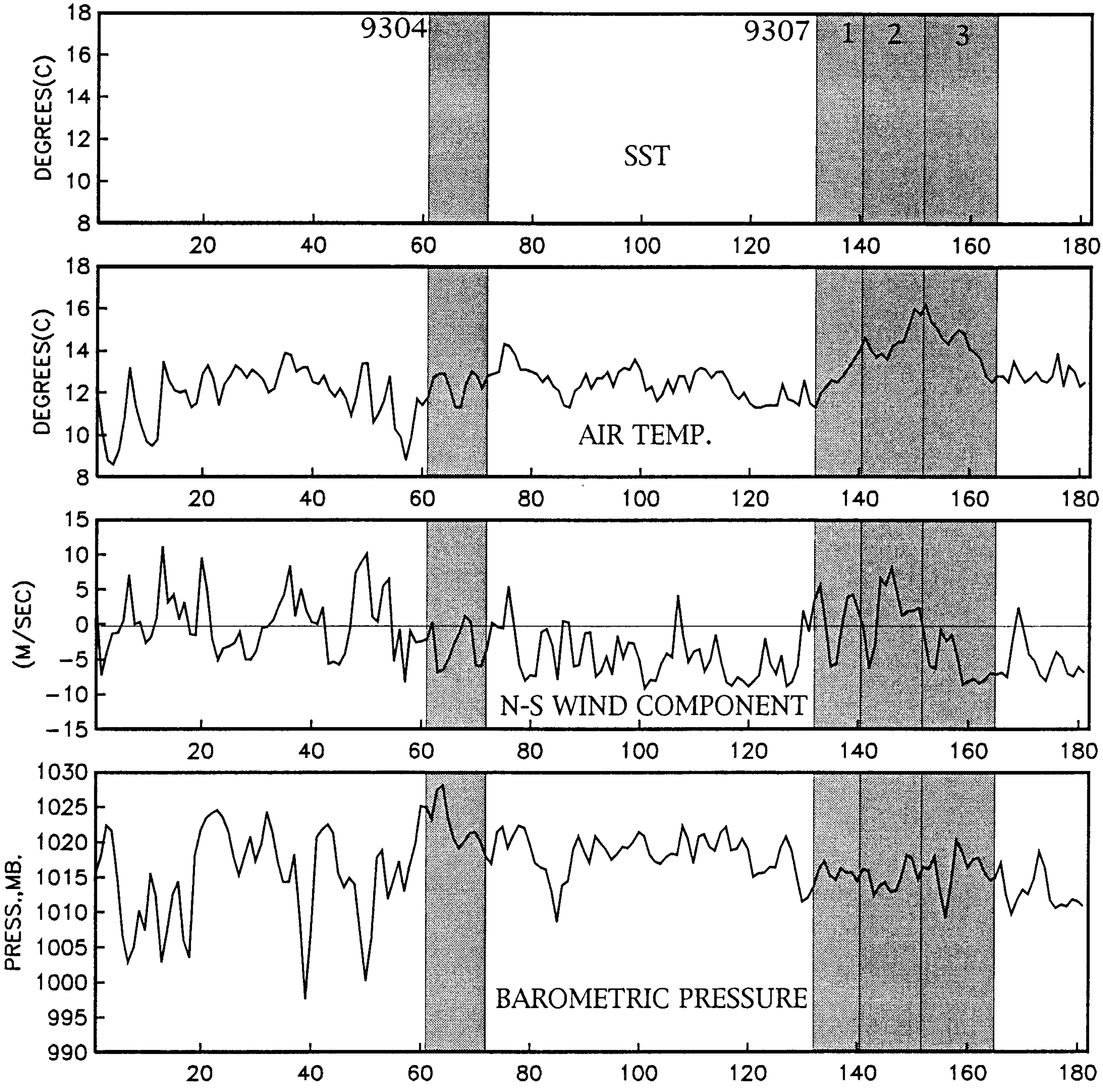
Buoy 46026 - FARALLONES (37.8° N, 122.7° W)



Buoy 46012 - HALF MOON BAY (37.4° N, 122.7° W)

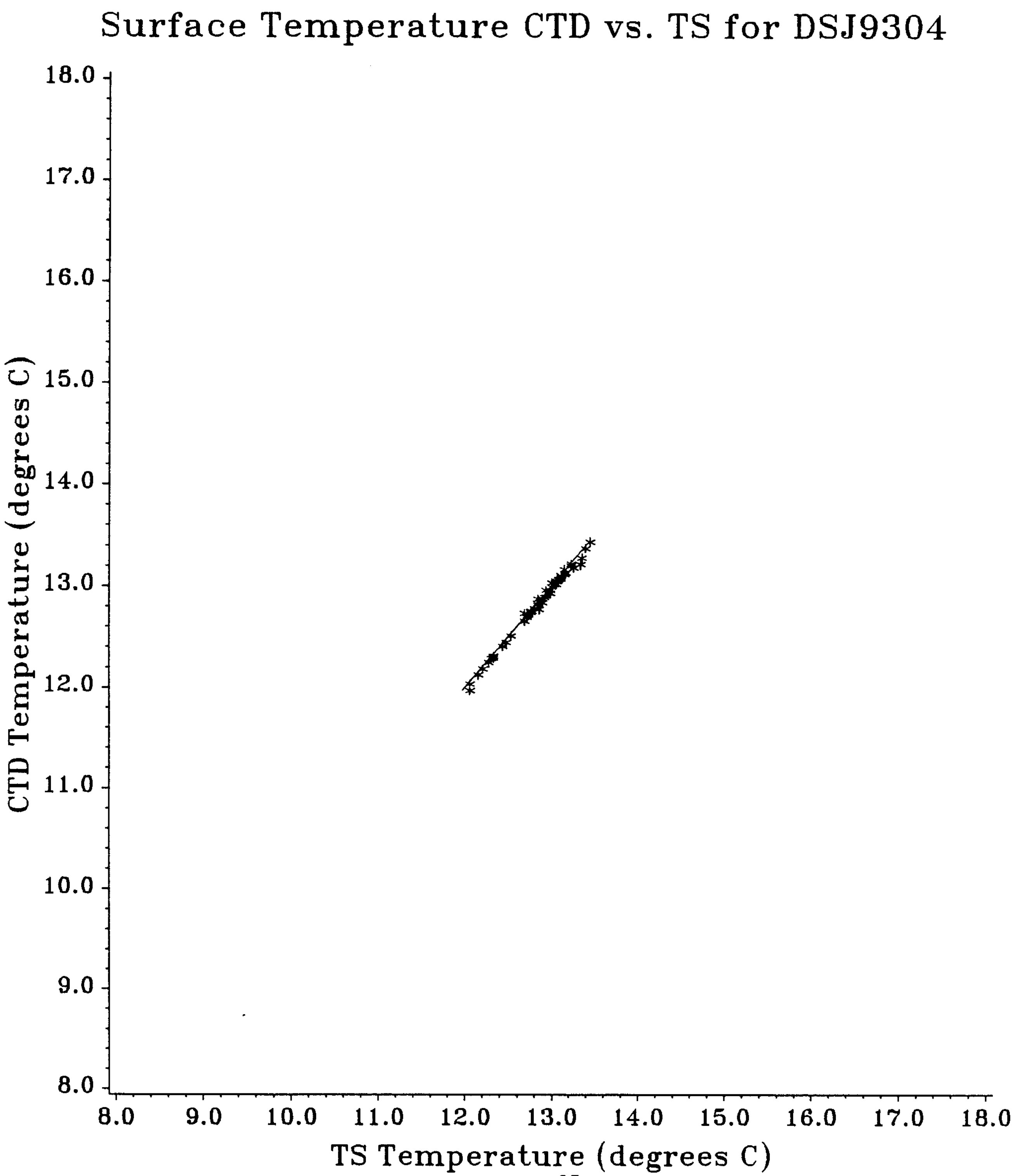


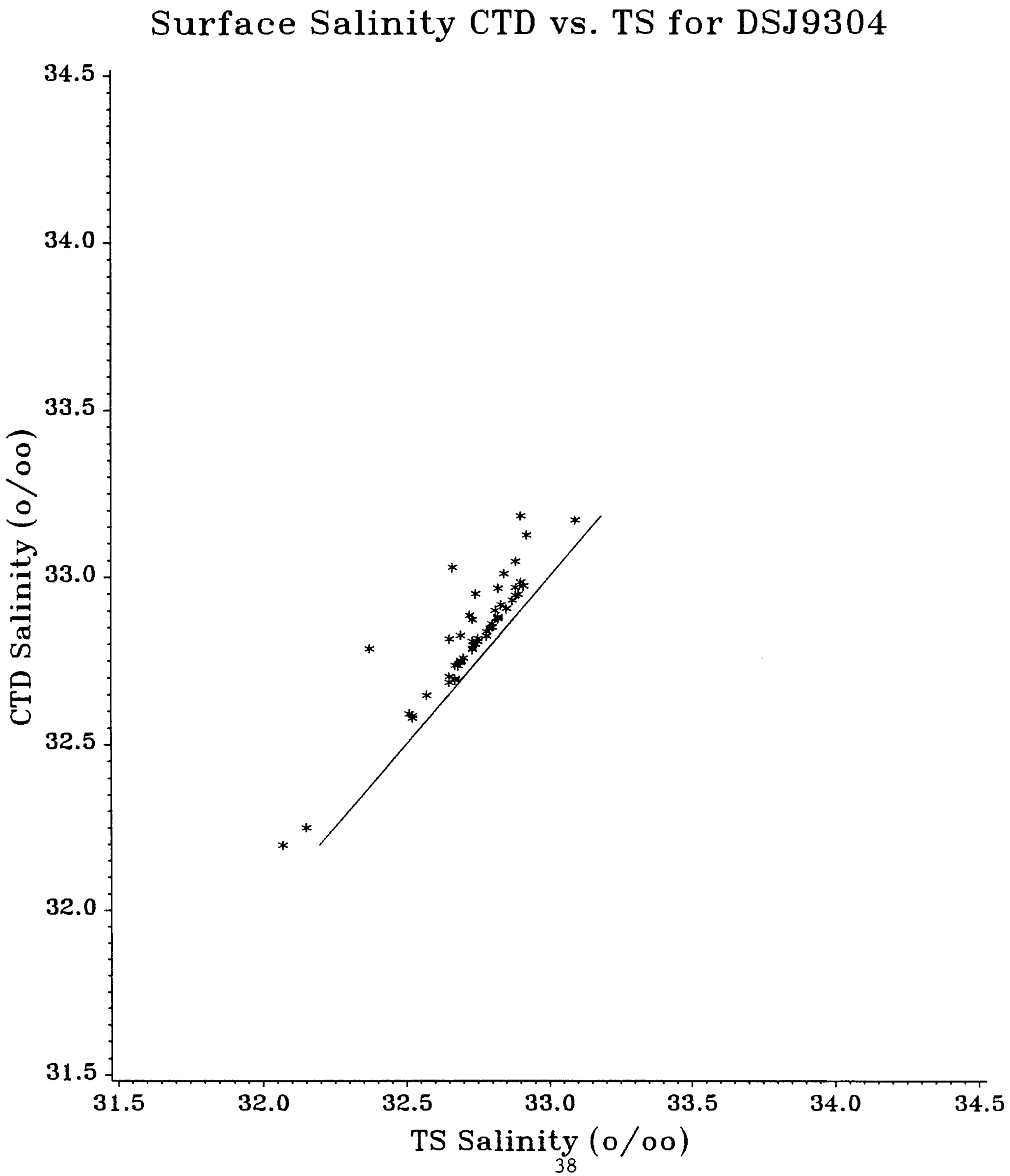
Buoy 46042 - MONTEREY BAY (37.4° N, 122.7° W)



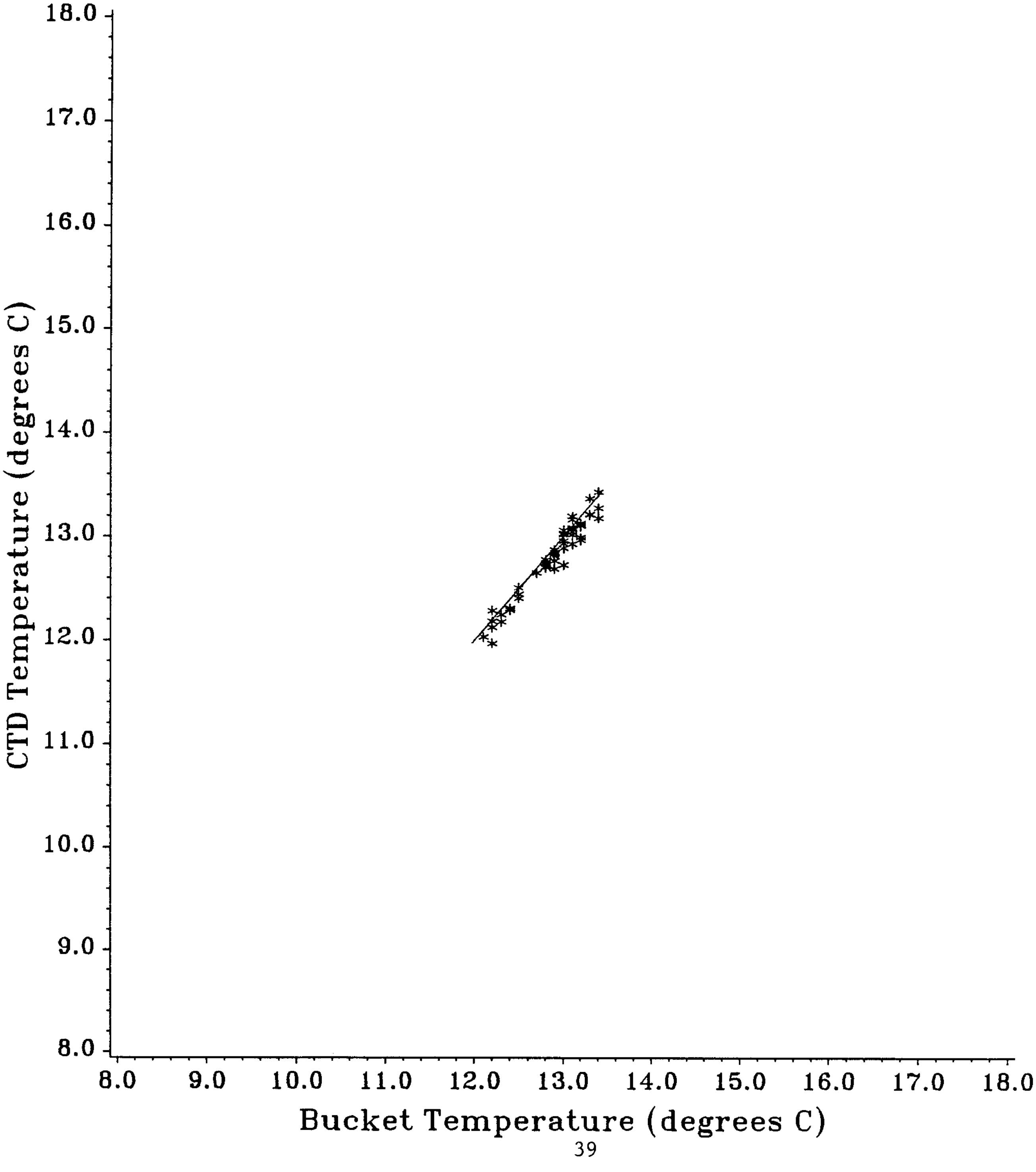
JULIAN DAY 1993

APPENDIX 5.1: REGRESSION COMPARISONS OF CTD, TS, AND BUCKET FOR DSJ9304

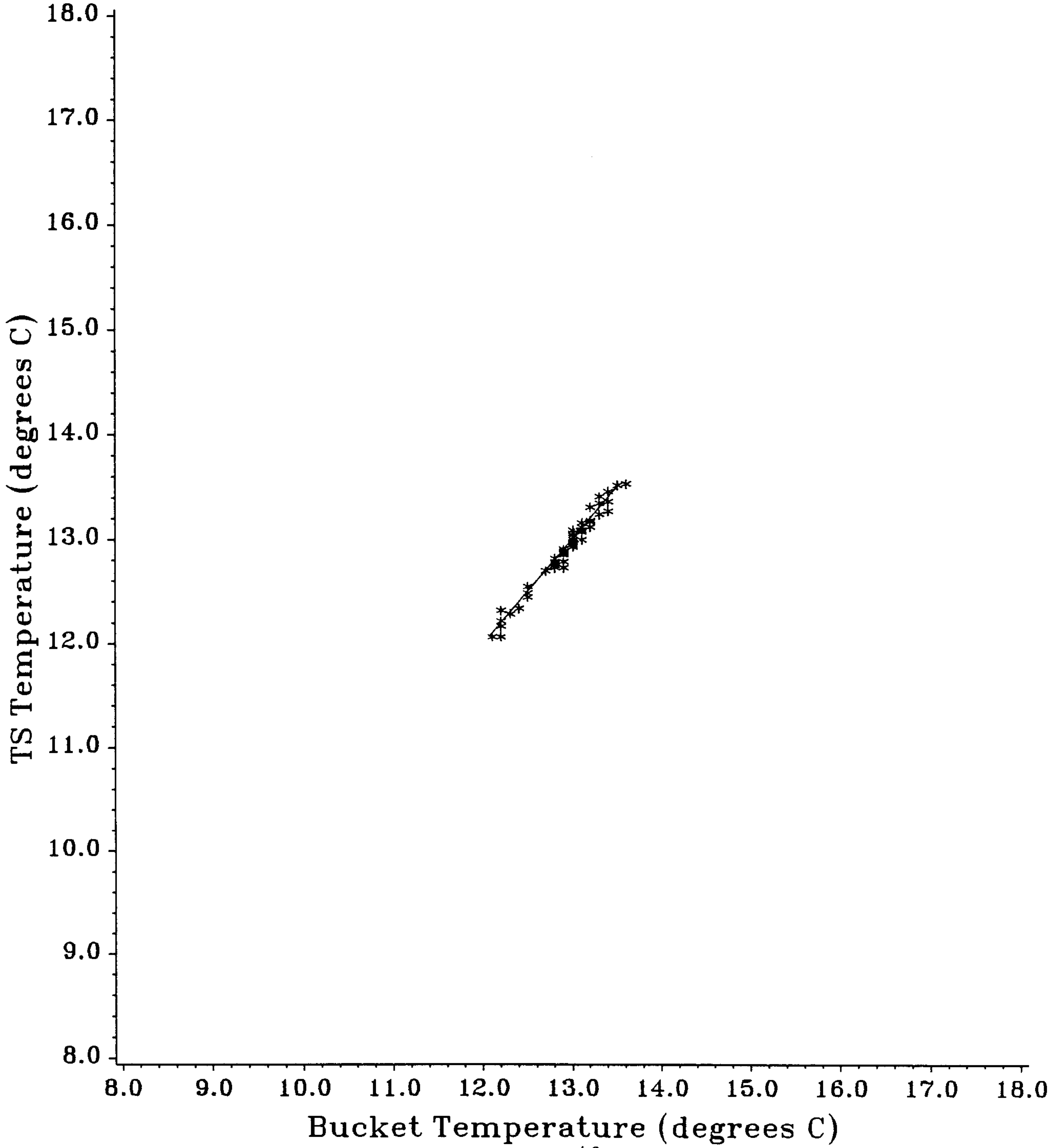

Surface Temperature CTD vs. TS for DSJ9304
CTD Temperature (degrees C)
TS Temperature (degrees C)
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0


Surface Salinity CTD vs. TS for DSJ9304
34.5
34.0
33.5
33.0
32.5
32.0
31.5
CTD Salinity (o/oo)
31.5
32.0
32.5
33.0
33.5
34.0
34.5
TS Salinity (o/oo)

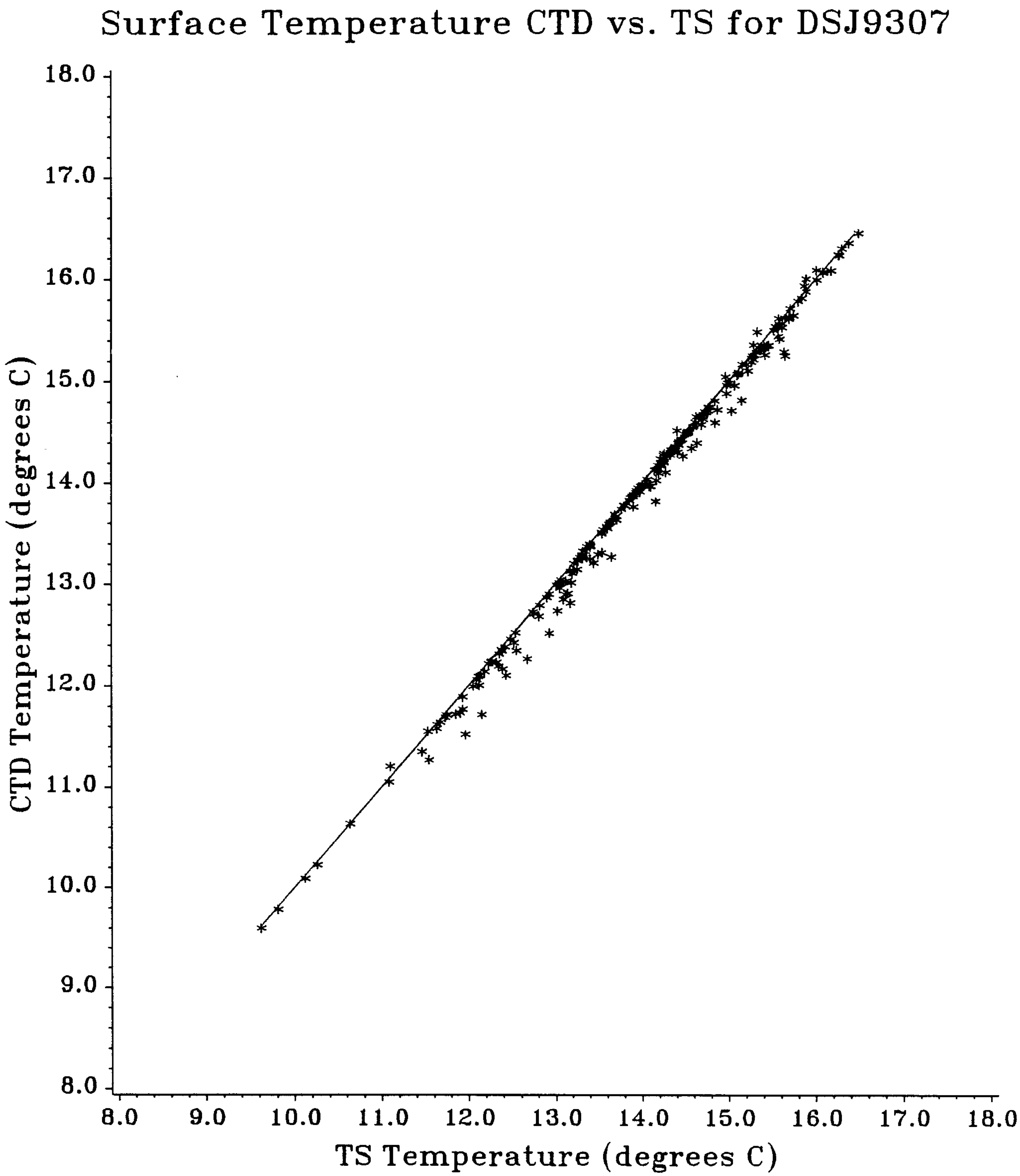
Surface Temperature CTD vs. Bucket for DSJ9304

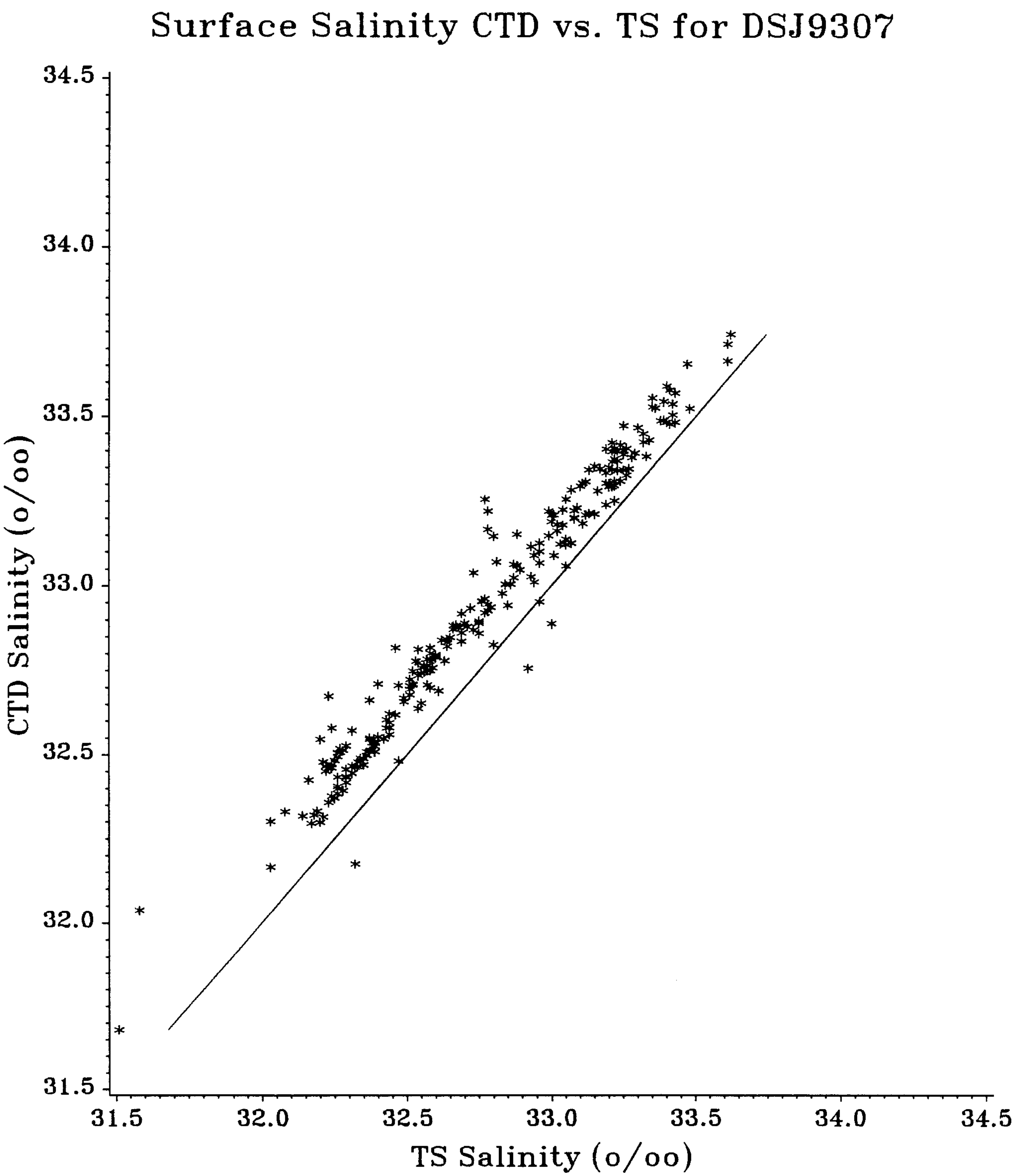


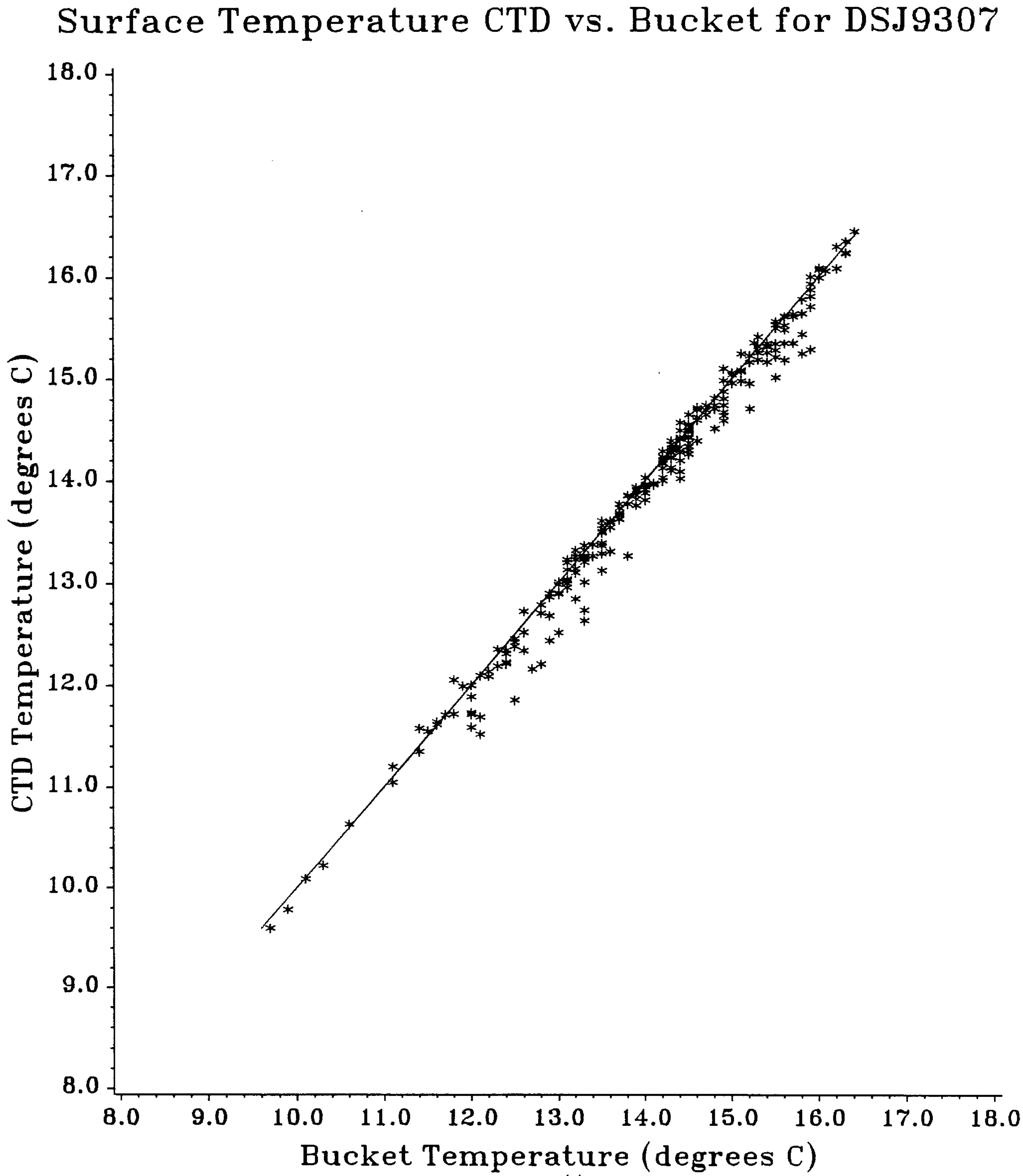
Surface Temperature TS vs. Bucket for DSJ9304



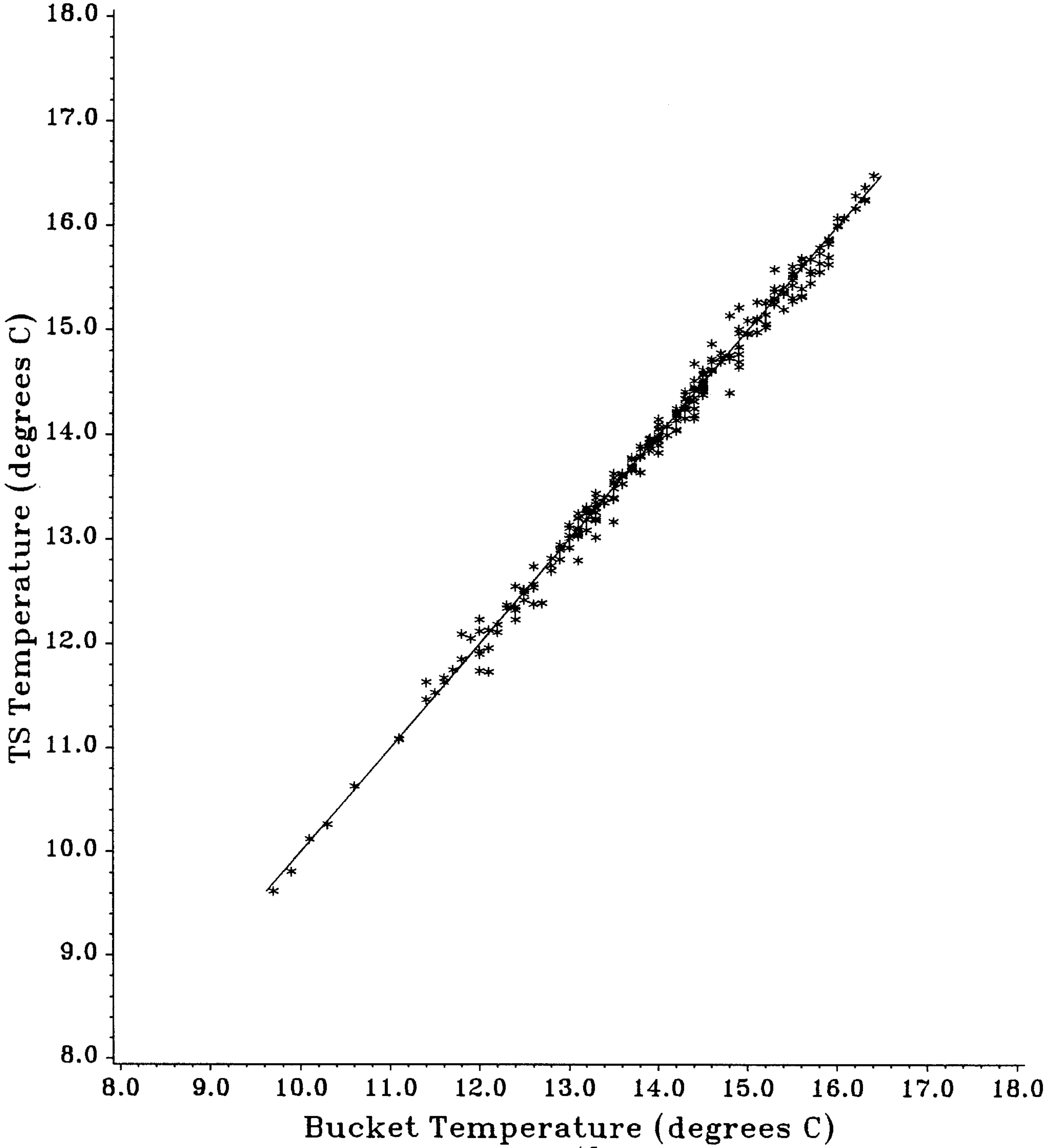
APPENDIX 5.2: REGRESSION COMPARISONS OF CTD, TS, AND BUCKET FOR DSJ9307


Surface Temperature CTD vs. TS for DSJ9307
CTD Temperature (degrees C)
TS Temperature (degrees C)
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0


Surface Salinity CTD vs. TS for DSJ9307
34.5
34.0
33.5
33.0
32.5
32.0
31.5
CTD Salinity (o/oo)
31.5
32.0
32.5
33.0
33.5
34.0
34.5
TS Salinity (o/oo)

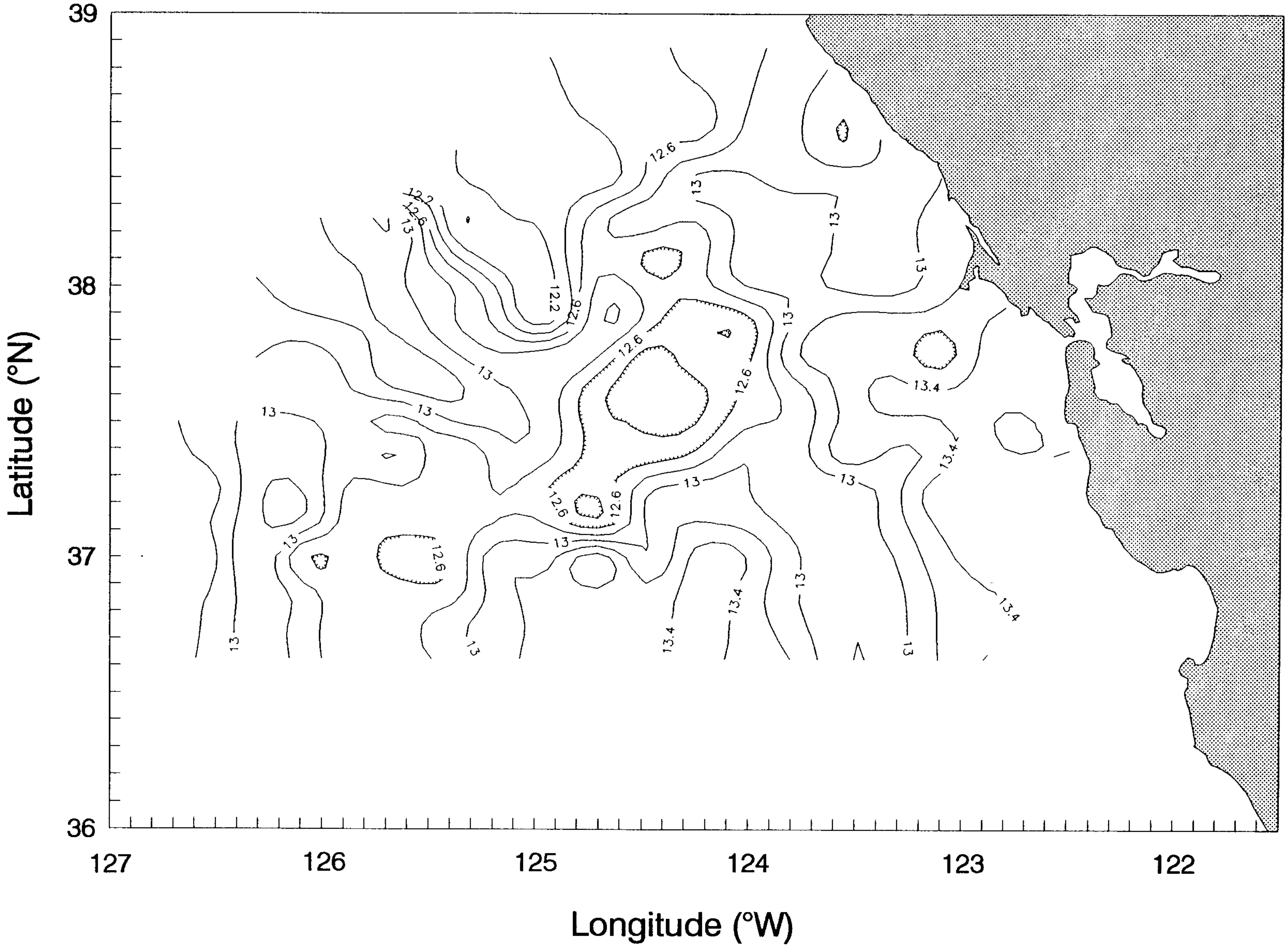

Surface Temperature CTD vs. Bucket for DSJ9307
CTD Temperature (degrees C)
Bucket Temperature (degrees C)
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0

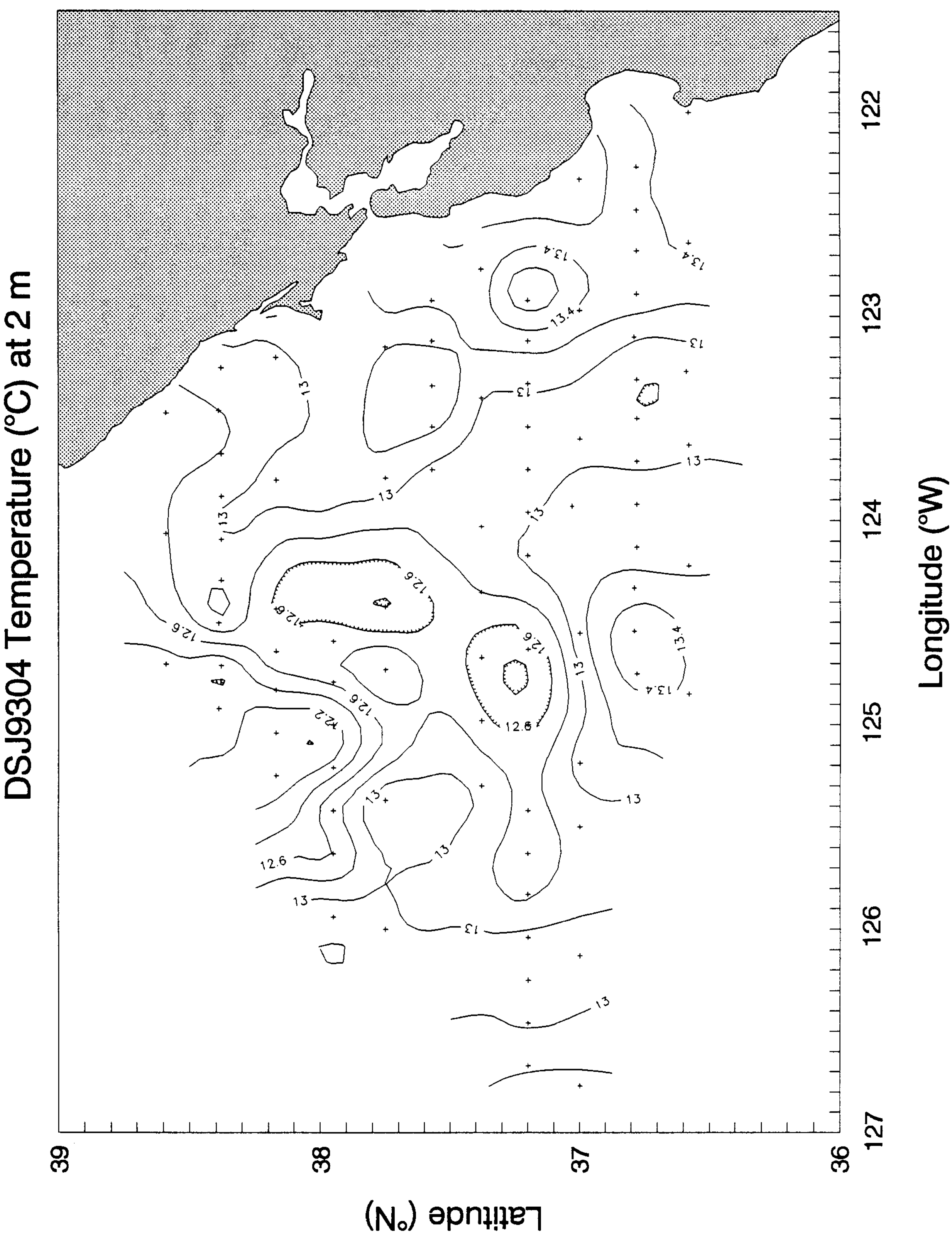
Surface Temperature TS vs. Bucket for DSJ9307



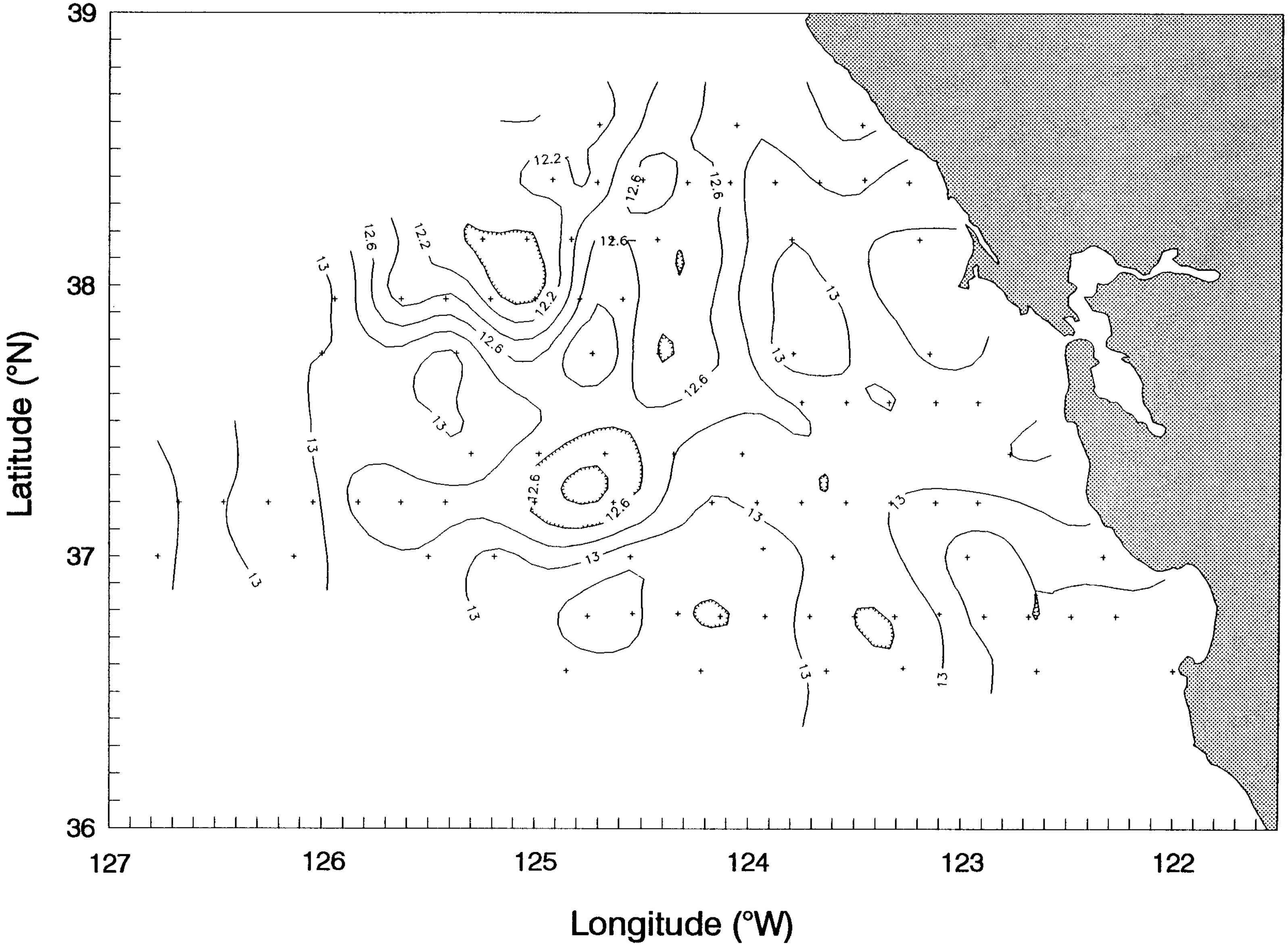
APPENDIX 6.1: HORIZONTAL MAPS OF CTD AND TS FOR DSJ9304

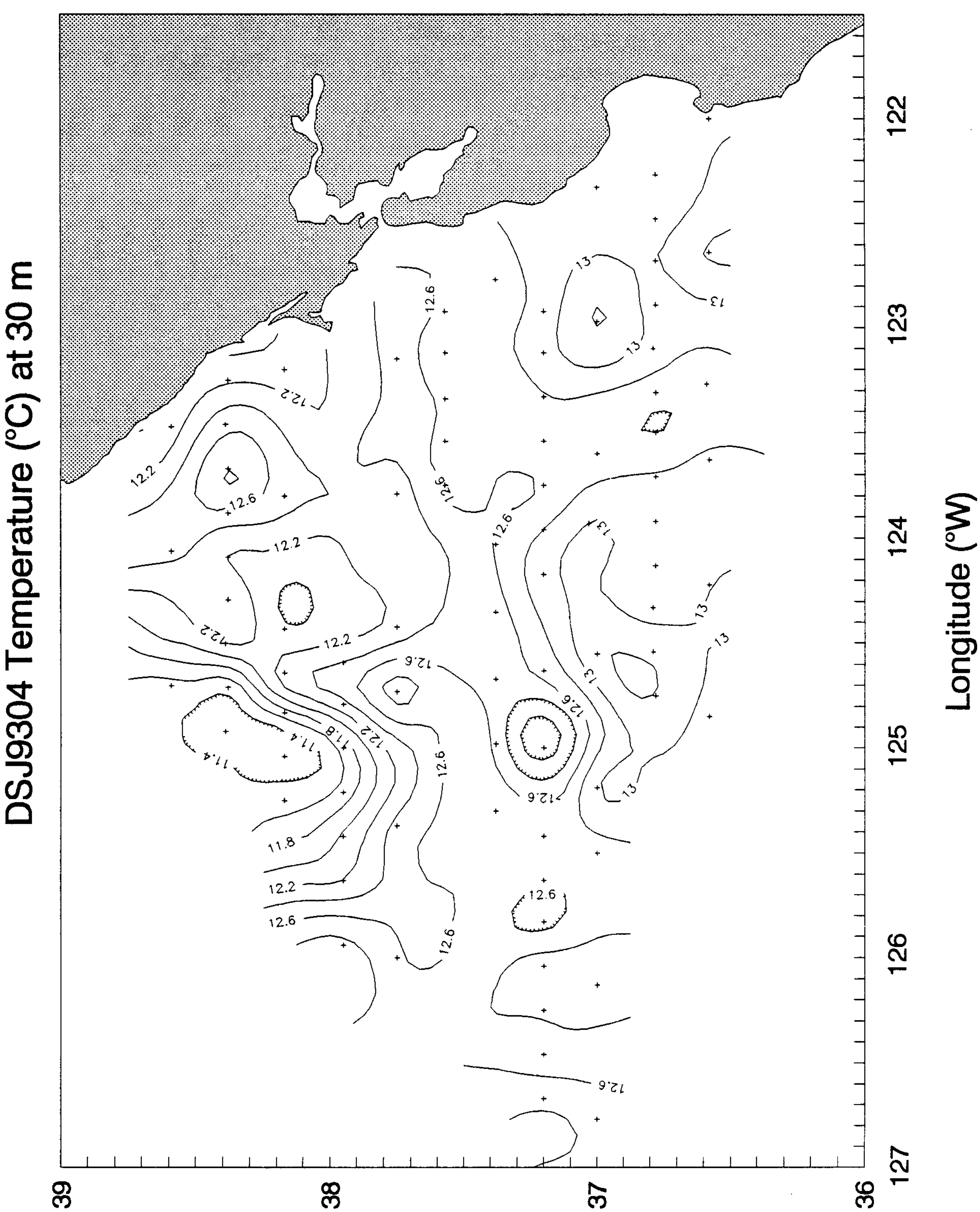
DSJ9304 TS Temperature (°C)

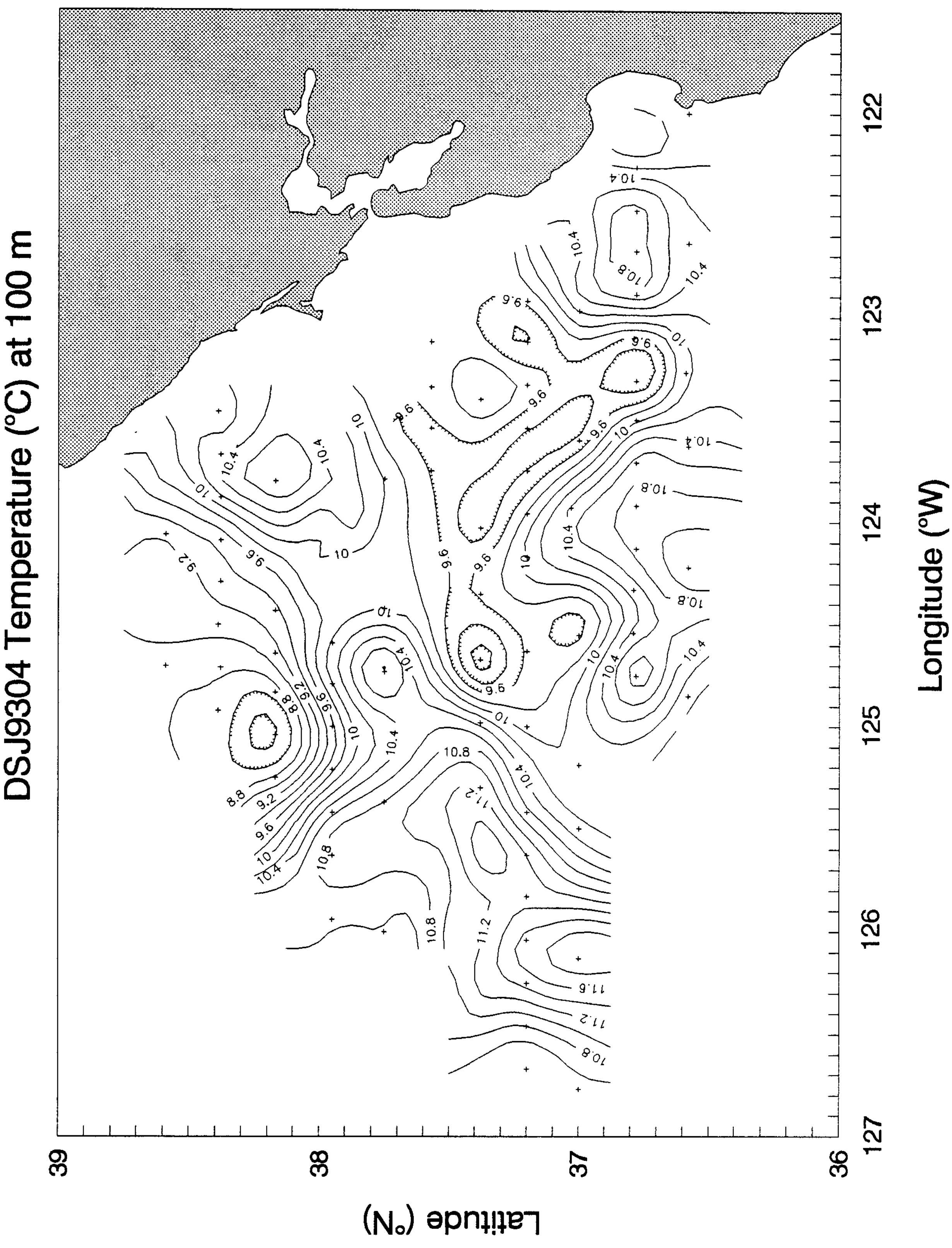



DSJ9304 Temperature (°C) at 2 m
Longitude (°W)
Latitude (°N)
127
126
125
124
123
122
39
38
37
36
12.6
13
13.4

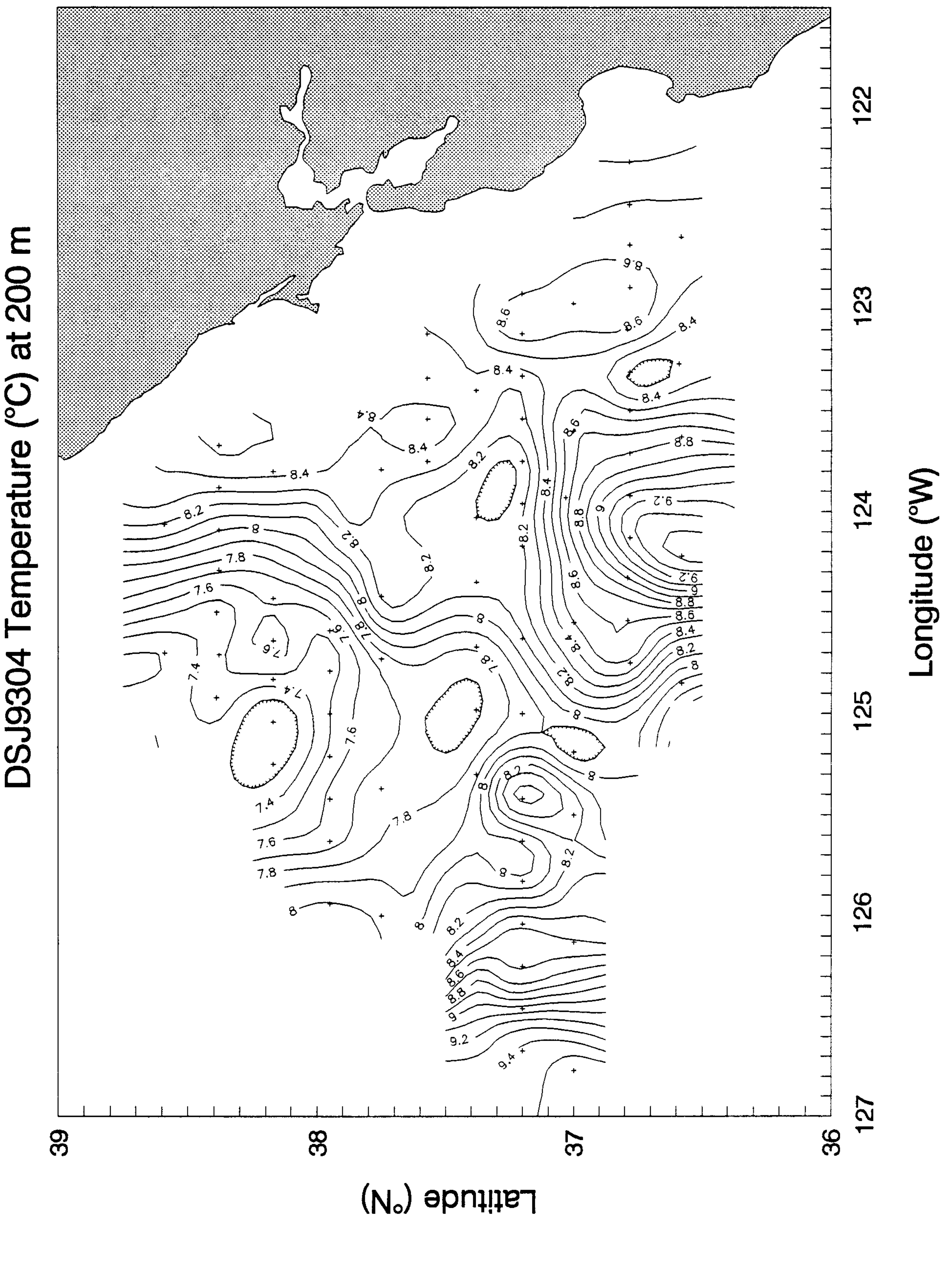
DSJ9304 Temperature (°C) at 10 m




DSJ9304 Temperature (°C) at 30 m
Longitude (°W)
Latitude (°N)
127
126
125
124
123
122
39
38
37
36
11.4
11.8
12.2
12.6
13

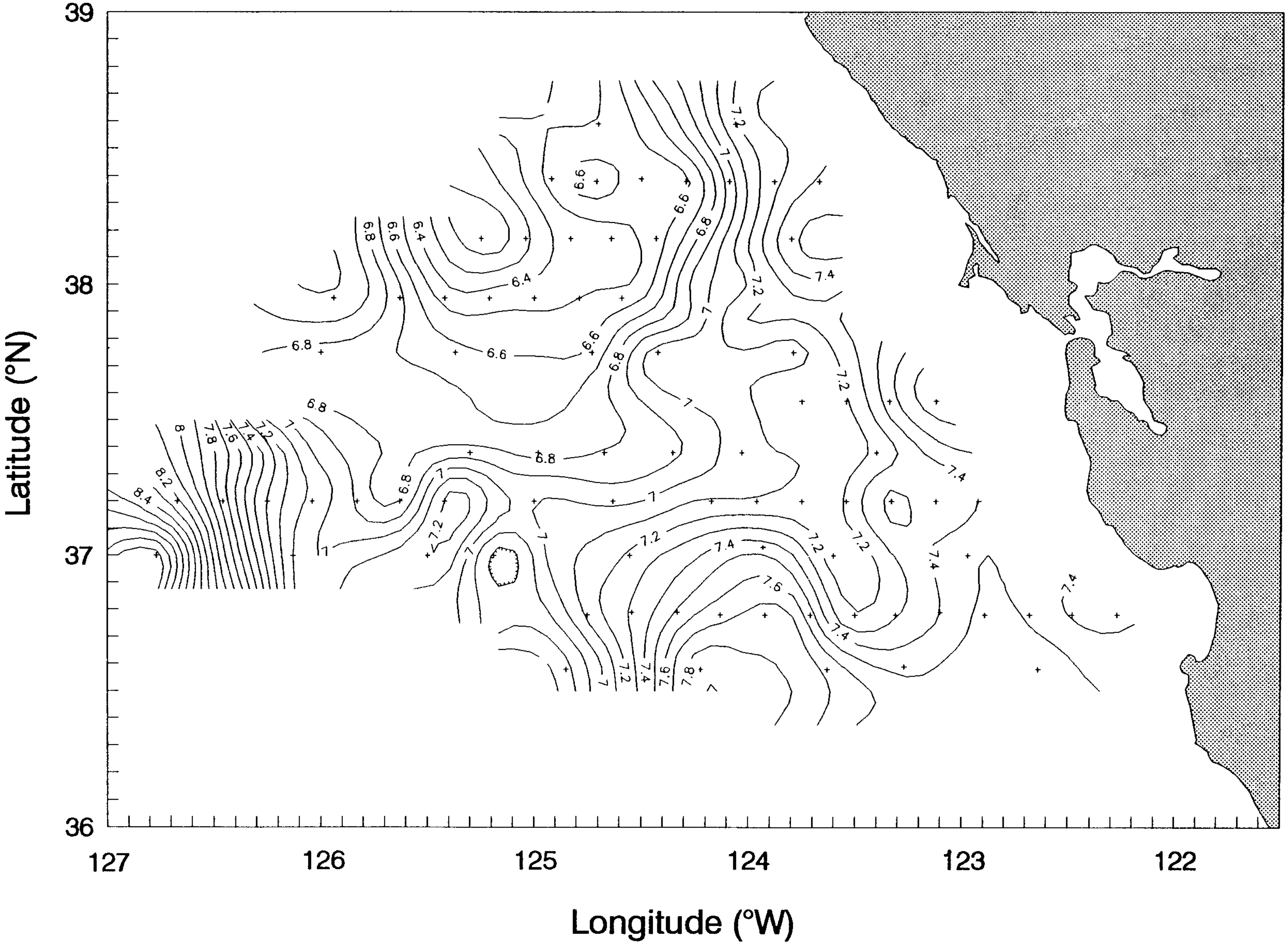


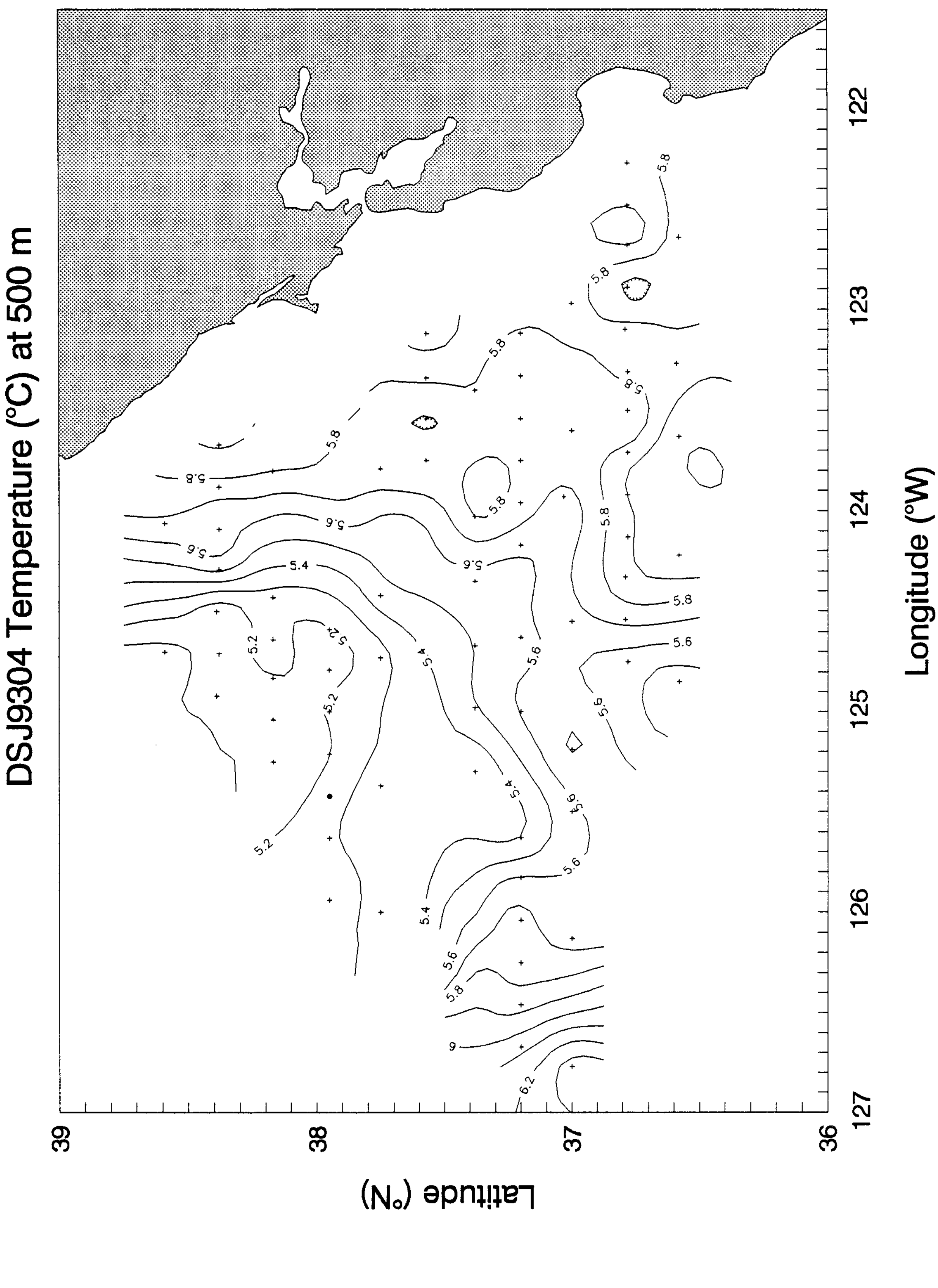
DSJ9304 Temperature (°C) at 100 m
Latitude (°N)
Longitude (°W)
39
38
37
36
127
126
125
124
123
122



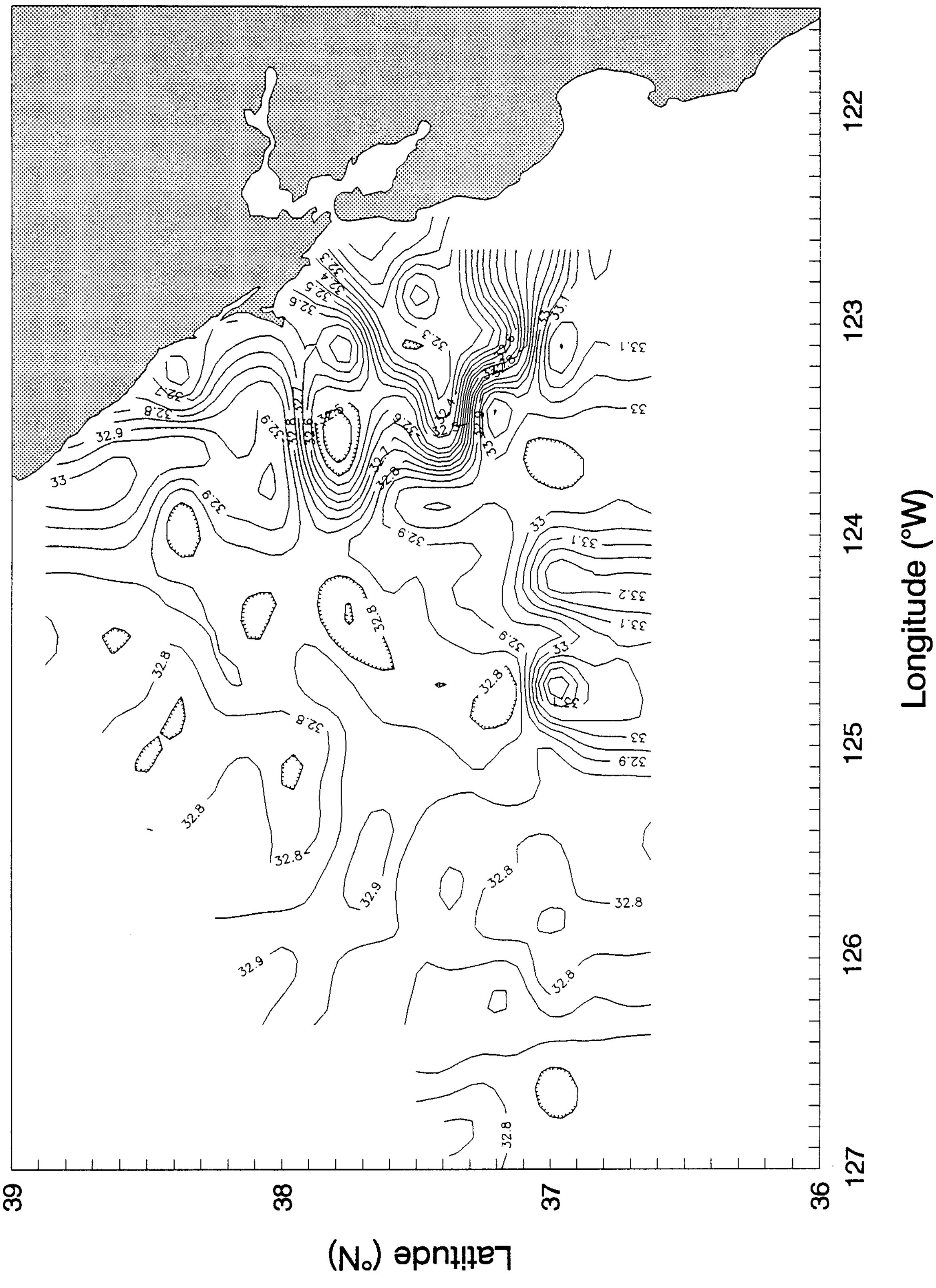
DSJ9304 Temperature (°C) at 200 m
Latitude (°N)
Longitude (°W)
39
38
37
36
127
126
125
124
123
122

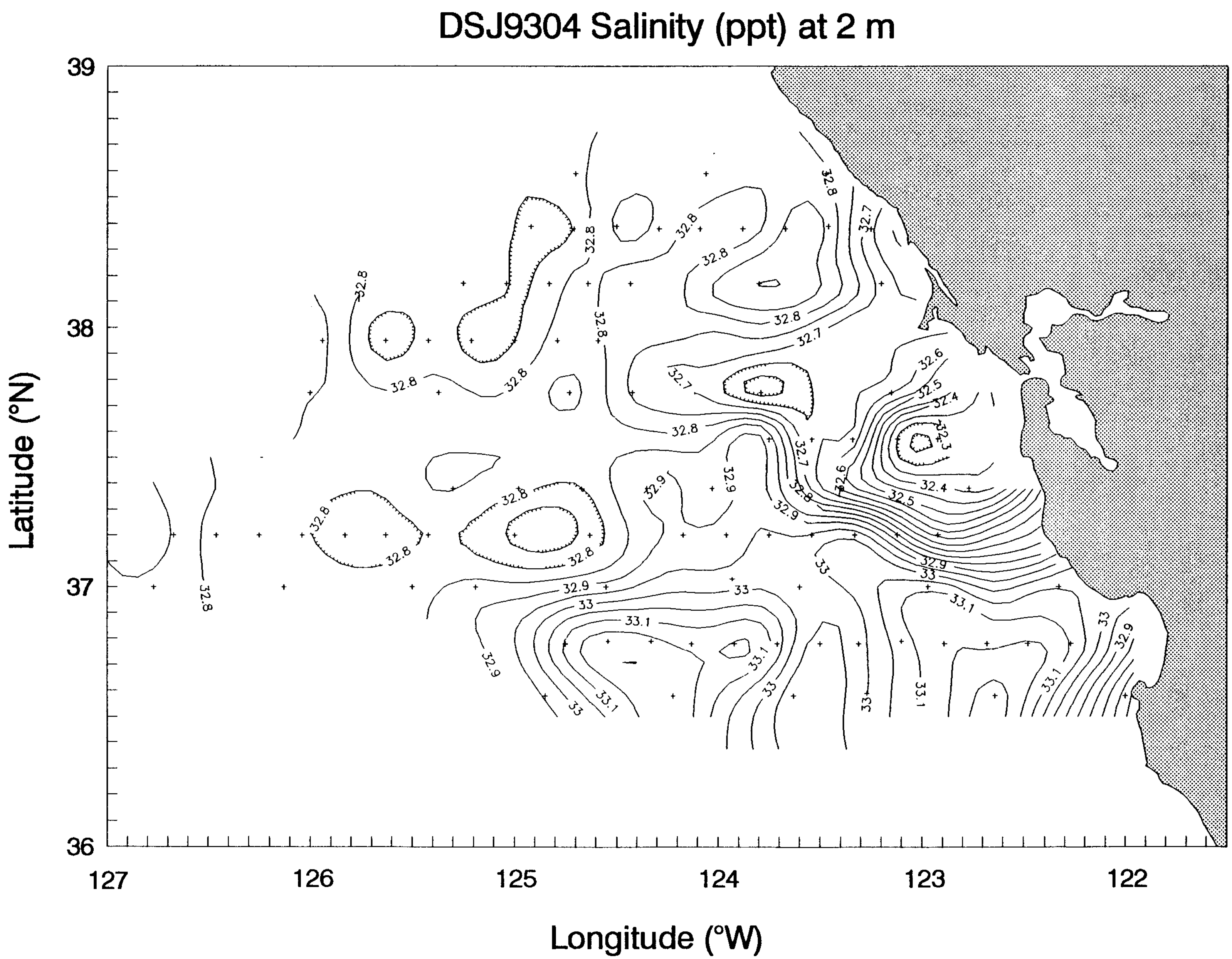
DSJ9304 Temperature (°C) at 300 m



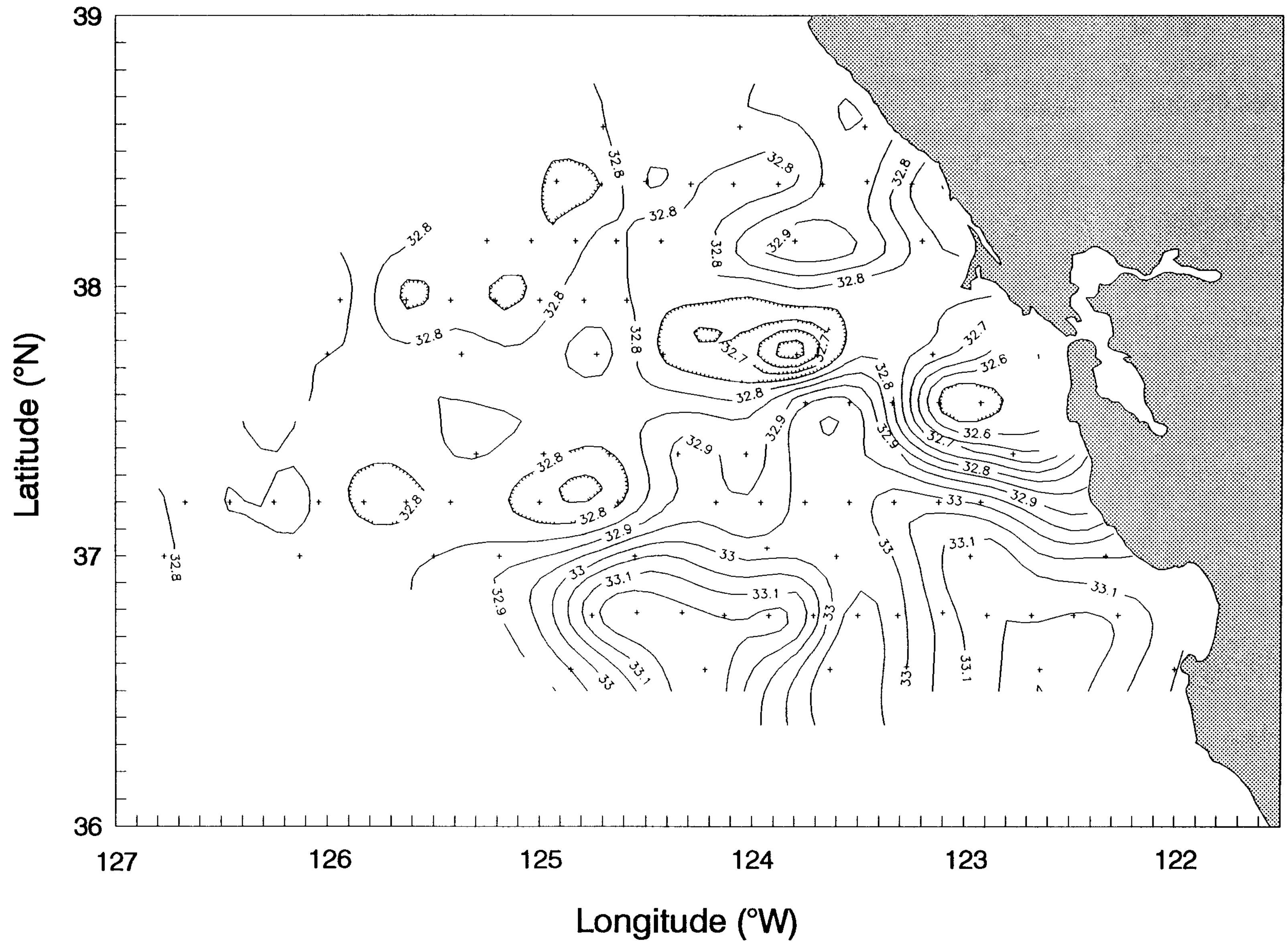

DSJ9304 Temperature (°C) at 500 m
Latitude (°N)
Longitude (°W)
39
38
37
36
127
126
125
124
123
122

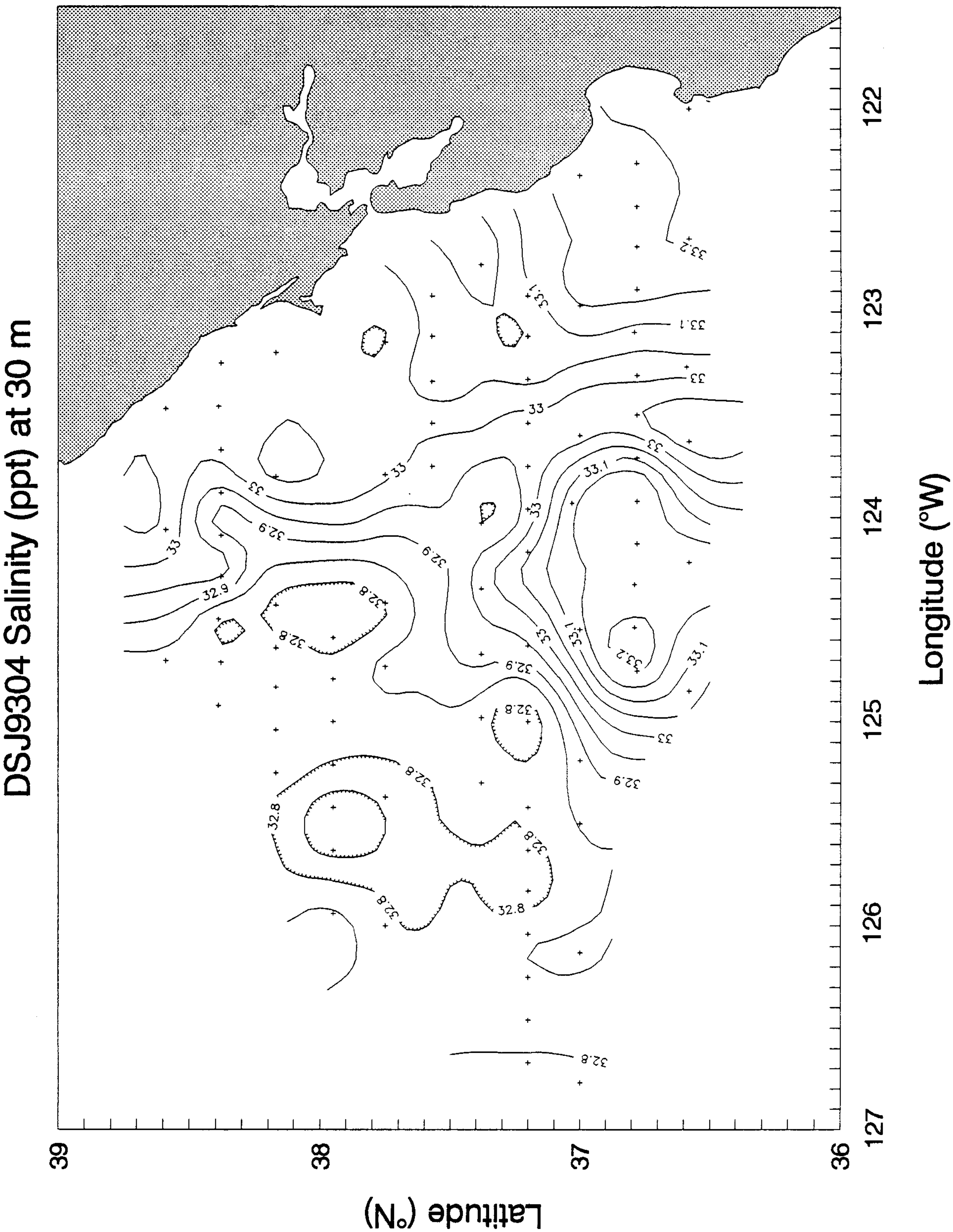
DSJ9304 TS Salinity (ppt)

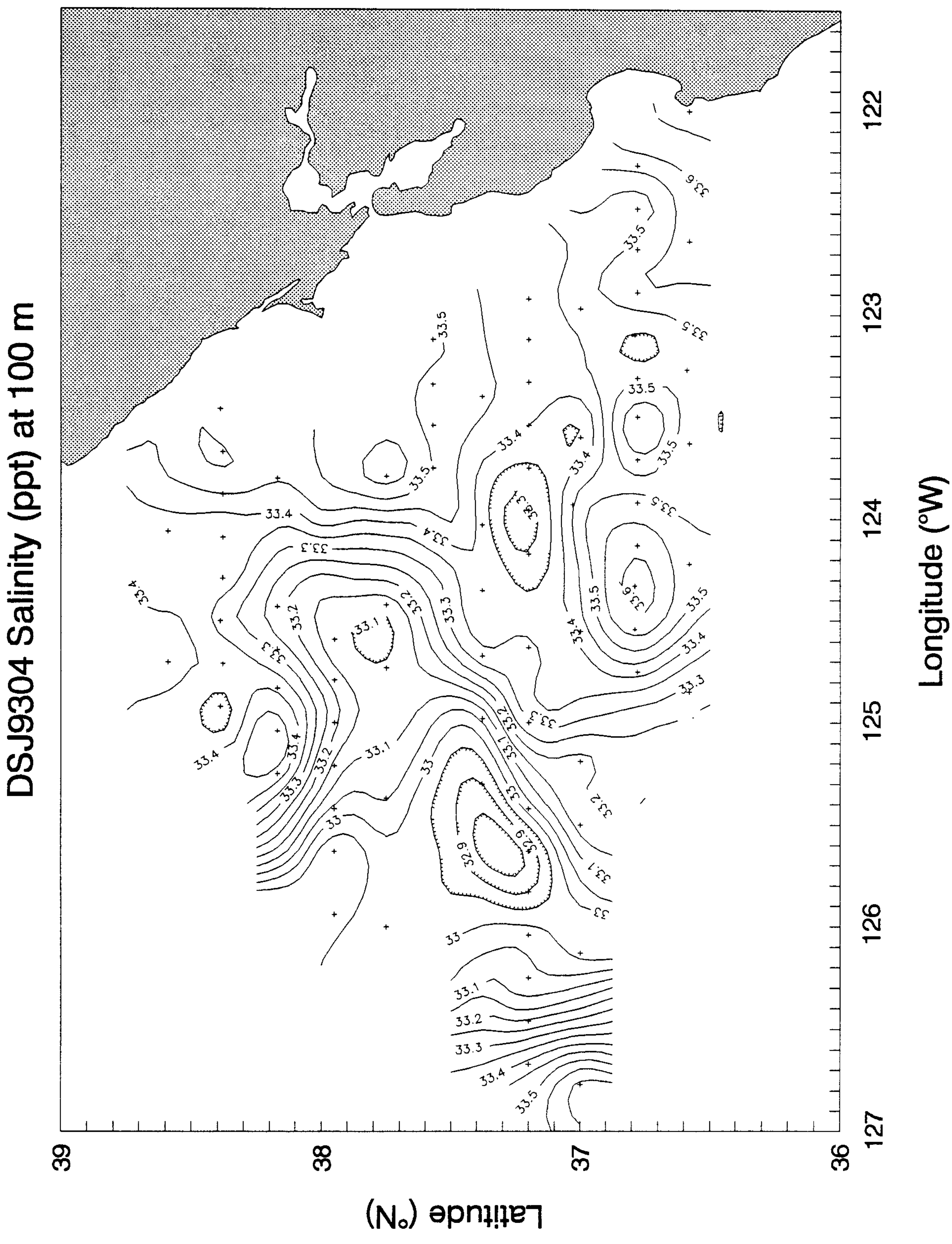


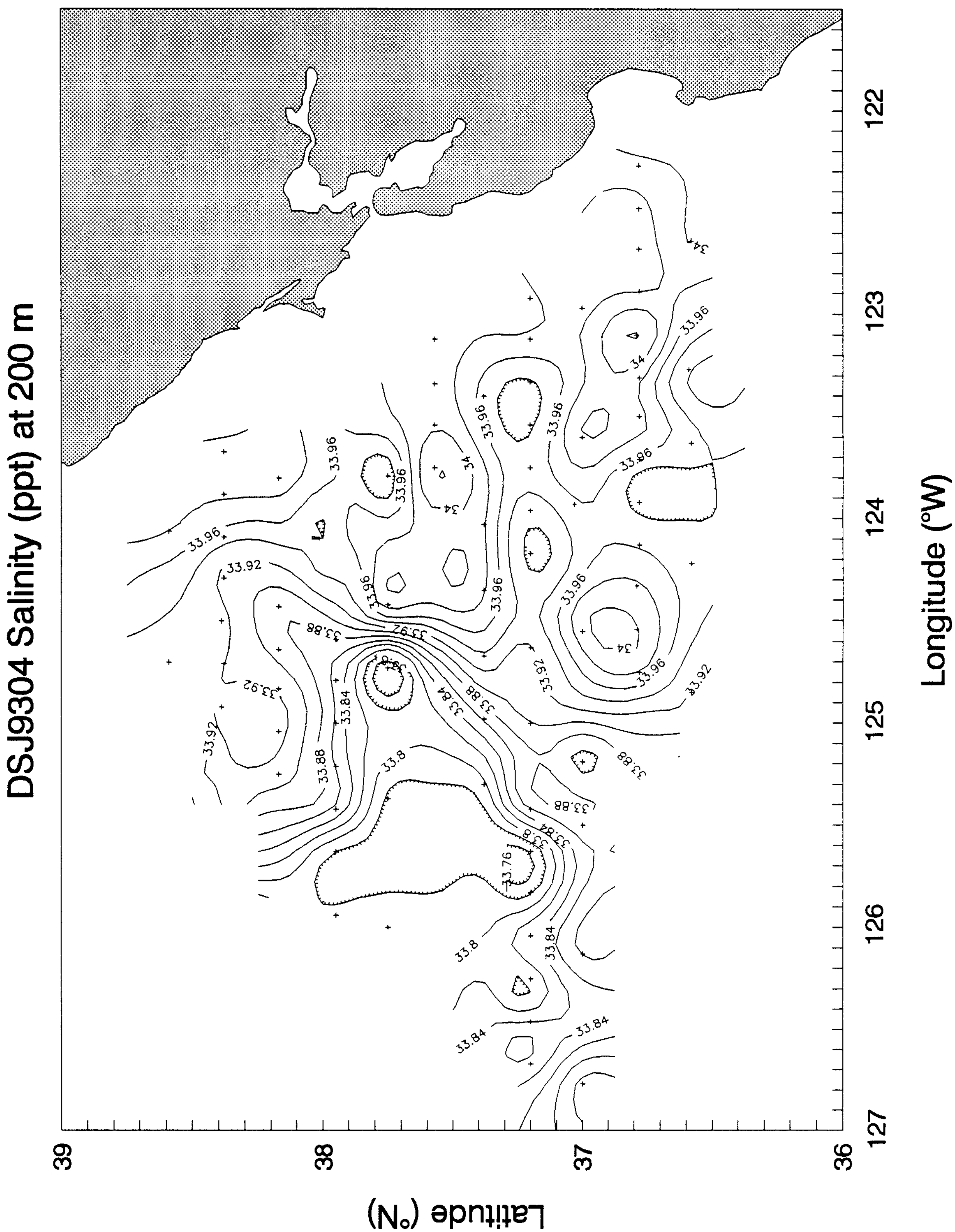

DSJ9304 Salinity (ppt) at 2 m
Latitude (°N)
Longitude (°W)
39
38
37
36
127
126
125
124
123
122
32.8
32.7
32.6
32.5
32.4
32.3
32.9
33
33.1

DSJ9304 Salinity (ppt) at 10 m

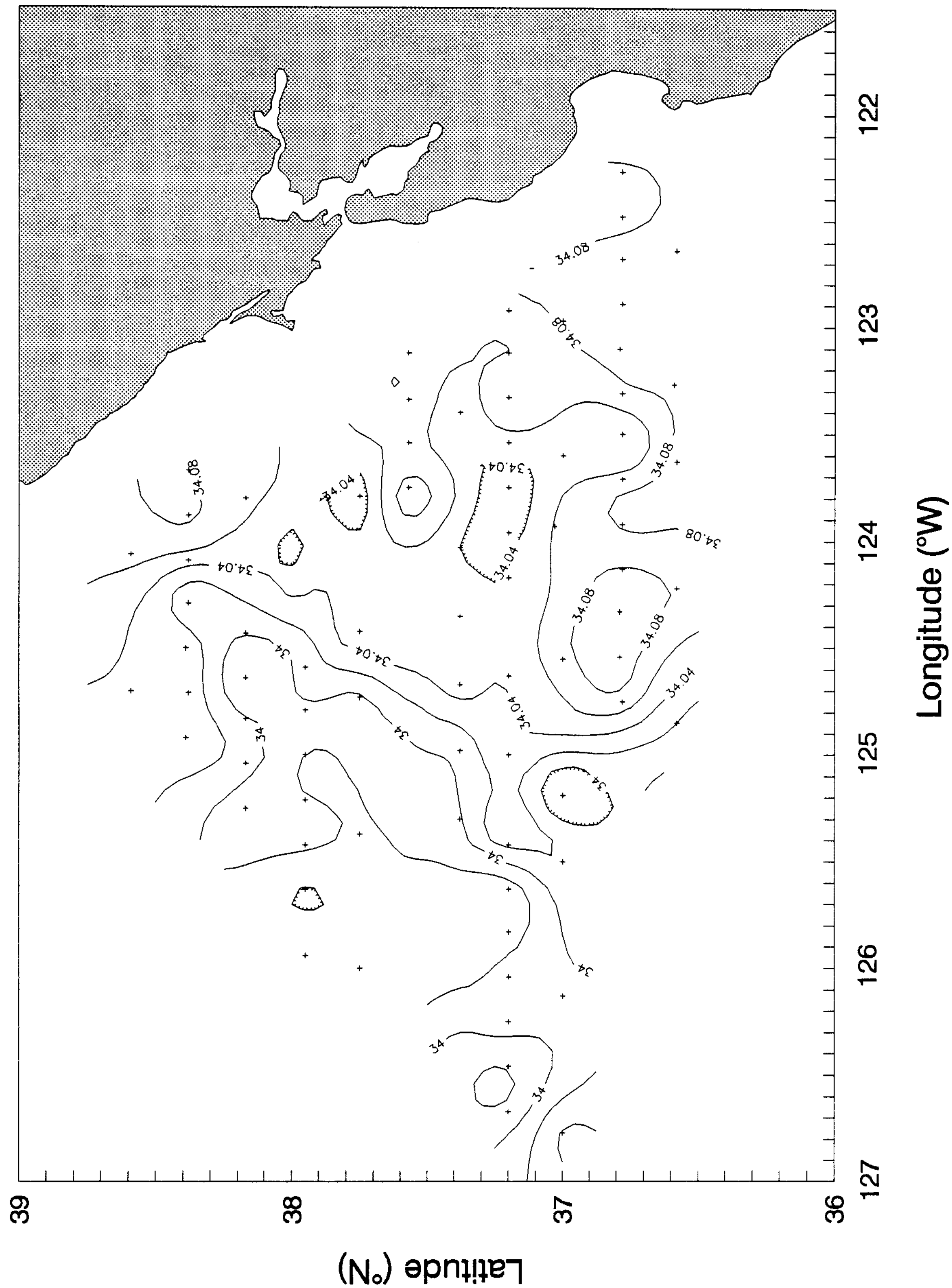



DSJ9304 Salinity (ppt) at 30 m
Longitude (°W)
Latitude (°N)
127
126
125
124
123
122
39
38
37
36

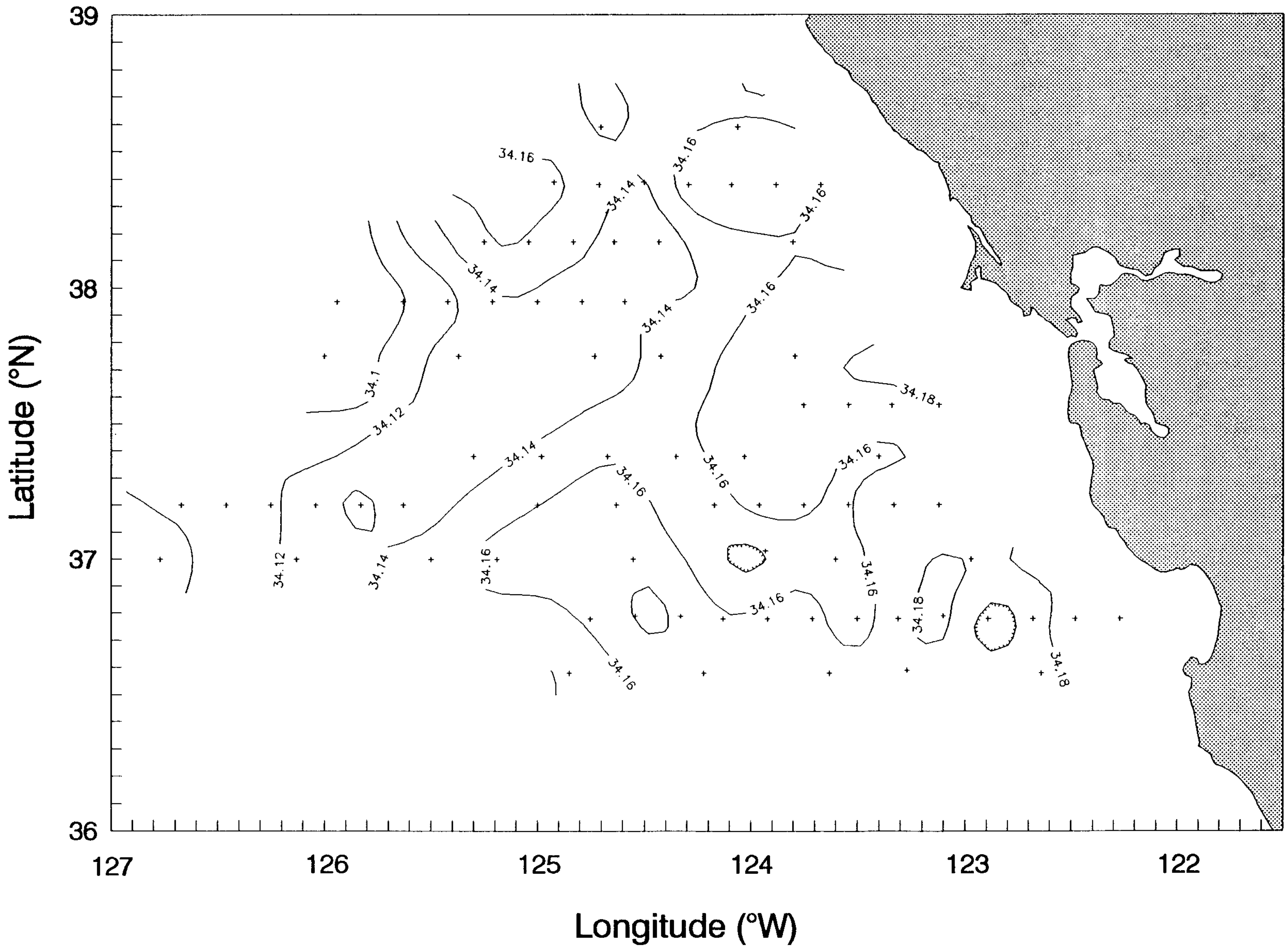

DSJ9304 Salinity (ppt) at 100 m
Longitude (°W)
Latitude (°N)
122
123
124
125
126
127
39
38
37
36


DSJ9304 Salinity (ppt) at 200 m
Latitude (°N)
Longitude (°W)
39
38
37
36
127
126
125
124
123
122
33.96
33.92
33.88
33.84
33.8
33.76
34

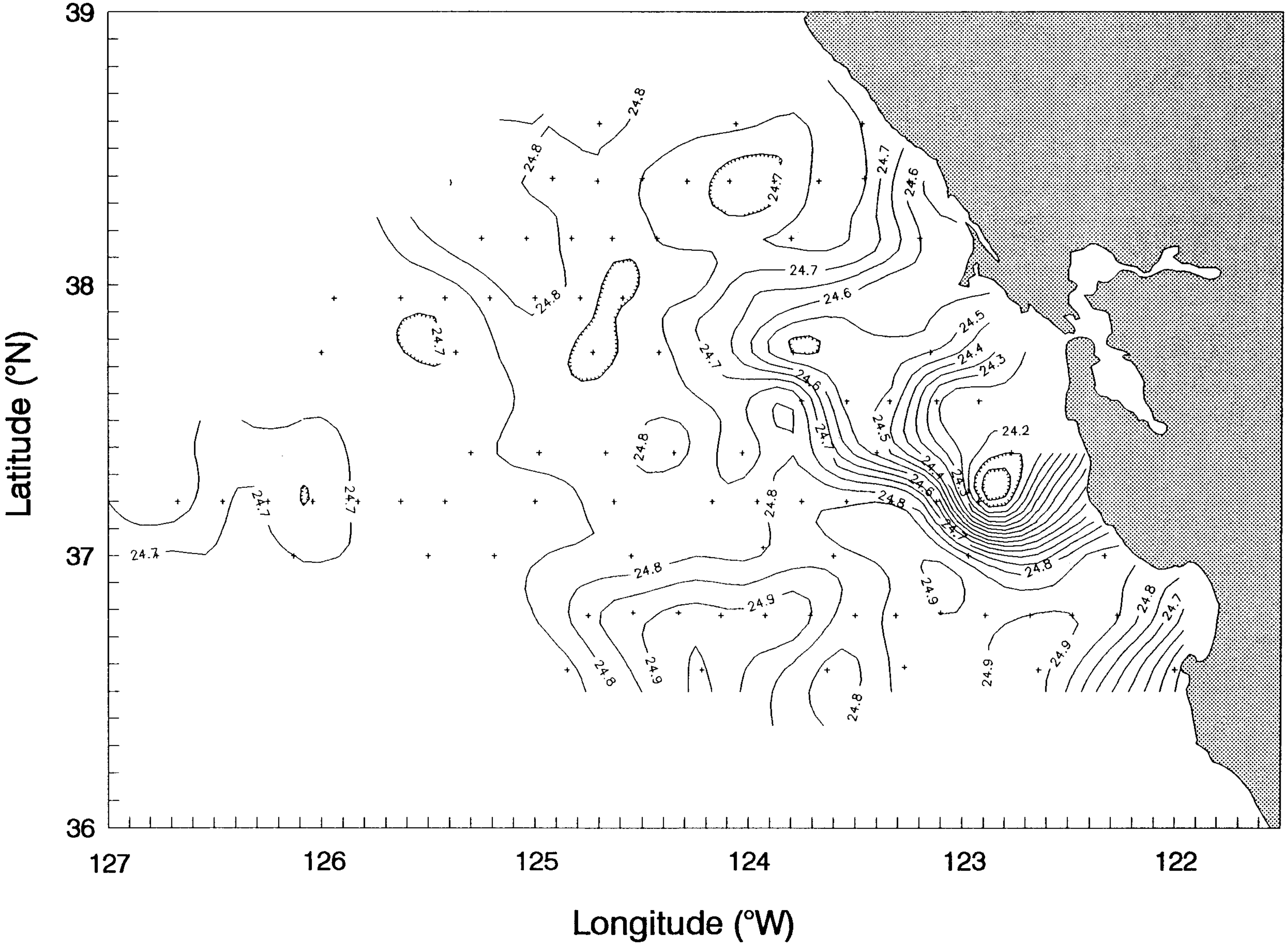
DSJ9304 Salinity (ppt) at 300 m

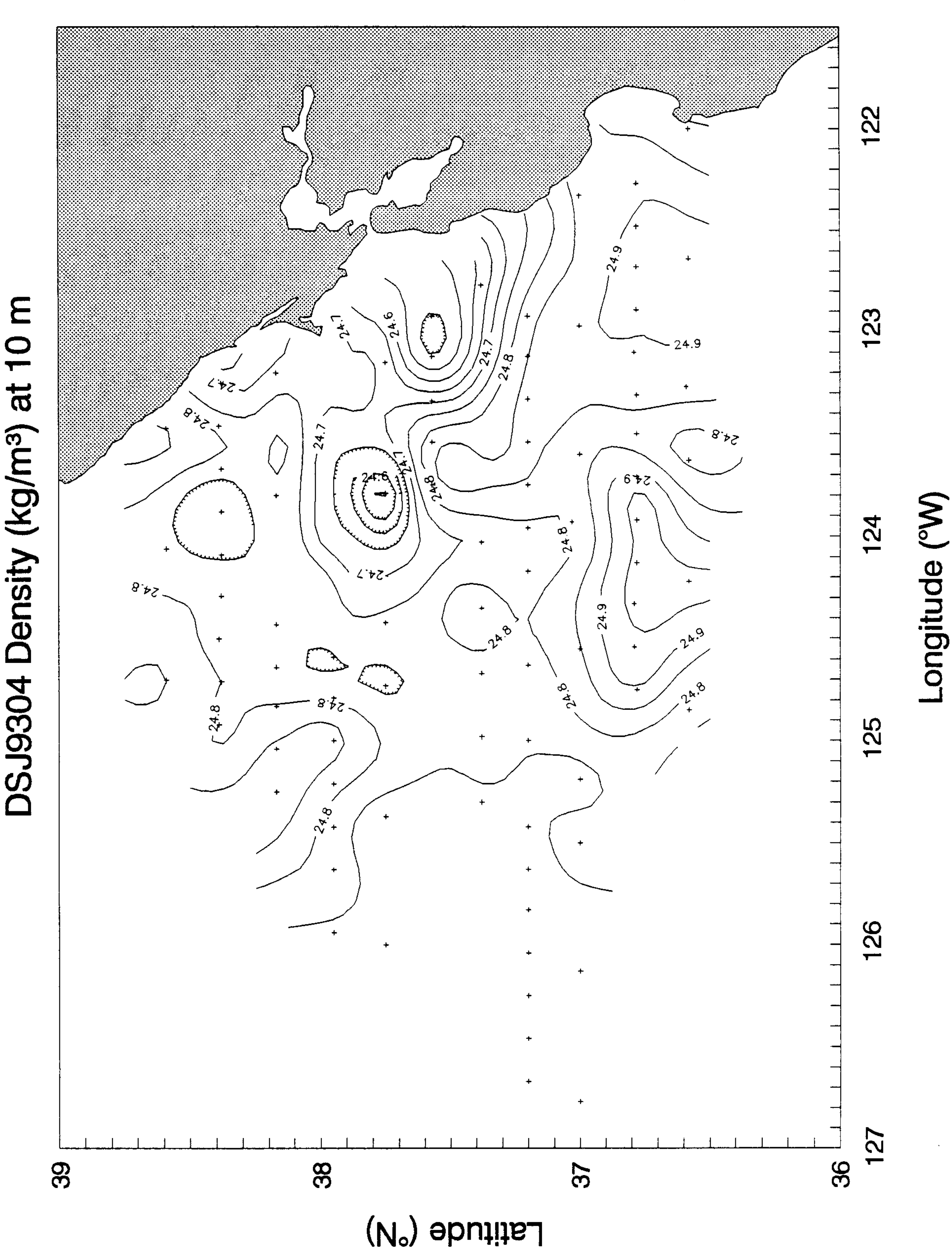


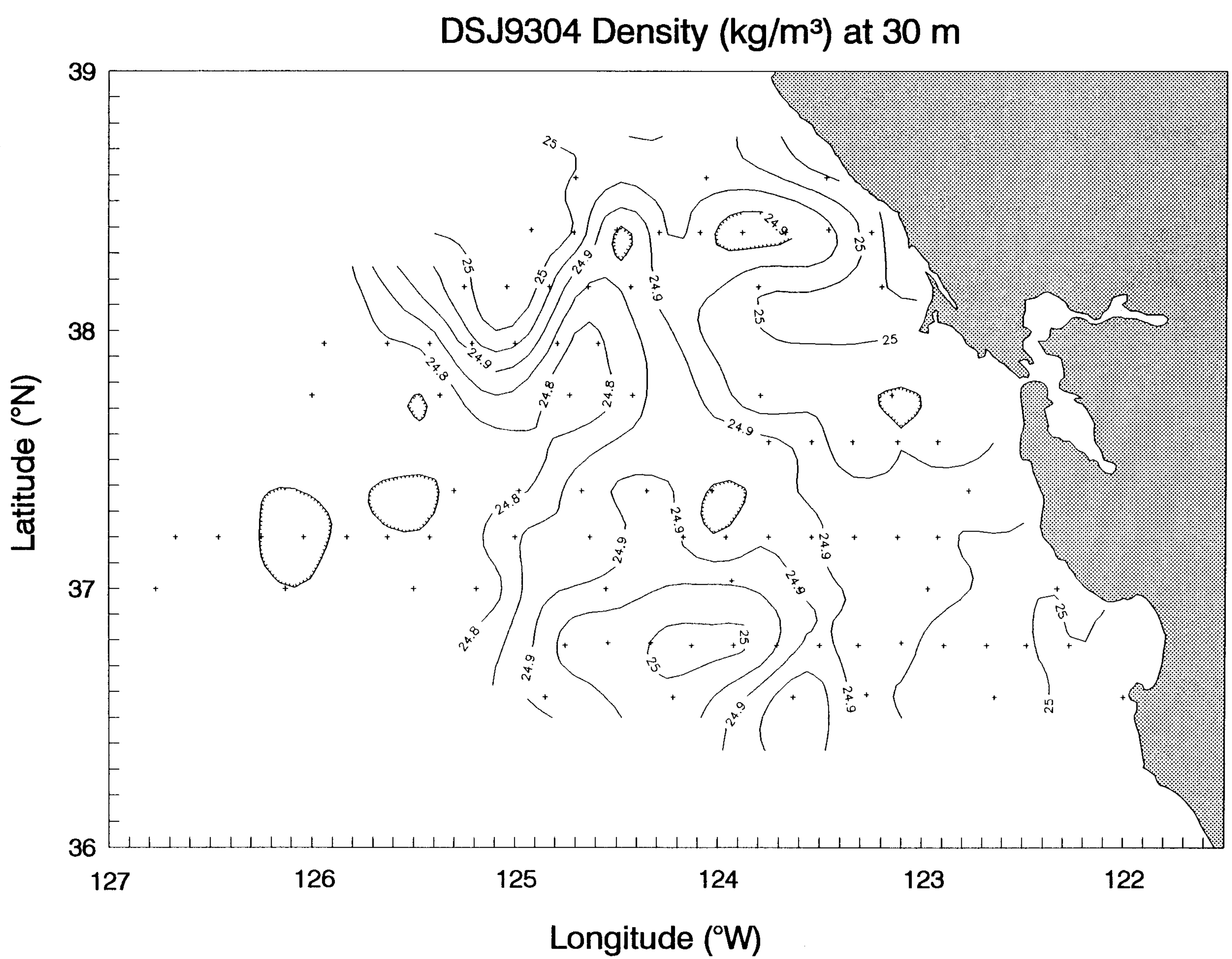
DSJ9304 Salinity (ppt) at 500 m

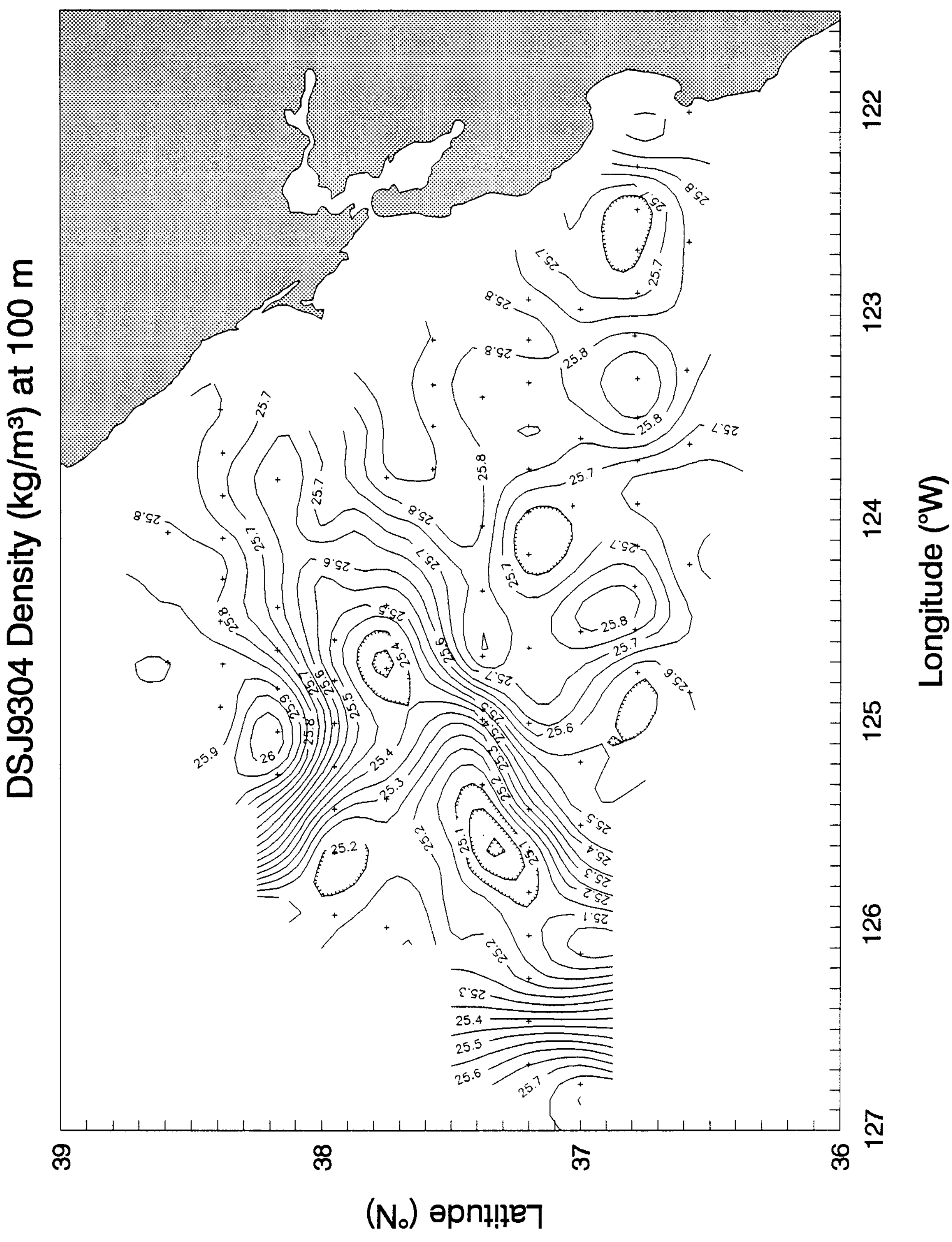


DSJ9304 Density (kg/m³) at 2 m

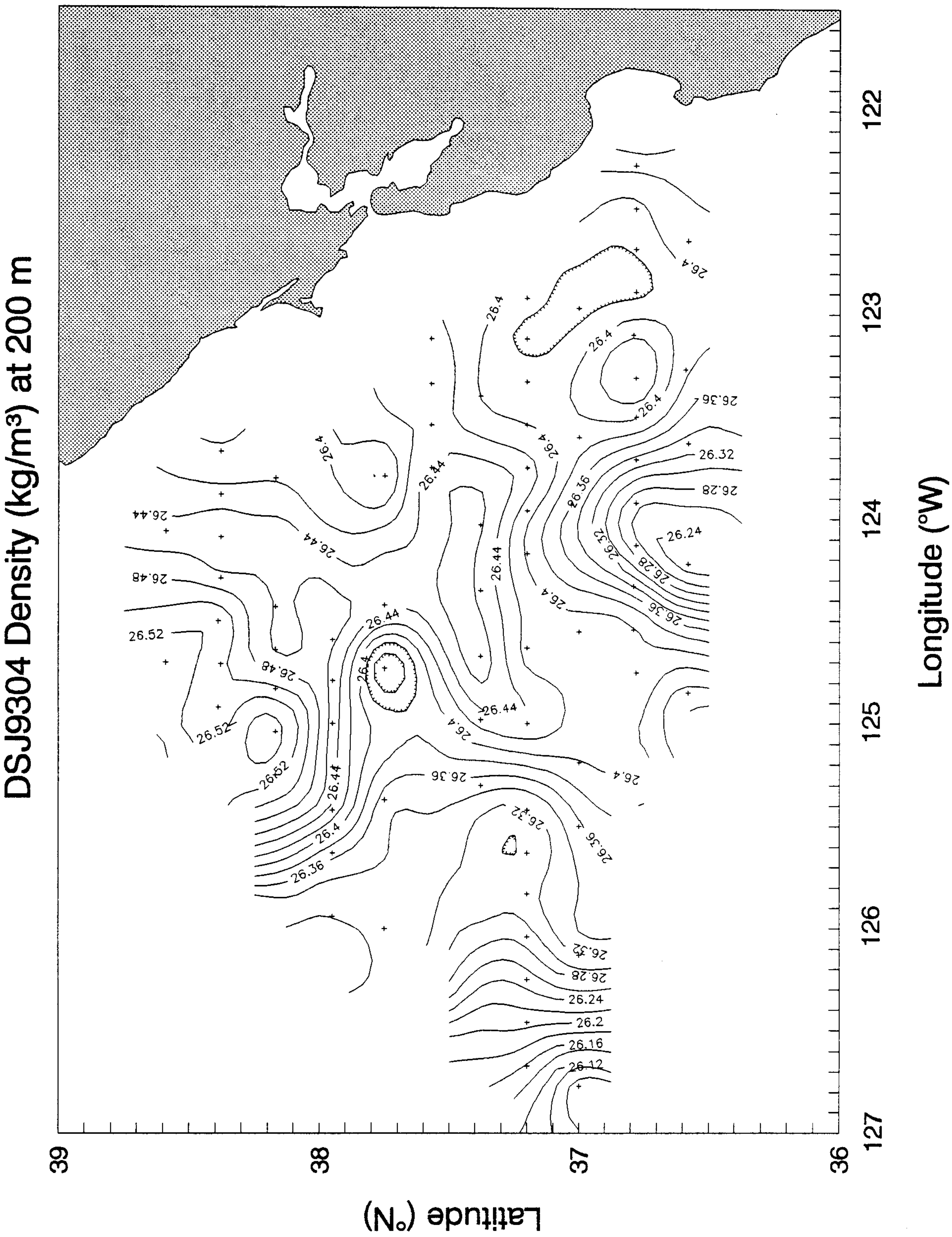


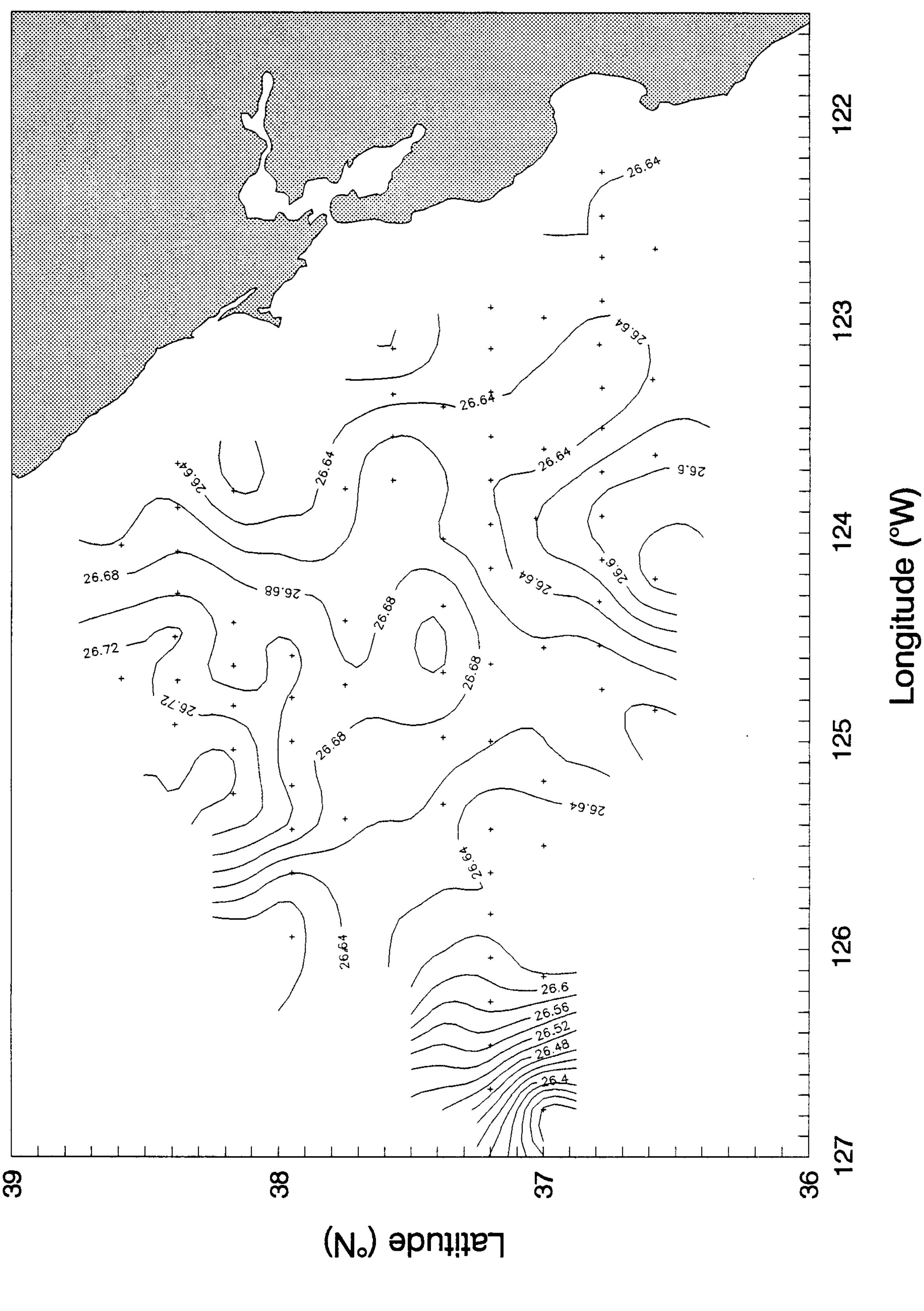

DSJ9304 Density (kg/m³) at 10 m
Latitude (°N)
Longitude (°W)
39
38
37
36
127
126
125
124
123
122
24.6
24.7
24.8
24.9


DSJ9304 Density (kg/m³) at 30 m
Latitude (°N)
Longitude (°W)
39
38
37
36
127
126
125
124
123
122
25
24.9
24.8

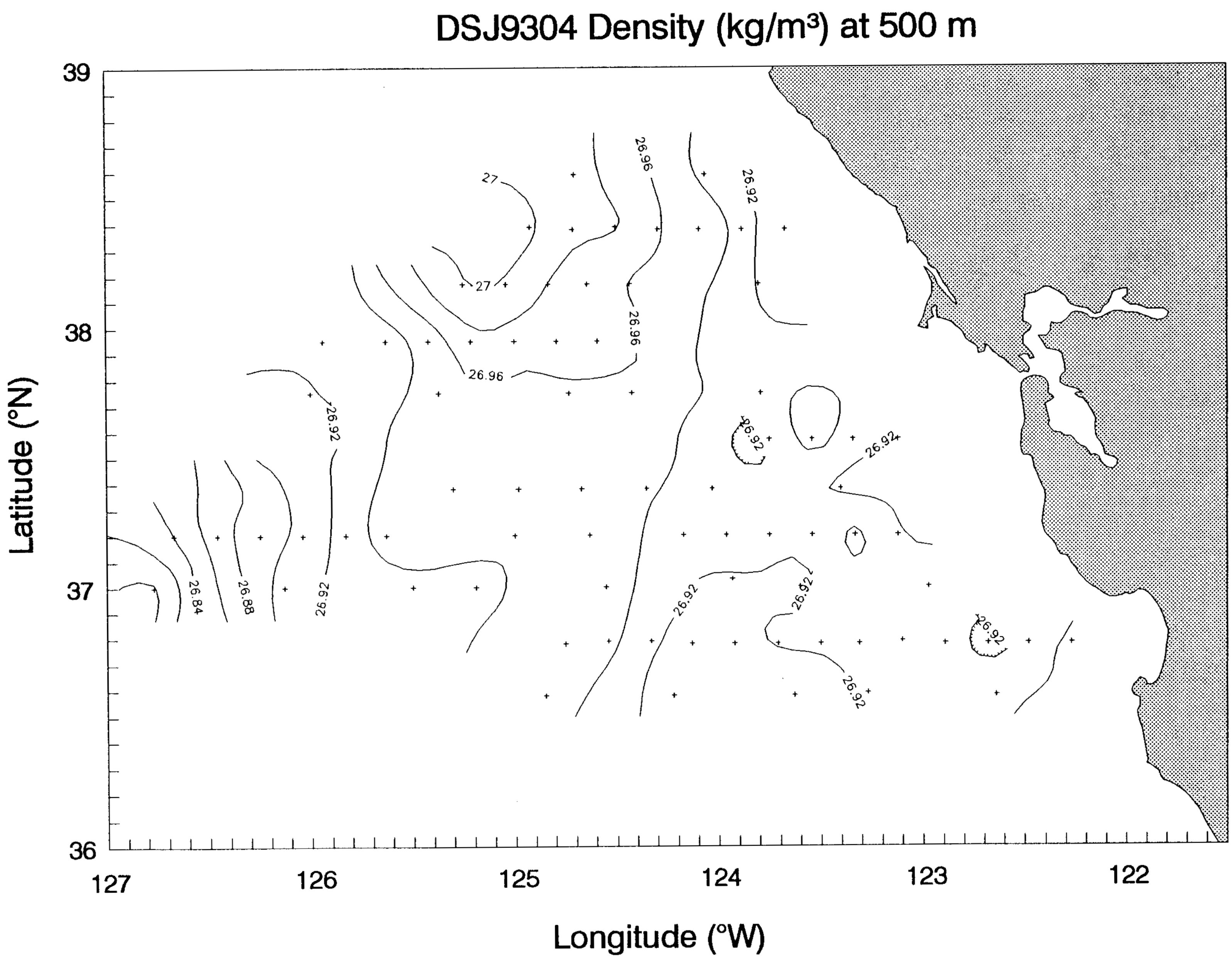


DSJ9304 Density (kg/m³) at 100 m
Latitude (°N)
Longitude (°W)


DSJ9304 Density (kg/m³) at 200 m
Longitude (°W)
Latitude (°N)
122
123
124
125
126
127
39
38
37
36
26.4
26.44
26.48
26.52
26.36
26.32
26.28
26.24
26.2
26.16
26.12

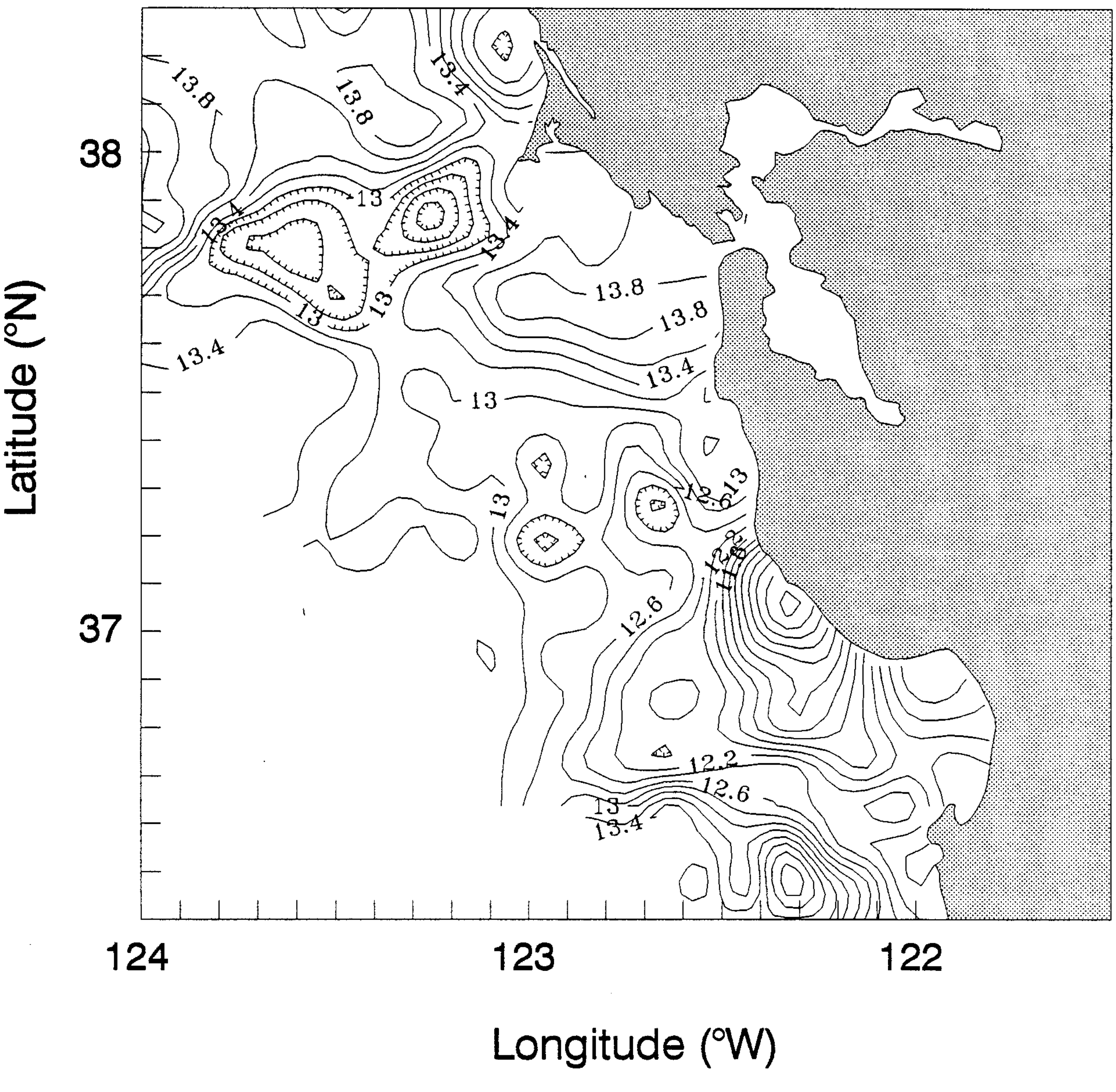


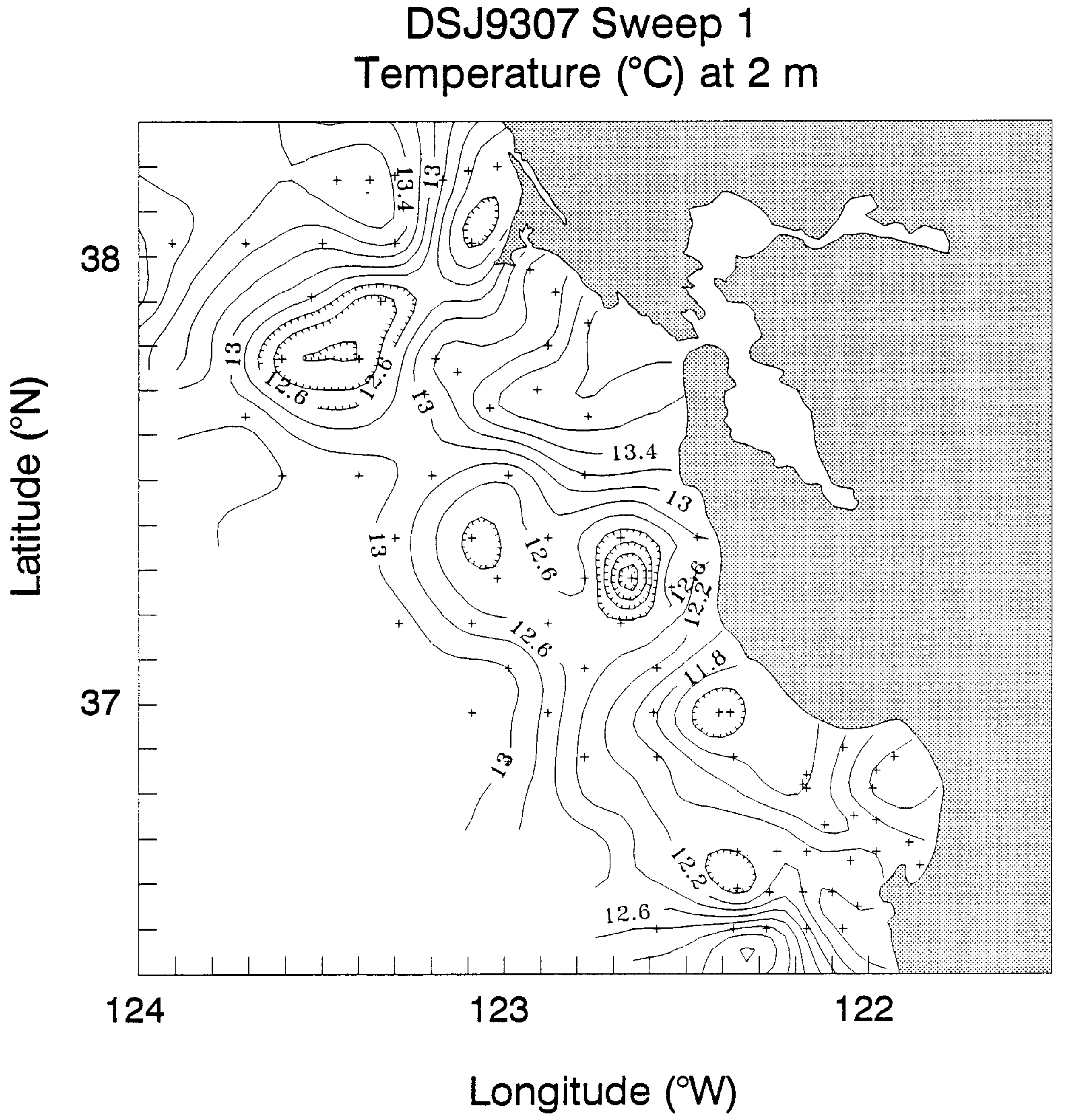
DSJ9304 Density (kg/m³) at 300 m


DSJ9304 Density (kg/m³) at 500 m
Latitude (°N)
Longitude (°W)
39
38
37
36
127
126
125
124
123
122
27
26.96
26.92
26.88
26.84

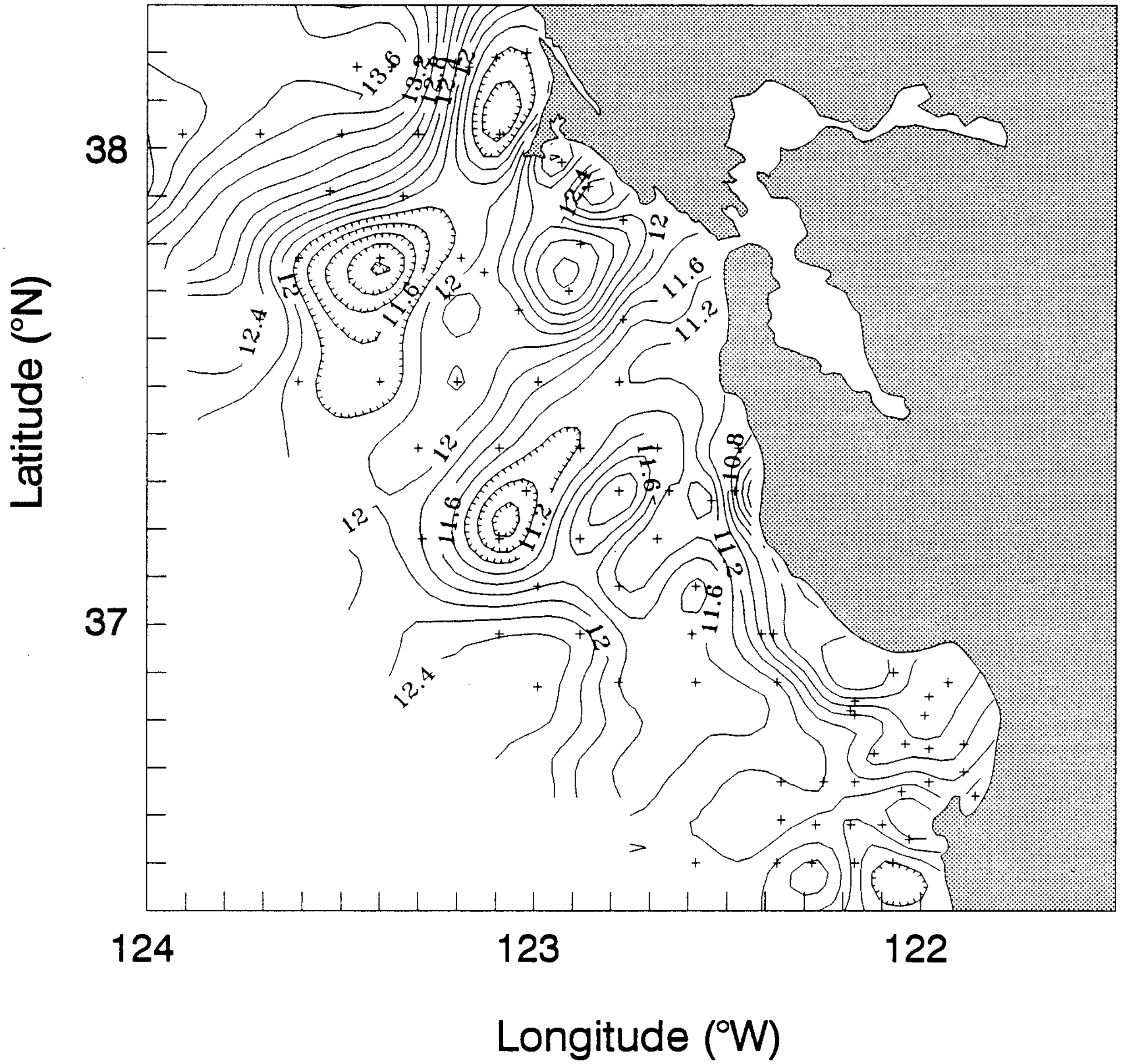
APPENDIX 6.2: HORIZONTAL MAPS OF CTD AND TS FOR DSJ9307, SWEEP 1

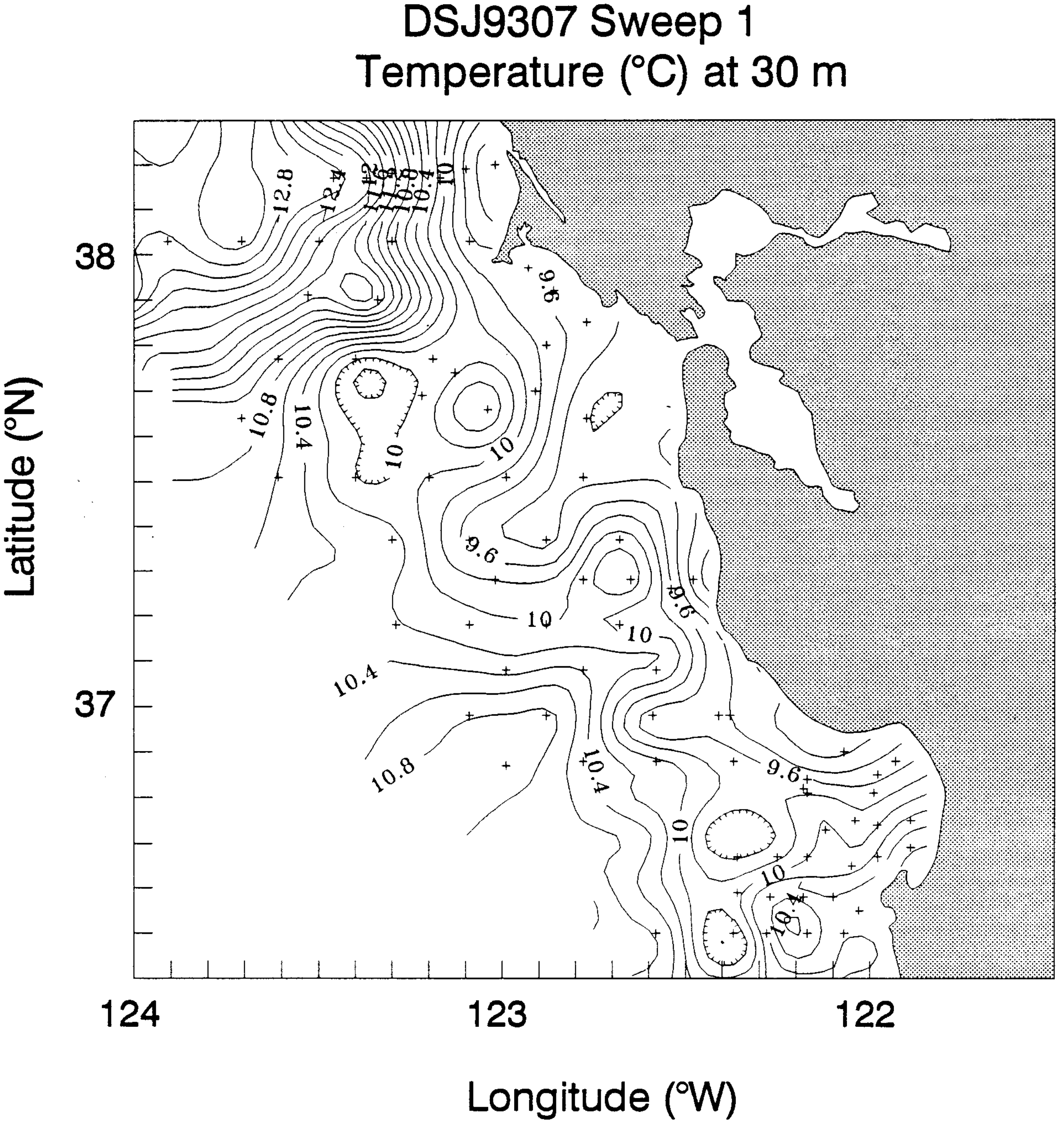
DSJ9307 Sweep 1
TS Temperature (°C)



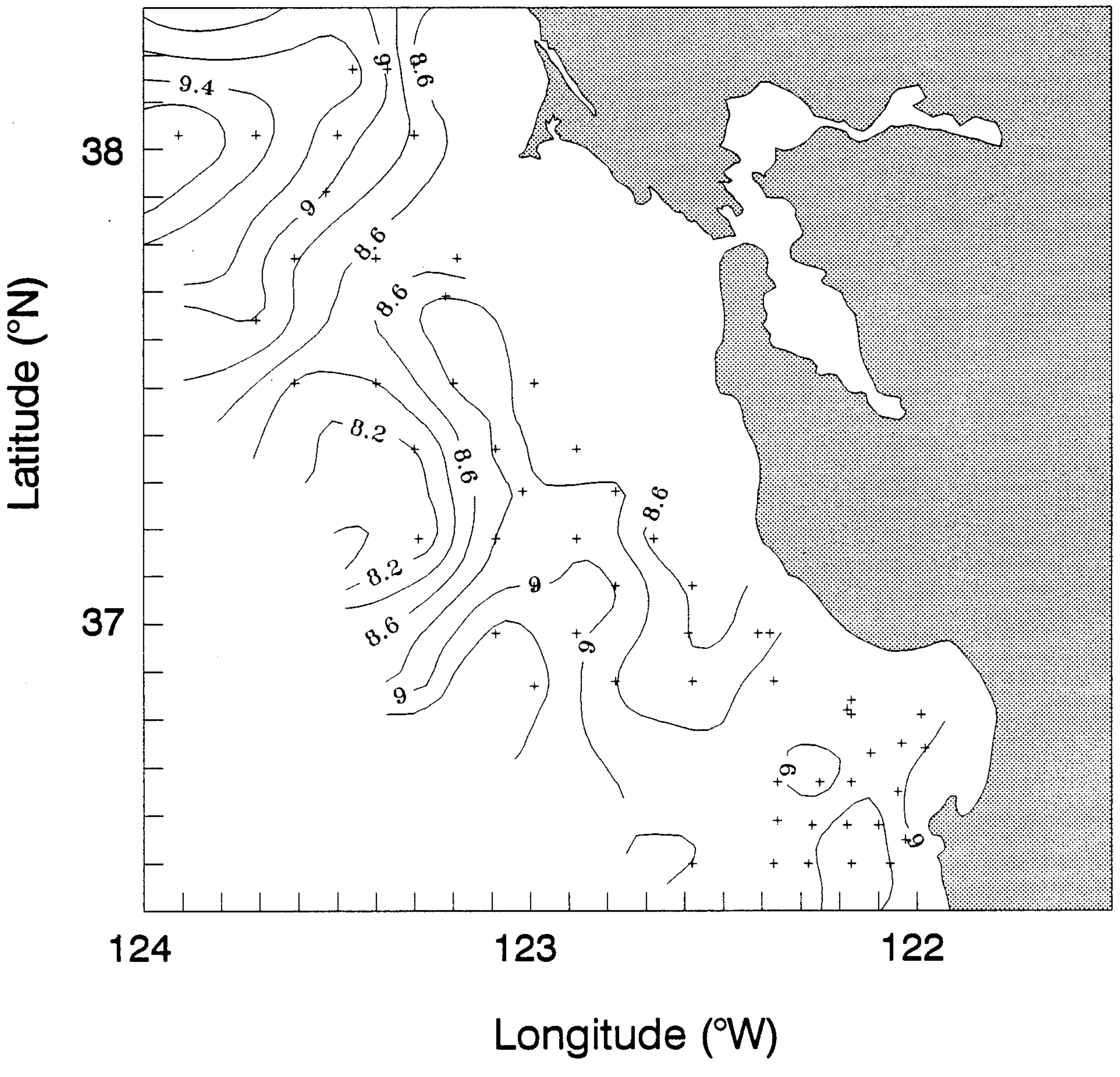

DSJ9307 Sweep 1
Temperature (°C) at 2 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)
13.4
13
12.6
12.2
11.8

DSJ9307 Sweep 1
Temperature (°C) at 10 m

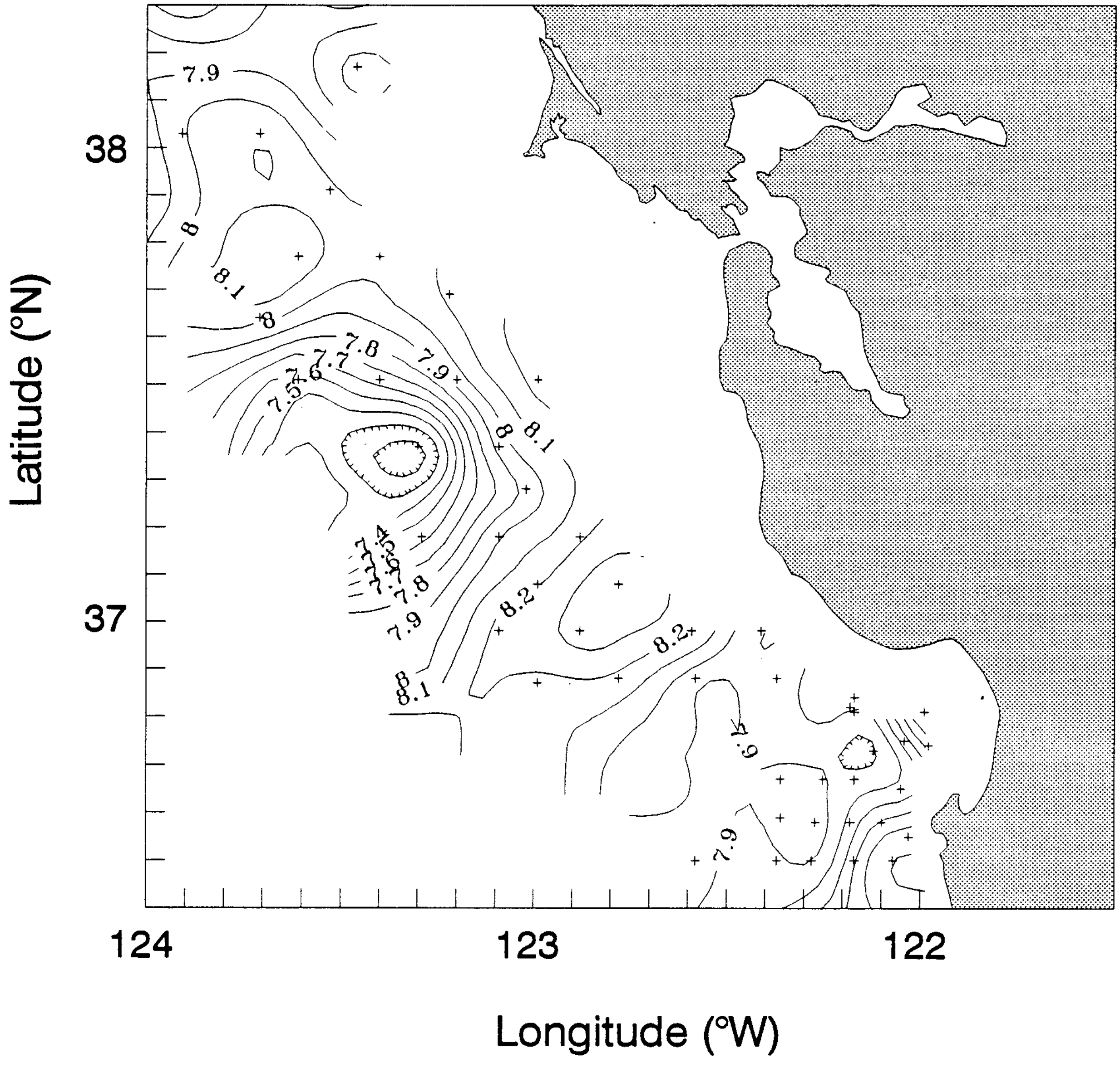


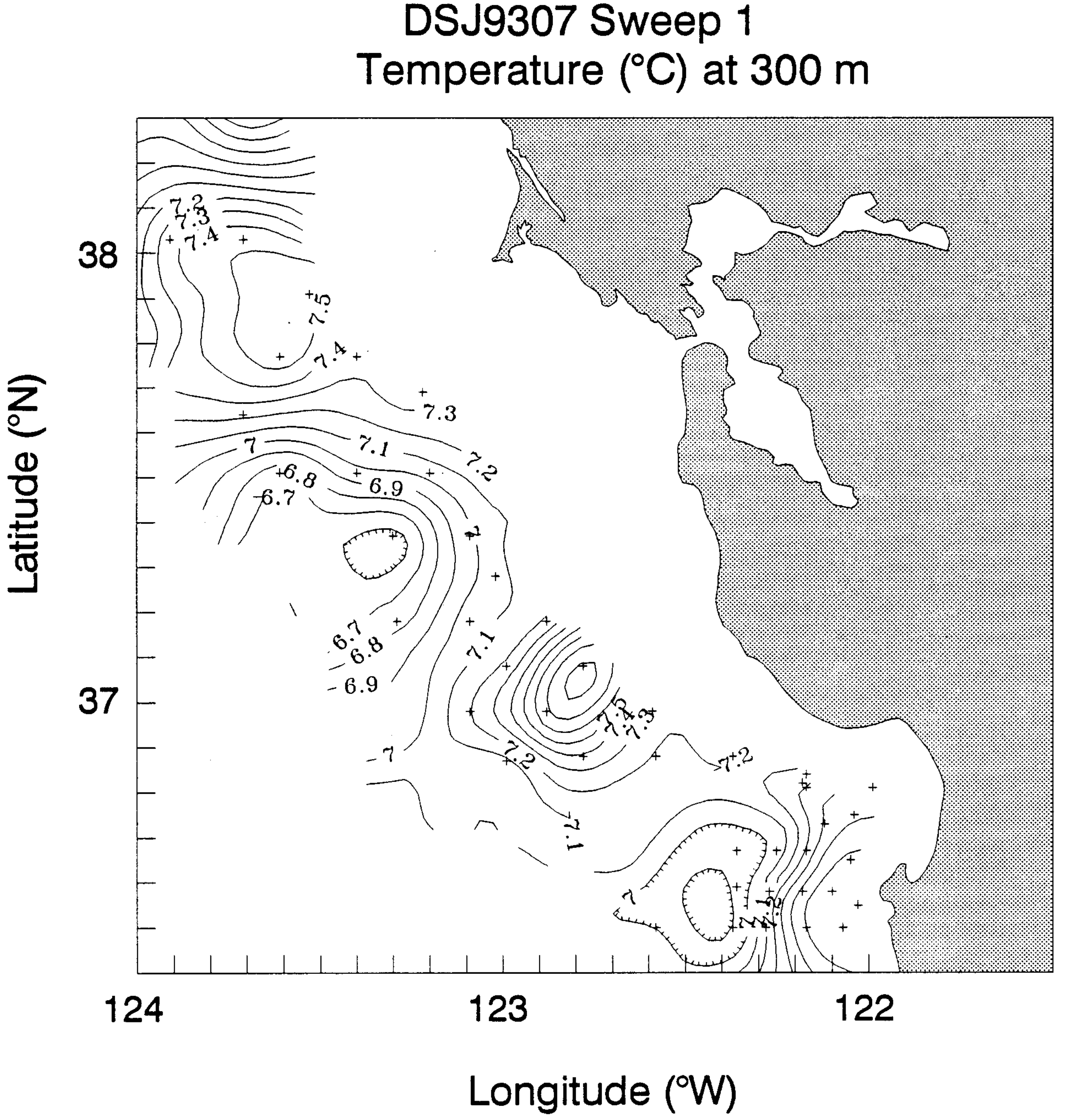

DSJ9307 Sweep 1
Temperature (°C) at 30 m
Latitude (°N)
38
37
Longitude (°W)
124
123
122
12.8
12.4
10.8
10.4
10
9.6

DSJ9307 Sweep 1
Temperature (°C) at 100 m

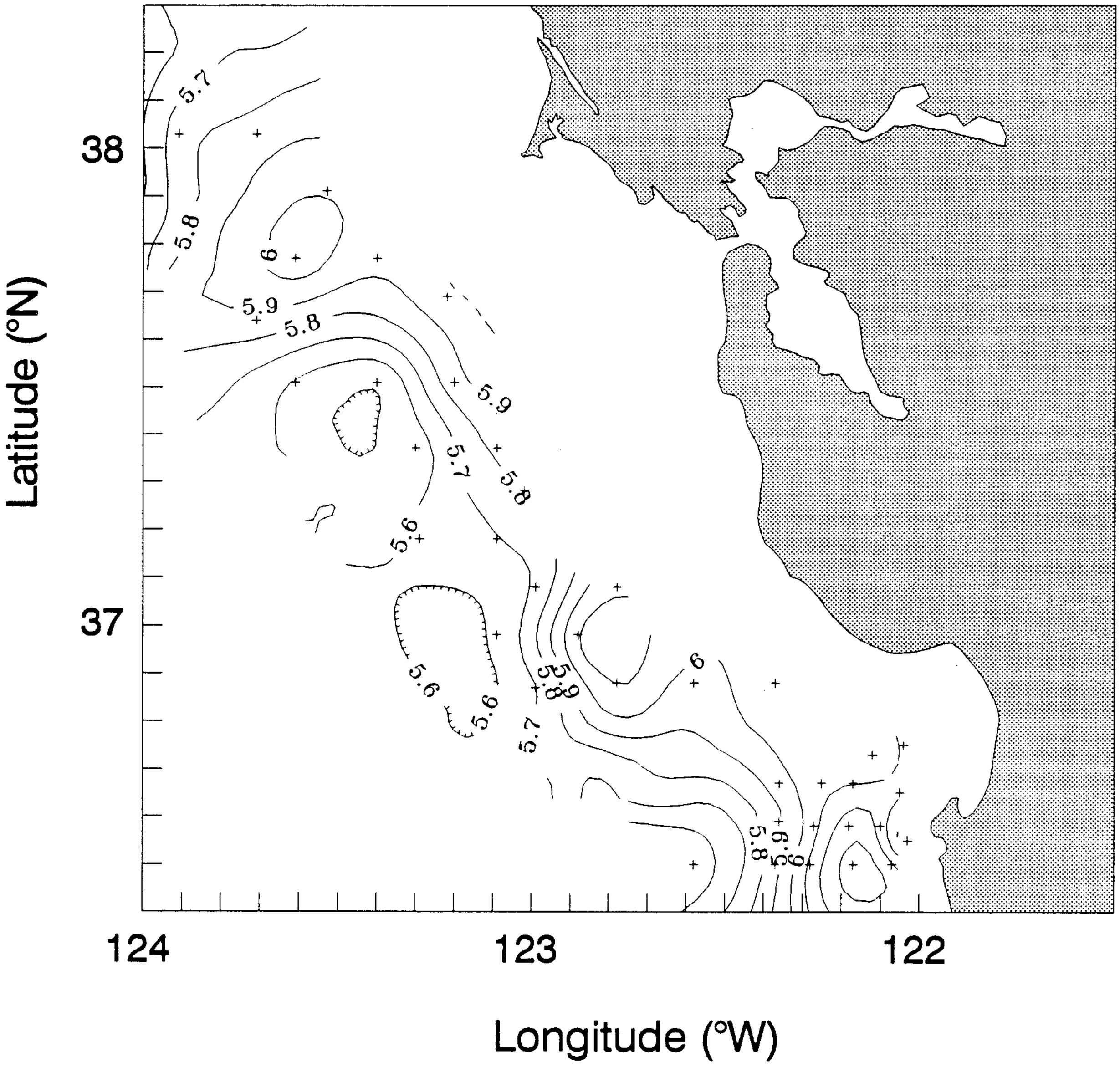


DSJ9307 Sweep 1
Temperature (°C) at 200 m

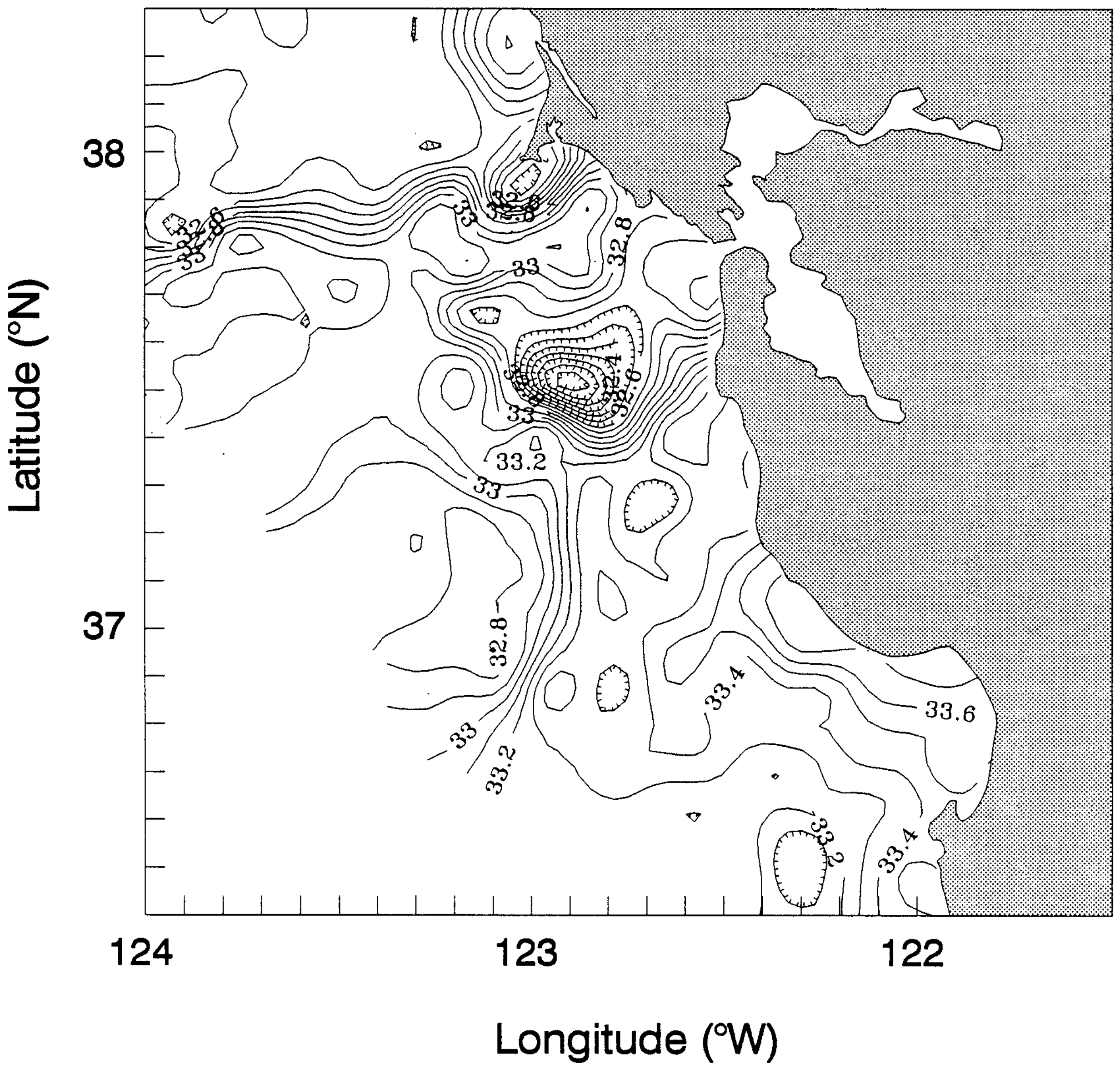



DSJ9307 Sweep 1
Temperature (°C) at 300 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)

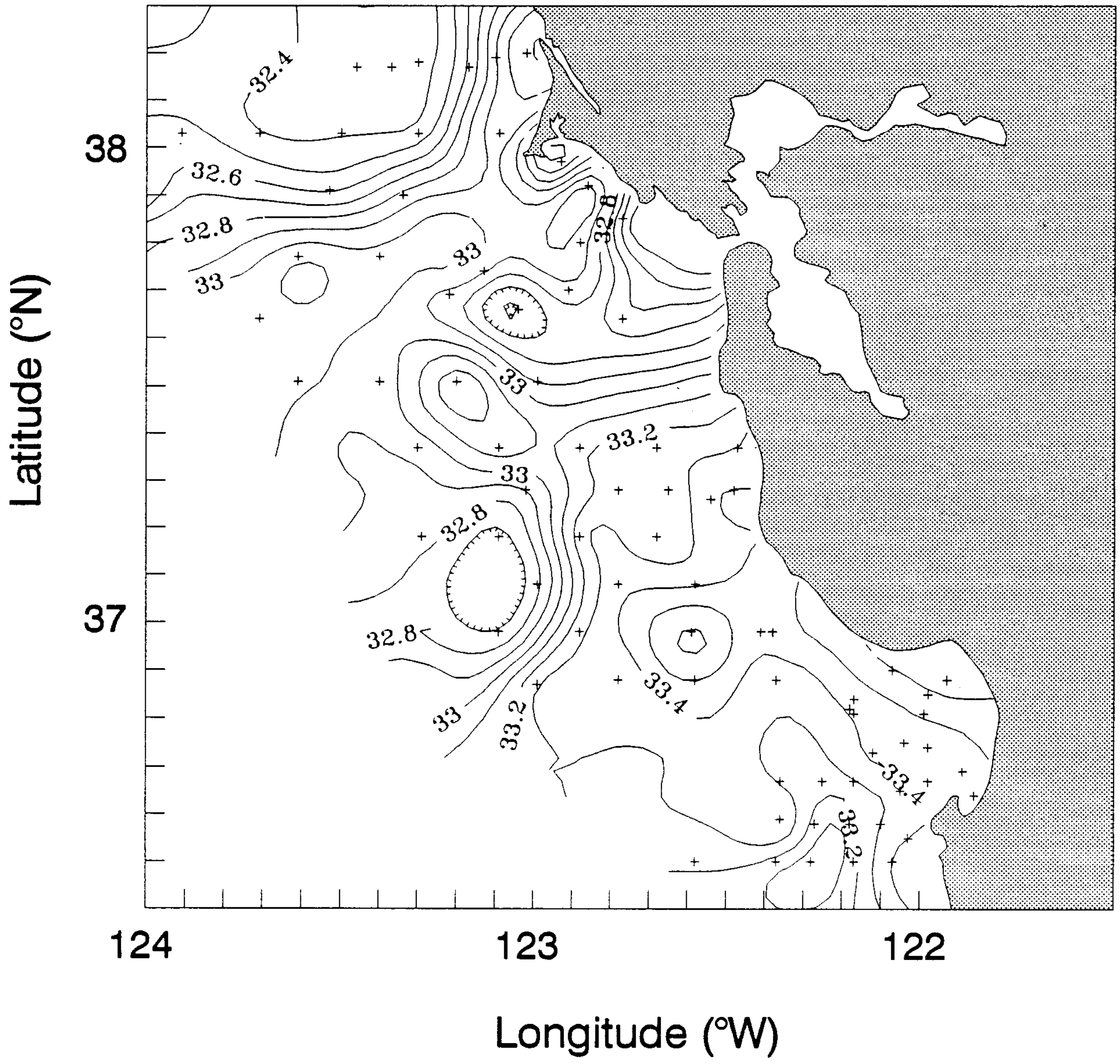
DSJ9307 Sweep 1
Temperature (°C) at 500 m

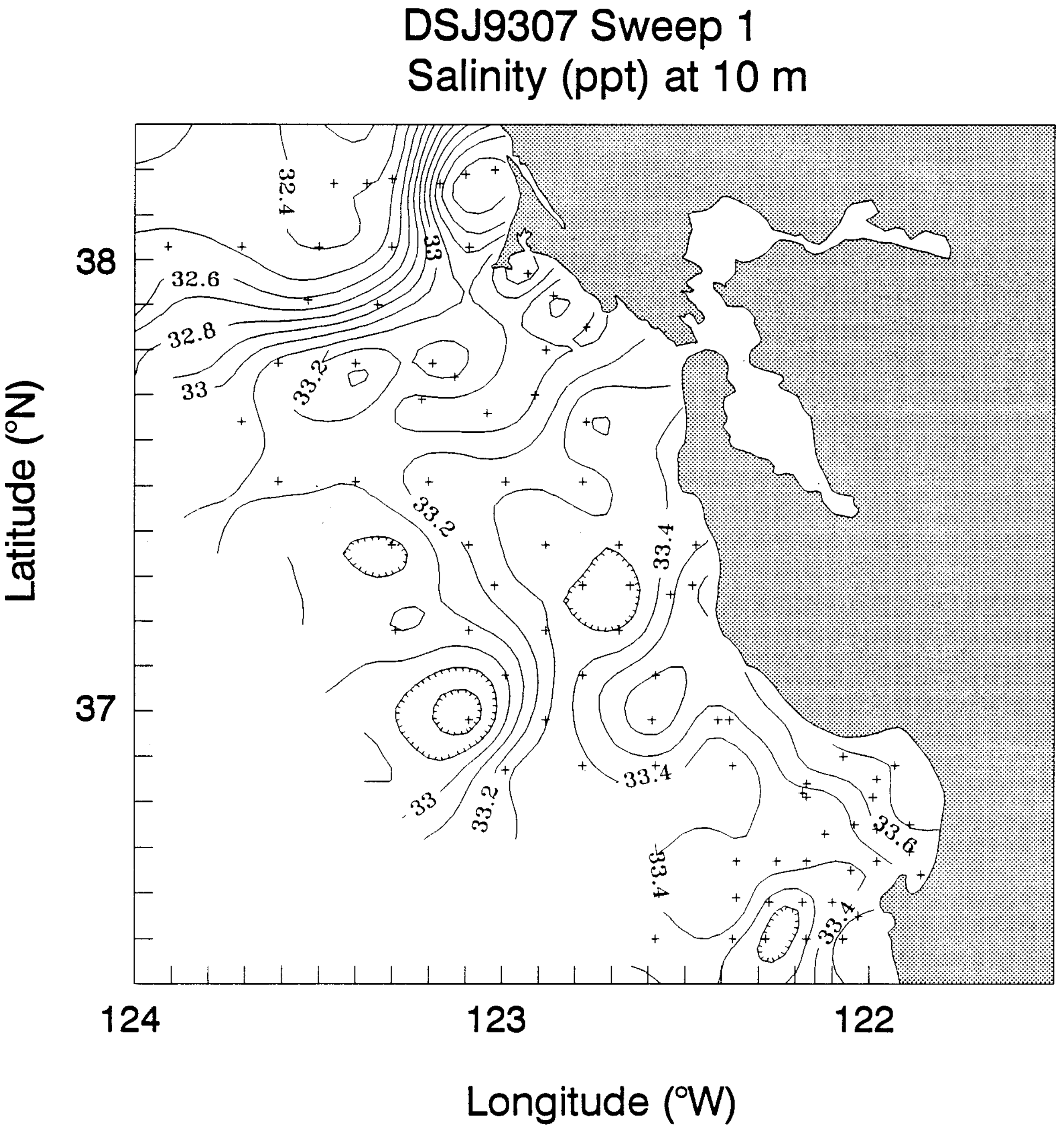


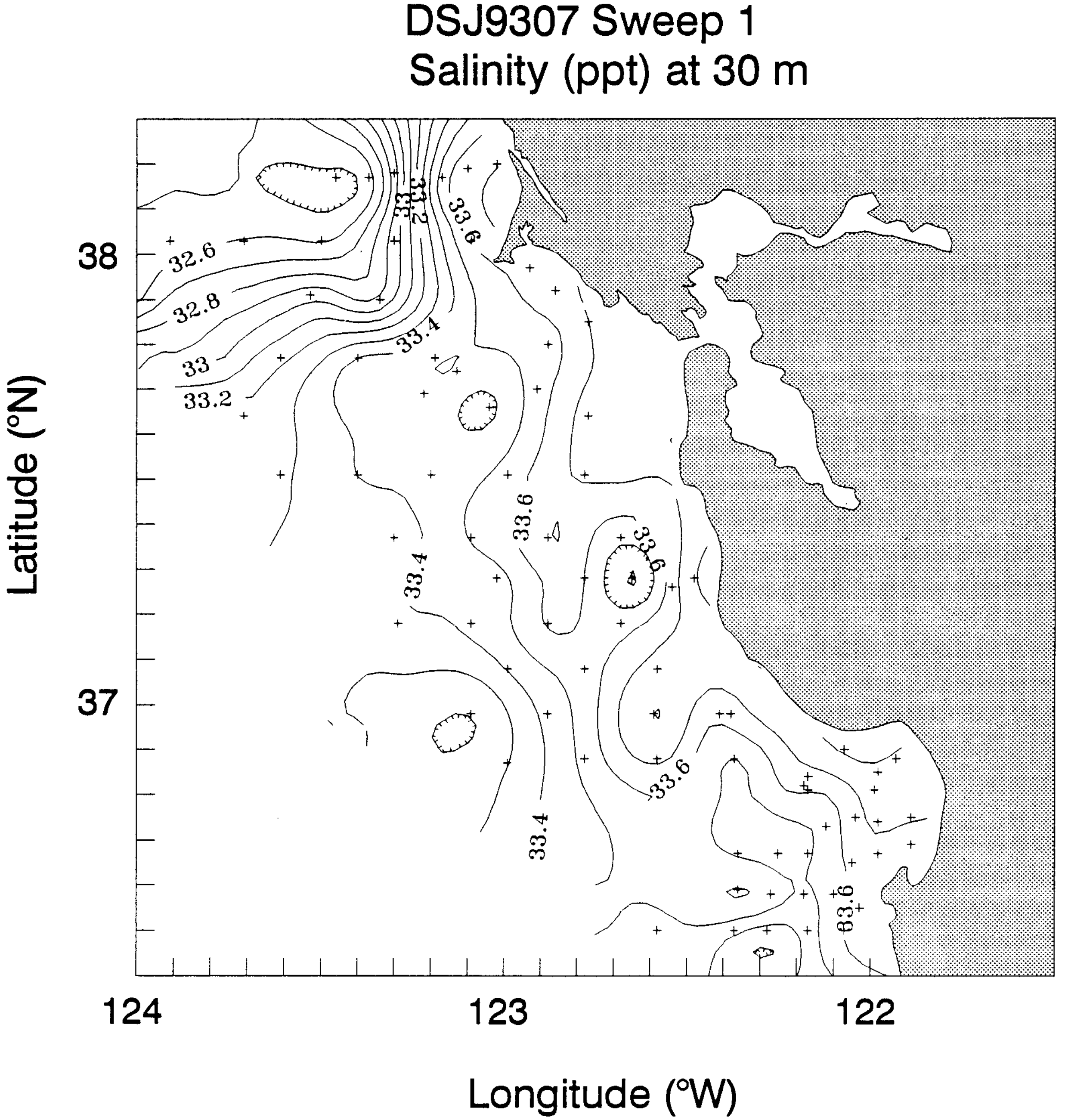
DSJ9307 Sweep 1
TS Salinity (ppt)



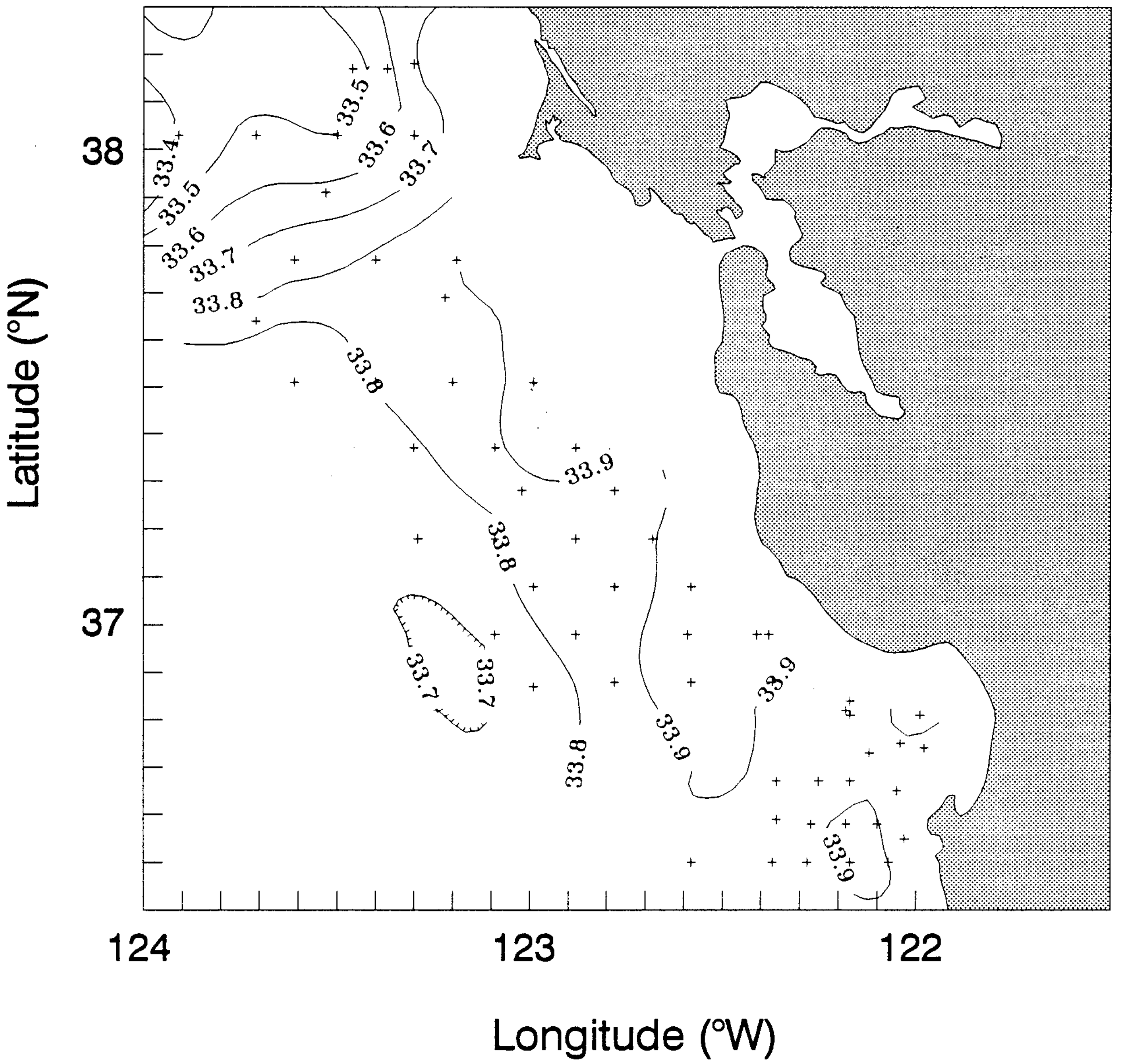
DSJ9307 Sweep 1
Salinity (ppt) at 2 m



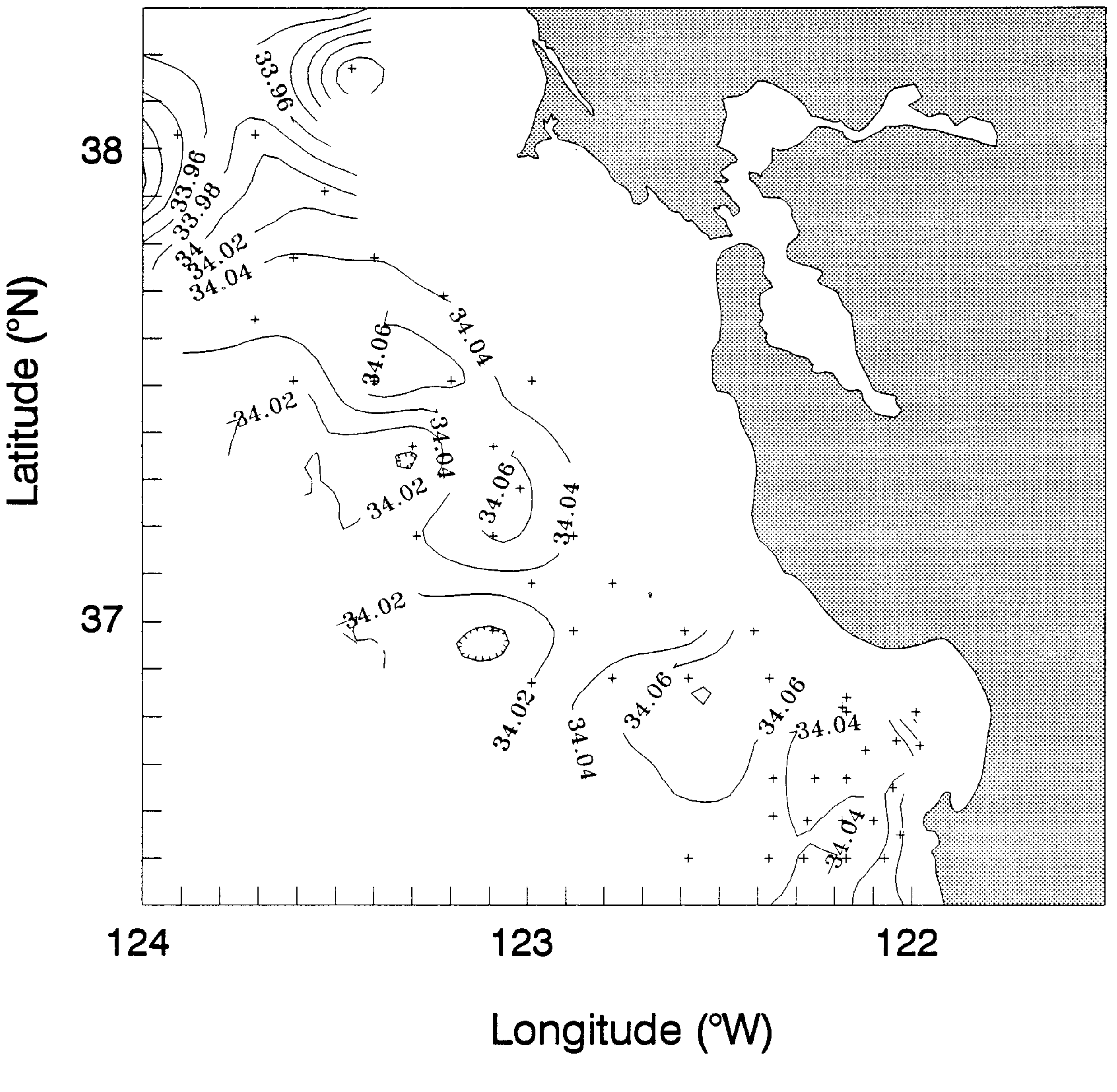

DSJ9307 Sweep 1
Salinity (ppt) at 10 m
32.4
33
32.6
32.8
33
33.2
33.2
33.4
33.4
33
33.2
33.4
33.6
33.4
38
37
124
123
122
Latitude (°N)
Longitude (°W)


DSJ9307 Sweep 1
Salinity (ppt) at 30 m
38
37
124
123
122
Latitude (°N)
Longitude (°W)
32.6
32.8
33
33.2
33.4
33.6

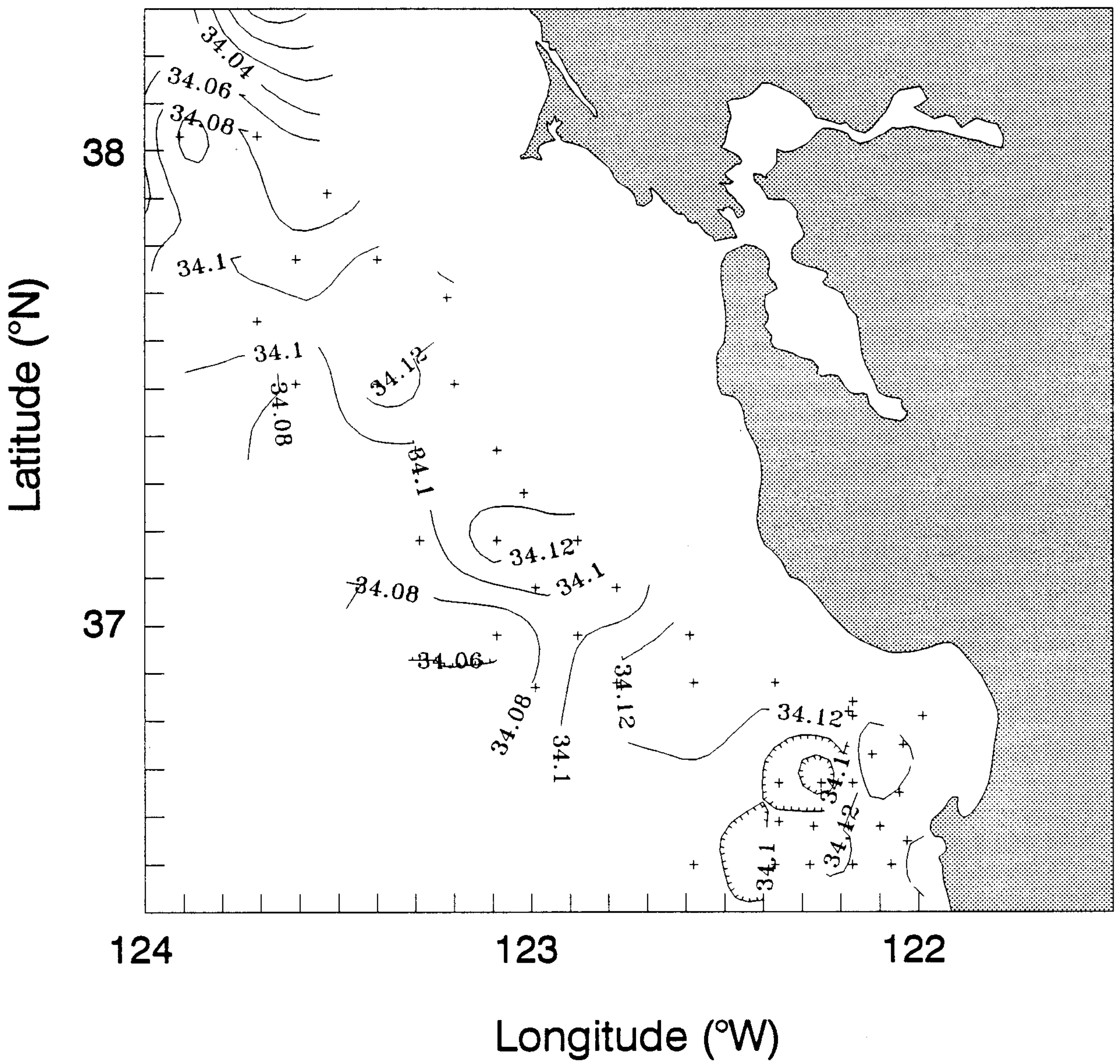
DSJ9307 Sweep 1
Salinity (ppt) at 100 m

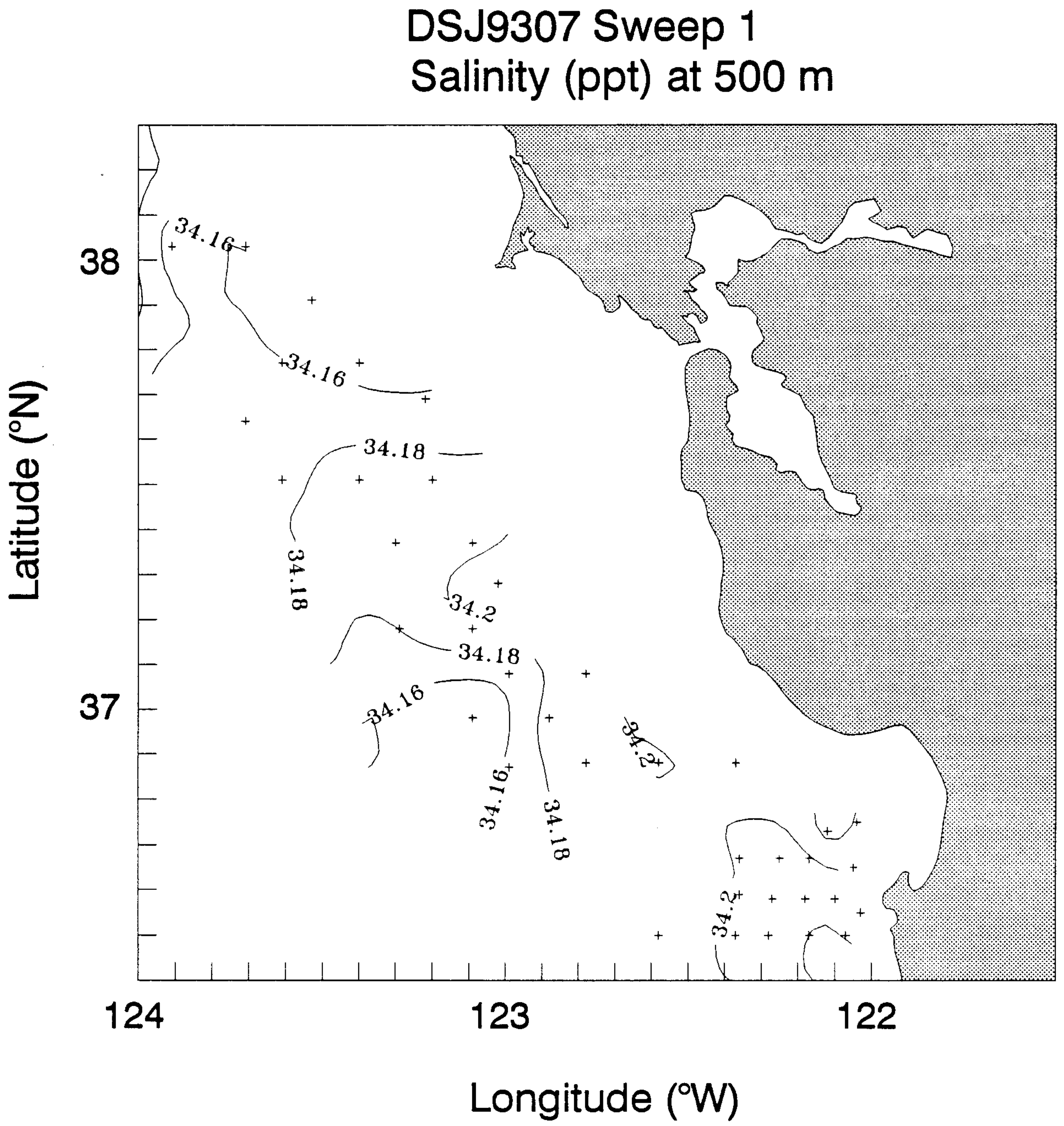


DSJ9307 Sweep 1
Salinity (ppt) at 200 m

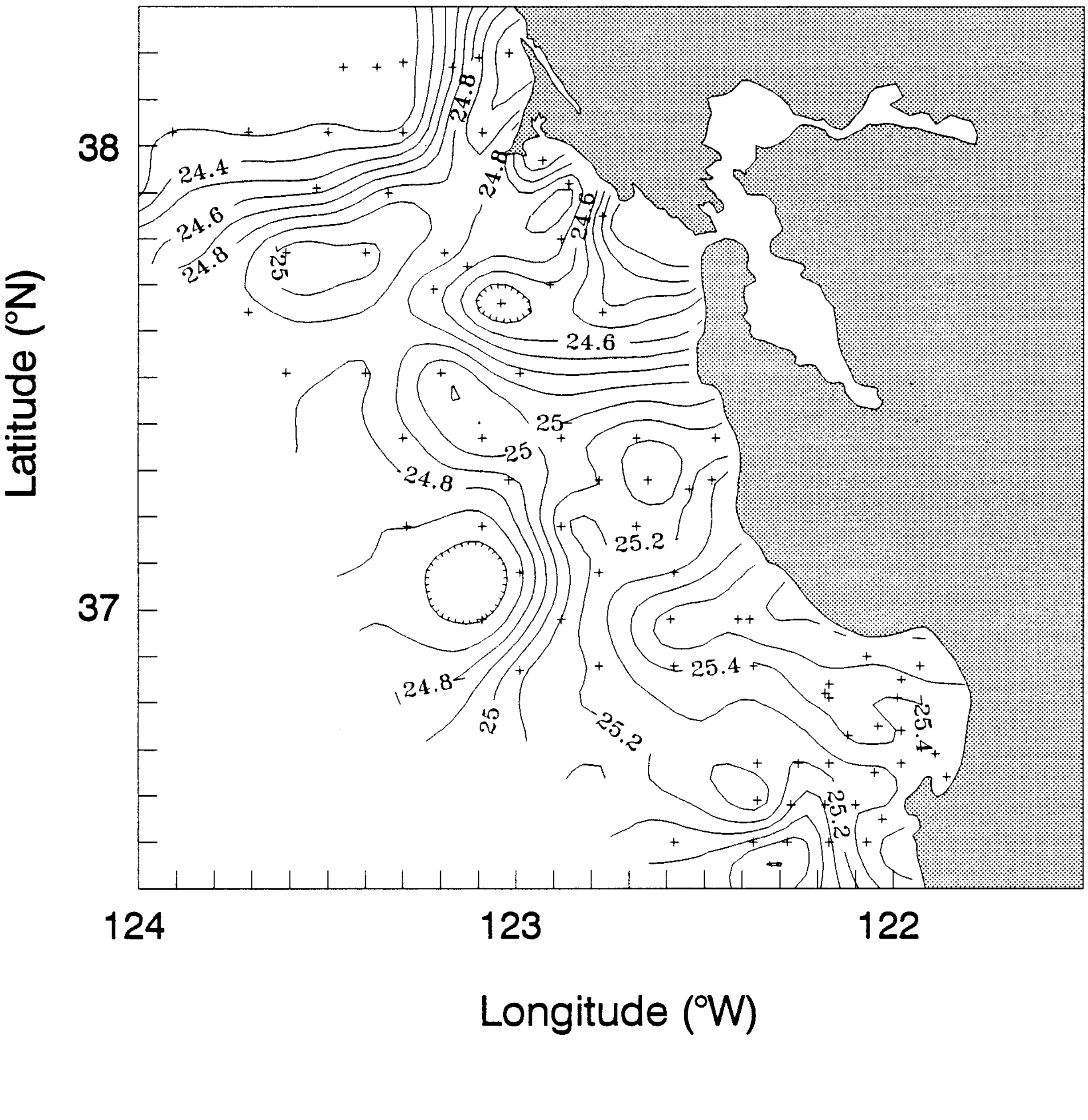


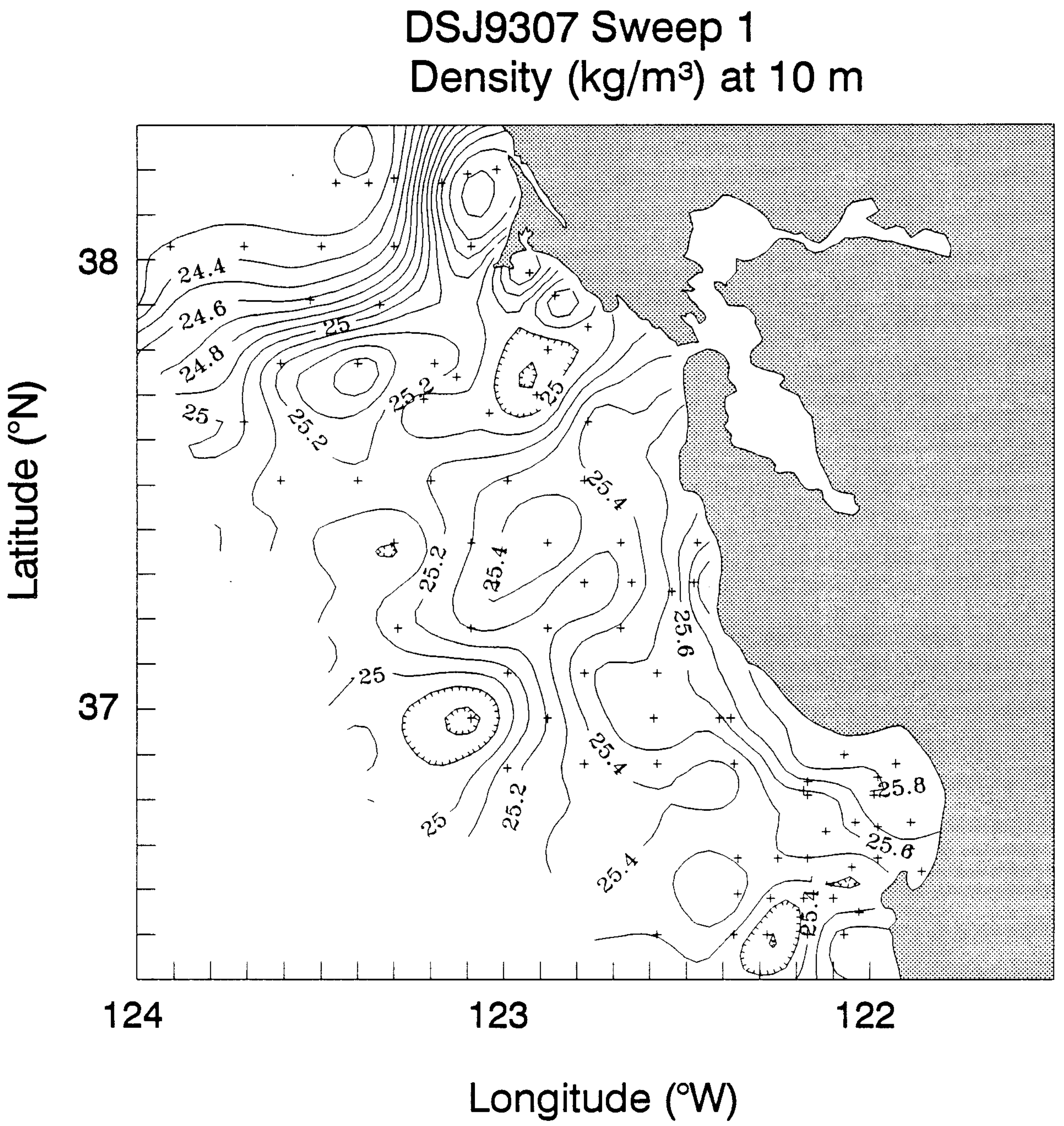
DSJ9307 Sweep 1
Salinity (ppt) at 300 m

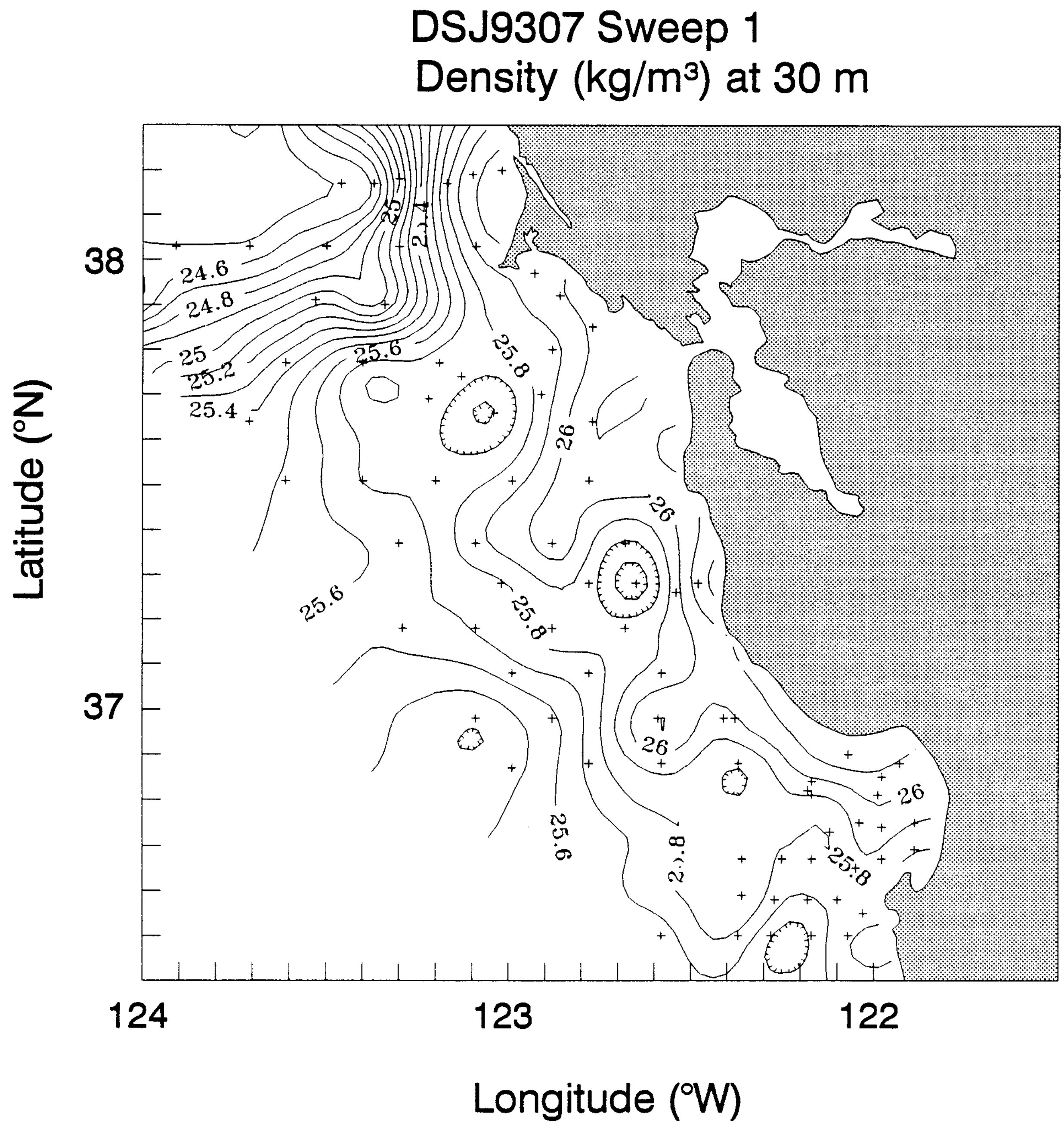


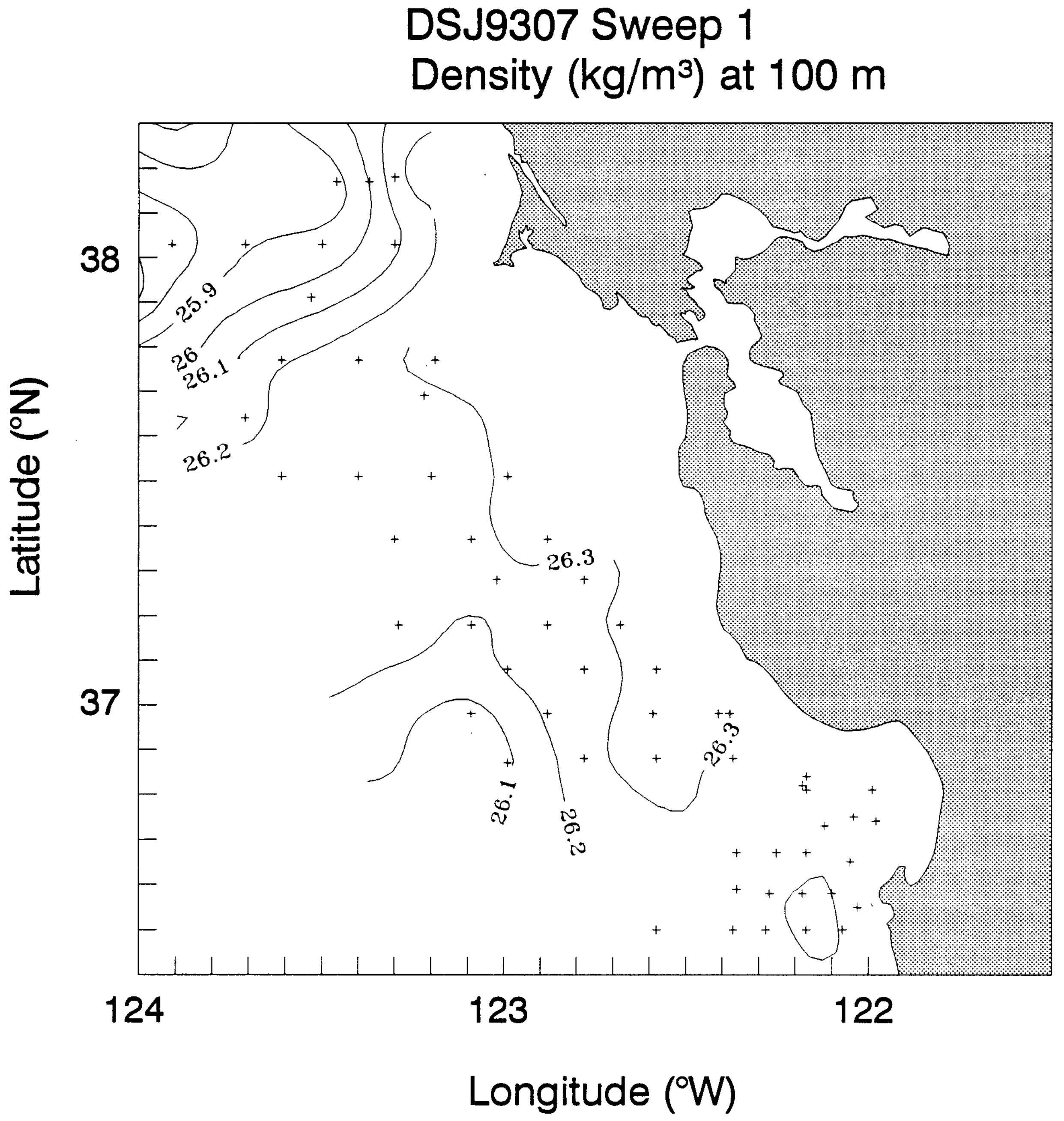

DSJ9307 Sweep 1
Salinity (ppt) at 500 m
34.16
34.16
34.18
34.18
34.2
34.18
34.16
34.16
34.18
34.2
34.2
38
37
Latitude (°N)
124
123
122
Longitude (°W)

DSJ9307 Sweep 1
Density (kg/m³) at 2 m



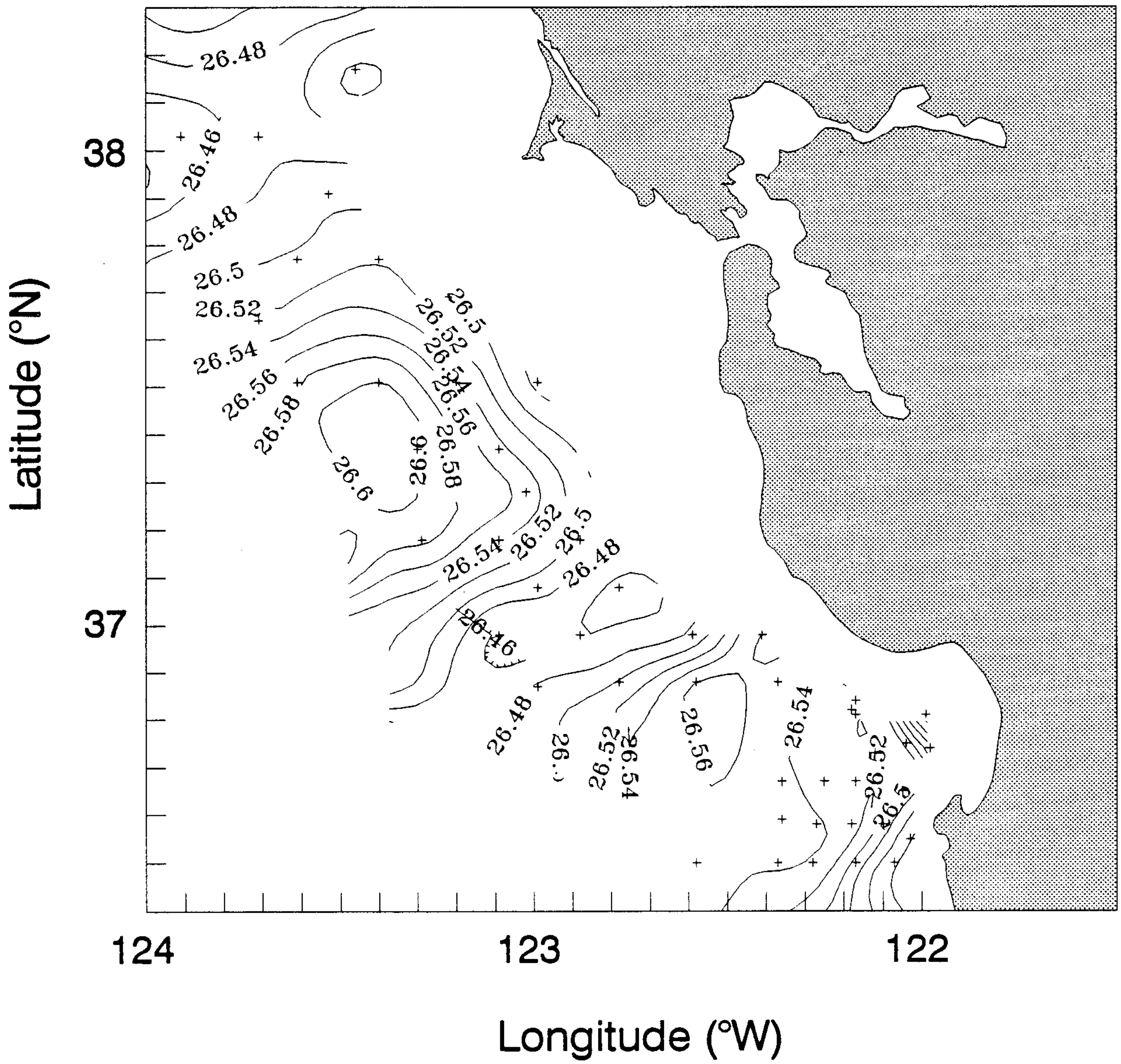

DSJ9307 Sweep 1
Density (kg/m³) at 10 m
24.4
24.6
24.8
25
25.2
25.4
25.6
25.8
38
37
Latitude (°N)
124
123
122
Longitude (°W)

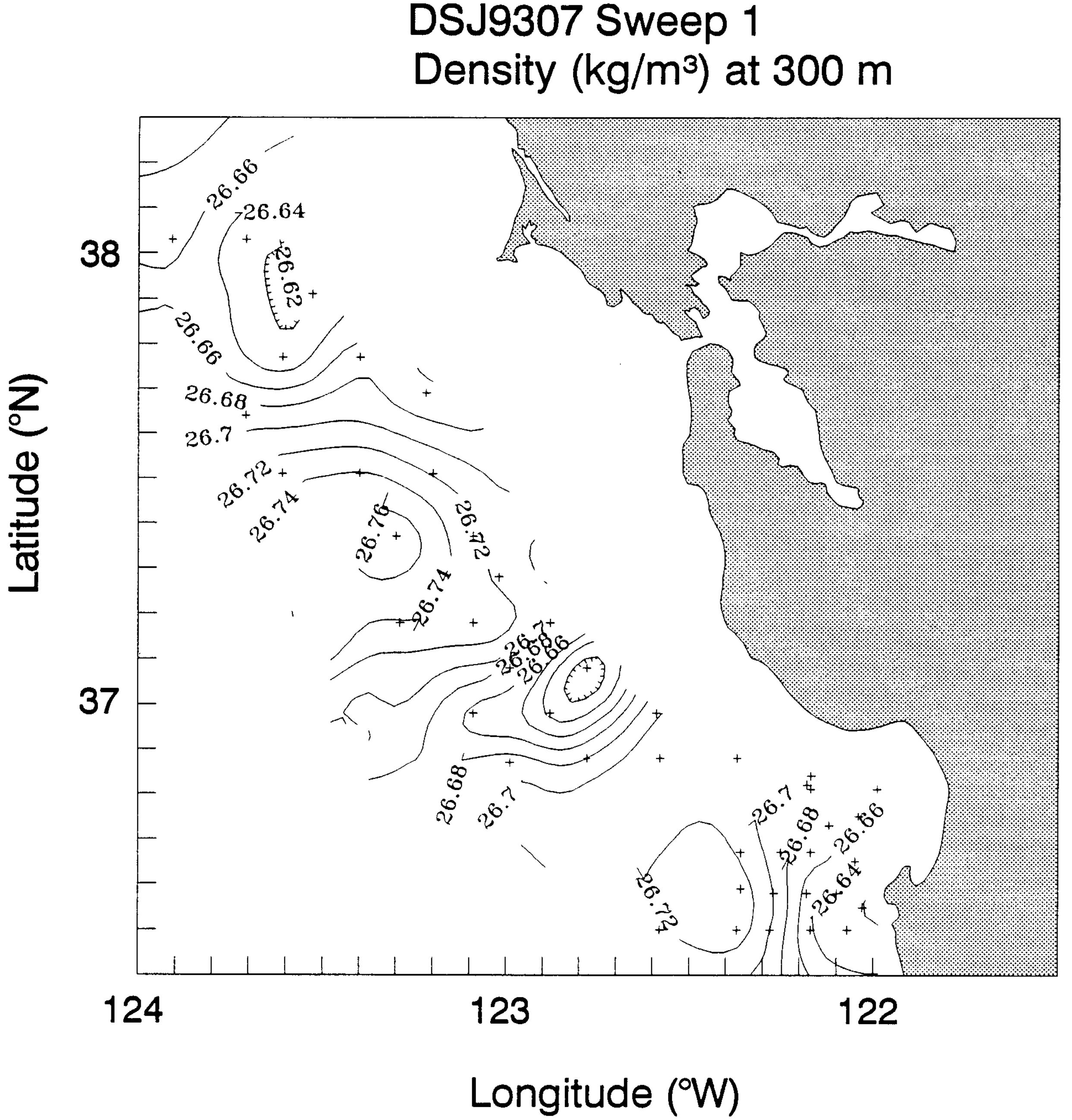

DSJ9307 Sweep 1
Density (kg/m³) at 30 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)
24.6
24.8
25
25.2
25.4
25.6
25.8
26

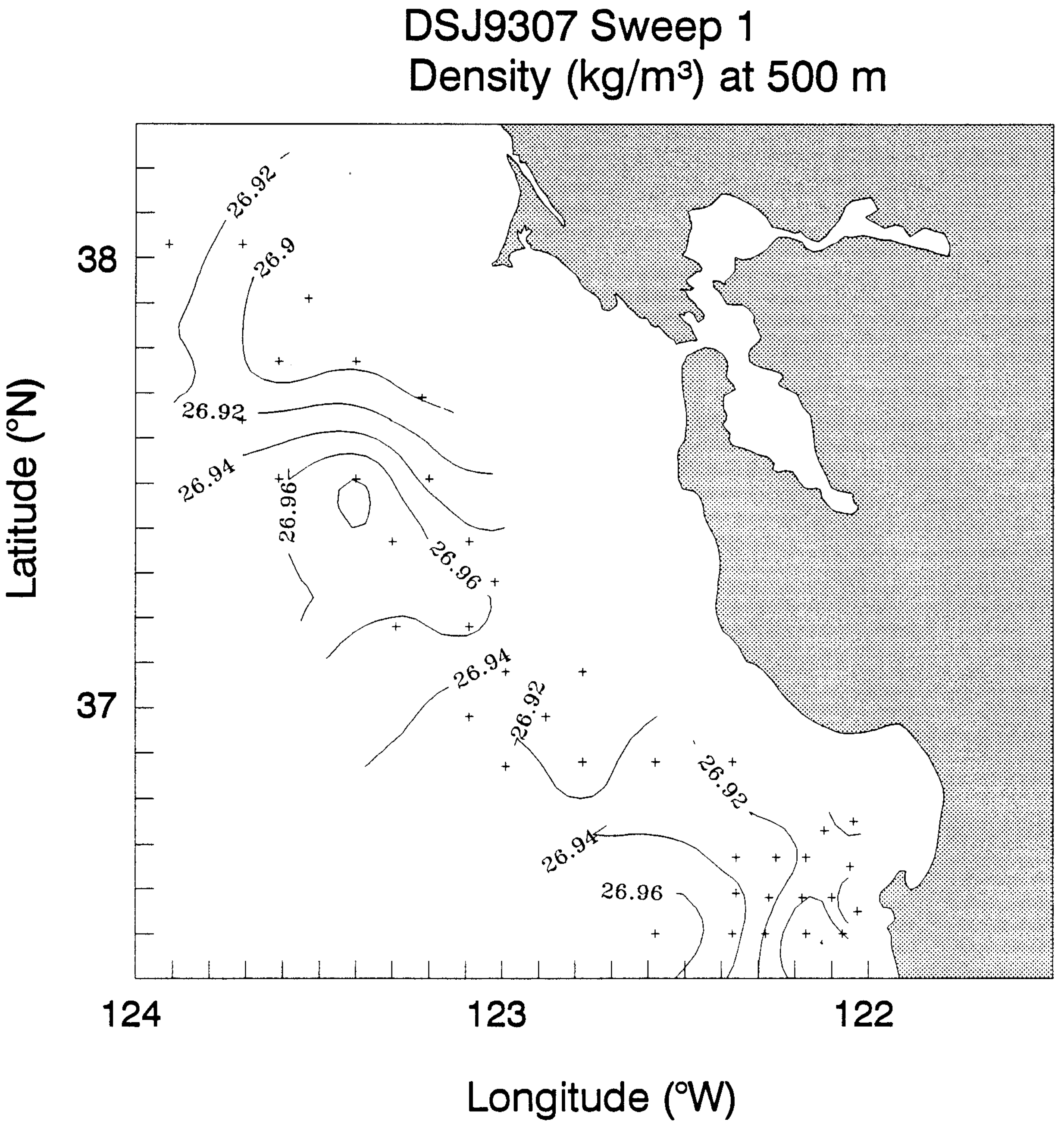


DSJ9307 Sweep 1
Density (kg/m³) at 100 m
Latitude (°N)
38
37
Longitude (°W)
124
123
122
25.9
26
26.1
26.2
26.3
26.3
26.1
26.2

DSJ9307 Sweep 1
Density (kg/m³) at 200 m



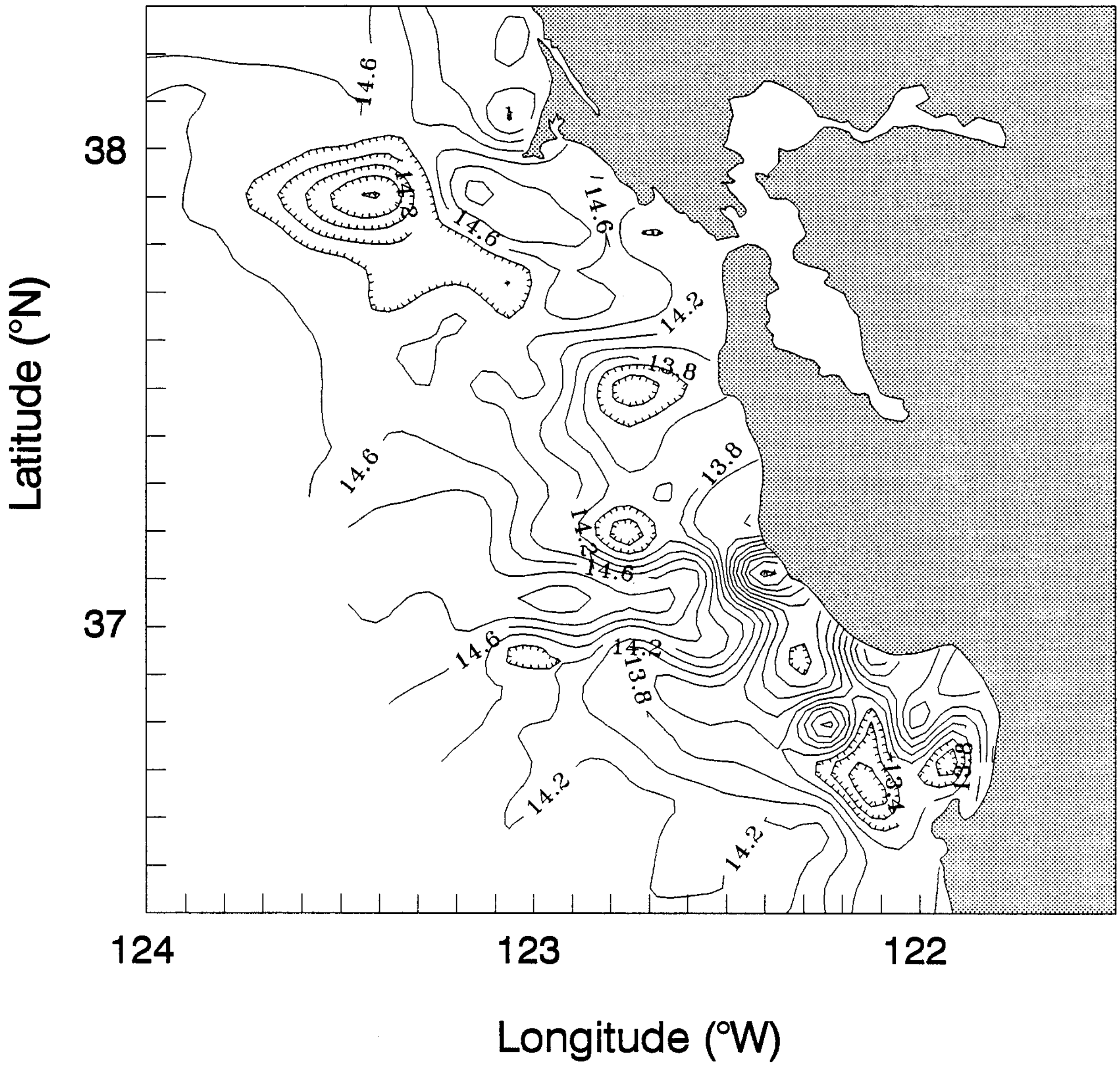

DSJ9307 Sweep 1
Density (kg/m³) at 300 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122
26.66
26.64
26.62
26.68
26.7
26.72
26.74
26.76

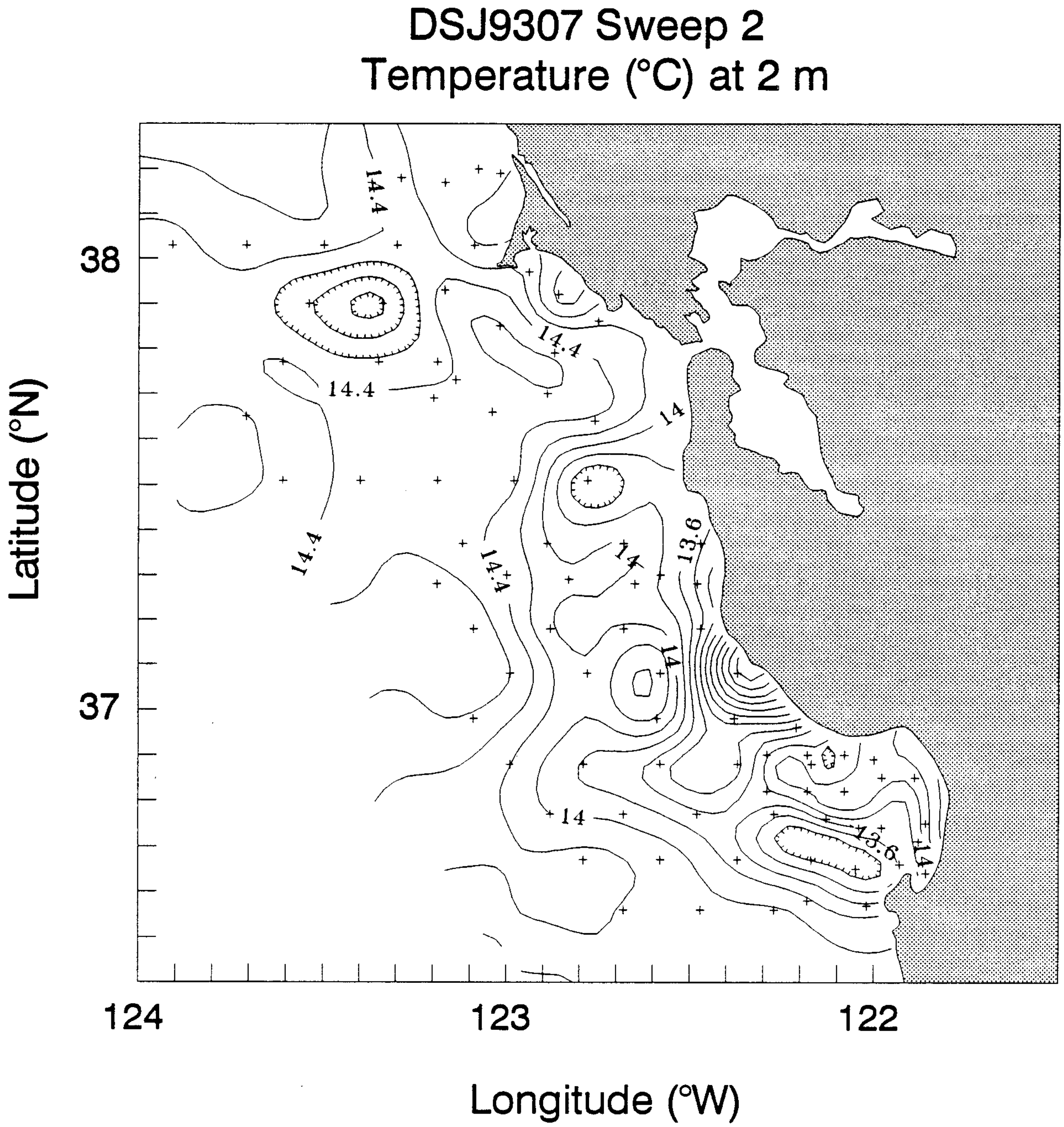


DSJ9307 Sweep 1
Density (kg/m³) at 500 m
Latitude (°N)
38
37
Longitude (°W)
124
123
122
26.92
26.9
26.92
26.94
26.96
26.96
26.94
26.92
26.92
26.94
26.96

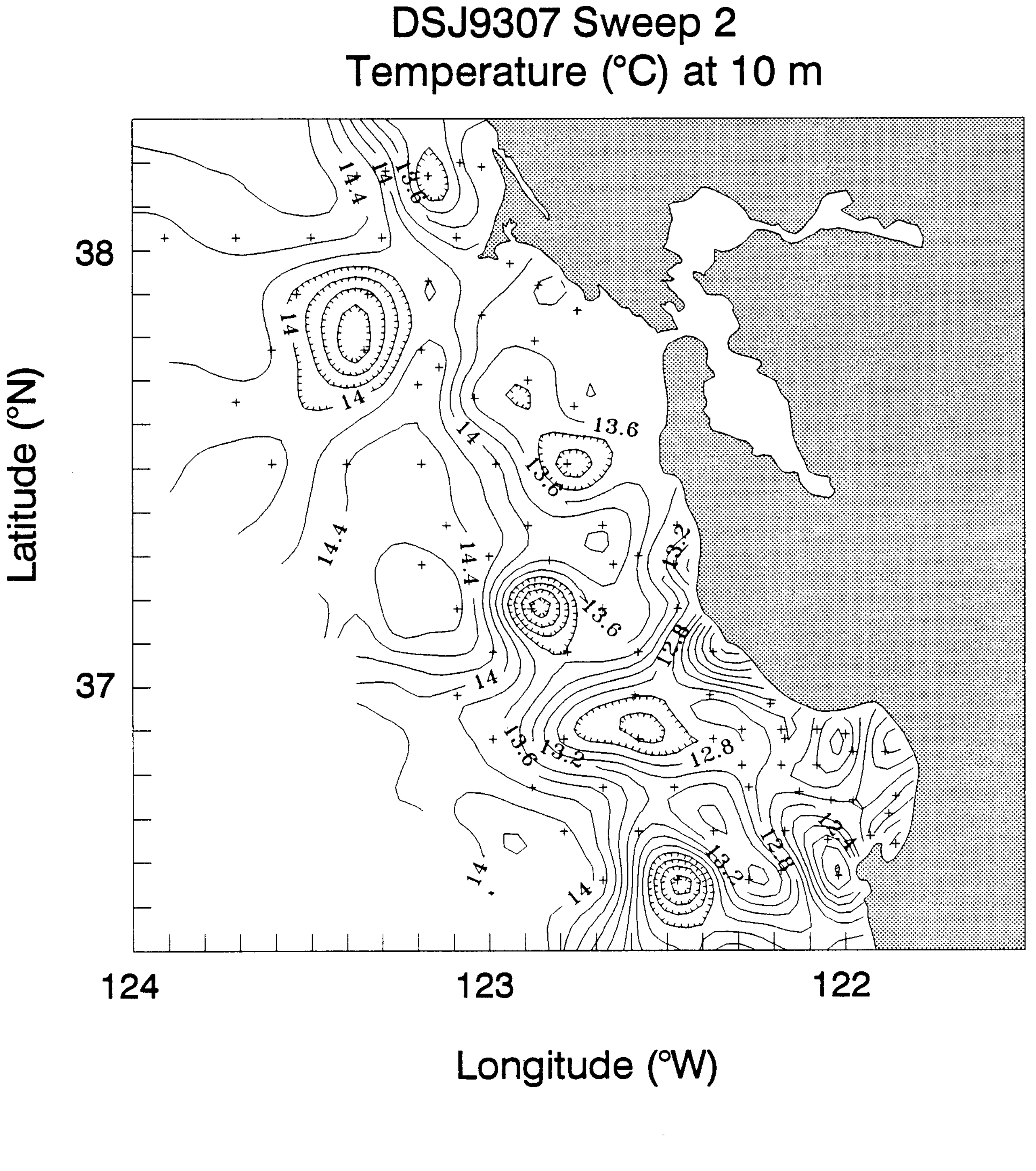
APPENDIX 6.3: HORIZONTAL MAPS OF CTD AND TS FOR DSJ9307, SWEEP 2

DSJ9307 Sweep 2
TS Temperature (°C)



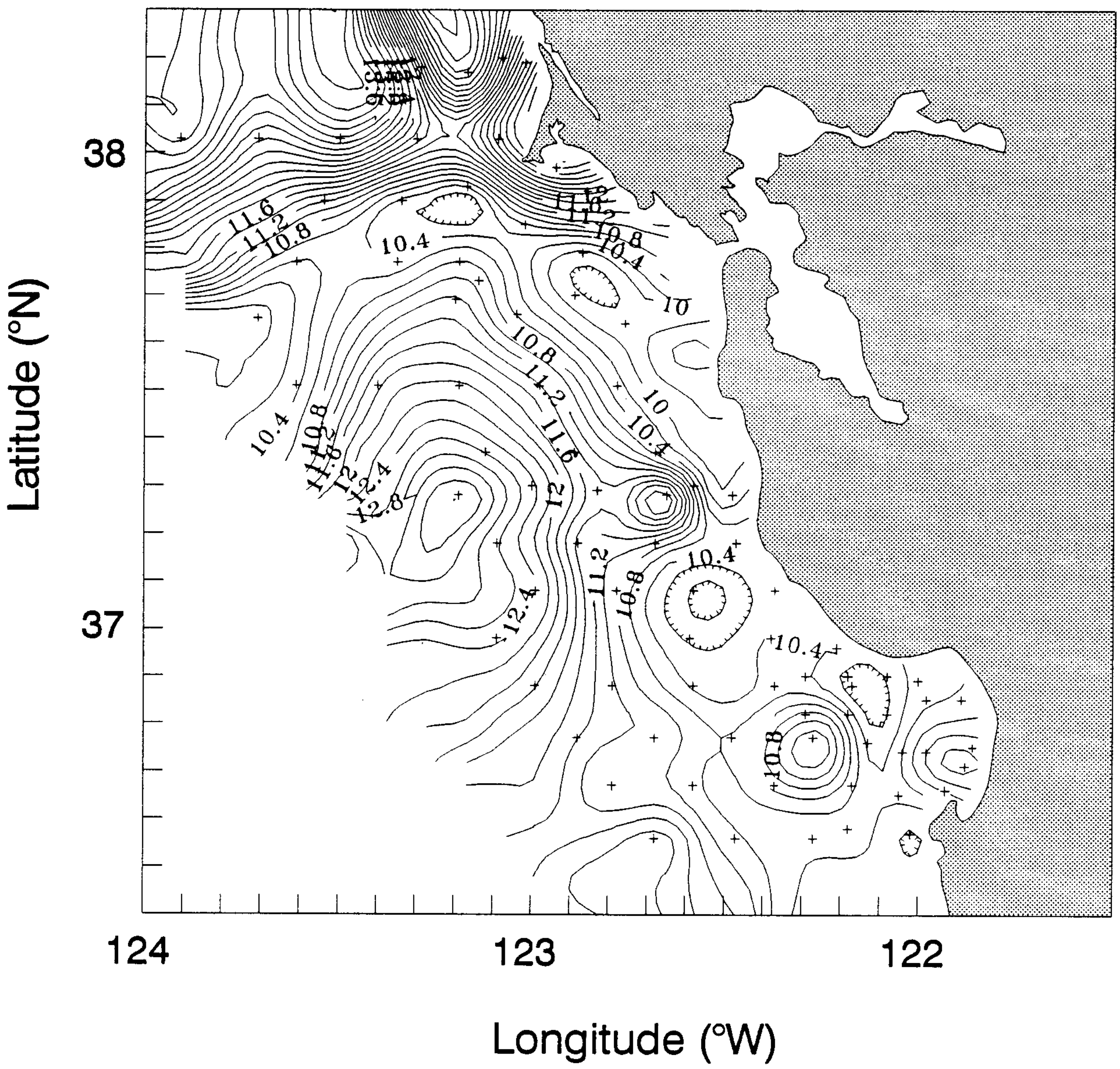


DSJ9307 Sweep 2
Temperature (°C) at 2 m
14.4
14.4
14.4
14
14.4
14.4
14
13.6
14
14
13.6
14
38
37
Latitude (°N)
124
123
122
Longitude (°W)

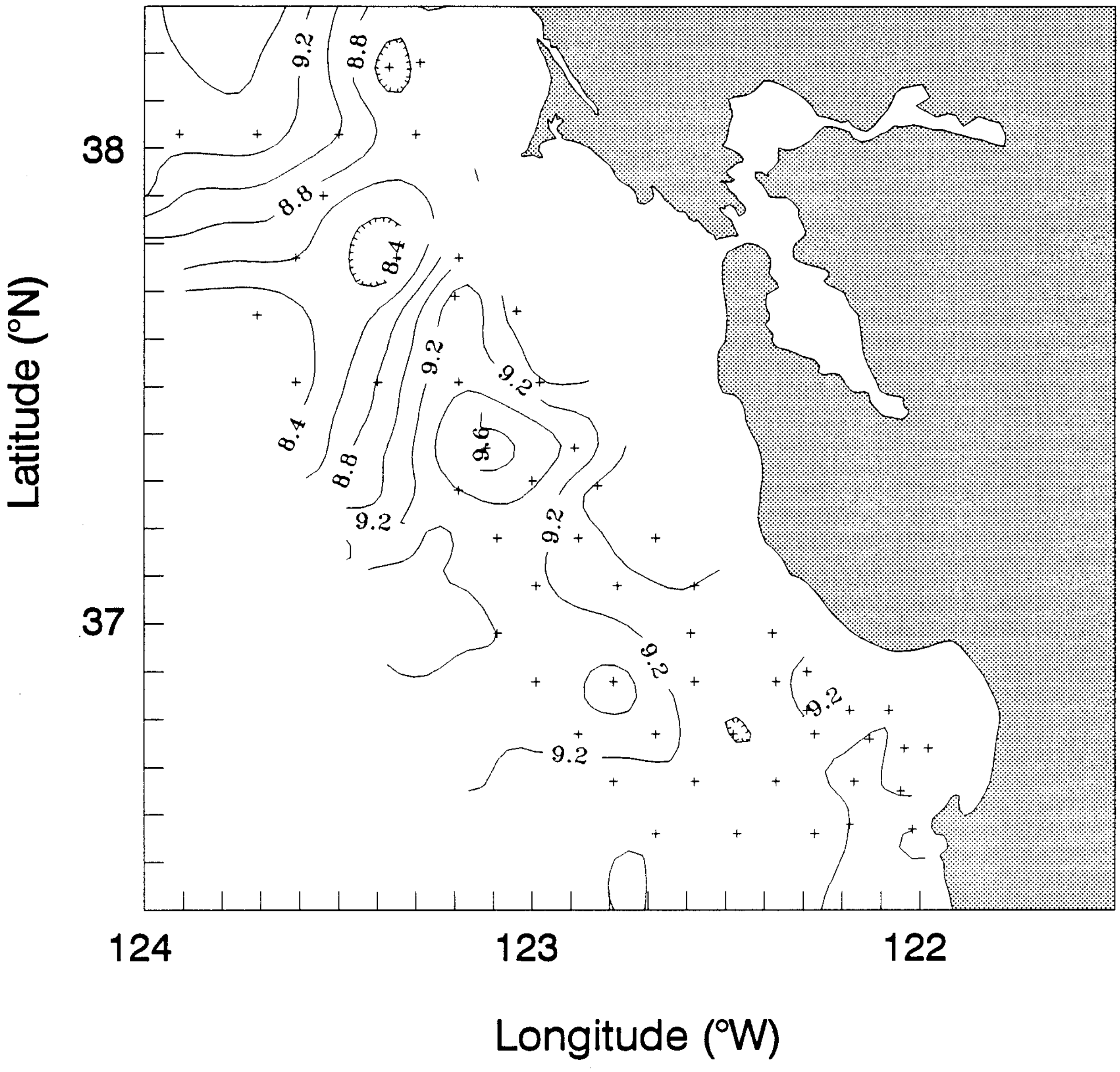


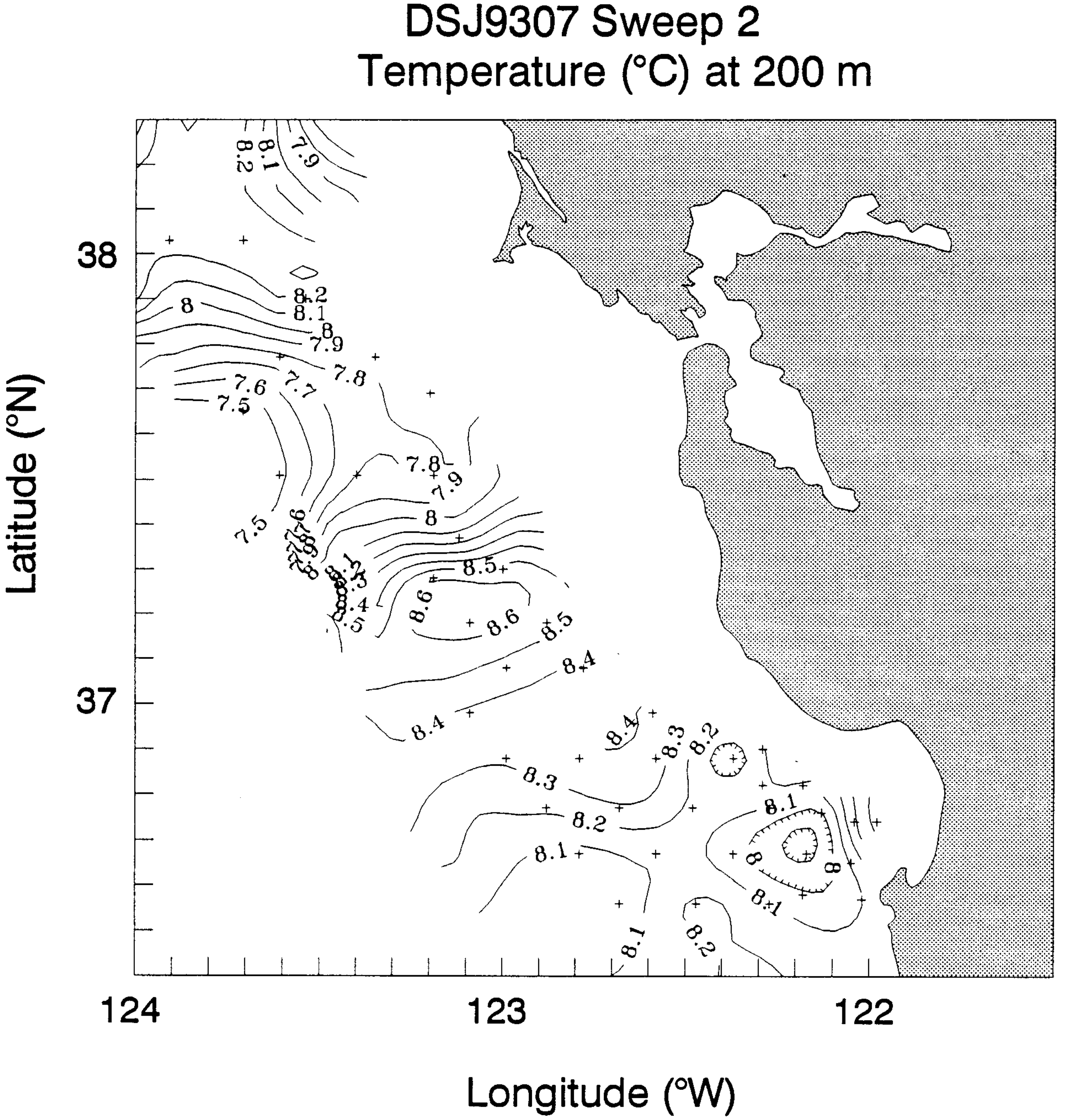
DSJ9307 Sweep 2
Temperature (°C) at 10 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122
14.4
14
13.6
12.8
13.2
12.4

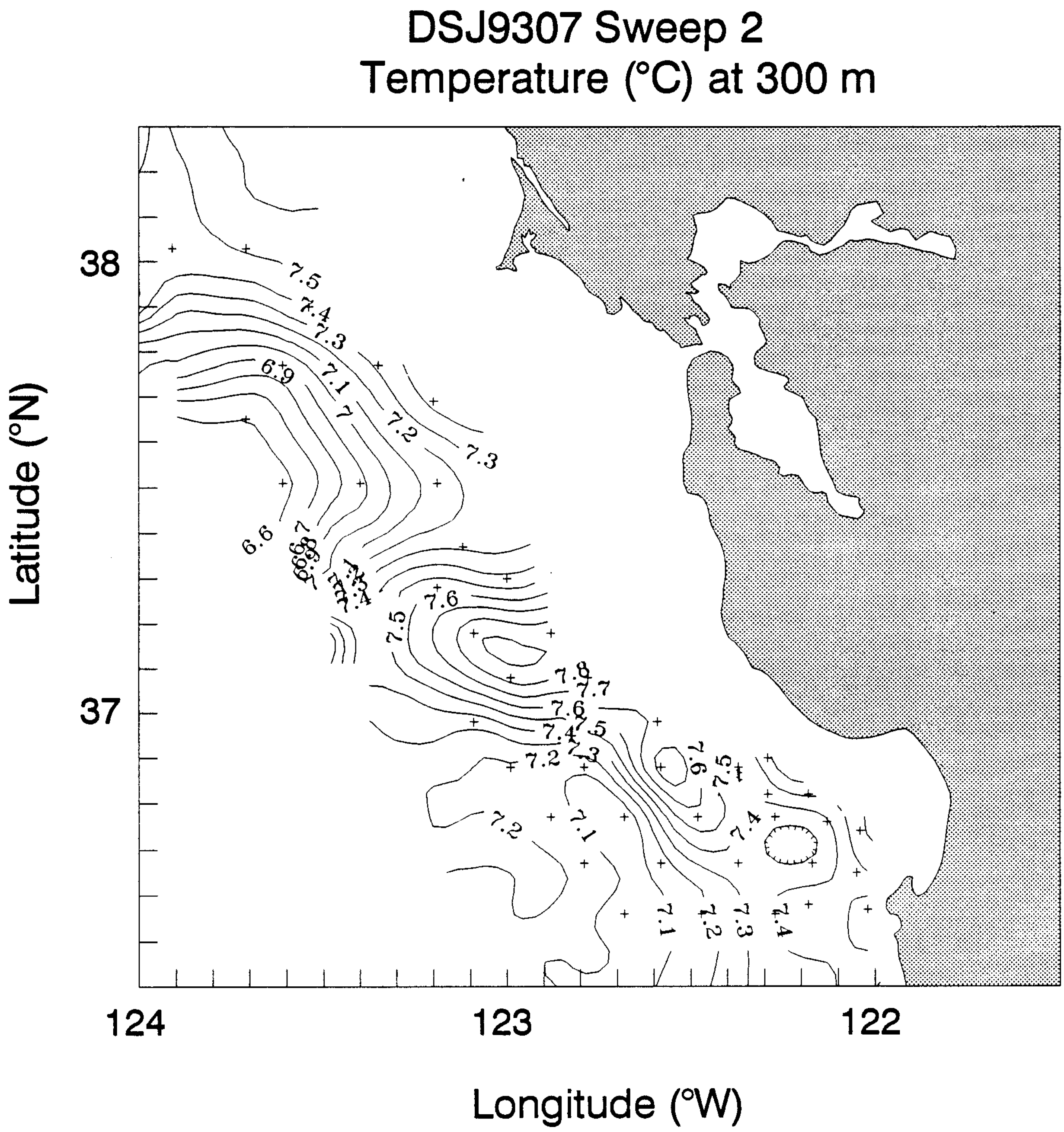
DSJ9307 Sweep 2
Temperature (°C) at 30 m

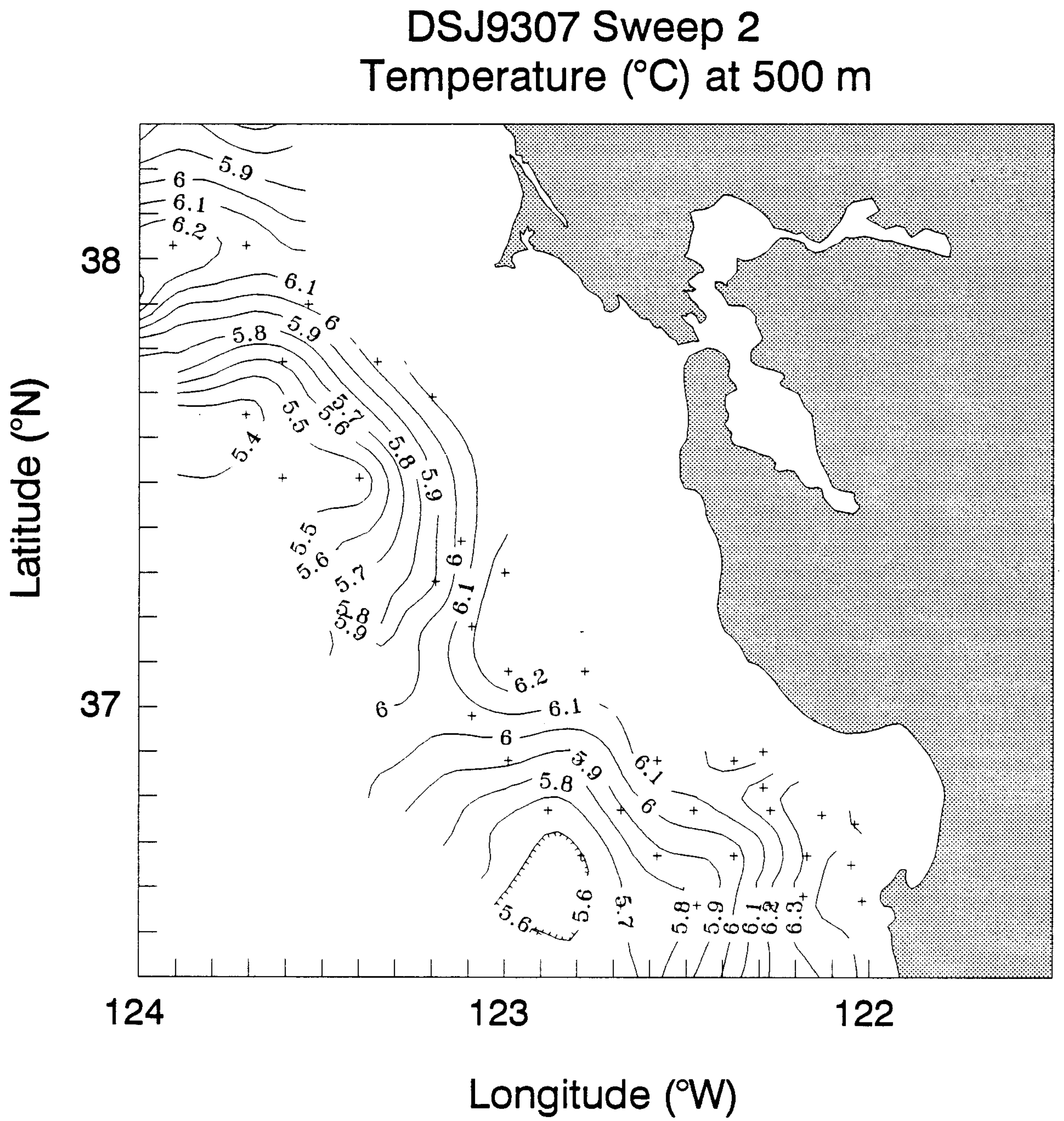


DSJ9307 Sweep 2
Temperature (°C) at 100 m



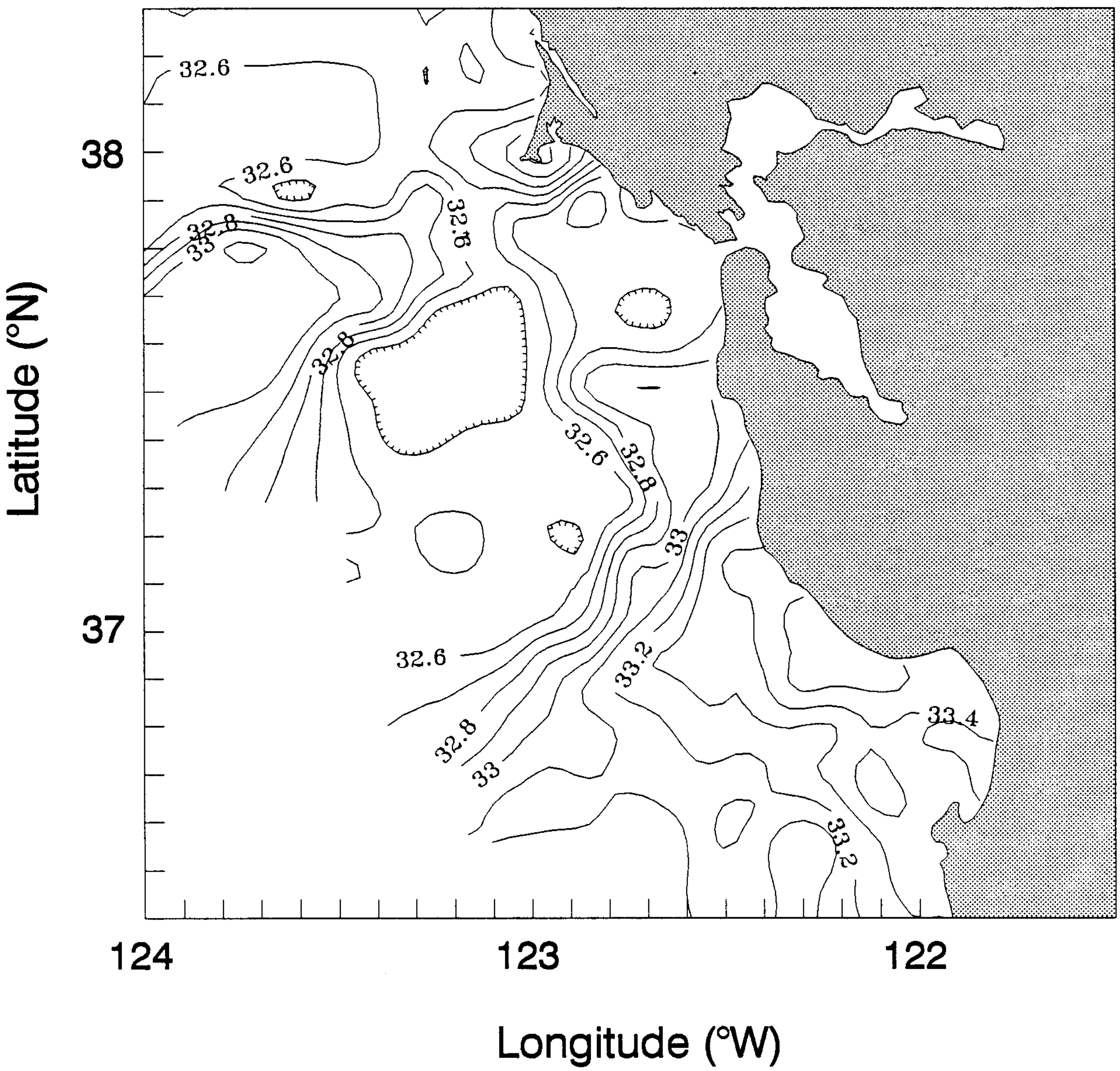

DSJ9307 Sweep 2
Temperature (°C) at 200 m
38
37
124
123
122
Latitude (°N)
Longitude (°W)


DSJ9307 Sweep 2
Temperature (°C) at 300 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122
7.5
7.4
7.3
6.9
7.1
7
7.2
7.3
6.6
7.6
7.5
7.8
7.7
7.6
7.4
7.5
7.2
7.3
7.6
7.2
7.1
7.4
7.1
7.2
7.3
7.4

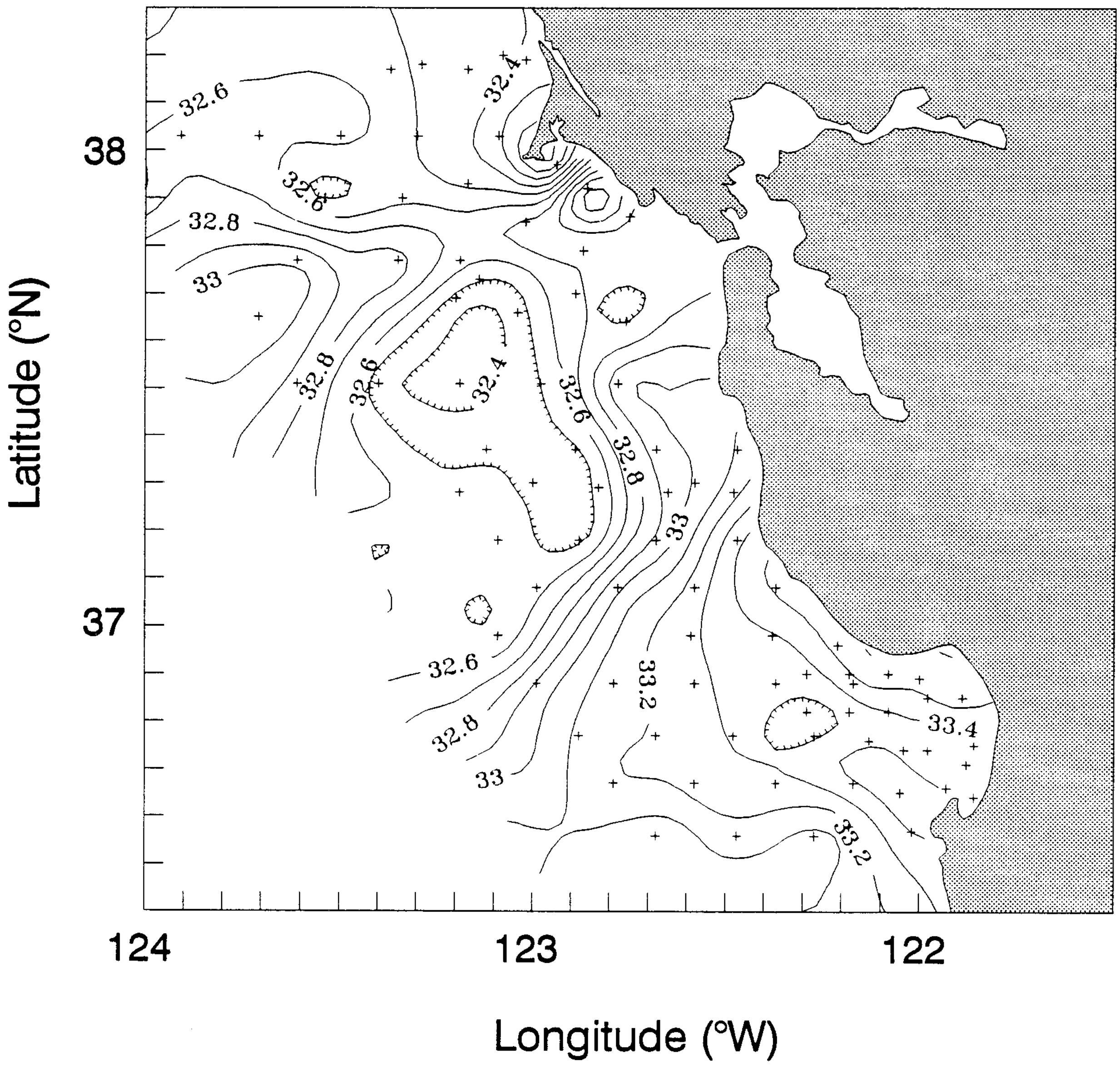


DSJ9307 Sweep 2
Temperature (°C) at 500 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122

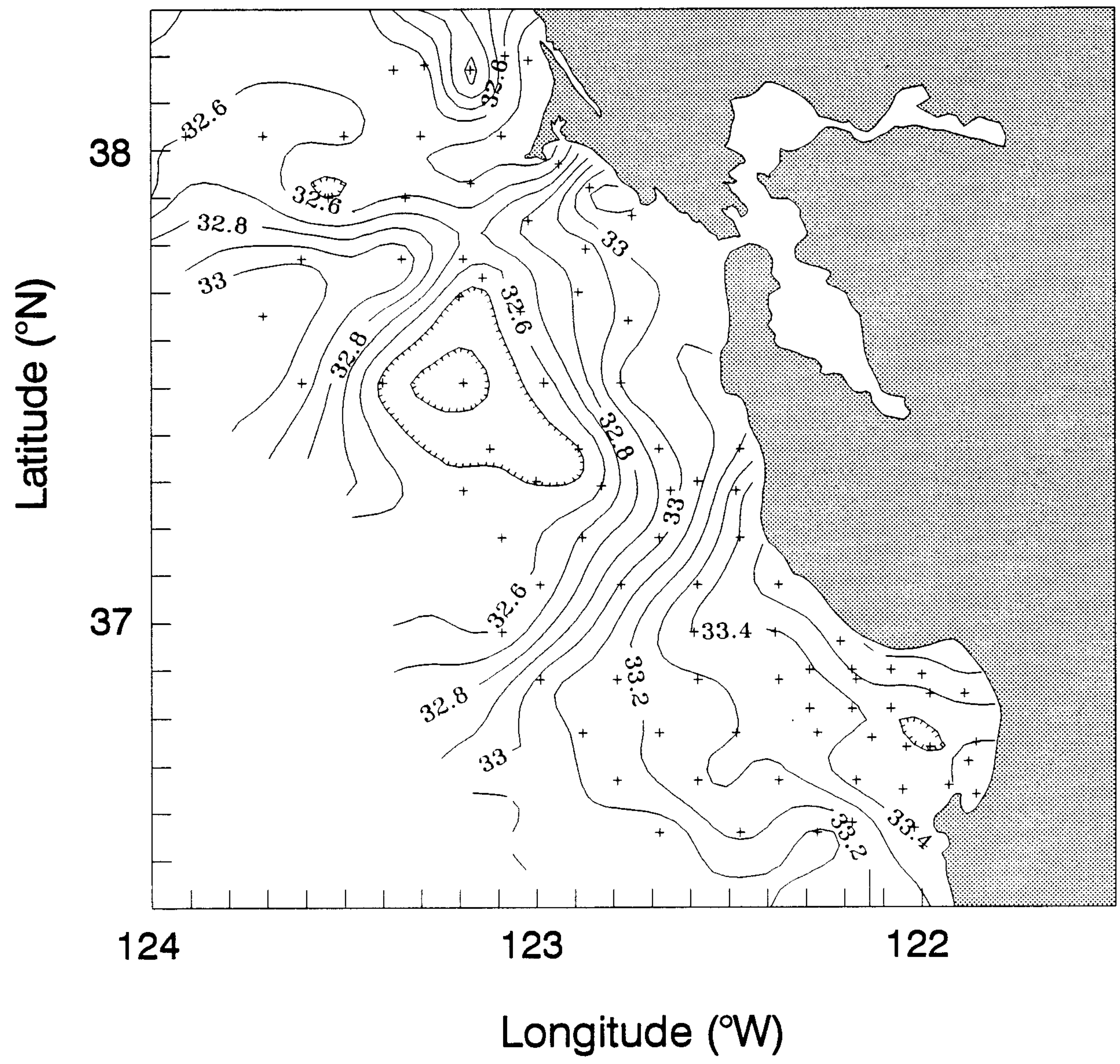
DSJ9307 Sweep 2
TS Salinity (ppt)

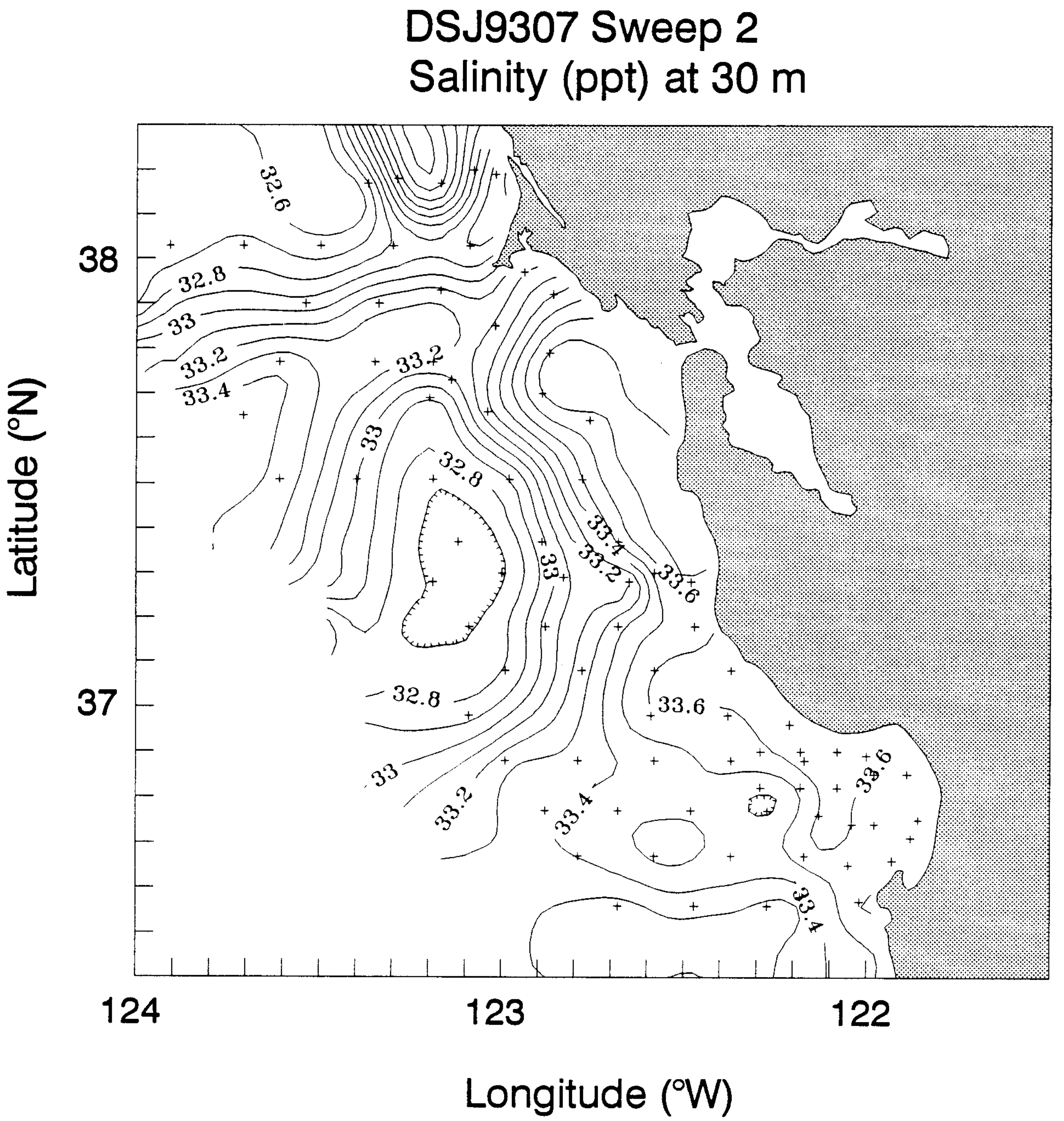


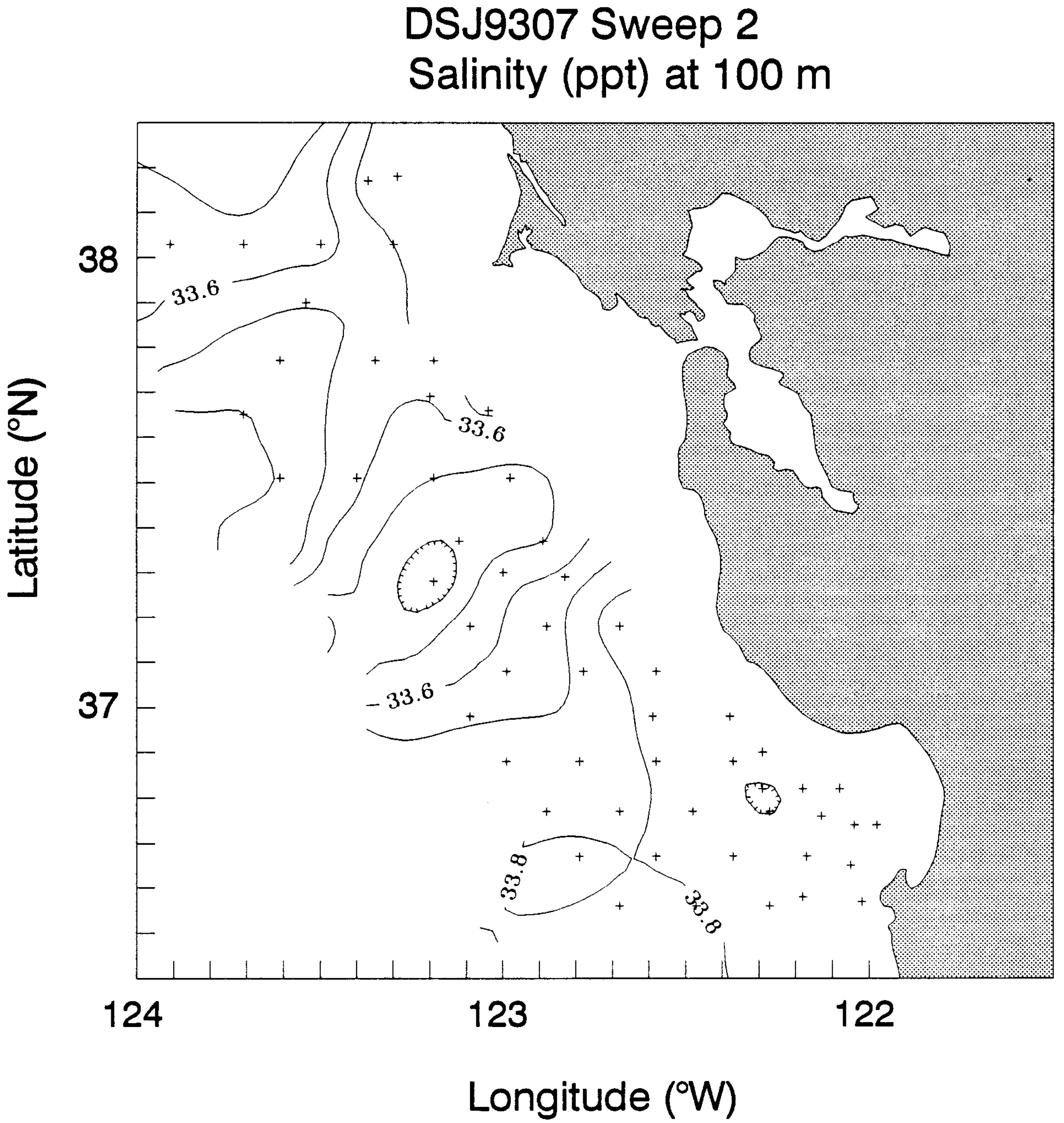
DSJ9307 Sweep 2
Salinity (ppt) at 2 m

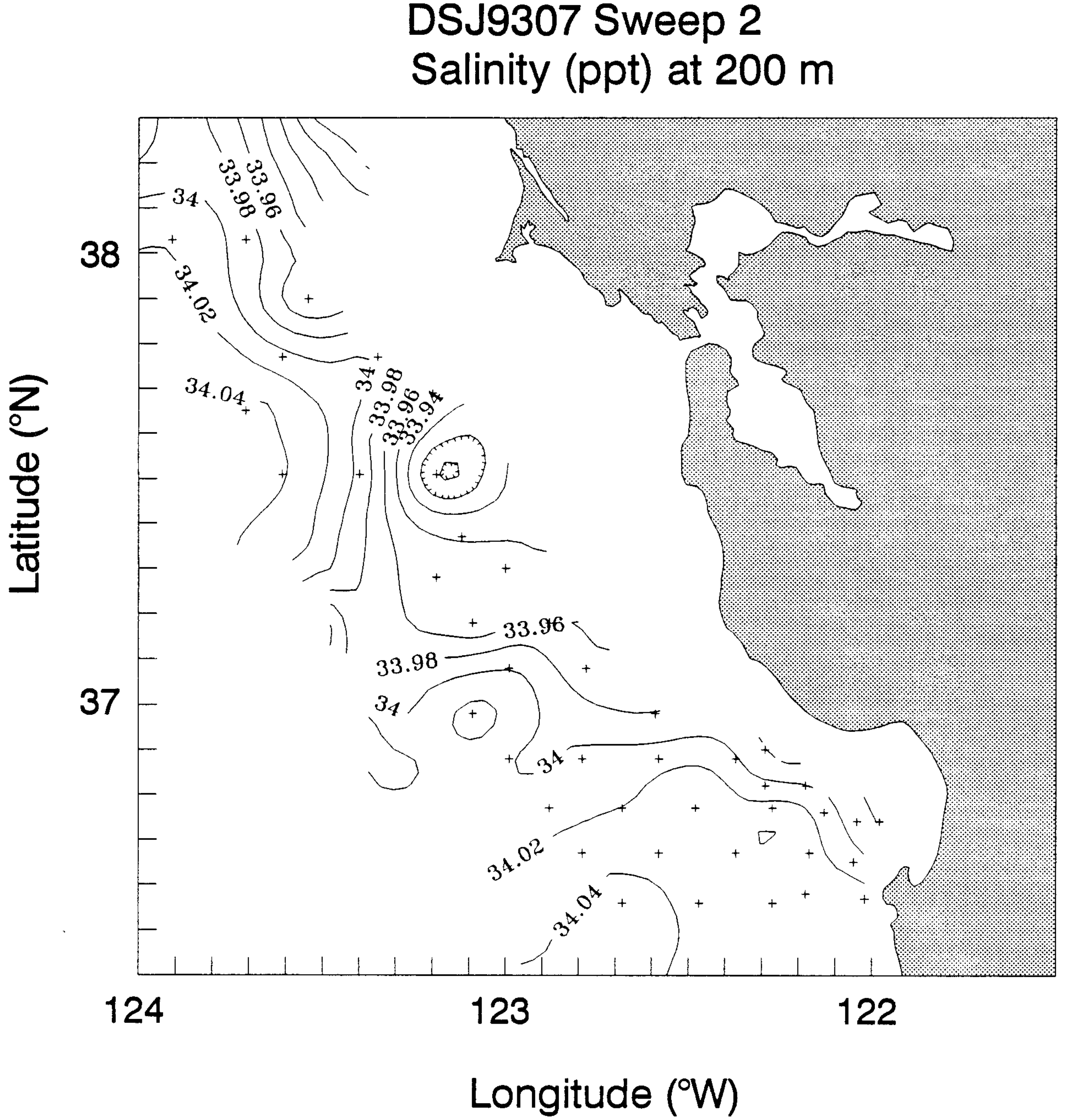


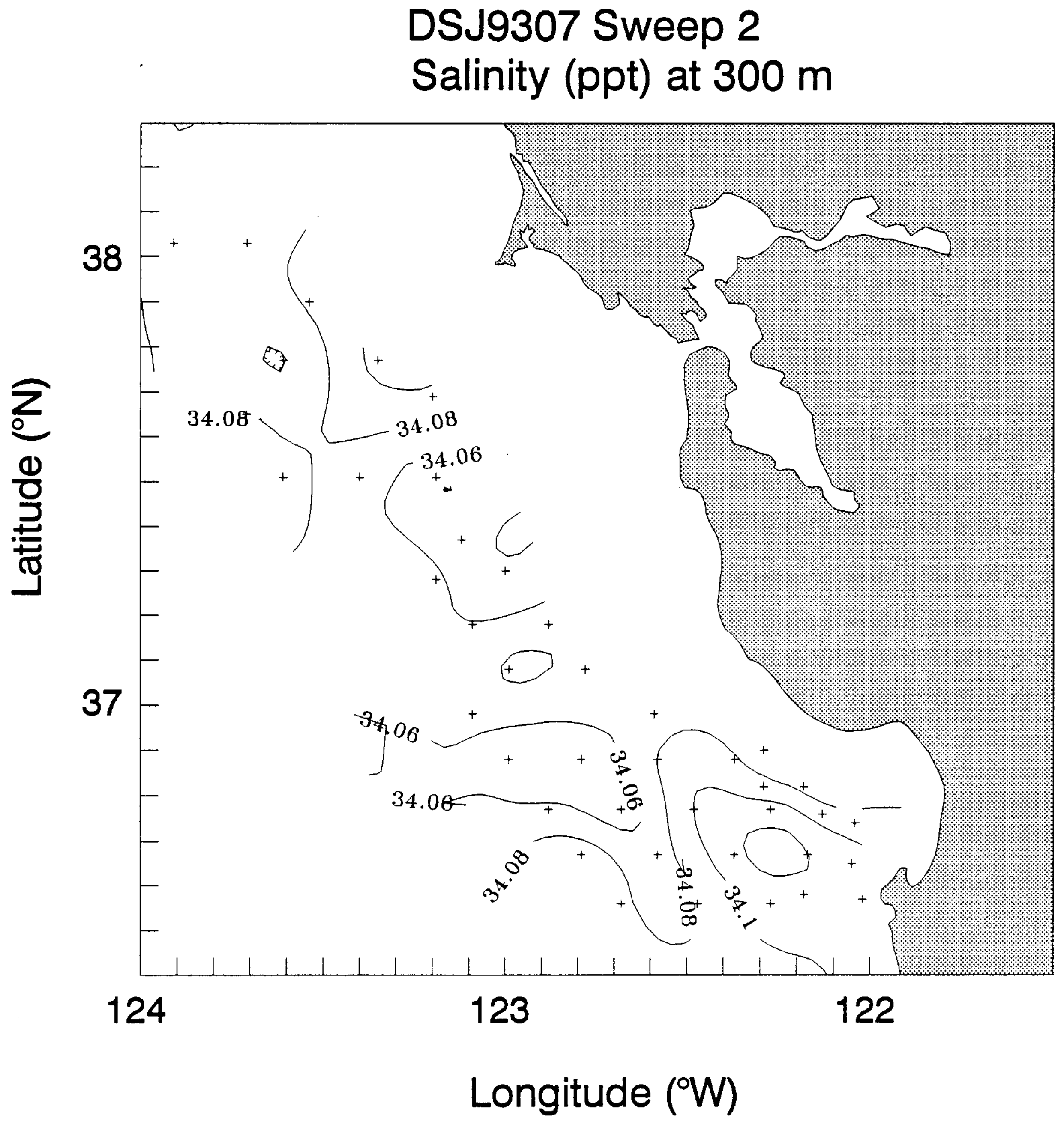
DSJ9307 Sweep 2
Salinity (ppt) at 10 m




DSJ9307 Sweep 2
Salinity (ppt) at 30 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)
32.6
32.8
33
33.2
33.4
33.6

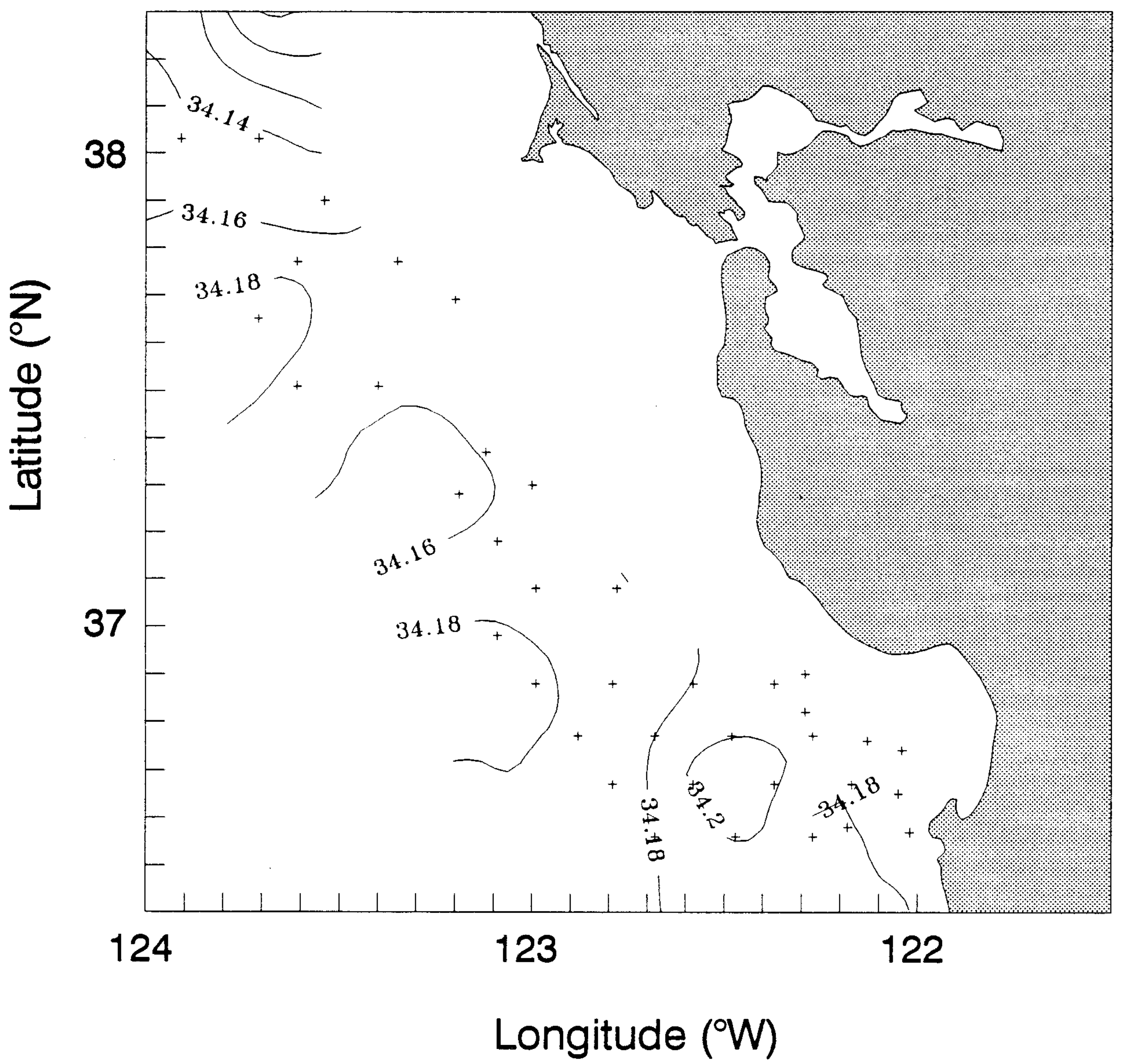

DSJ9307 Sweep 2
Salinity (ppt) at 100 m
33.6
33.6
33.6
33.8
33.8
38
37
Latitude (°N)
124
123
122
Longitude (°W)


DSJ9307 Sweep 2
Salinity (ppt) at 200 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122
34
33.98
33.96
34.02
34.04
33.94
34
33.98
33.96
33.98
34
34
34.02
34.04

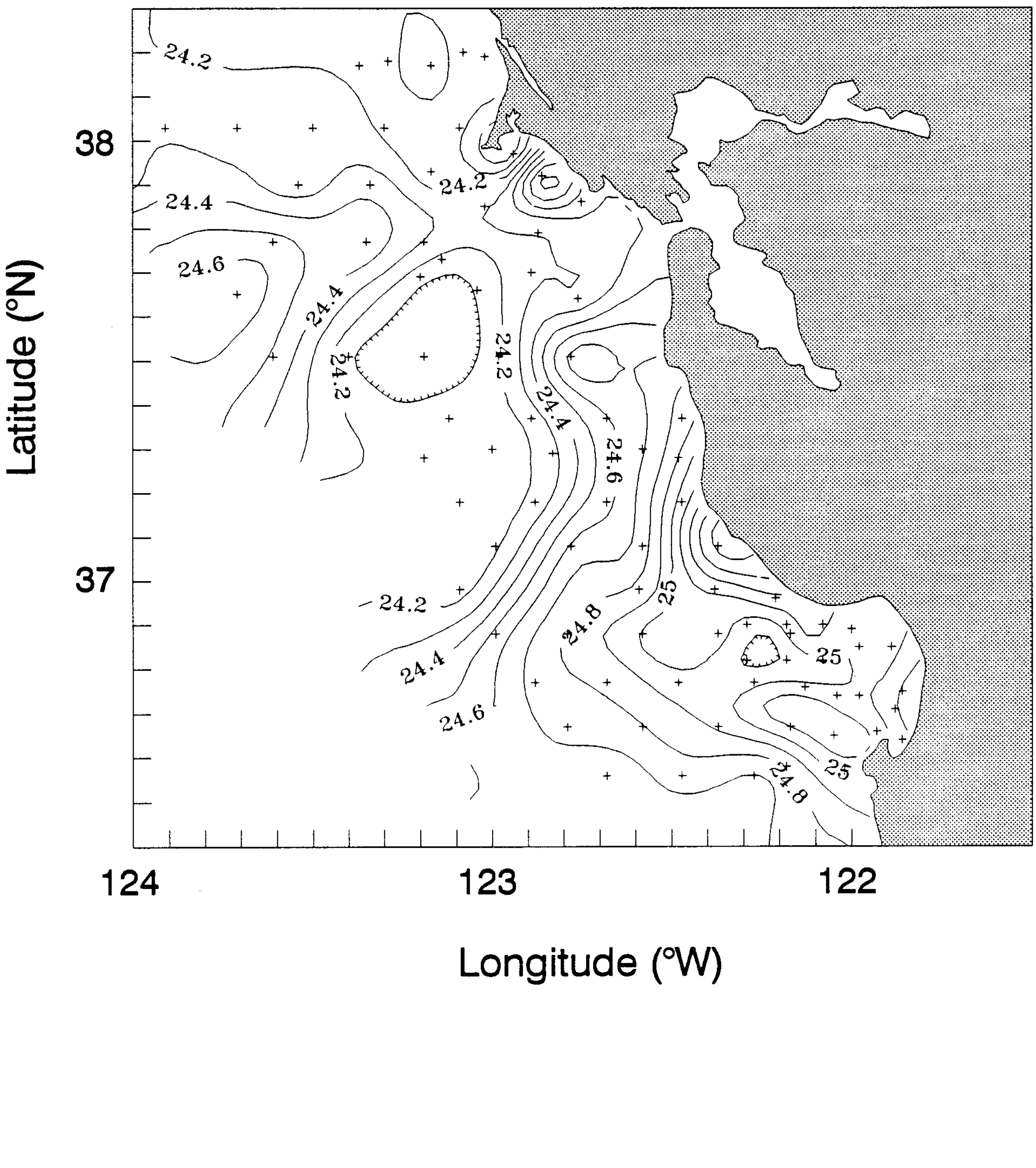


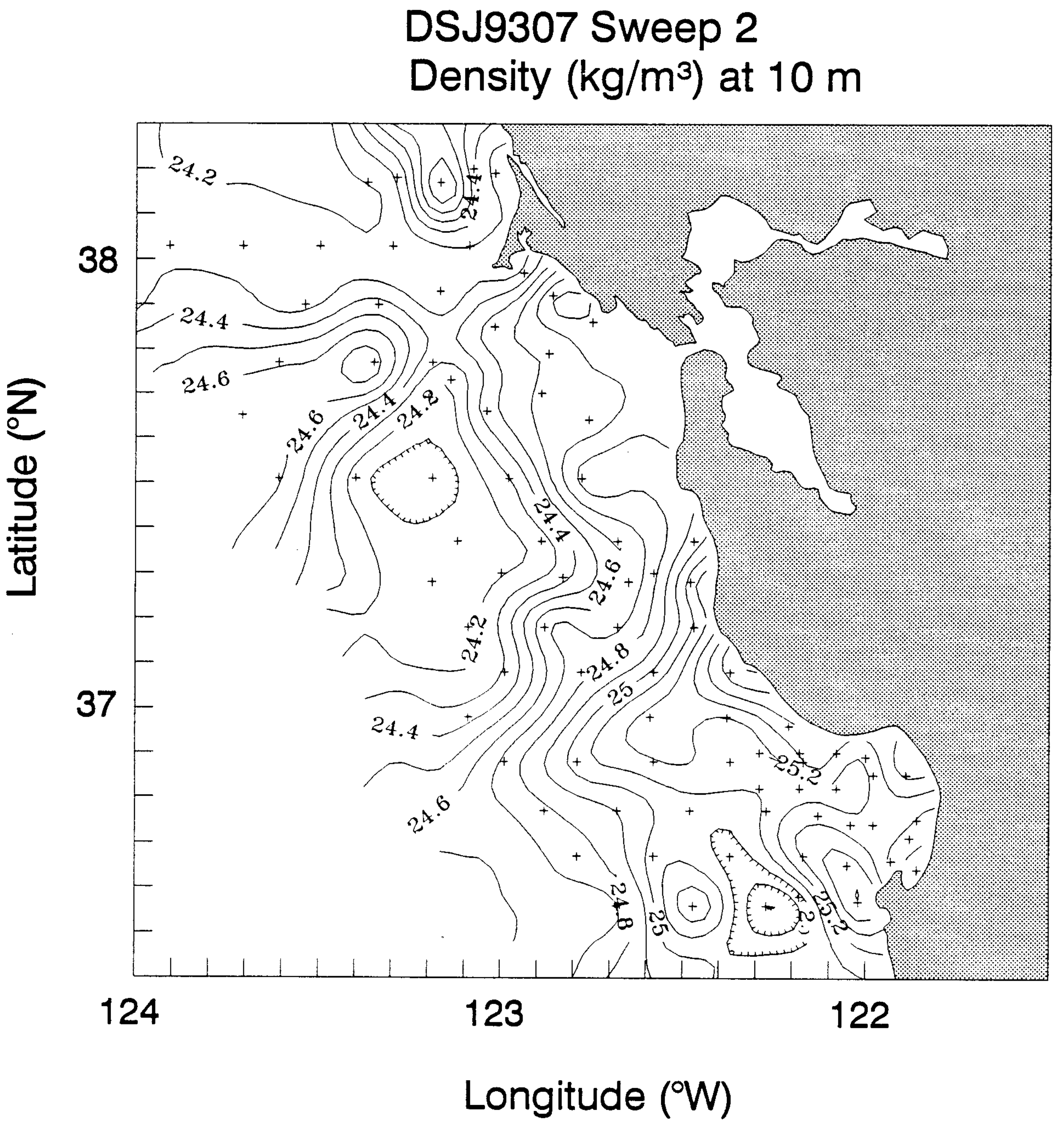
DSJ9307 Sweep 2
Salinity (ppt) at 300 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122
34.08
34.08
34.06
34.06
34.06
34.06
34.08
34.08
34.1

DSJ9307 Sweep 2
Salinity (ppt) at 500 m



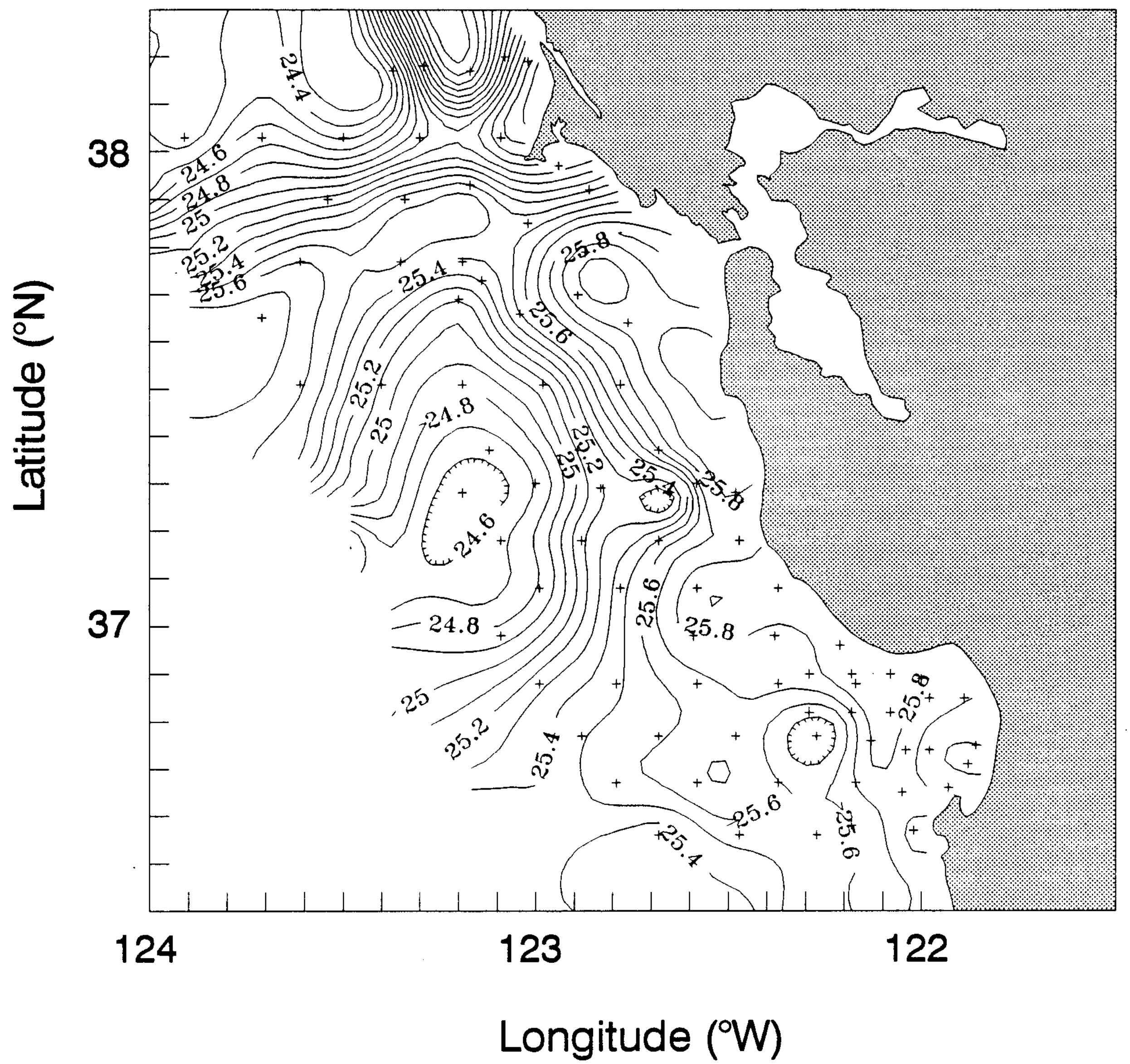
DSJ9307 Sweep 2
Density (kg/m³) at 2 m



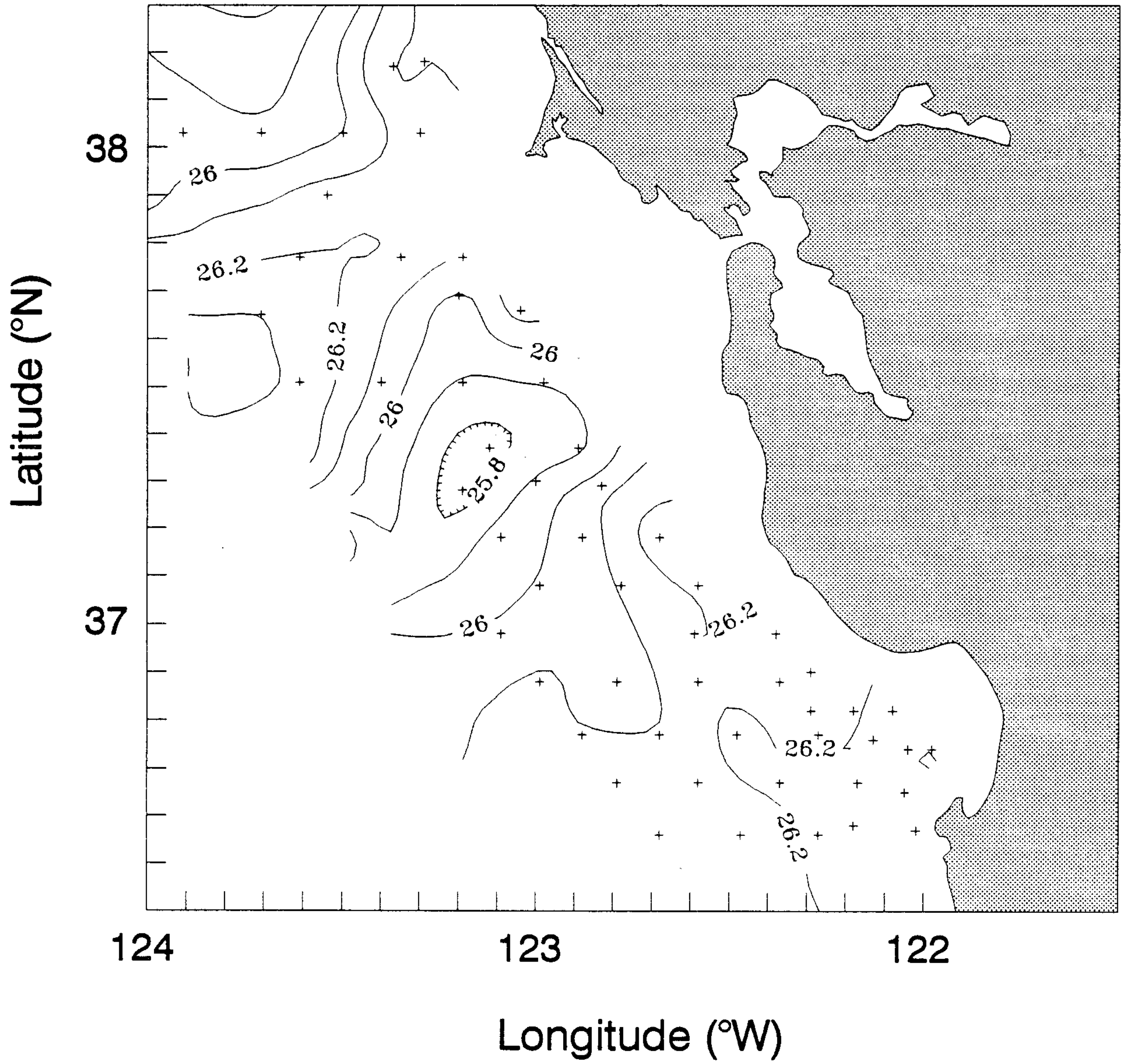


DSJ9307 Sweep 2
Density (kg/m³) at 10 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)
24.2
24.4
24.6
24.8
25
25.2

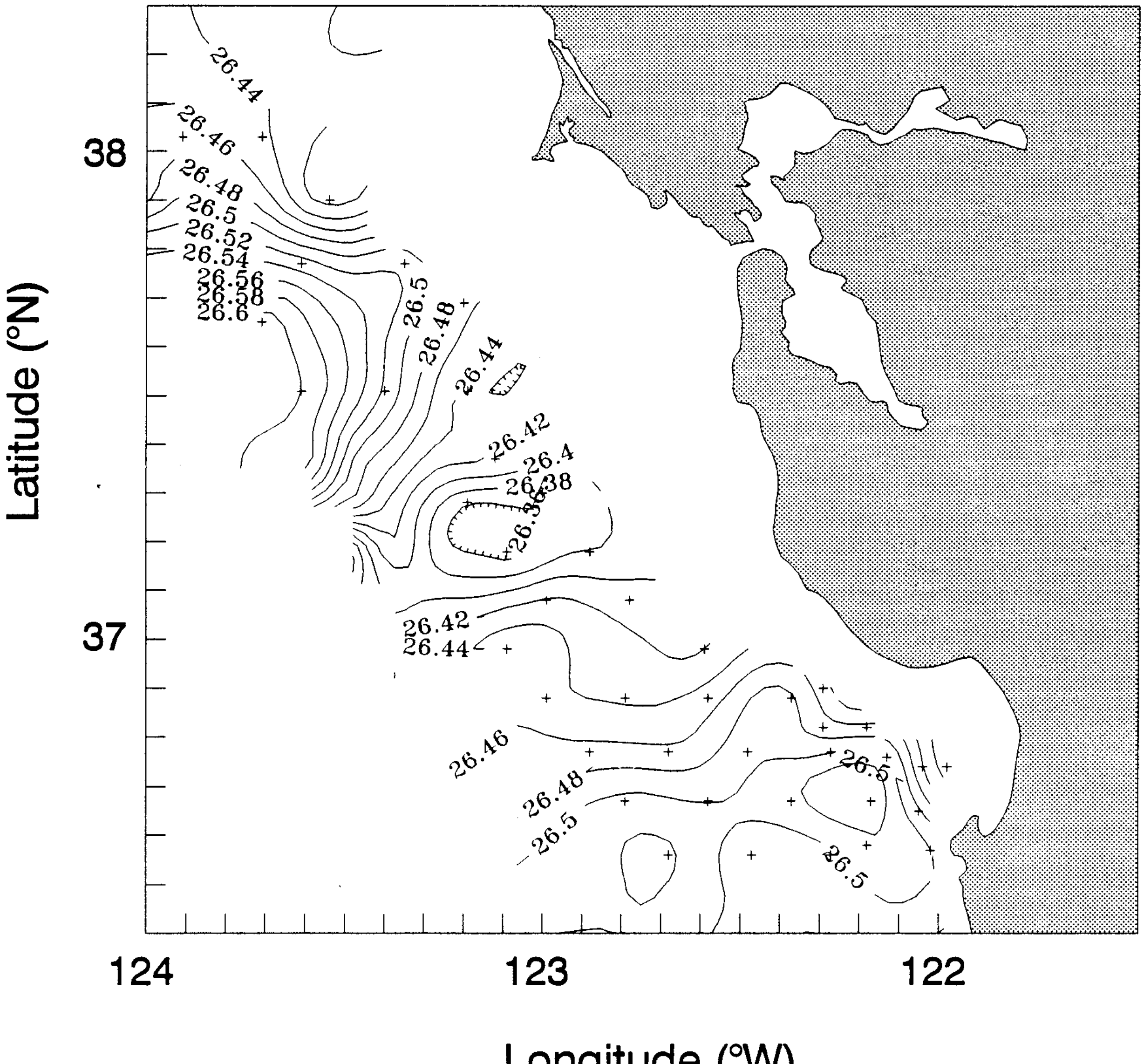
DSJ9307 Sweep 2
Density (kg/m³) at 30 m

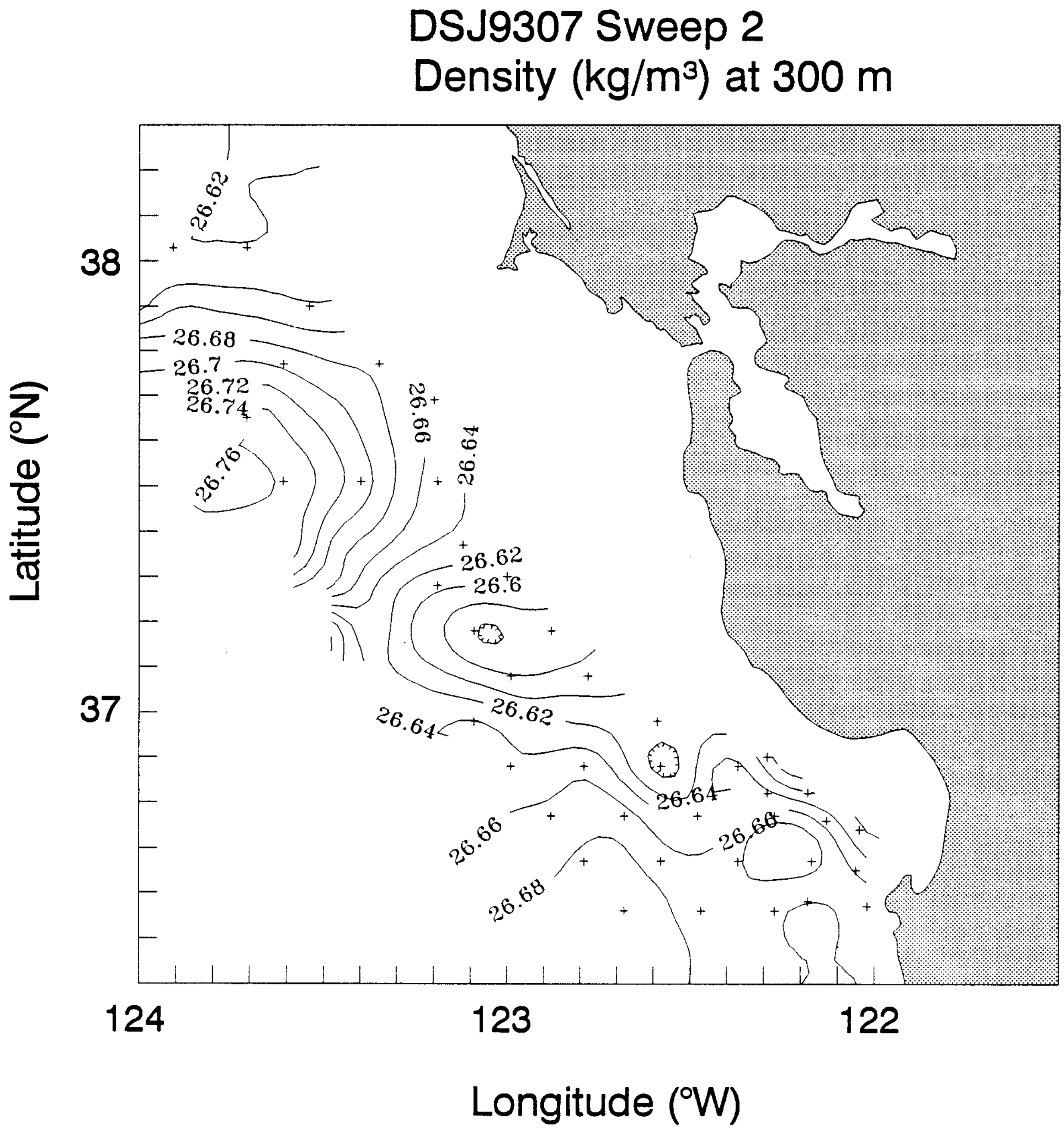


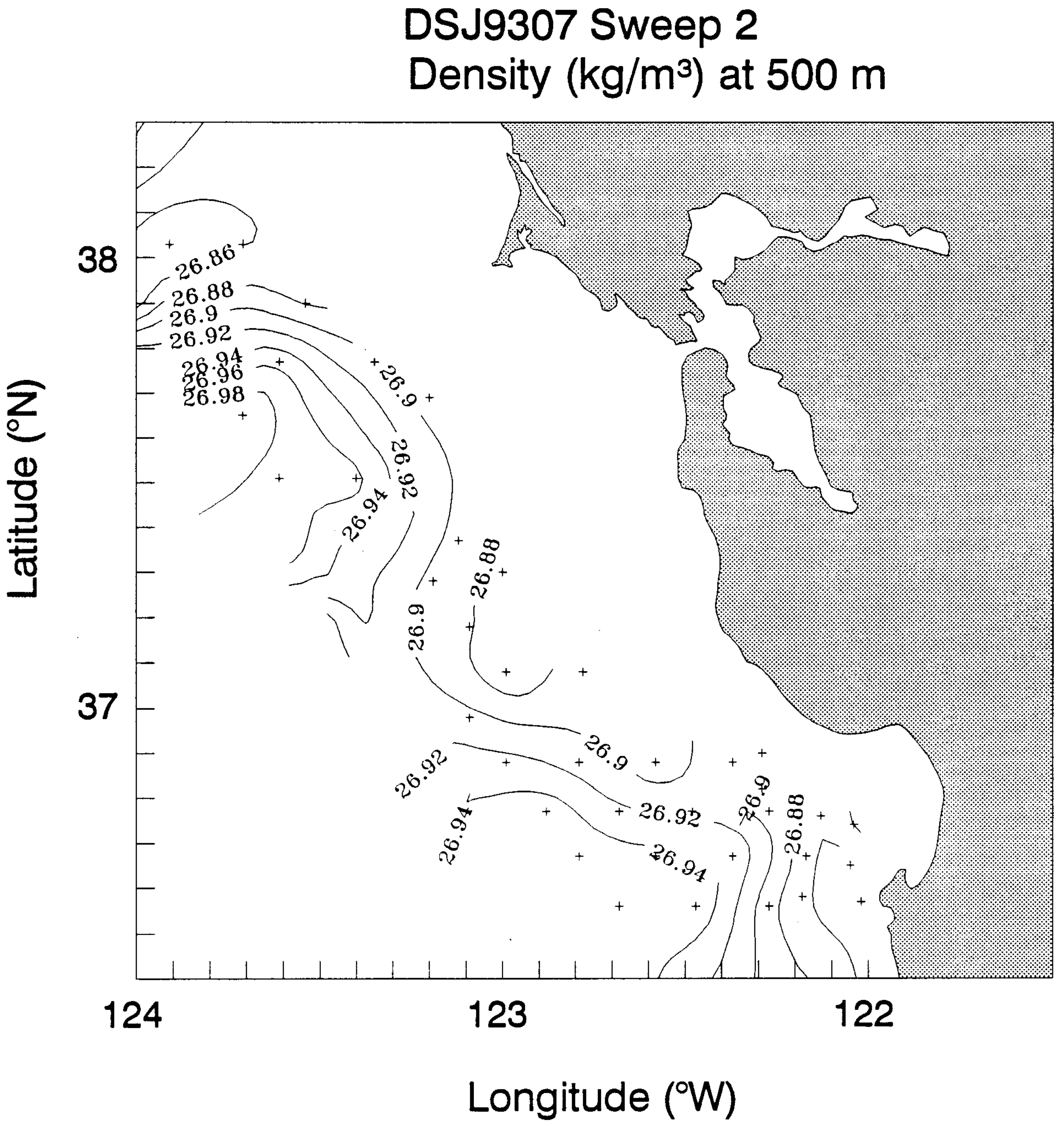
DSJ9307 Sweep 2
Density (kg/m^3) at 100 m



DSJ9307 Sweep 2
Density (kg/m³) at 200 m

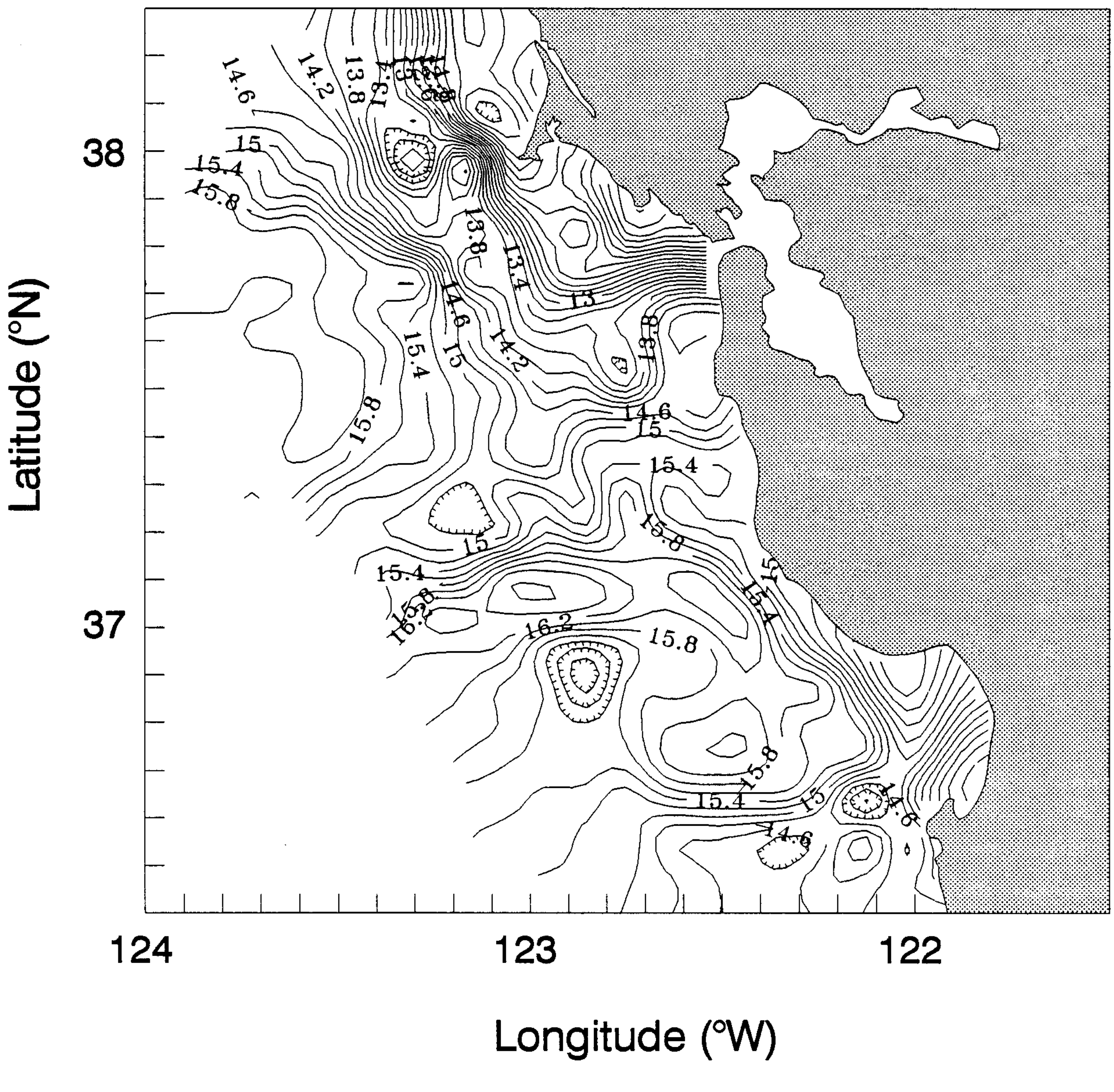


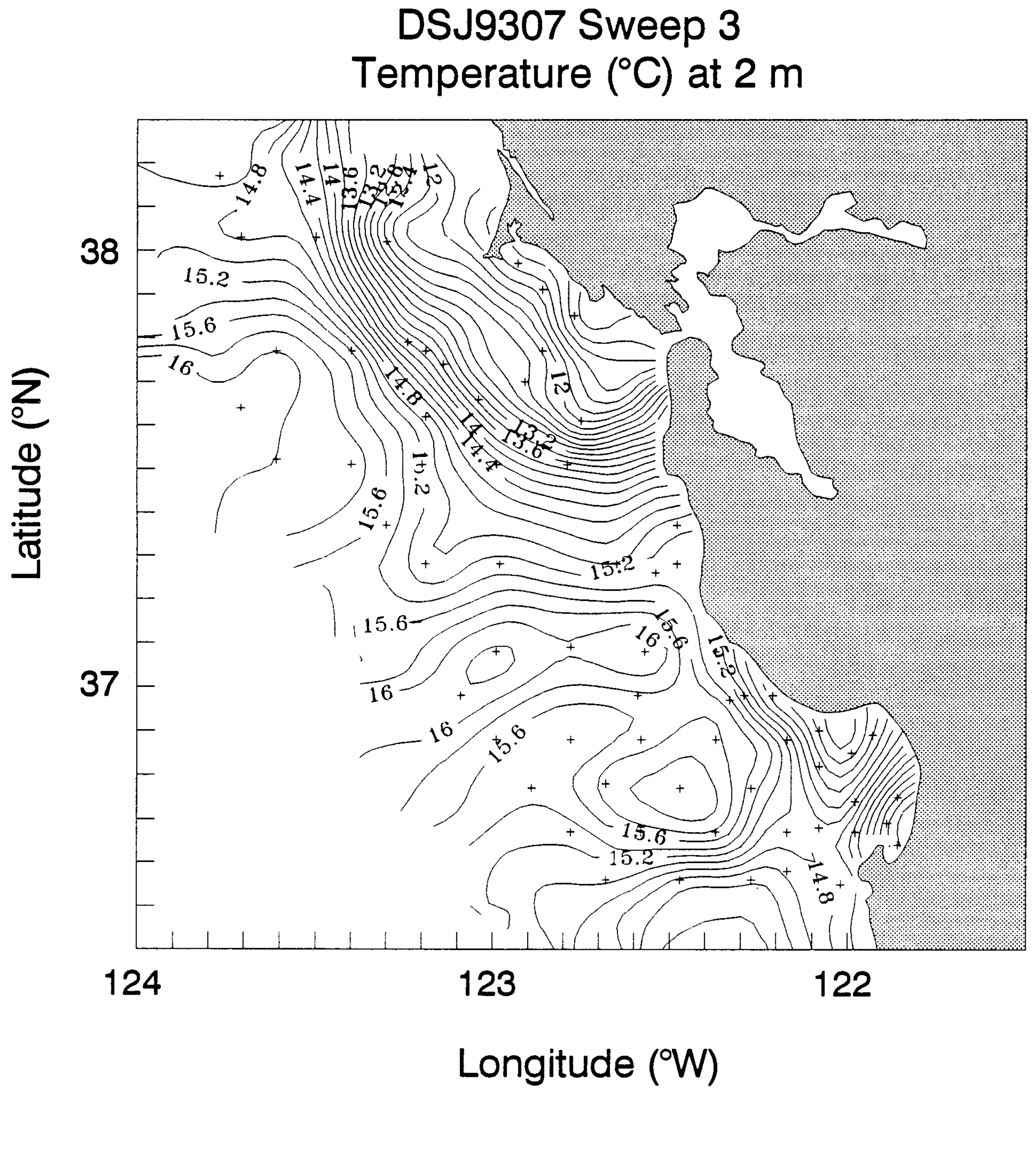

DSJ9307 Sweep 2
Density (kg/m³) at 300 m
26.62
26.68
26.7
26.72
26.74
26.76
26.66
26.64
26.62
26.6
26.62
26.64
26.64
26.66
26.66
26.68
38
37
124
123
122
Latitude (°N)
Longitude (°W)


DSJ9307 Sweep 2
Density (kg/m³) at 500 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)
26.86
26.88
26.9
26.92
26.94
26.96
26.98
26.9
26.92
26.94
26.88
26.9
26.9
26.92
26.94
26.92
26.94
26.9
26.88

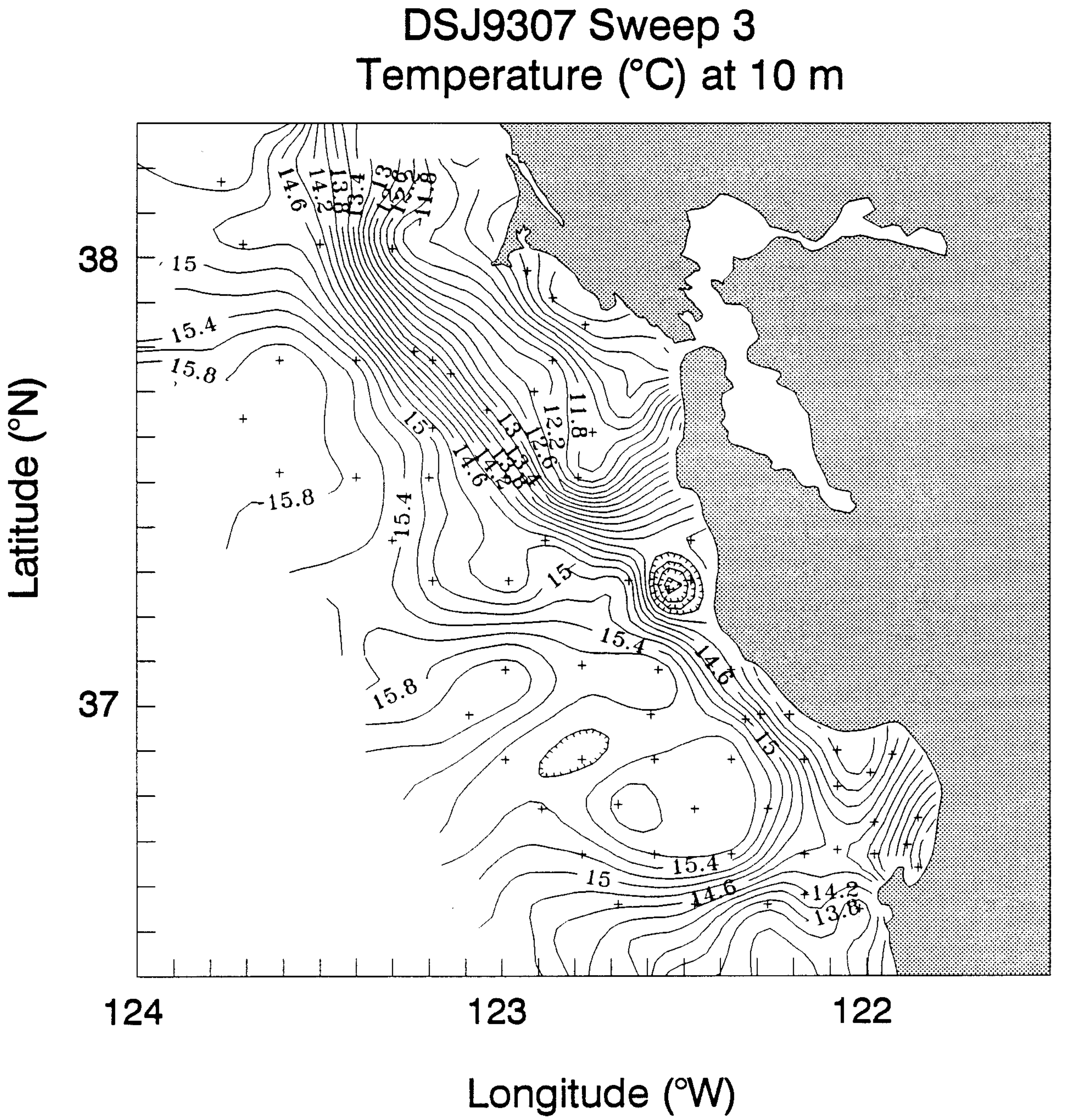
APPENDIX 6.4: HORIZONTAL MAPS OF CTD AND TS FOR DSJ9307, SWEEP 3

DSJ9307 Sweep 3
TS Temperature (°C)

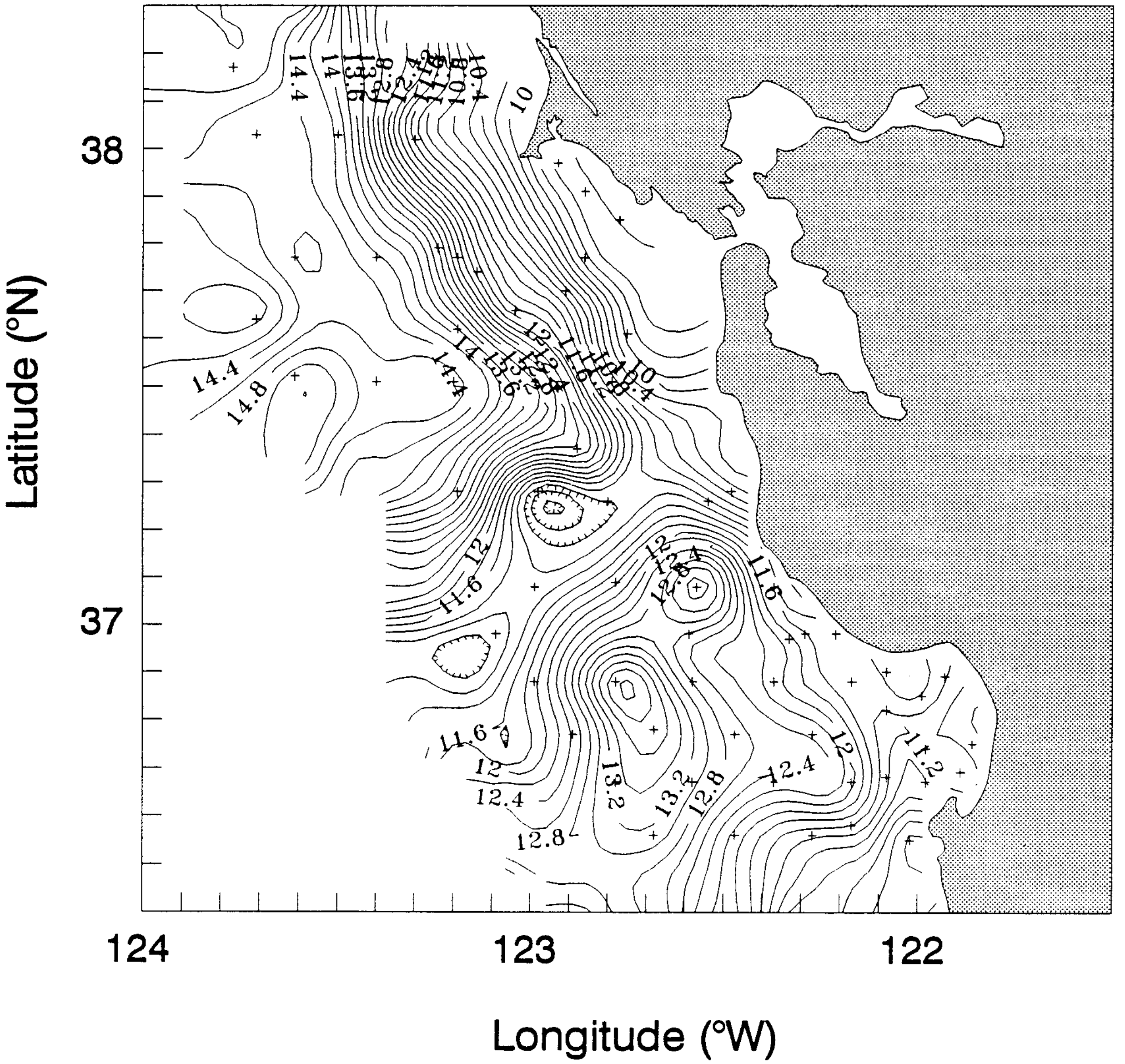




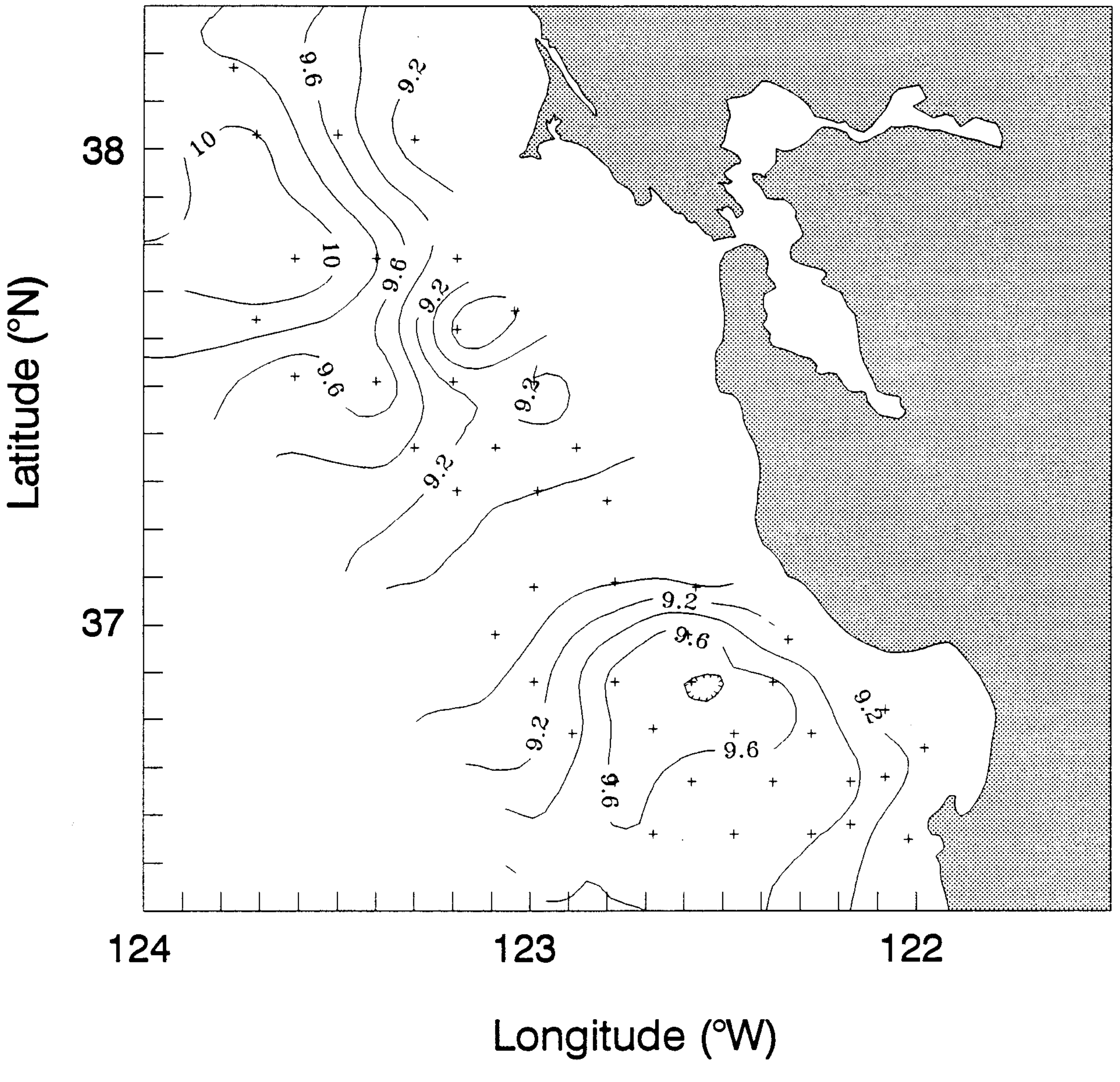
DSJ9307 Sweep 3
Temperature (°C) at 2 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122

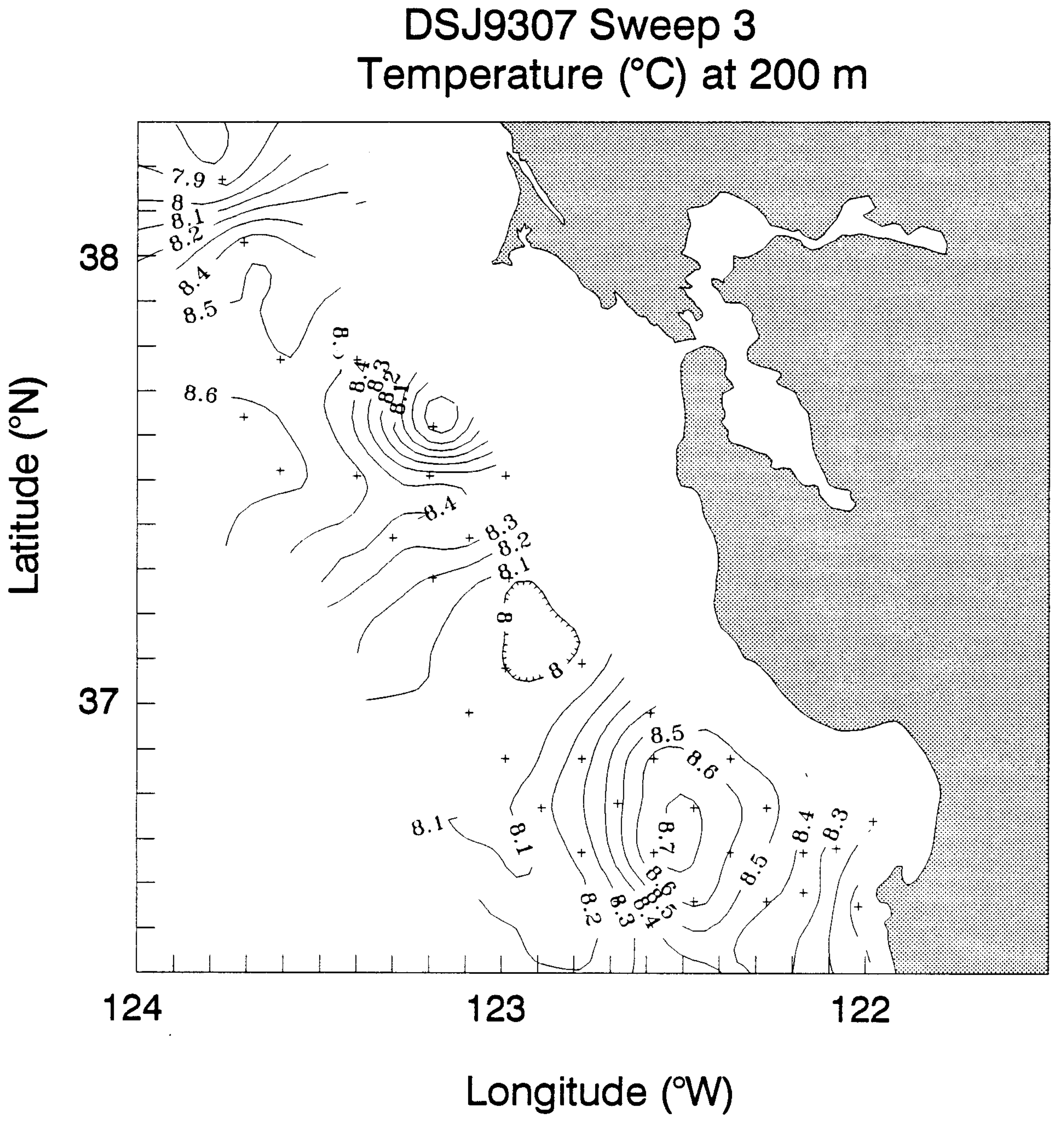

DSJ9307 Sweep 3
Temperature (°C) at 10 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)
15
15.4
15.8
14.6
14.2
13.8
12.2
11.8
12.6
15.4
15
14.6
14.2
13.8

DSJ9307 Sweep 3
Temperature (°C) at 30 m

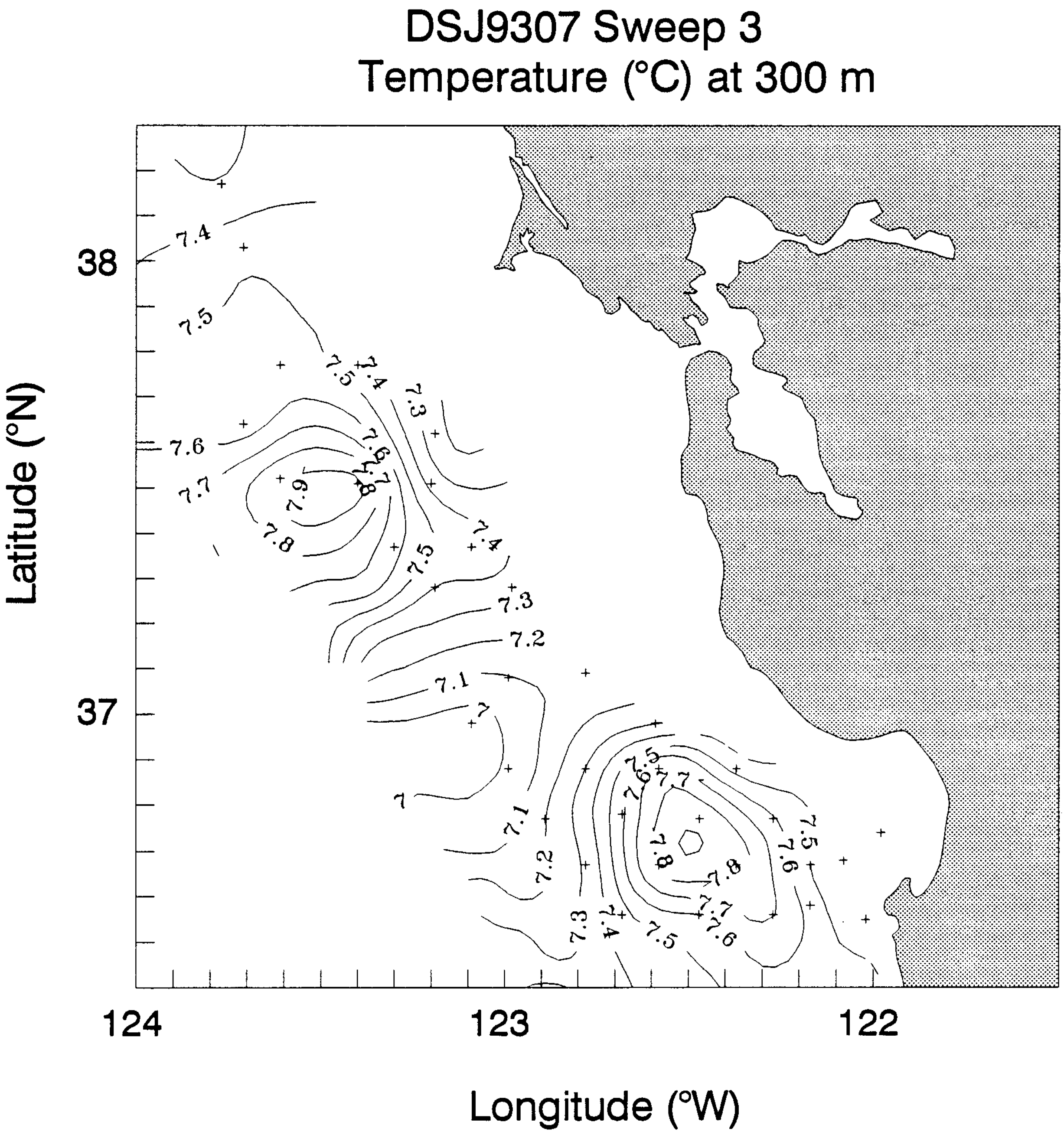


DSJ9307 Sweep 3
Temperature (°C) at 100 m

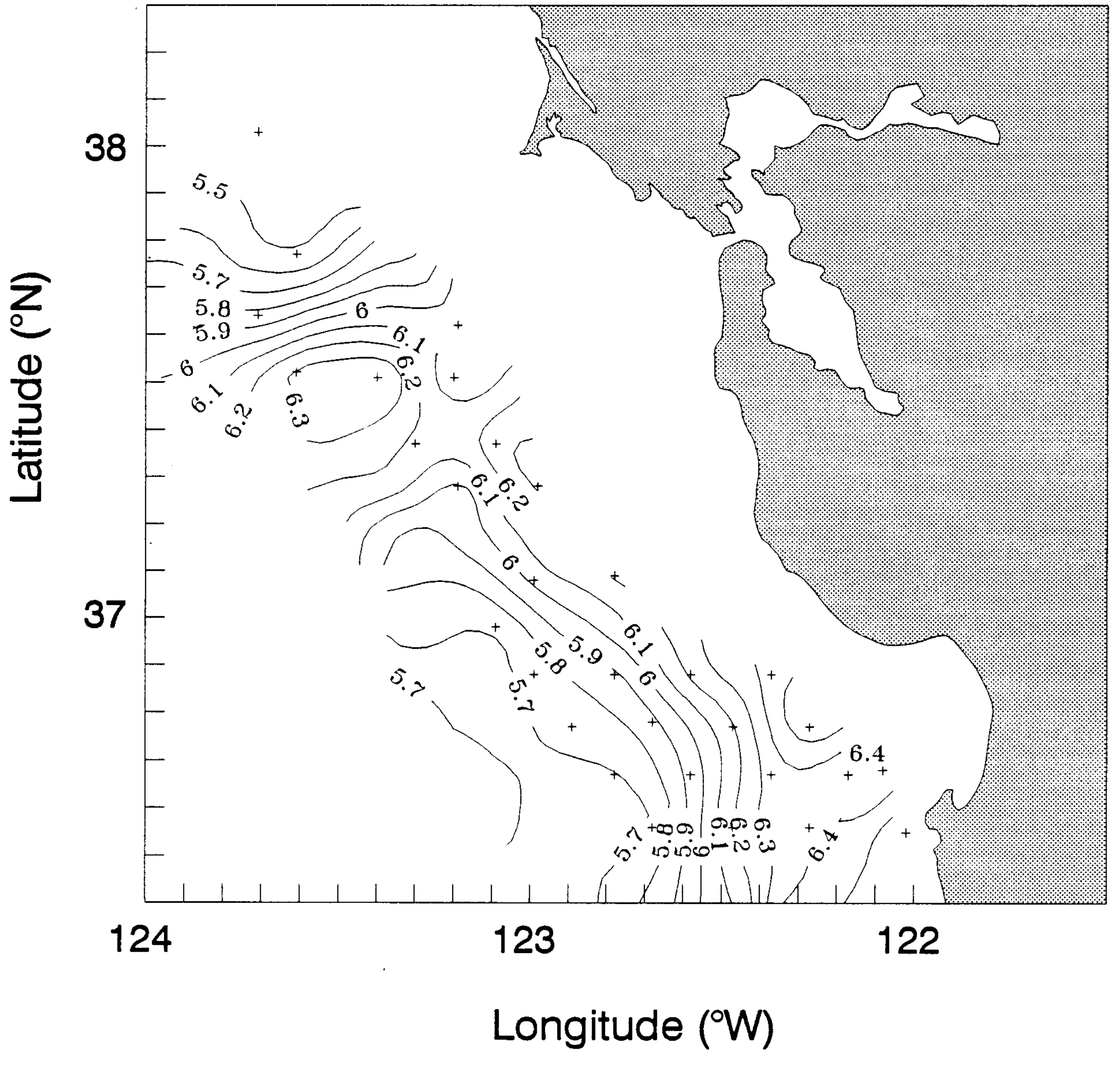


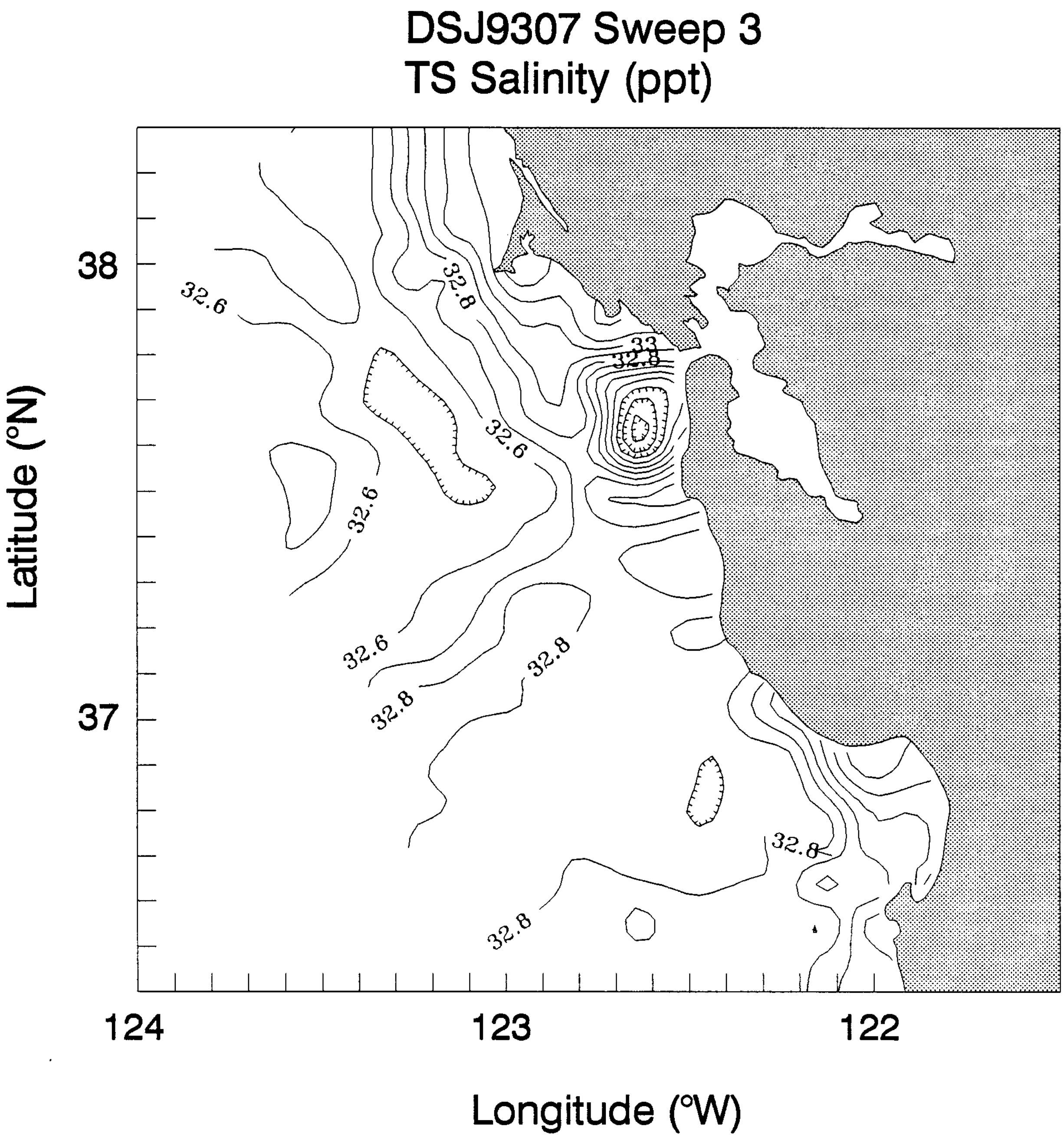


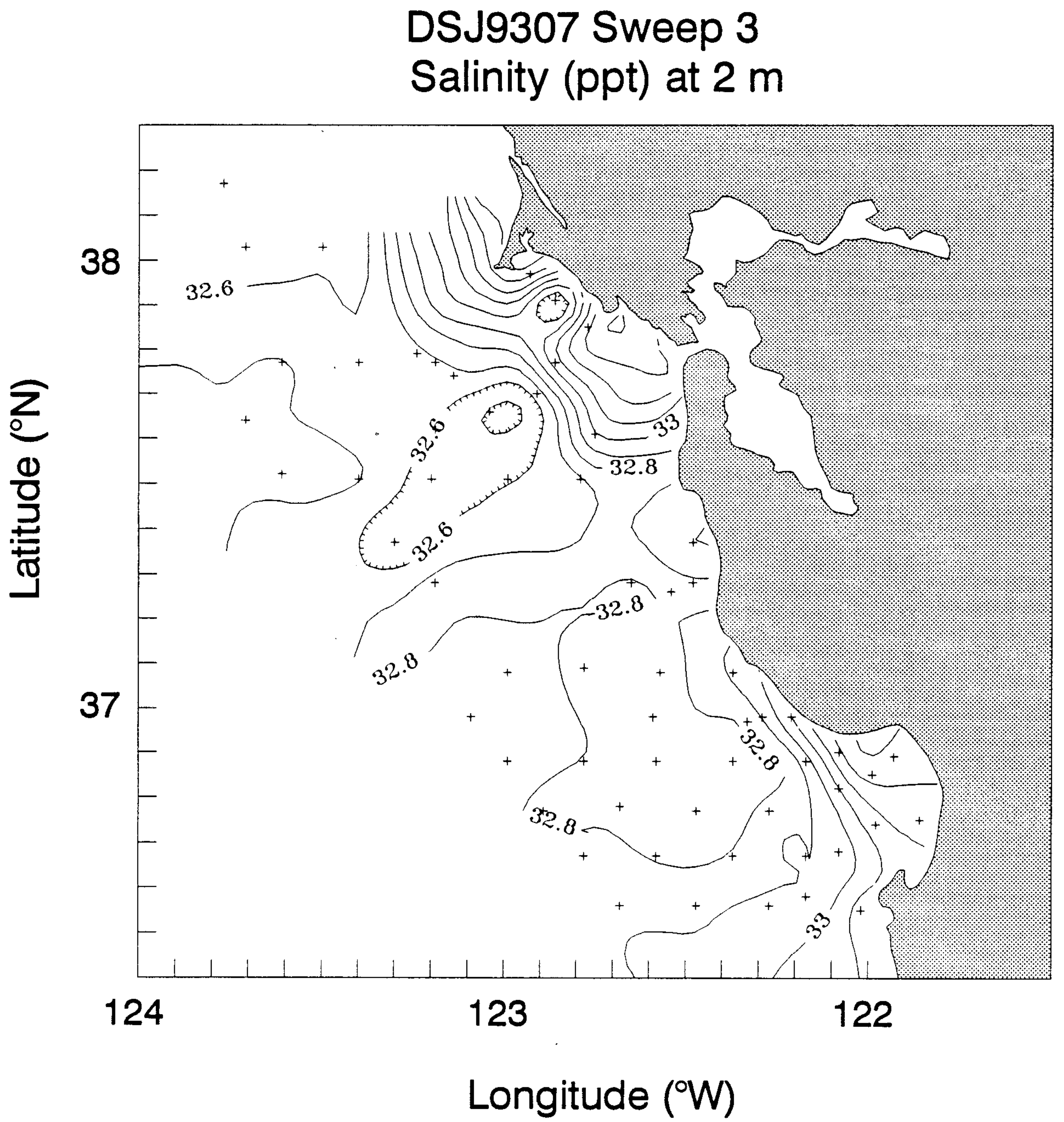
DSJ9307 Sweep 3
Temperature (°C) at 200 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122
7.9
8
8.1
8.2
8.4
8.5
8.6
8.3
8.7

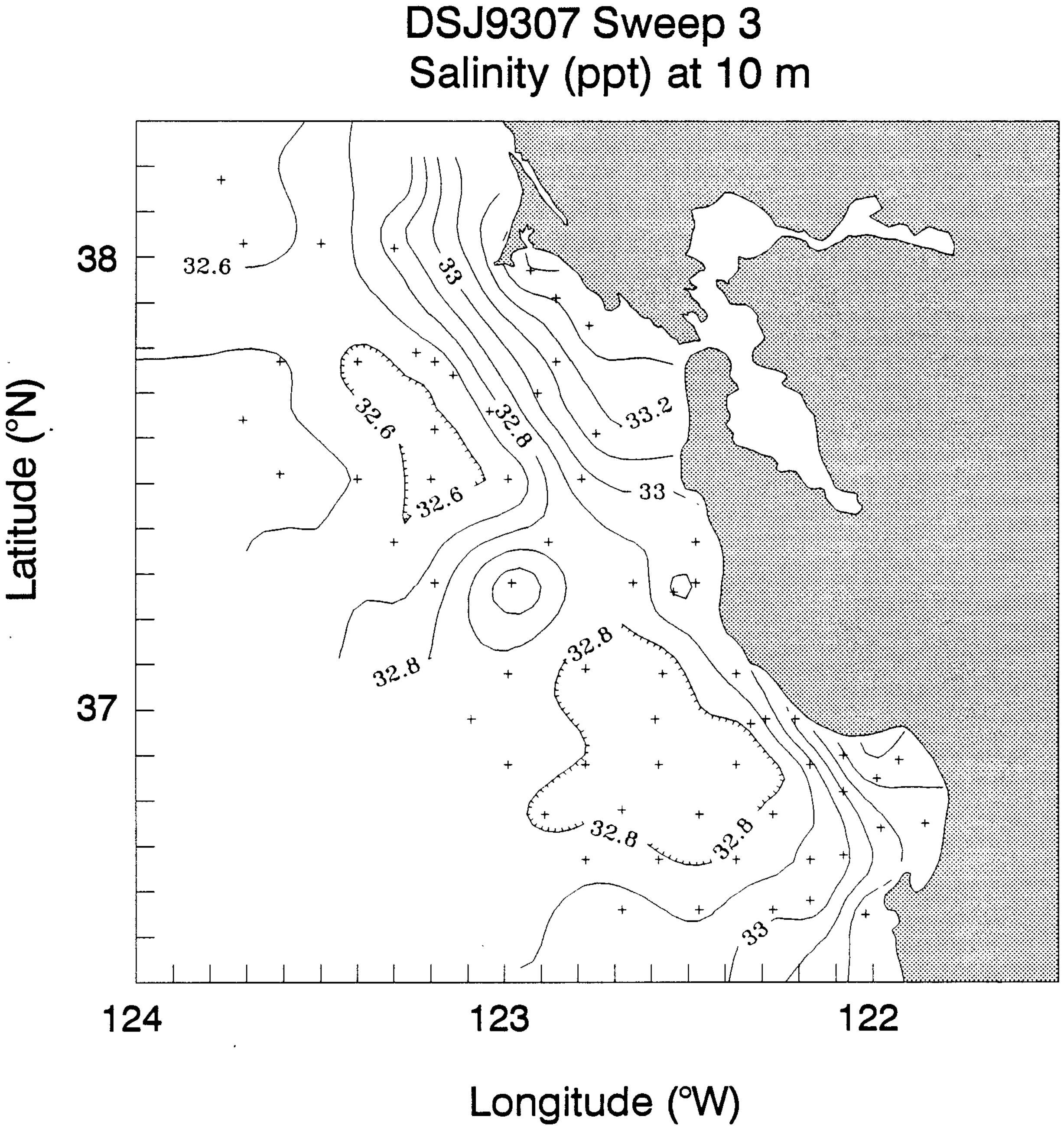

DSJ9307 Sweep 3
Temperature (°C) at 300 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)

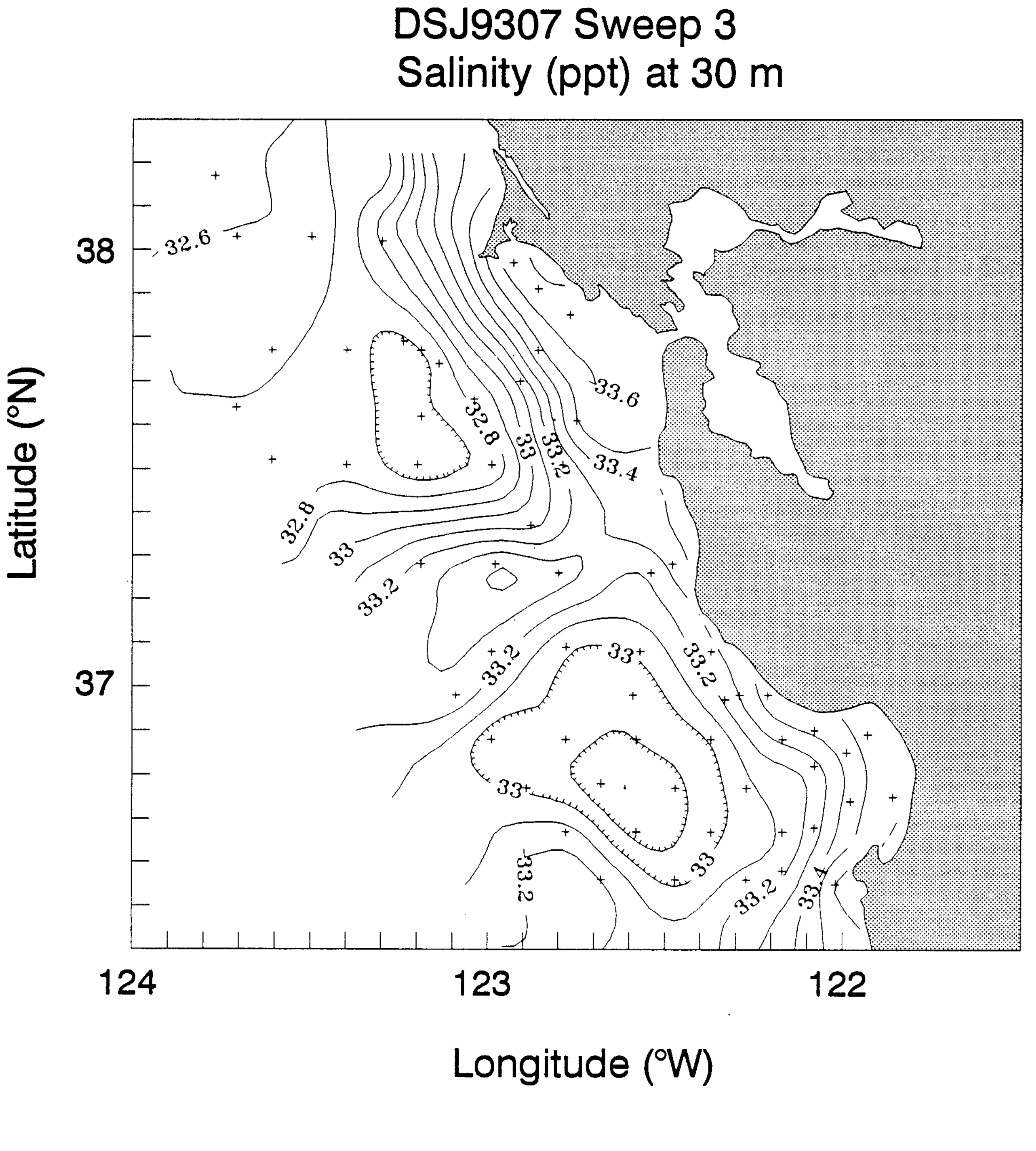
DSJ9307 Sweep 3
Temperature (°C) at 500 m




DSJ9307 Sweep 3
TS Salinity (ppt)
Latitude (°N)
38
37
Longitude (°W)
124
123
122
32.6
32.8
33
32.6
32.6
32.6
32.8
32.8
32.8
32.8

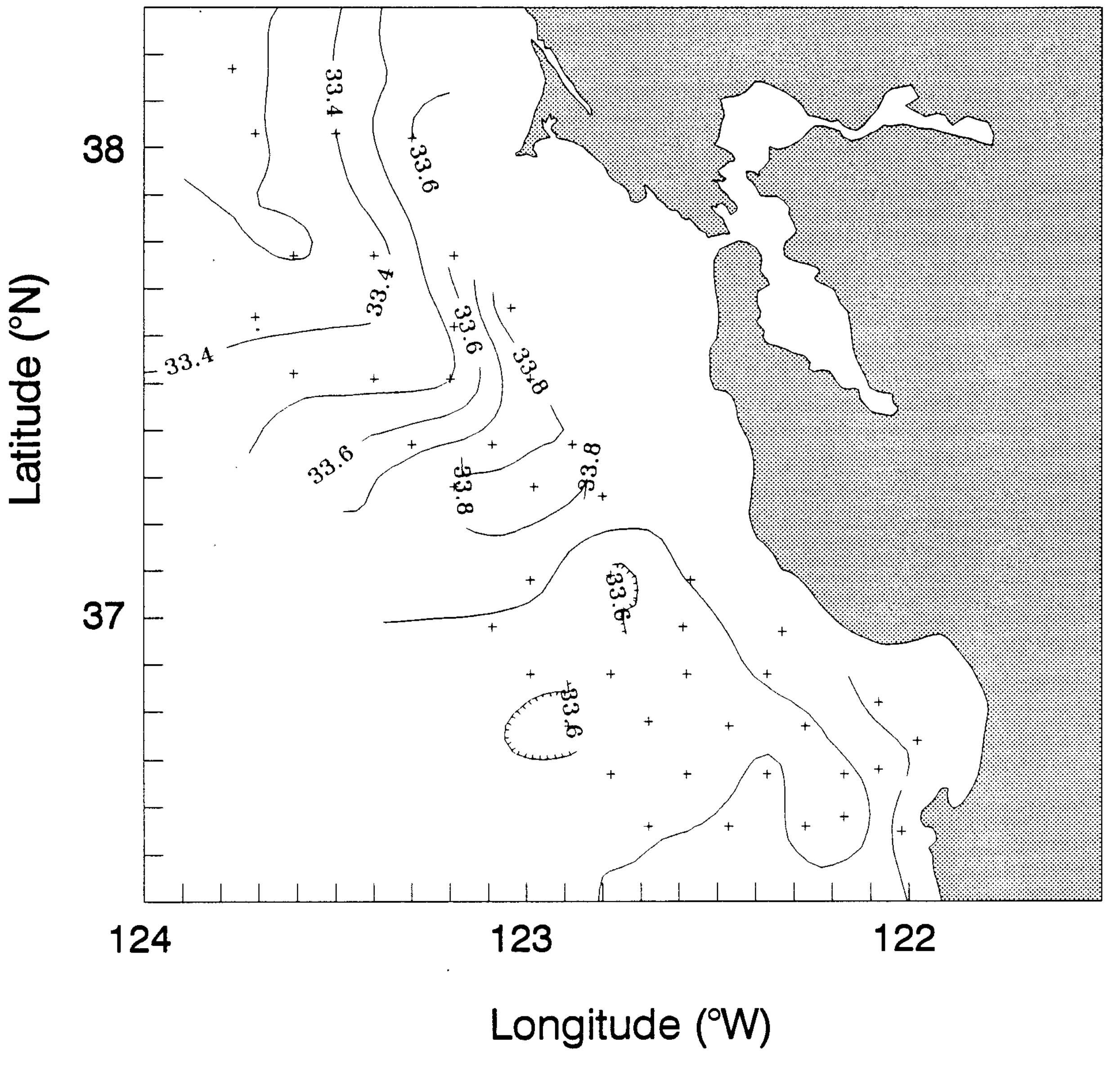

DSJ9307 Sweep 3
Salinity (ppt) at 2 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)
32.6
32.6
32.6
33
32.8
32.8
32.8
32.8
32.8
33


DSJ9307 Sweep 3
Salinity (ppt) at 10 m
38
37
124
123
122
Latitude (°N)
Longitude (°W)
32.6
33
33.2
32.8

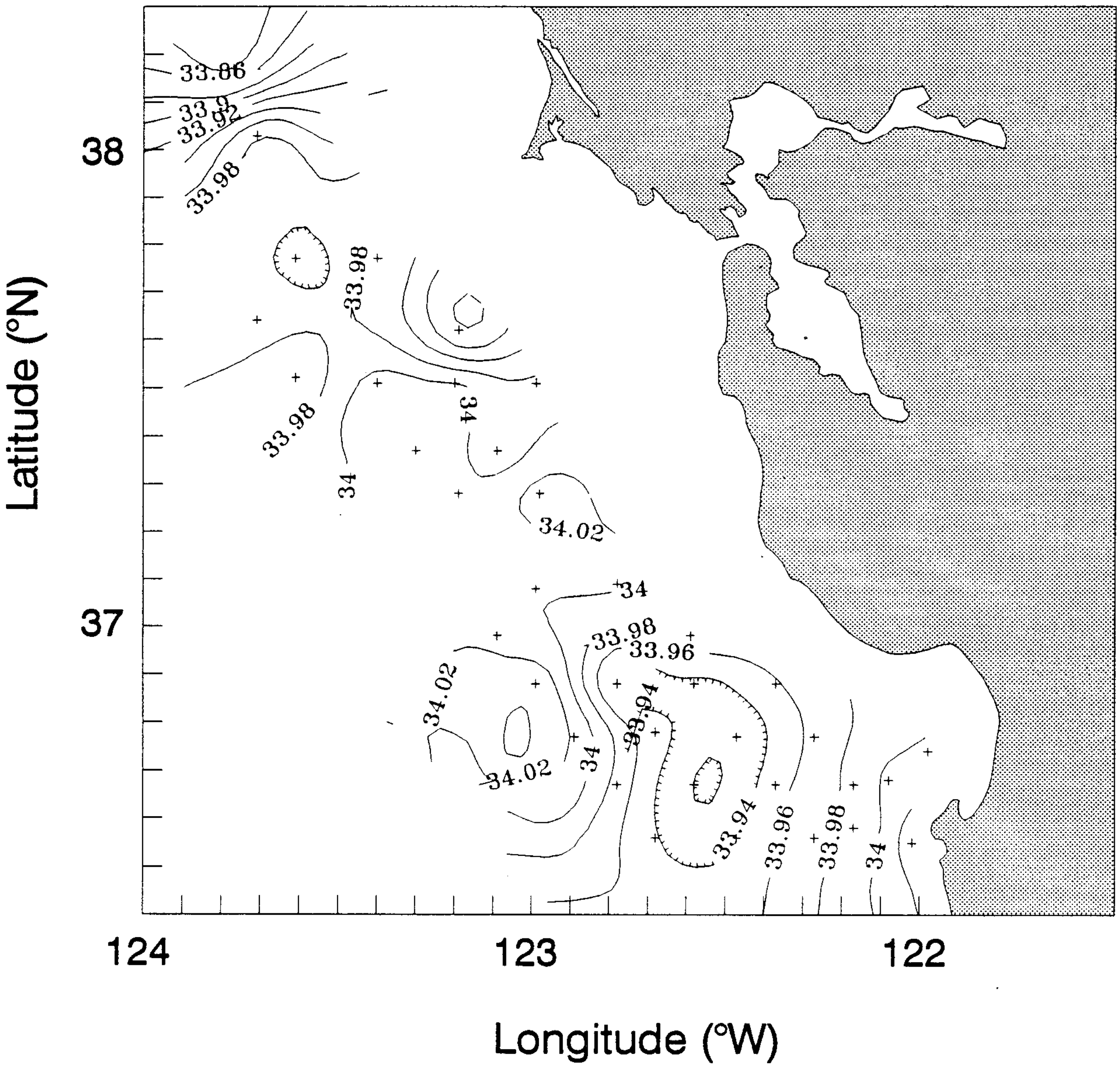


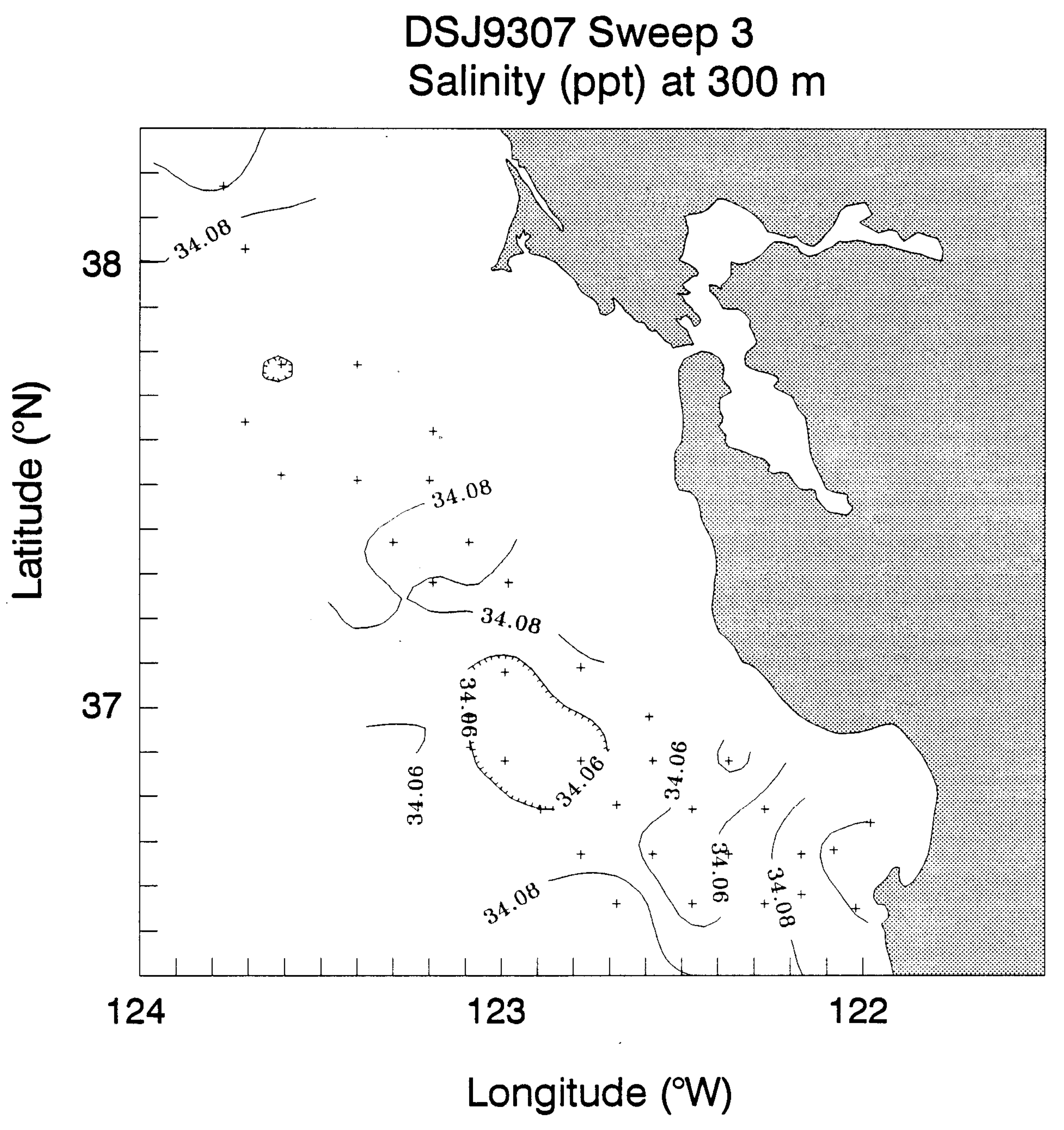
DSJ9307 Sweep 3
Salinity (ppt) at 30 m
32.6
32.8
33
33.2
33.4
33.6
38
37
Latitude (°N)
124
123
122
Longitude (°W)

DSJ9307 Sweep 3
Salinity (ppt) at 100 m



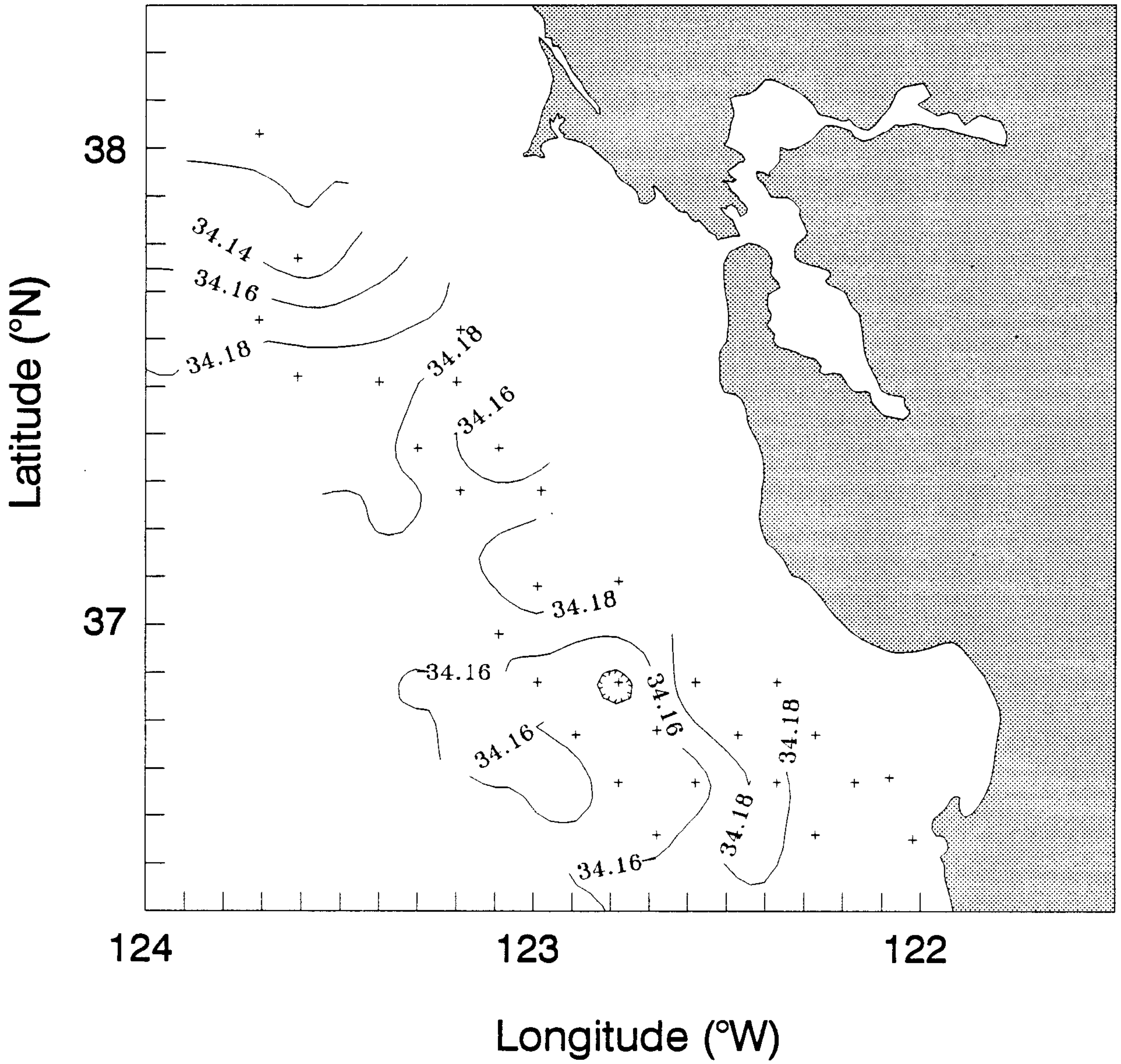
DSJ9307 Sweep 3
Salinity (ppt) at 200 m

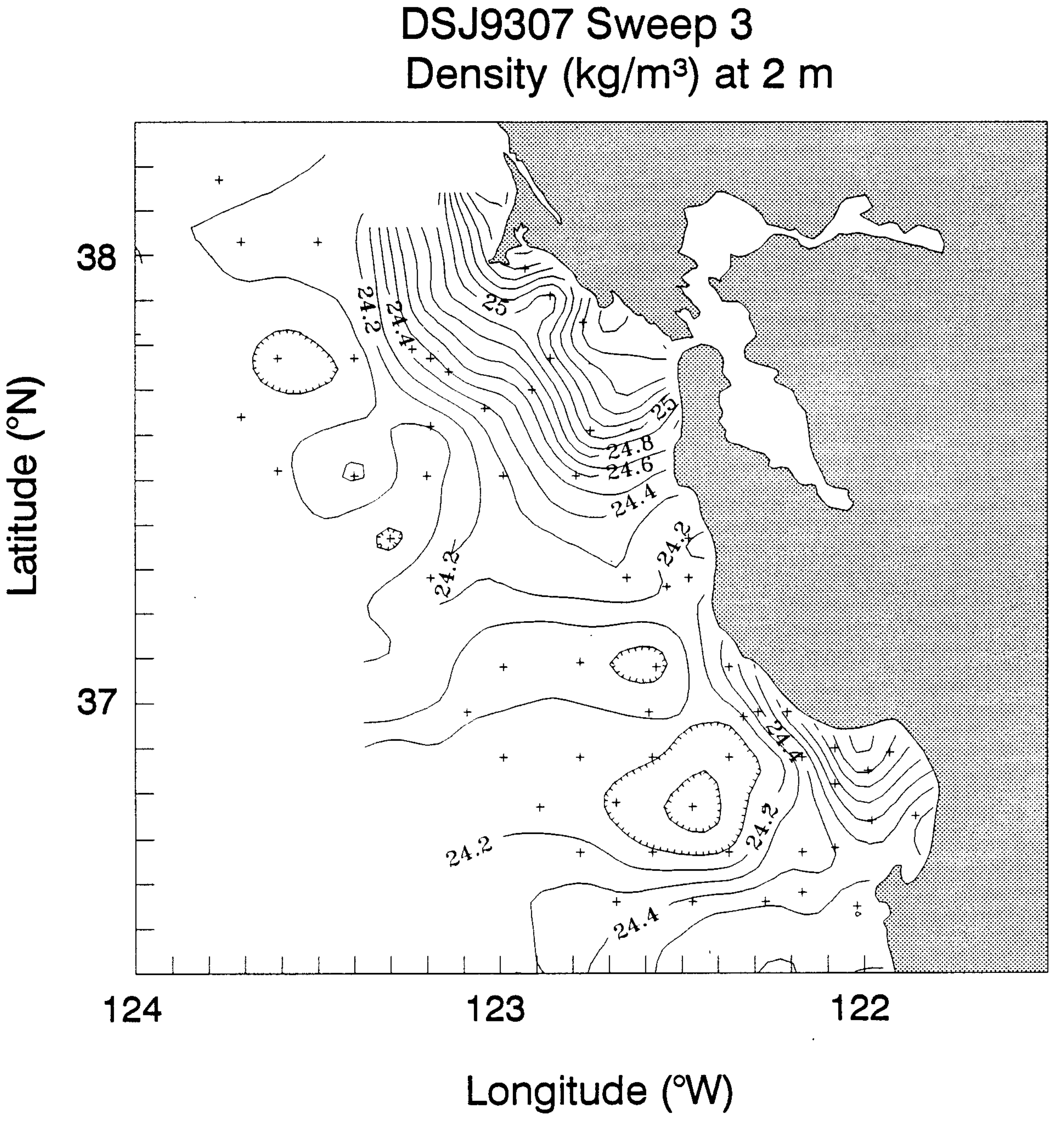




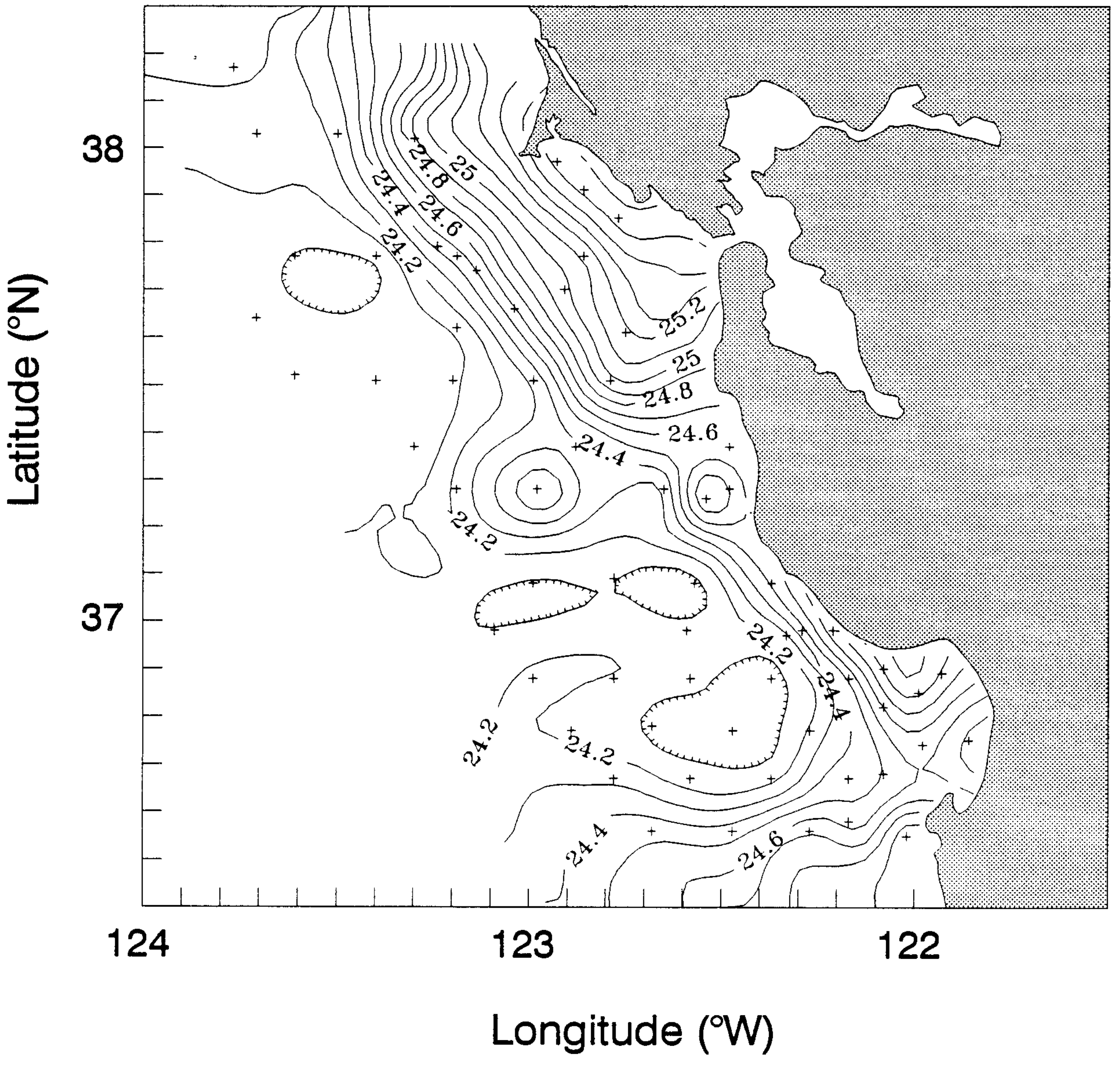
DSJ9307 Sweep 3
Salinity (ppt) at 300 m
Latitude (°N)
38
37
Longitude (°W)
124
123
122
34.08
34.08
34.08
34.08
34.06
34.06
34.06
34.06
34.06
34.08

DSJ9307 Sweep 3
Salinity (ppt) at 500 m

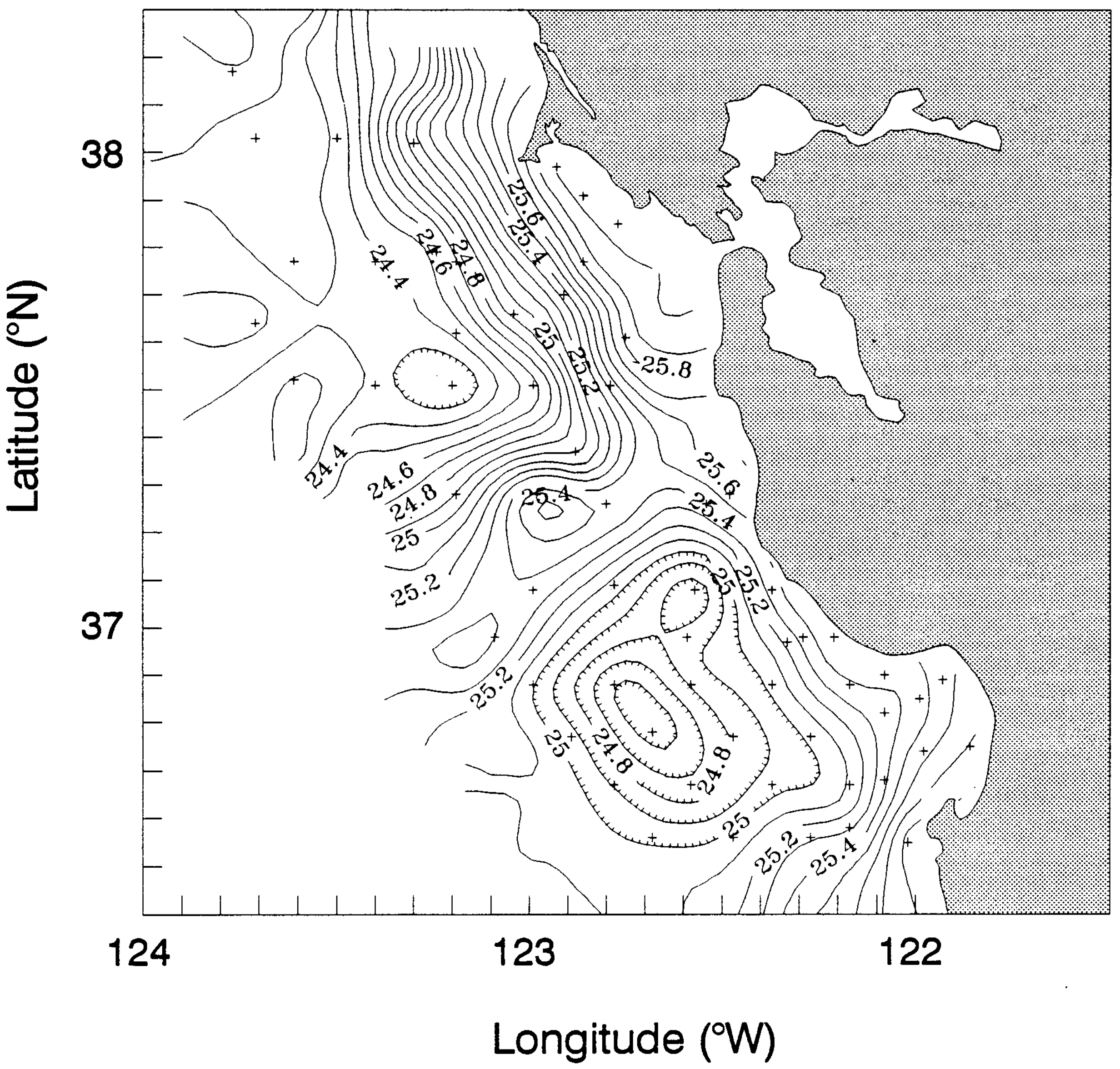



DSJ9307 Sweep 3
Density (kg/m³) at 2 m
Latitude (°N)
38
37
Longitude (°W)
124
123
122
25
24.8
24.6
24.4
24.2

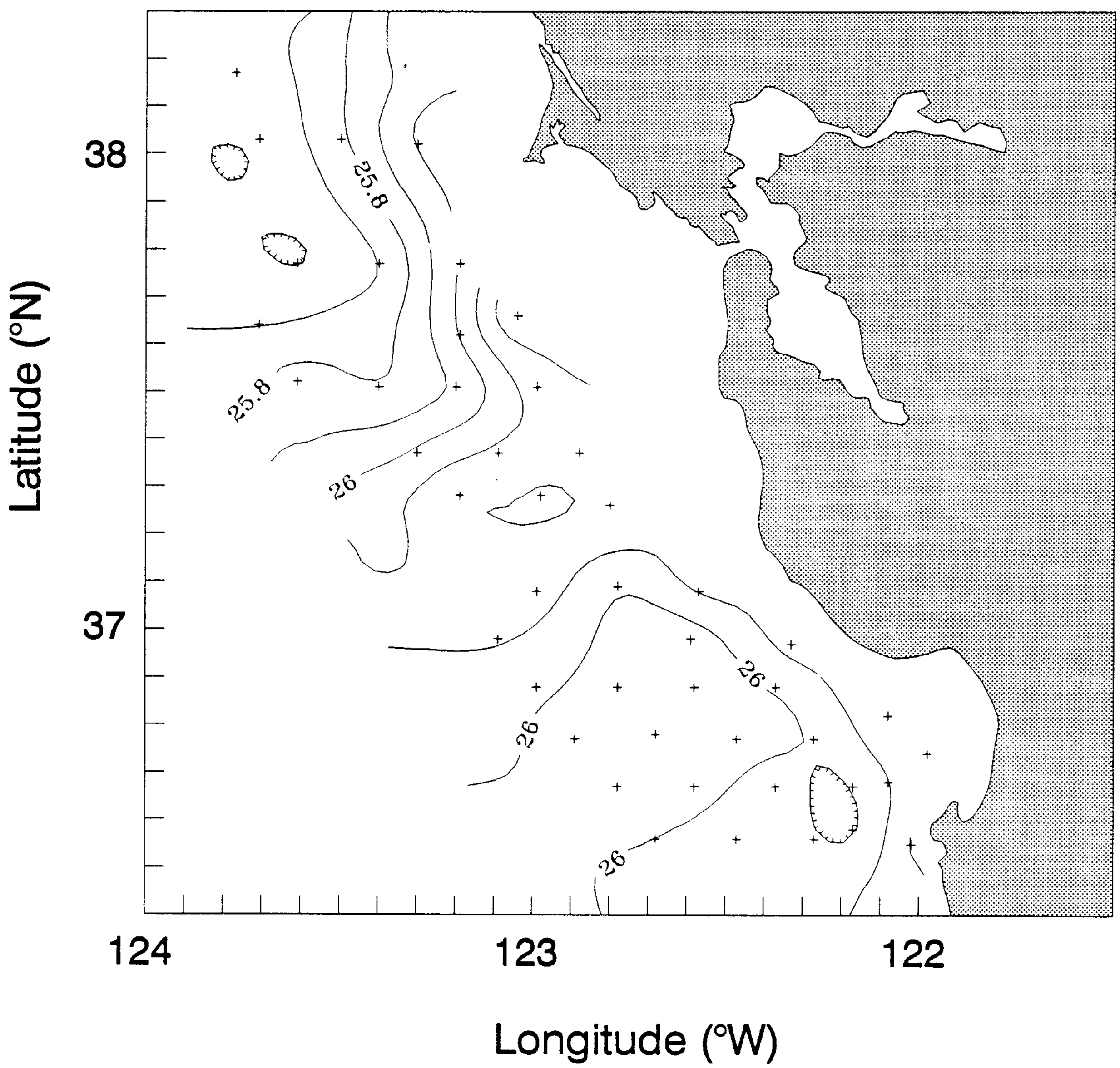
DSJ9307 Sweep 3
Density (kg/m³) at 10 m

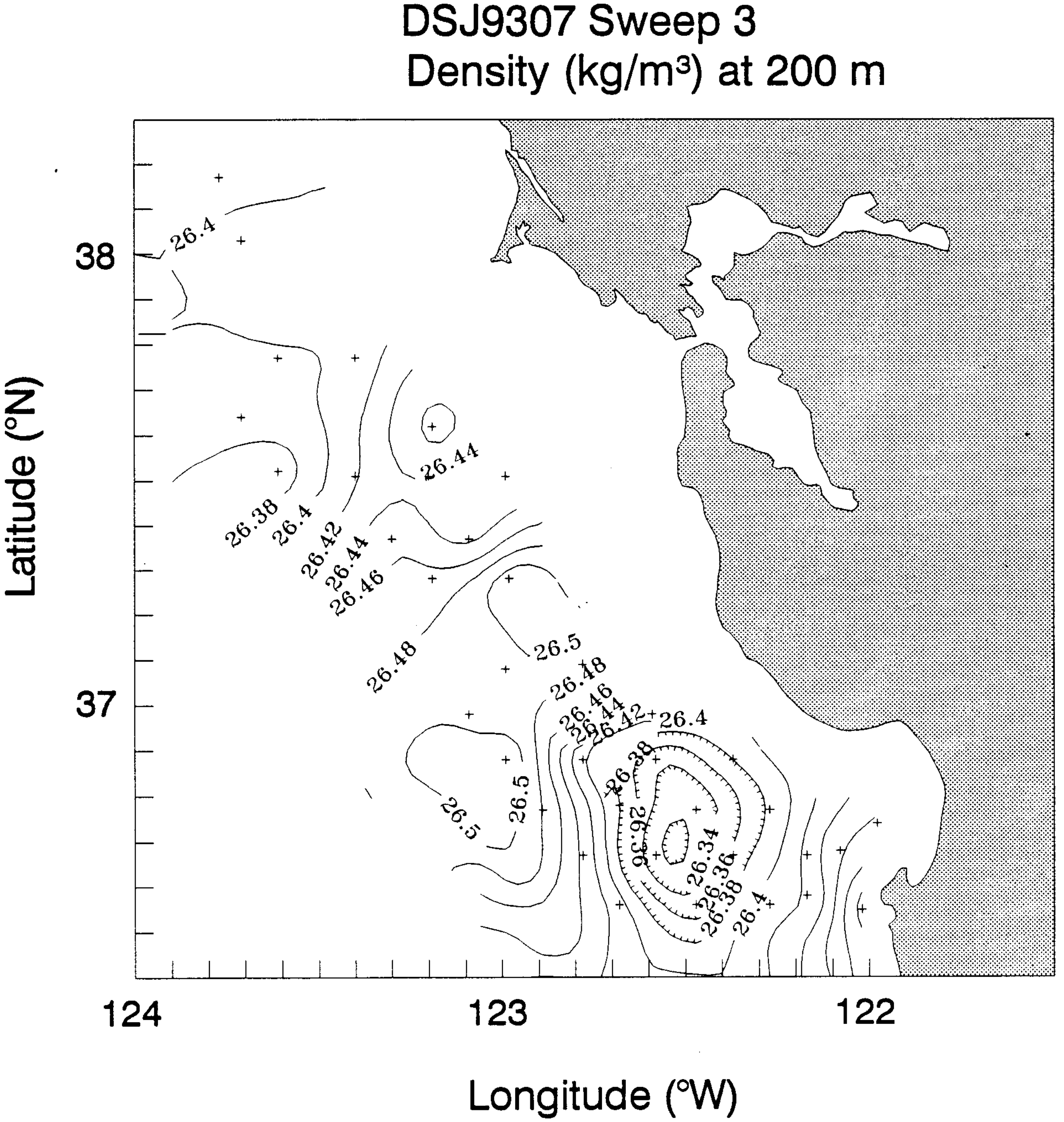


DSJ9307 Sweep 3
Density (kg/m³) at 30 m

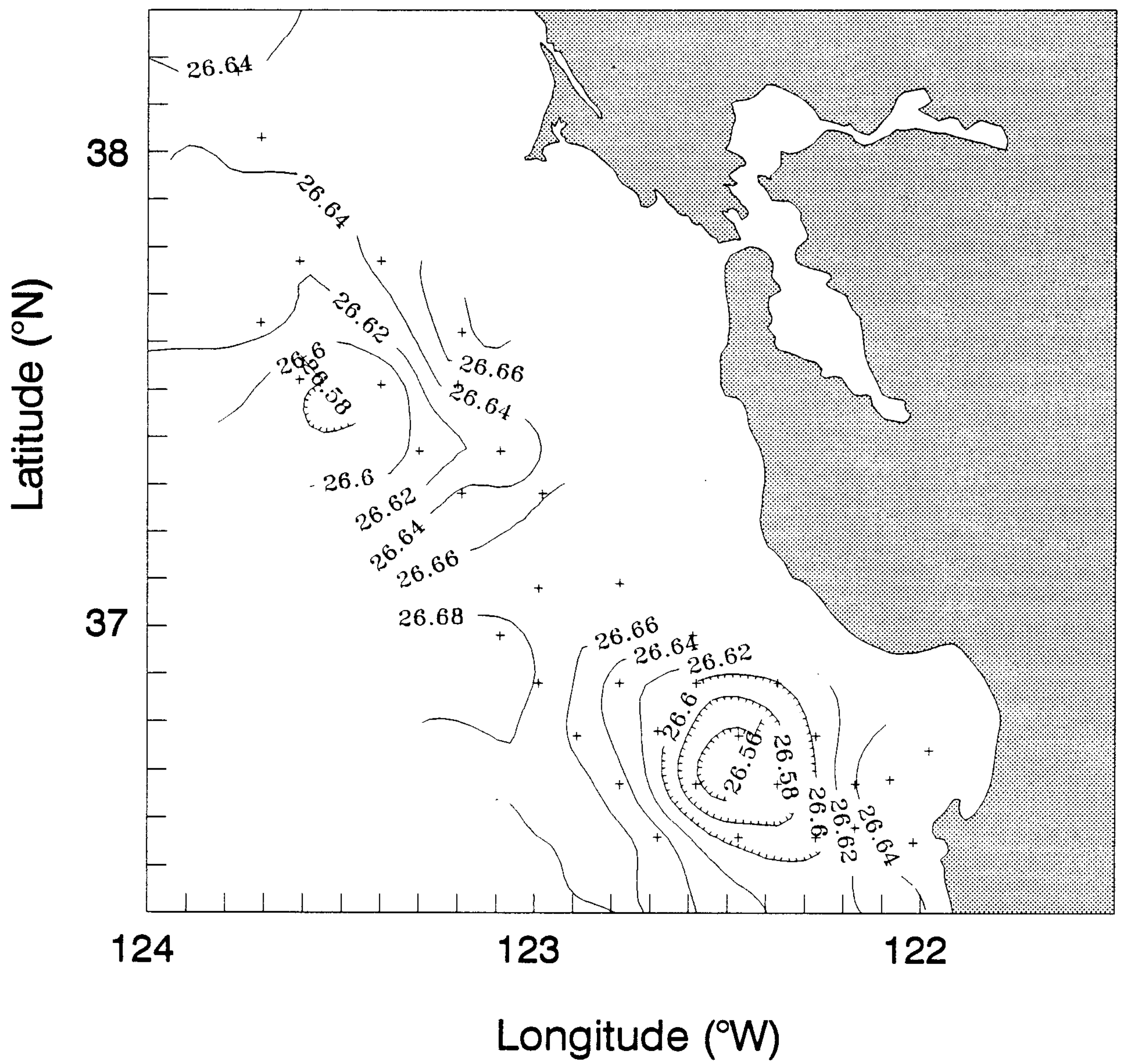


DSJ9307 Sweep 3
Density (kg/m³) at 100 m

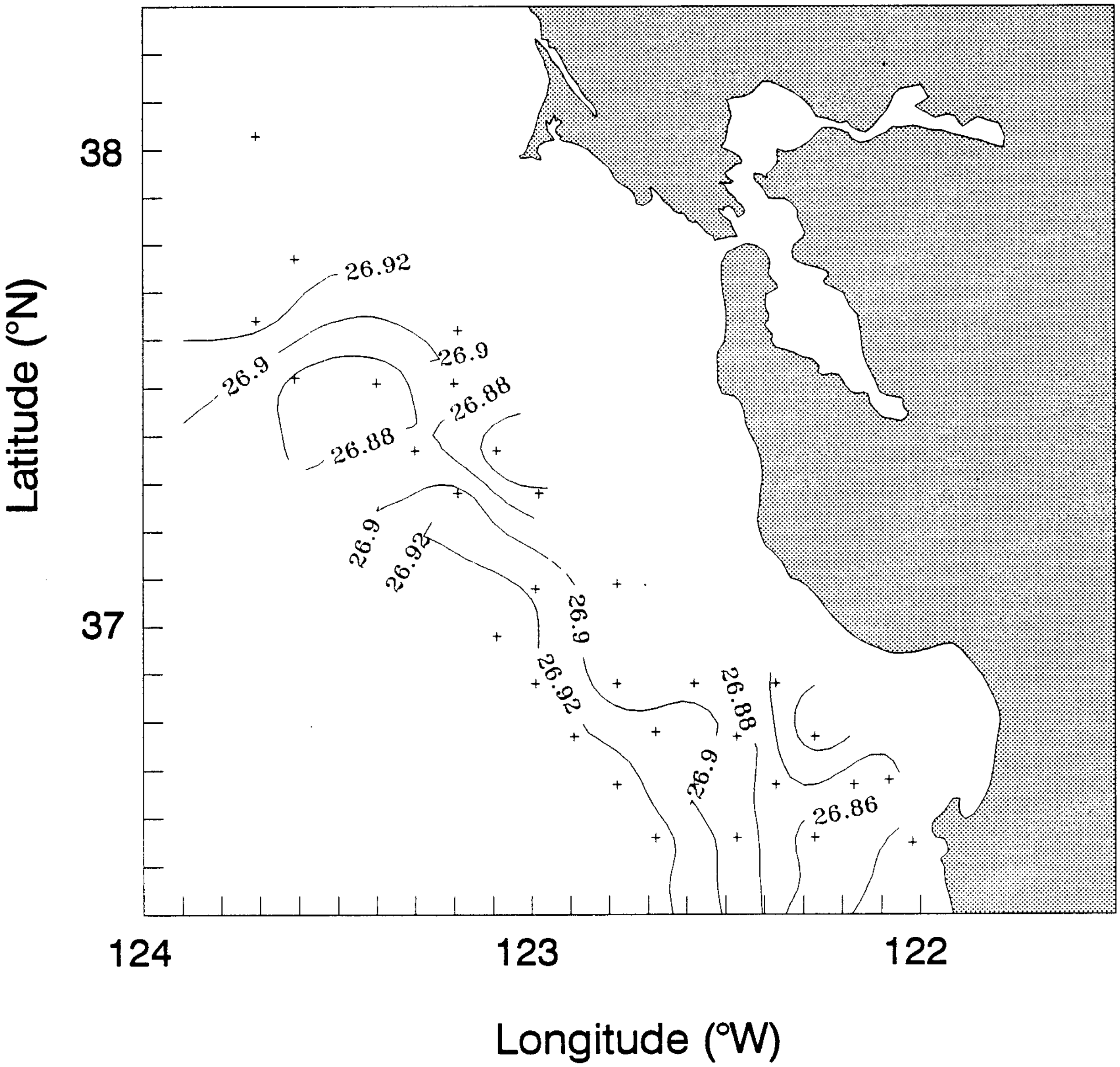



DSJ9307 Sweep 3
Density (kg/m³) at 200 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122
26.4
26.38
26.4
26.42
26.44
26.46
26.44
26.48
26.5
26.48
26.46
26.44
26.42
26.4
26.38
26.36
26.34
26.36
26.38
26.4
26.5
26.5

DSJ9307 Sweep 3
Density (kg/m³) at 300 m

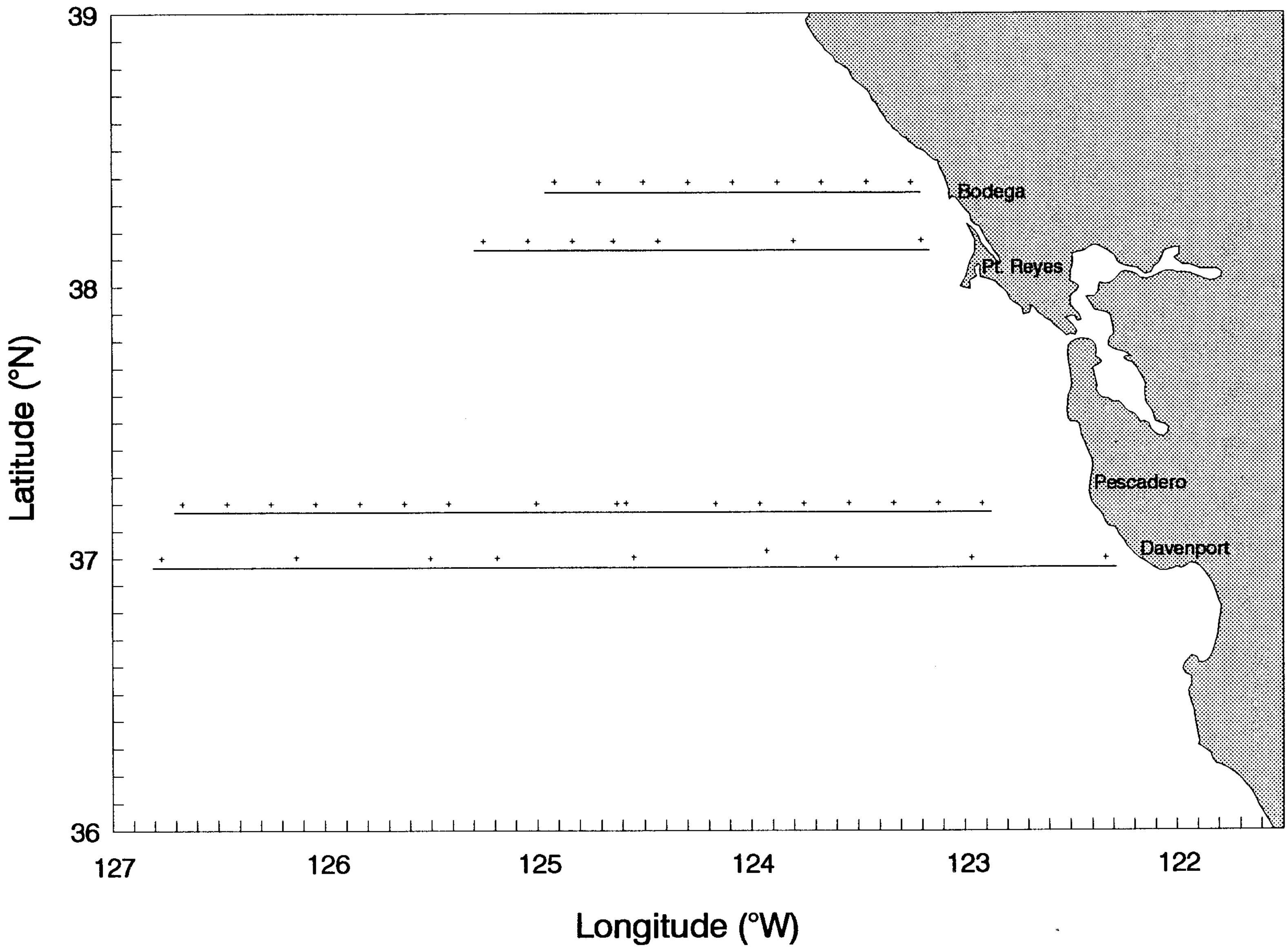


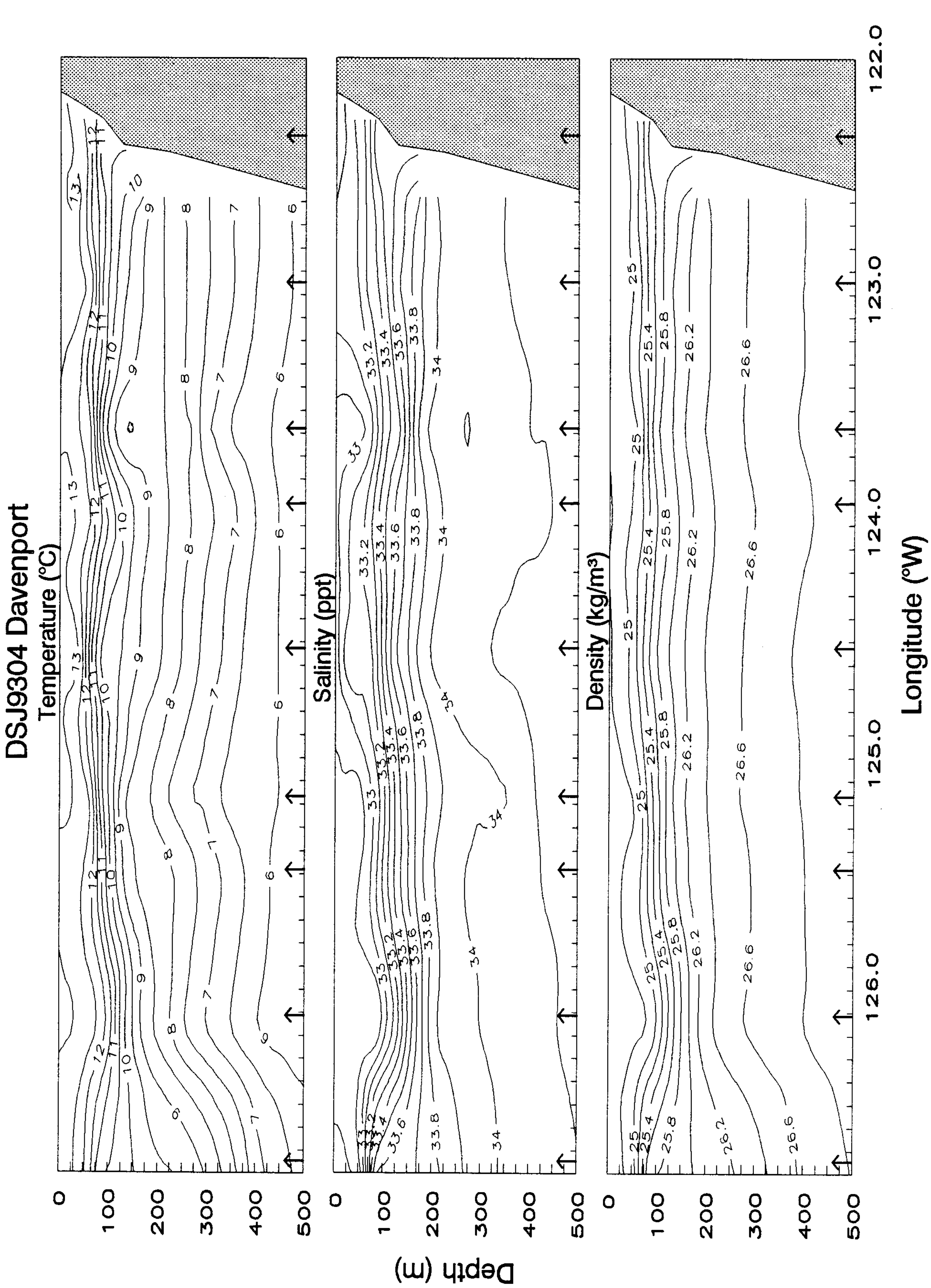
DSJ9307 Sweep 3
Density (kg/m³) at 500 m



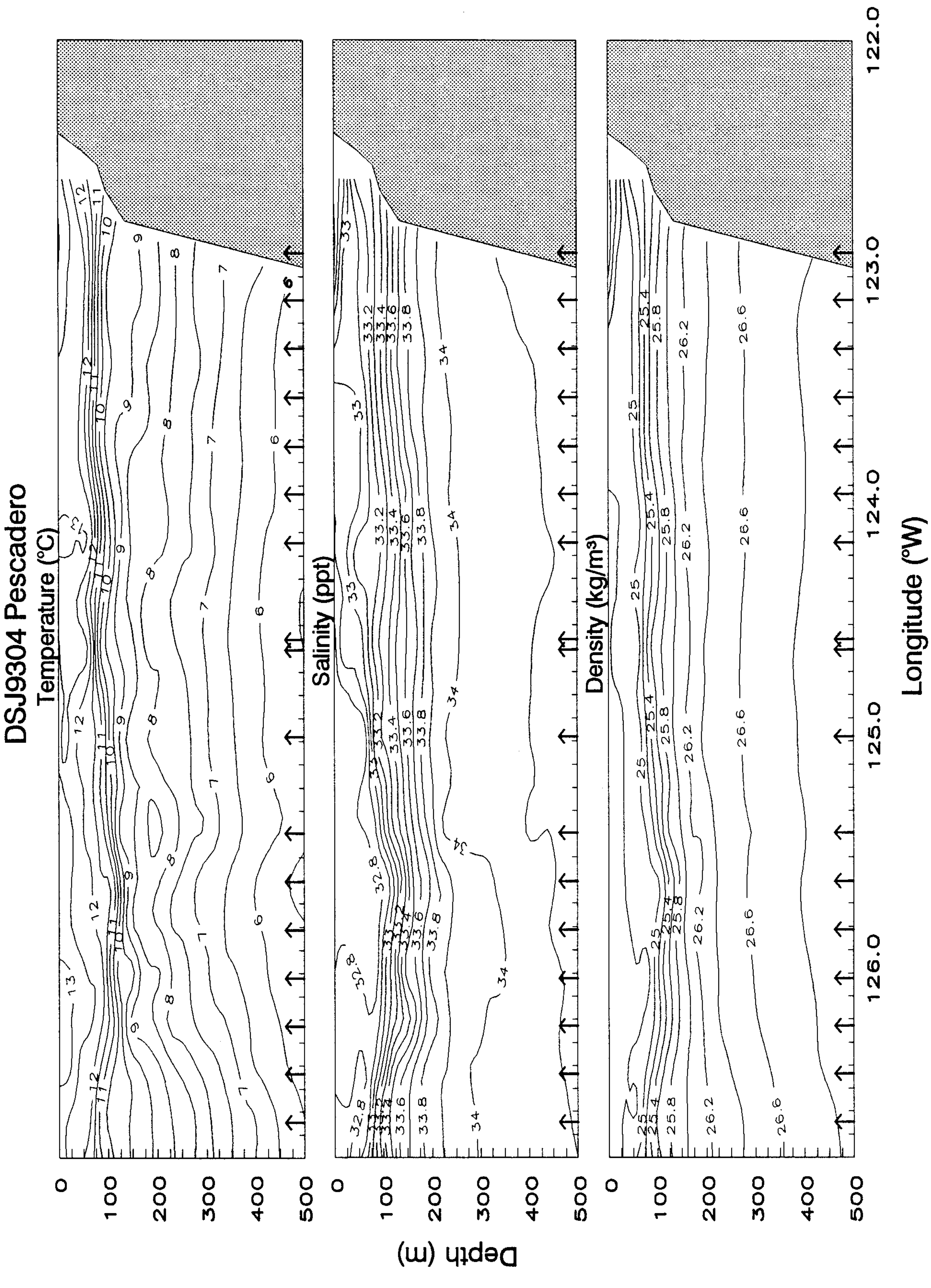
APPENDIX 7.1: VERTICAL TRANSECTS FOR DSJ9304

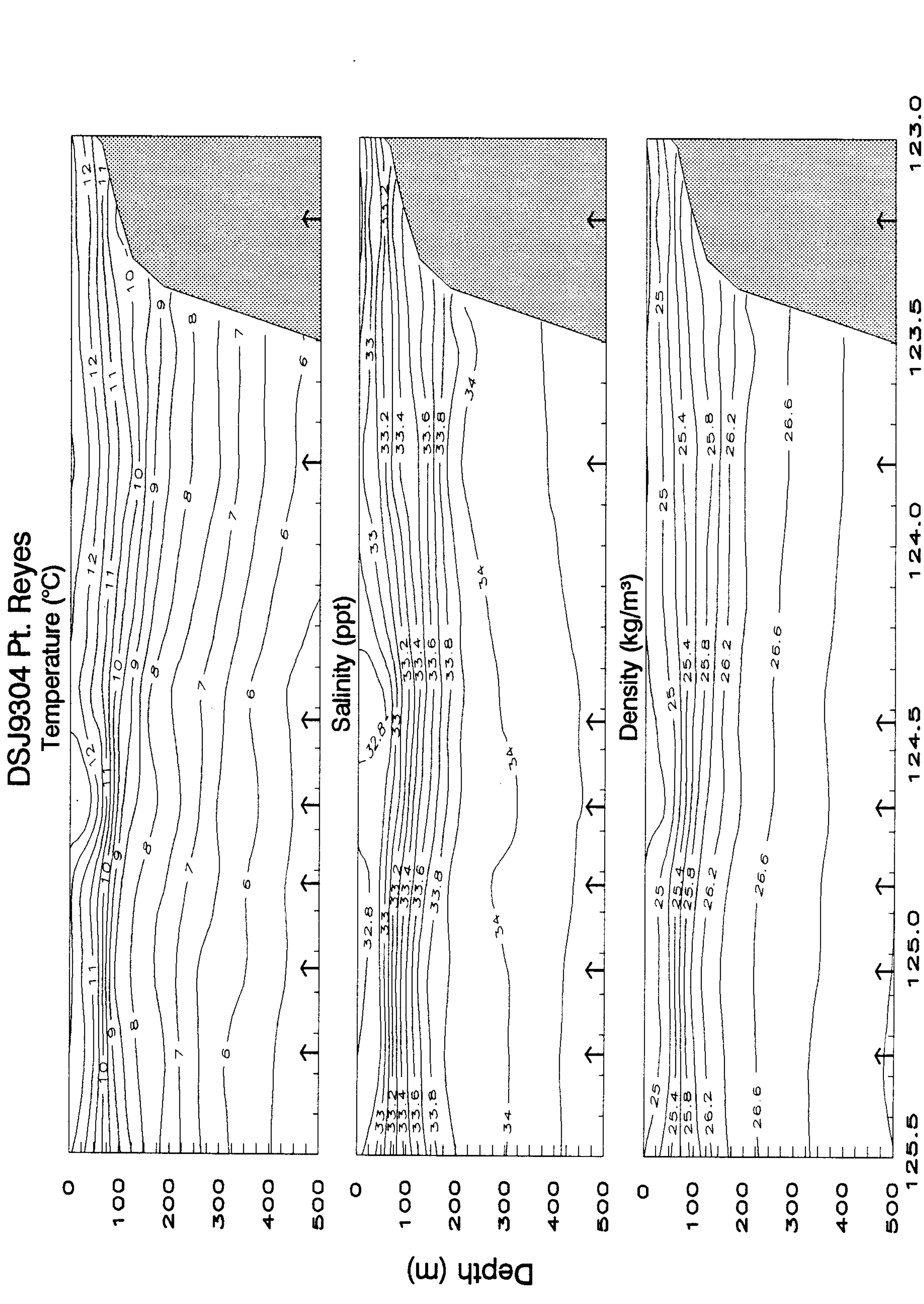
DSJ9304 Vertical Transect CTD Stations

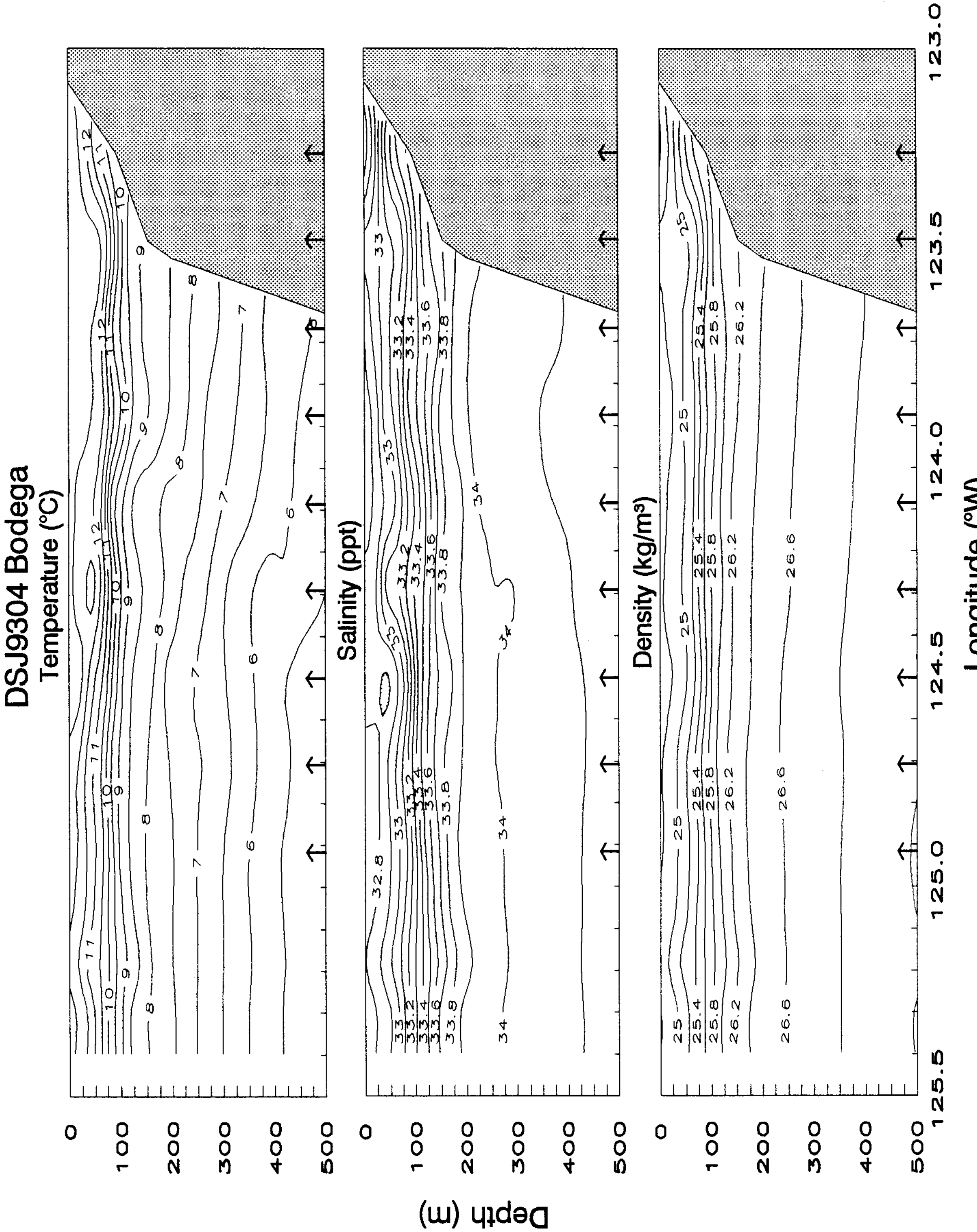




DSJ9304 Davenport
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
126.0
125.0
124.0
123.0
122.0
0
100
200
300
400
500

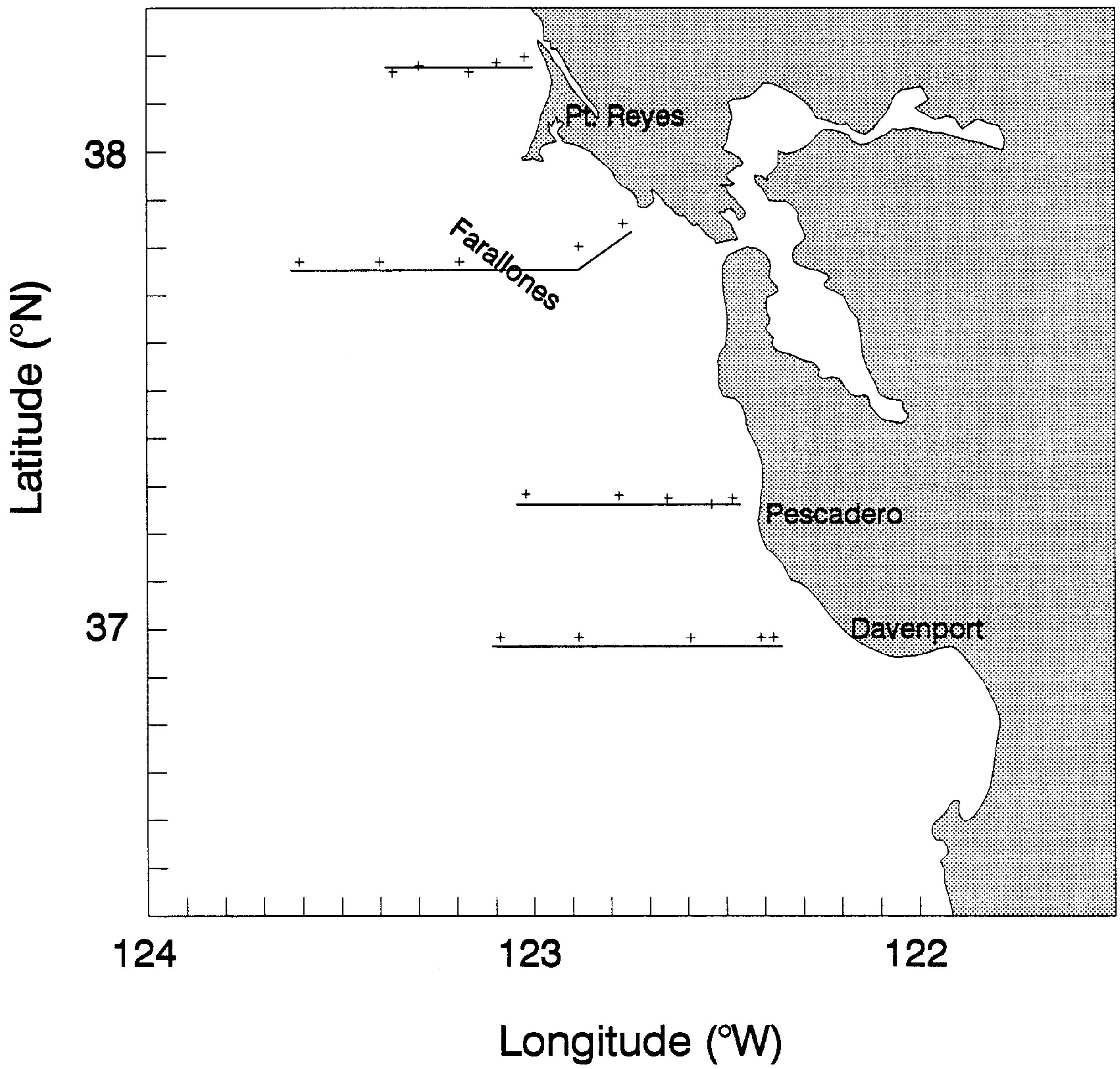

DSJ9304 Pescadero
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
0
100
200
300
400
500
126.0
125.0
124.0
123.0
122.0

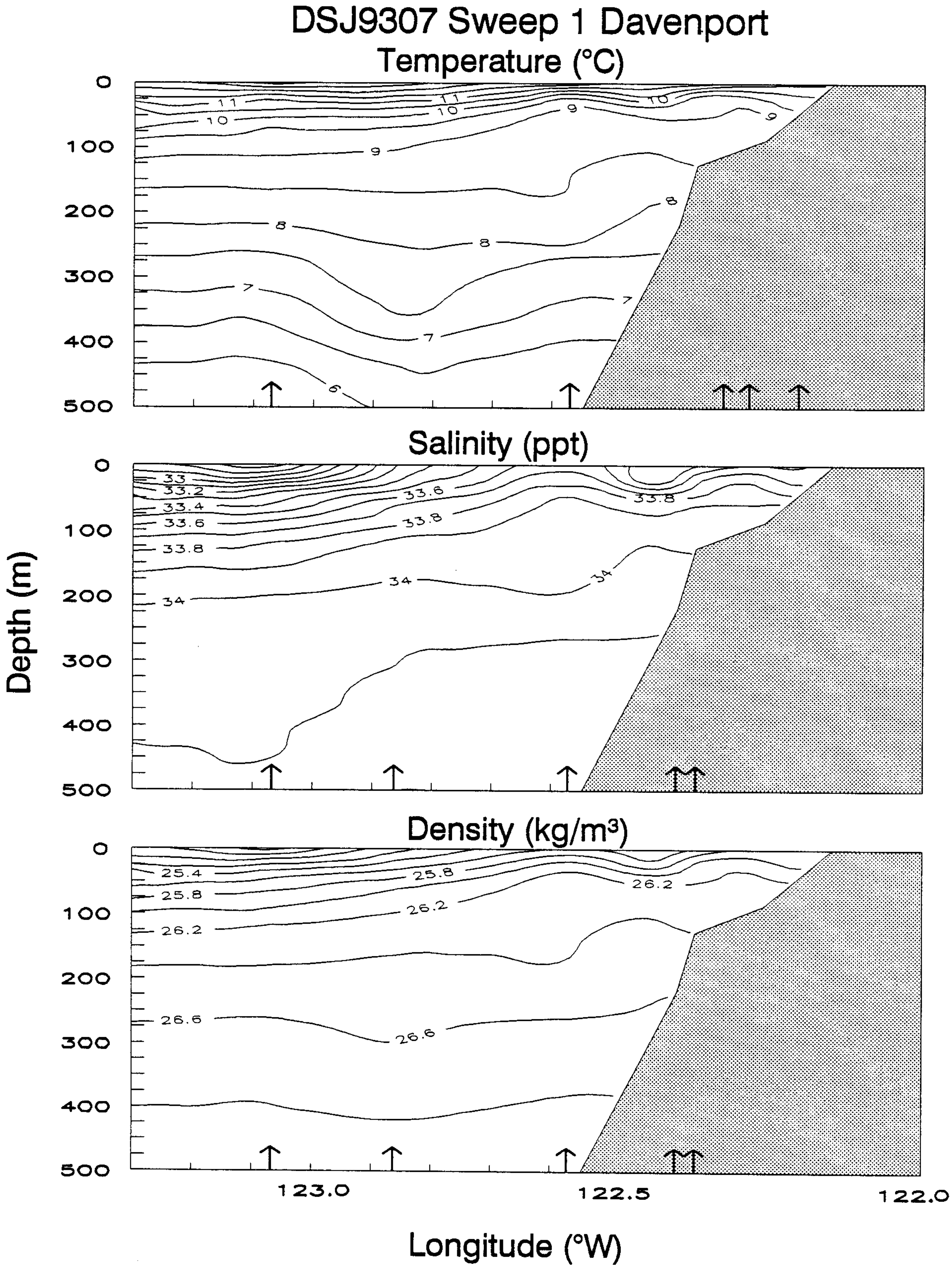

DSJ9304 Pt. Reyes
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
125.5
125.0
124.5
124.0
123.5
123.0
0
100
200
300
400
500


DSJ9304 Bodega
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)

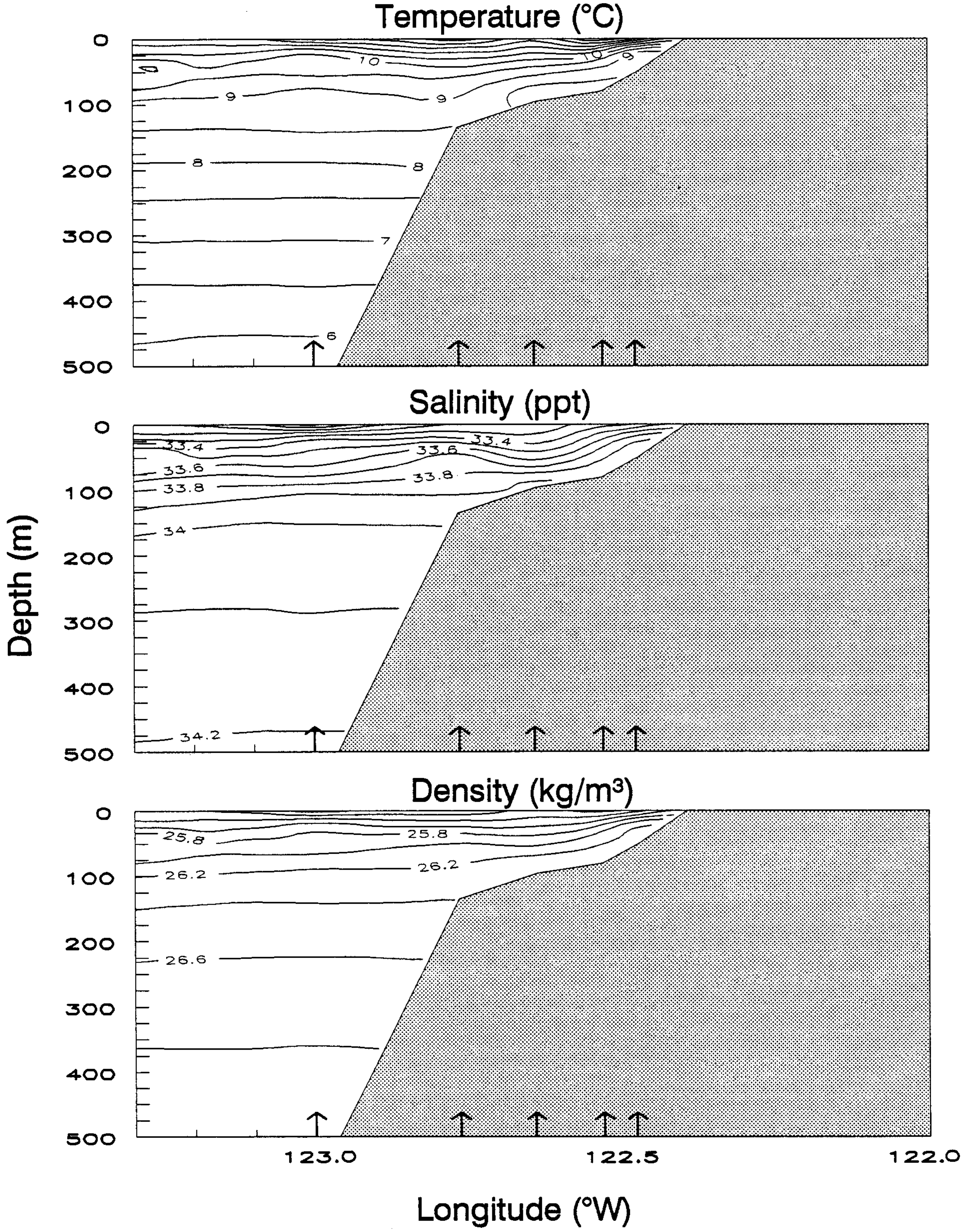
APPENDIX 7.2: VERTICAL TRANSECTS FOR DSJ9307

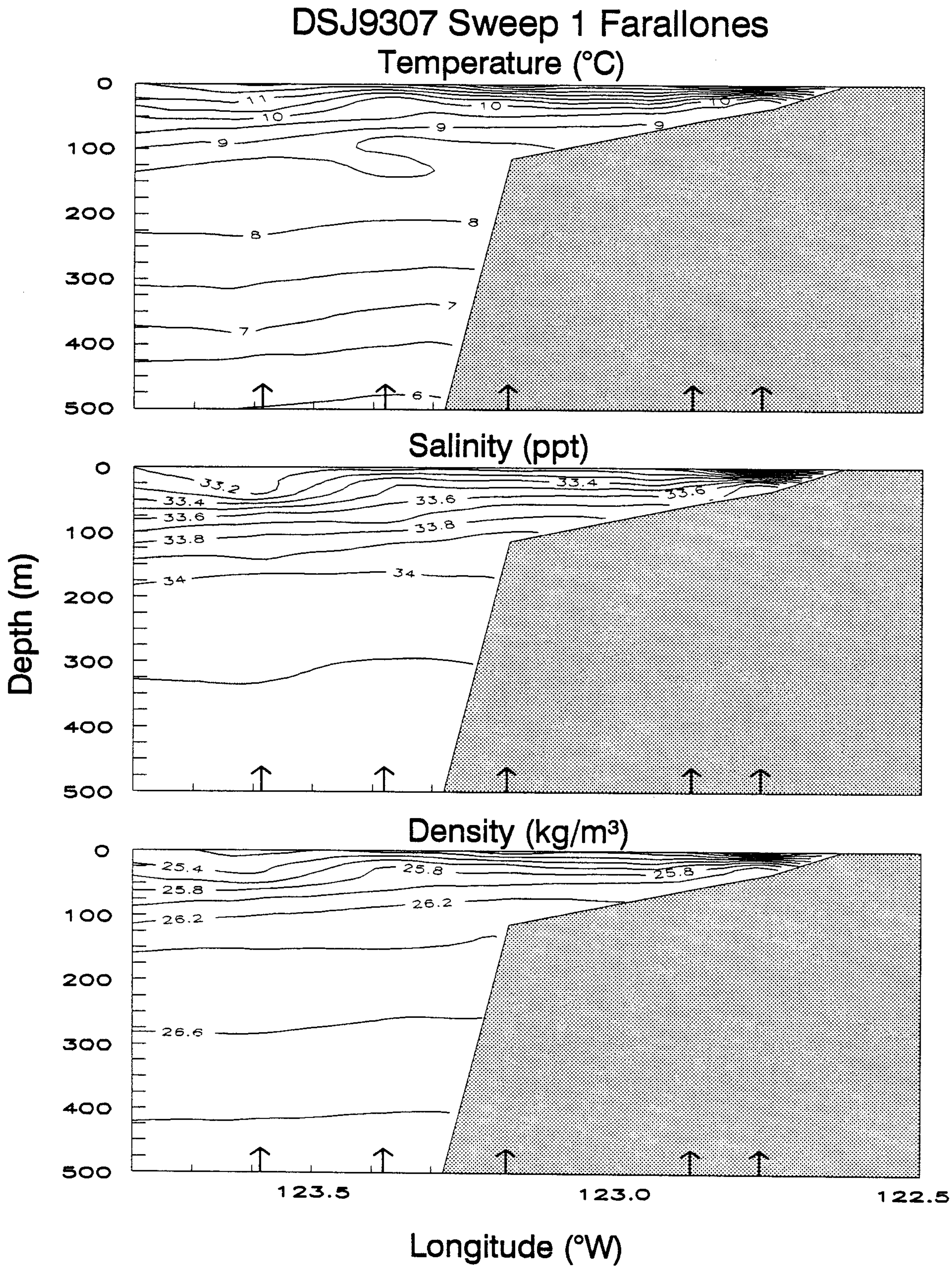
DSJ9307 Sweep 1
Vertical Transect CTD Stations



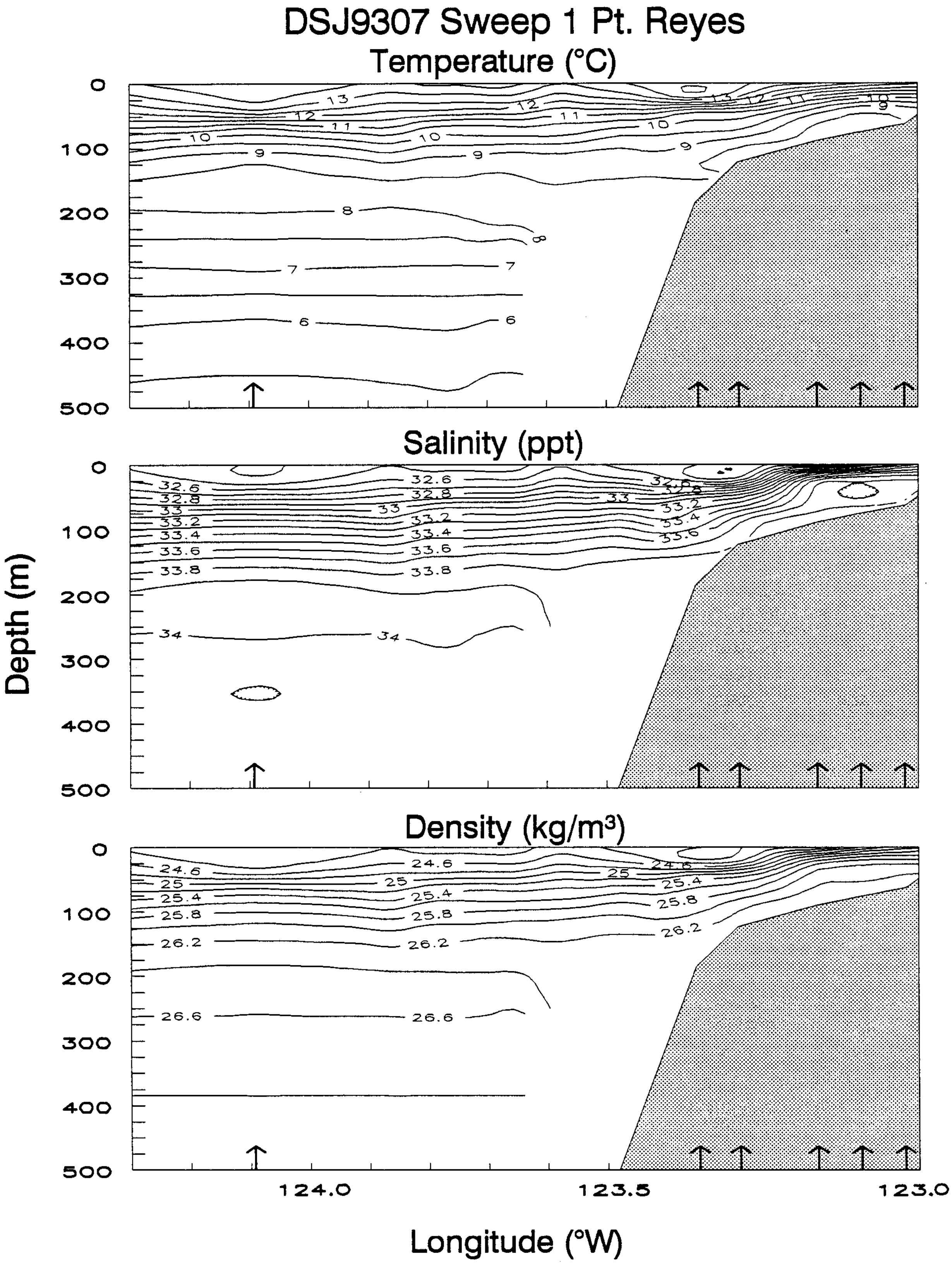

DSJ9307 Sweep 1 Davenport
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
123.0
122.5
122.0
0
100
200
300
400
500
11
10
9
8
7
6
33
33.2
33.4
33.6
33.8
34
25.4
25.8
26.2
26.6

DSJ9307 Sweep 1 Pescadero



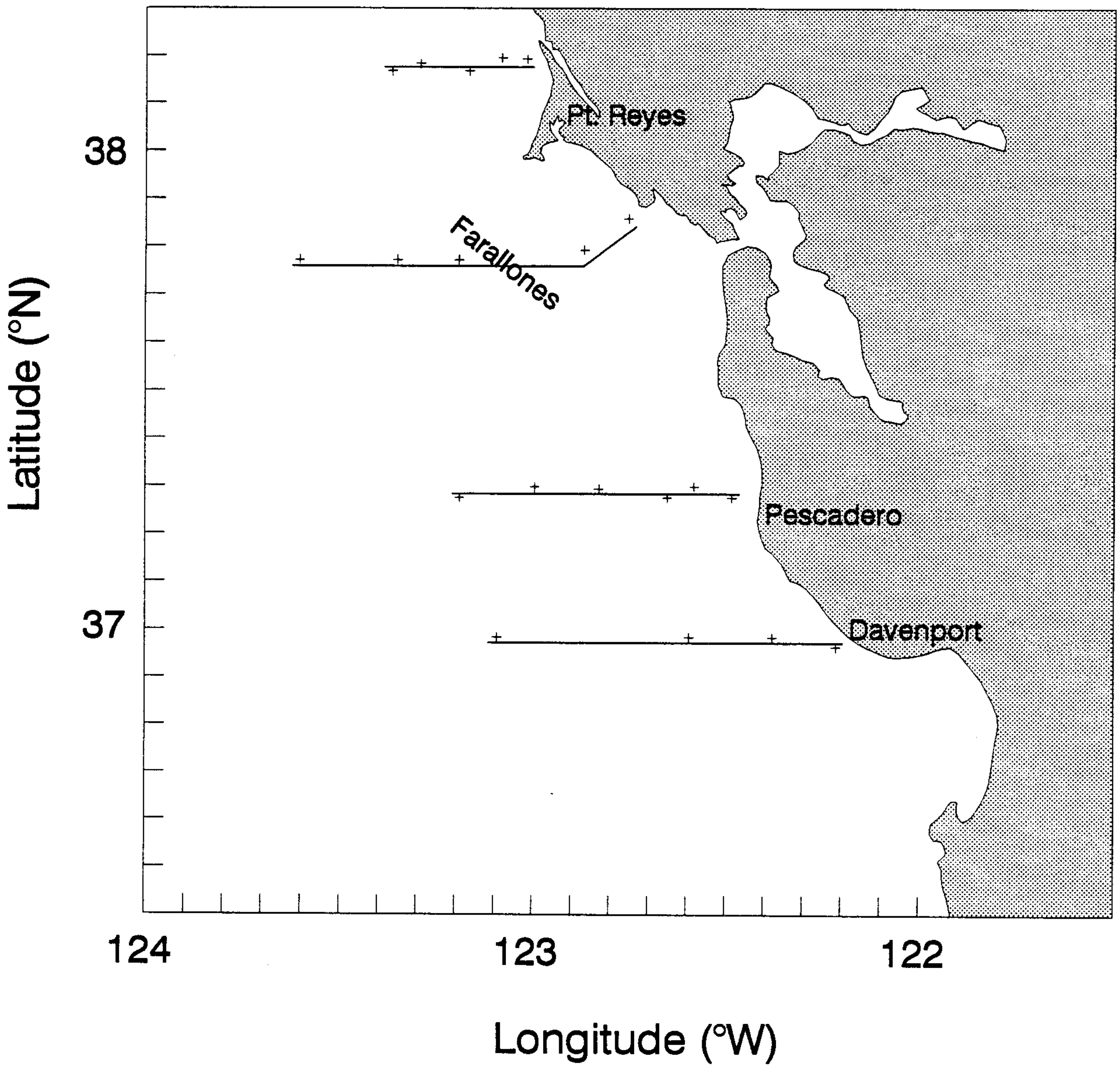


DSJ9307 Sweep 1 Farallones
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
0
100
200
300
400
500
11
10
9
8
7
6
33.2
33.4
33.6
33.8
34
25.4
25.8
26.2
26.6
123.5
123.0
122.5
Longitude (°W)

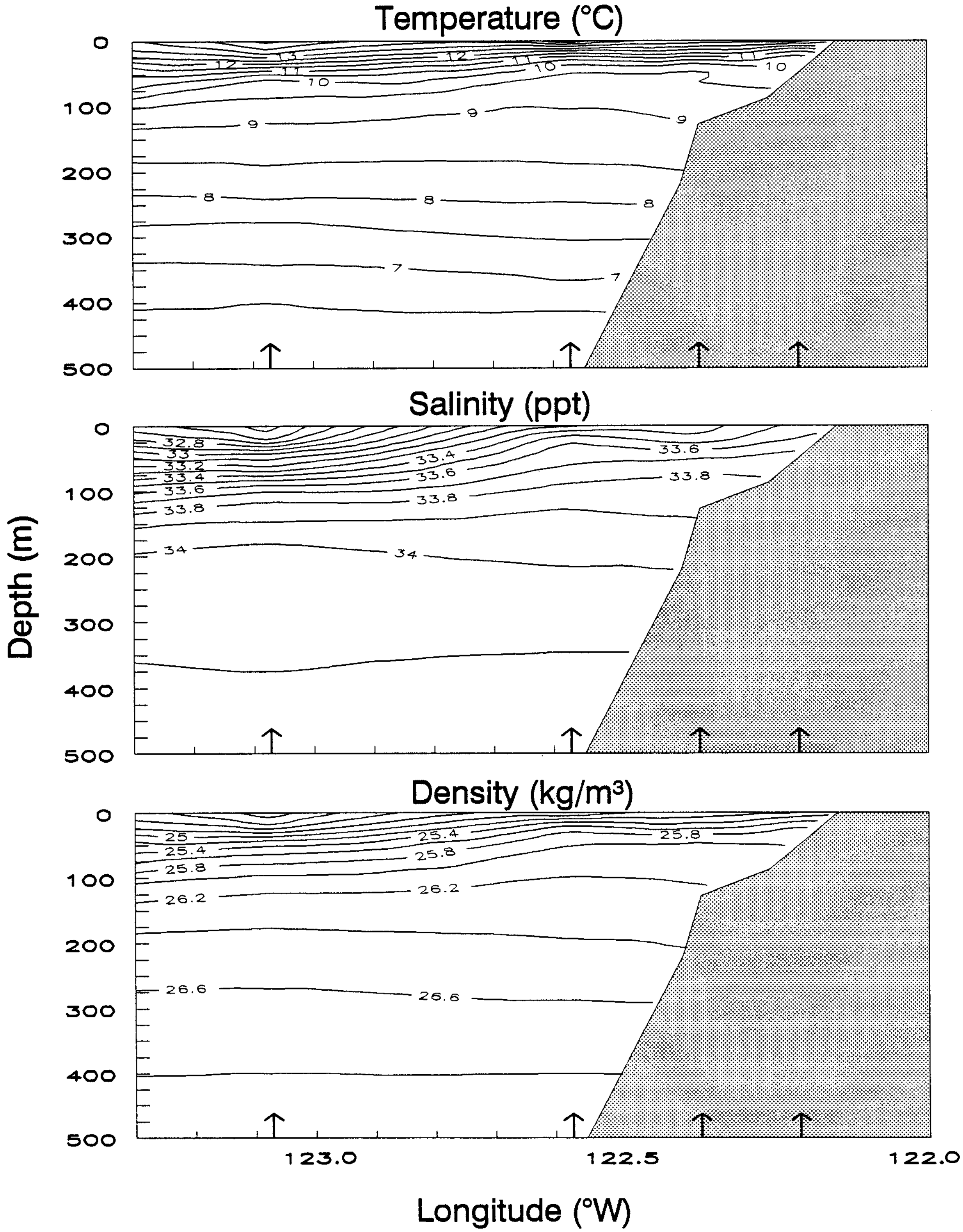


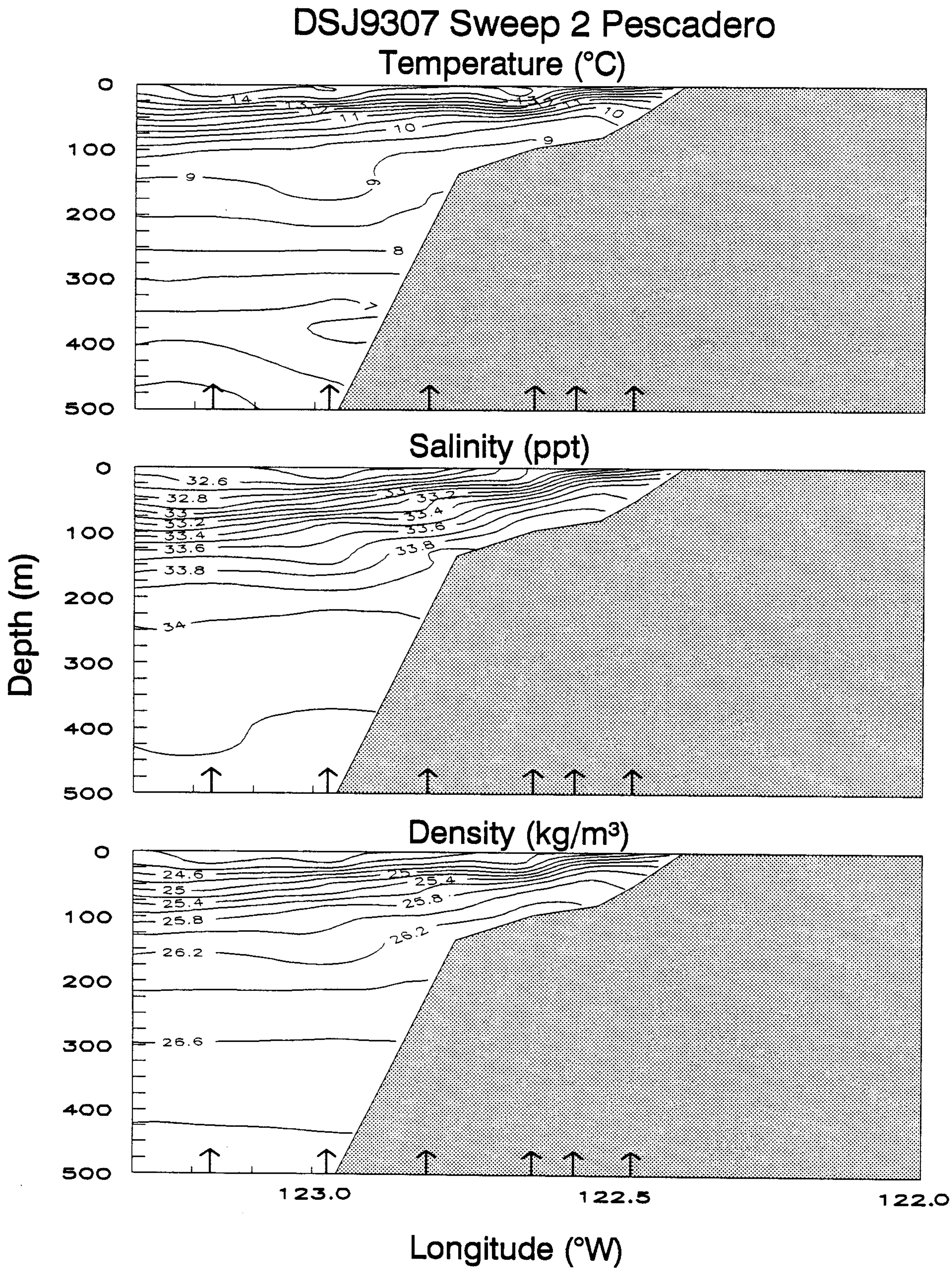
DSJ9307 Sweep 1 Pt. Reyes
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
124.0
123.5
123.0

DSJ9307 Sweep 2
Vertical Transect CTD Stations

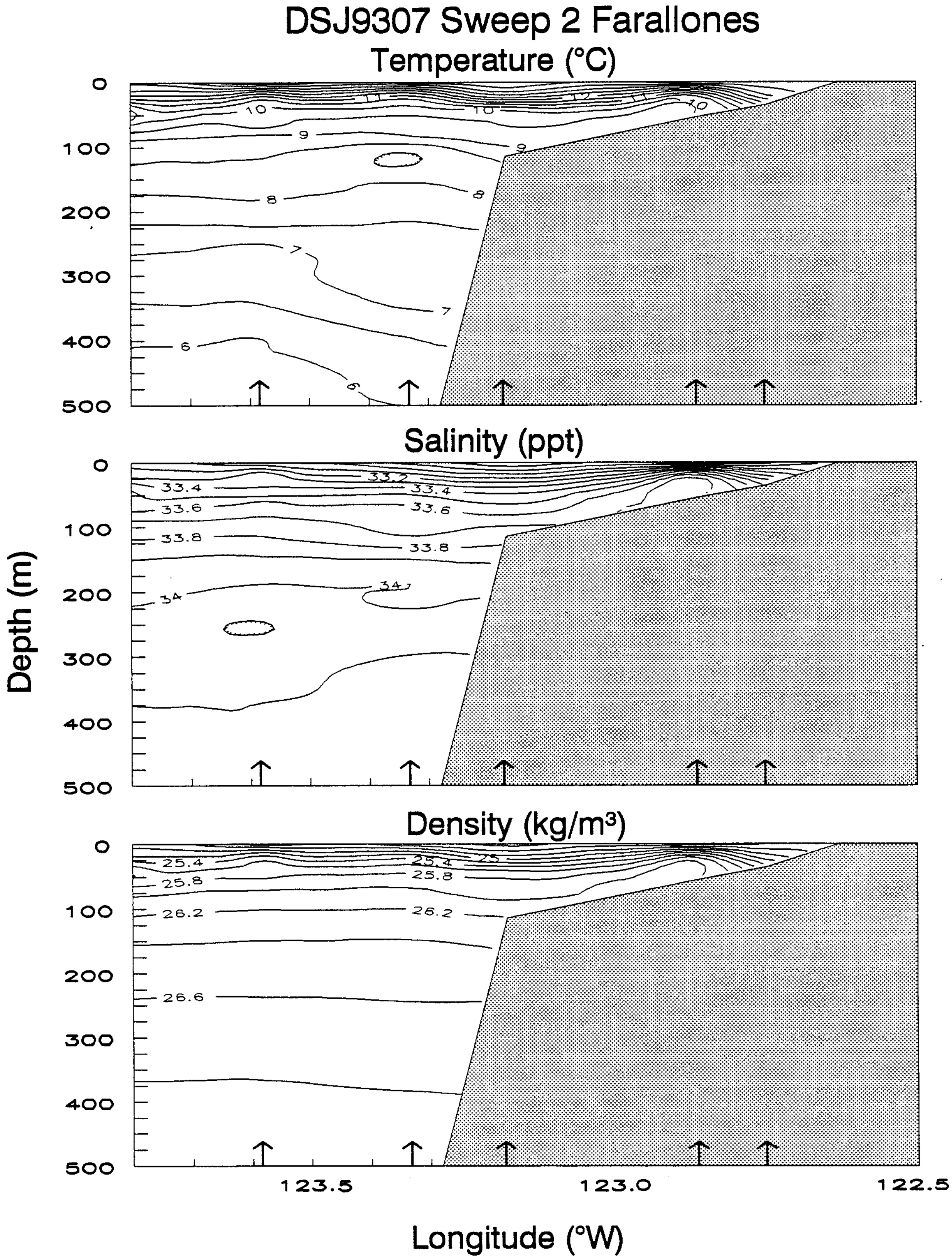


DSJ9307 Sweep 2 Davenport

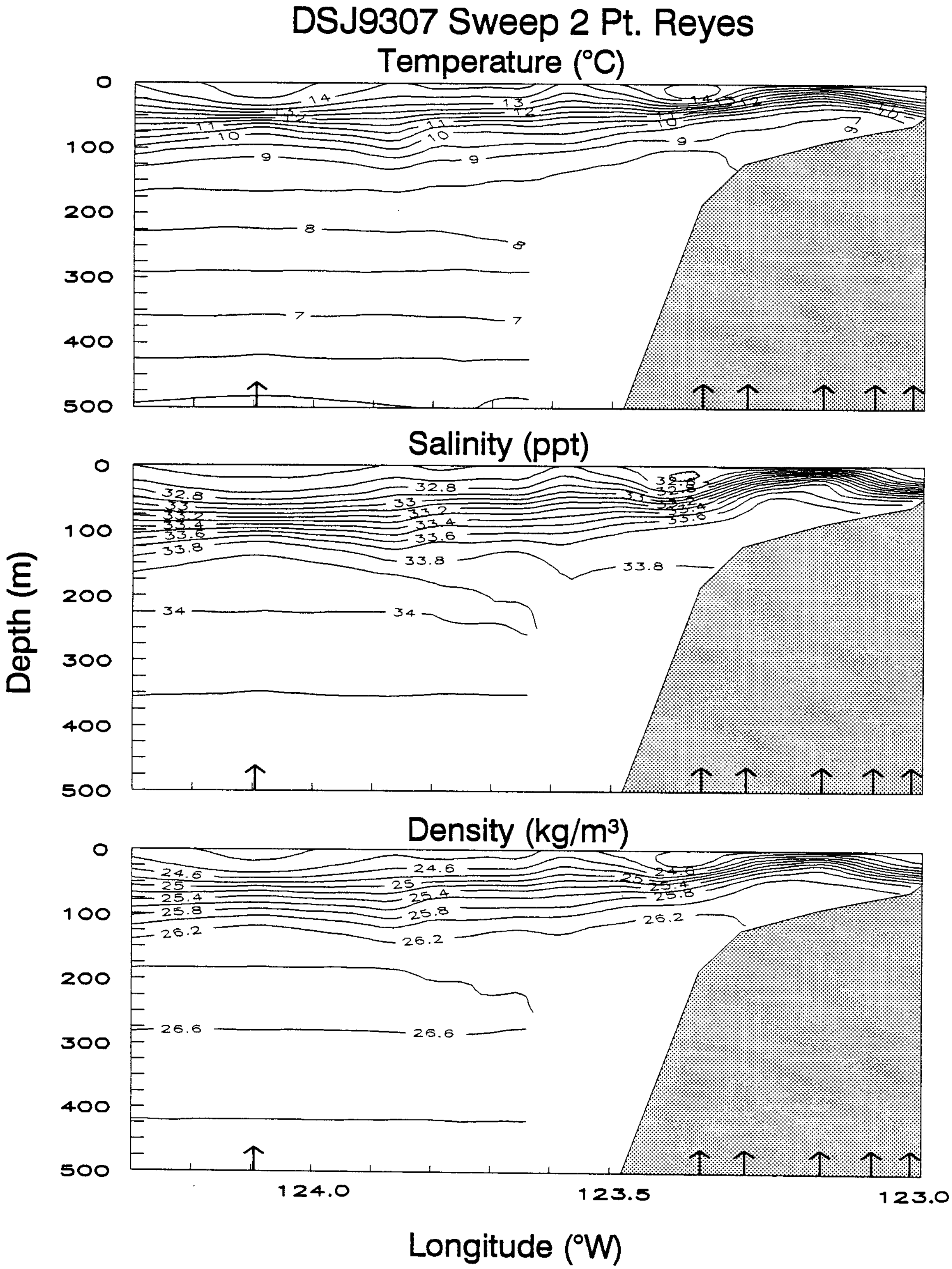




DSJ9307 Sweep 2 Pescadero
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
0
100
200
300
400
500
123.0
122.5
122.0
14
13
12
11
10
9
8
7
32.6
32.8
33
33.2
33.4
33.6
33.8
34
24.6
25
25.4
25.8
26.2
26.6

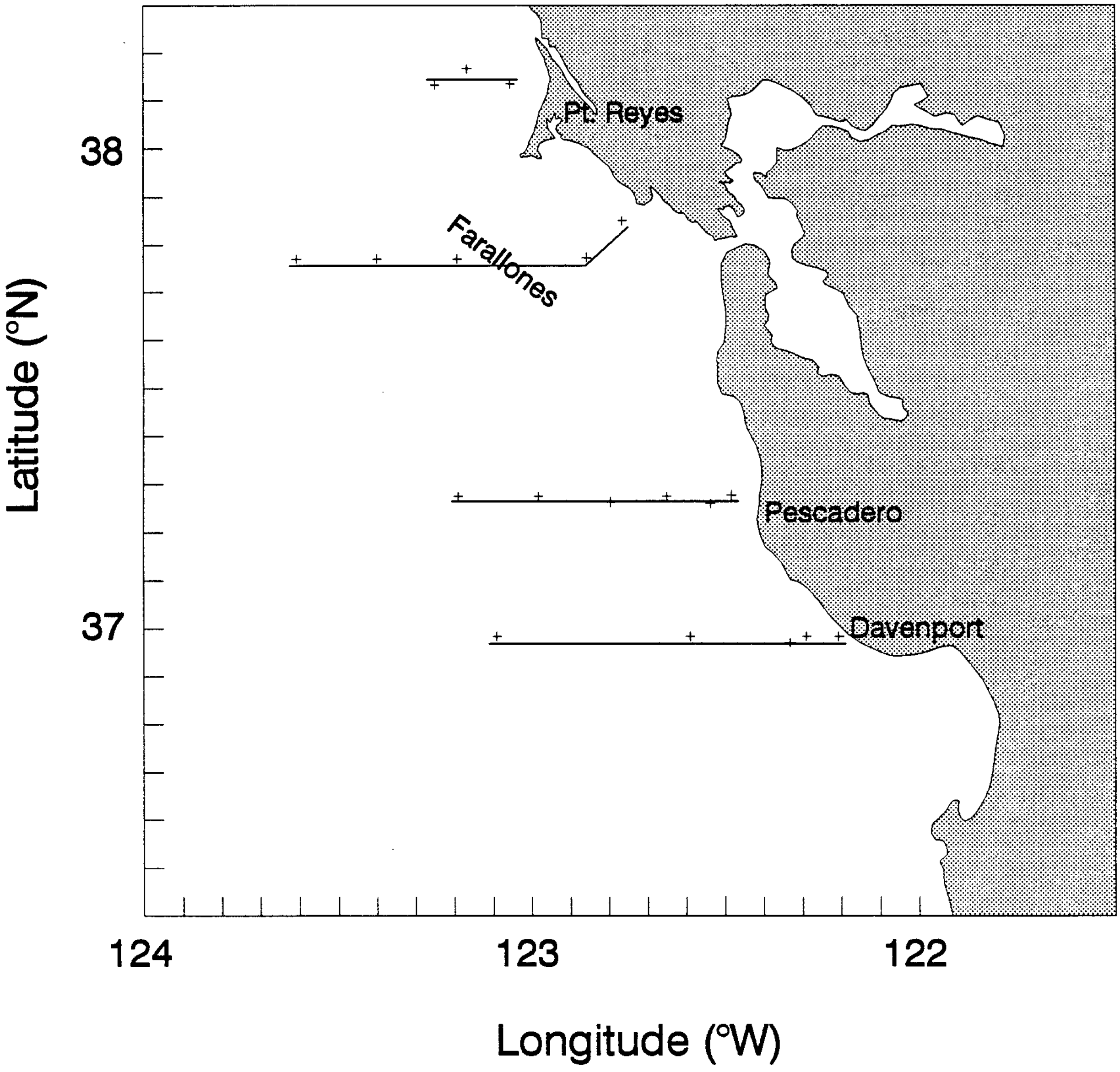


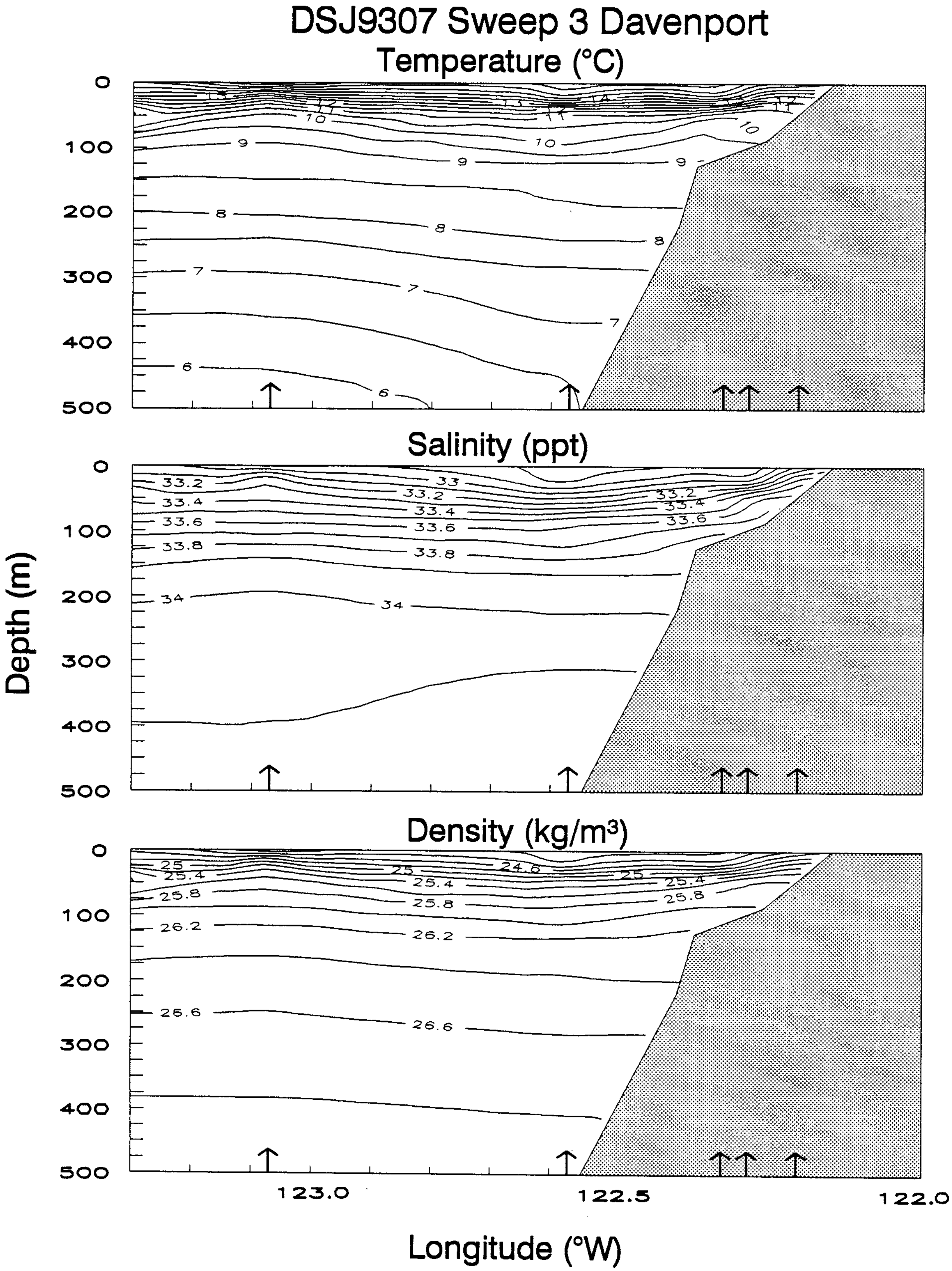
DSJ9307 Sweep 2 Farallones
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
0
100
200
300
400
500
123.5
123.0
122.5
10
9
8
7
6
11
12
33.2
33.4
33.6
33.8
34
25
25.4
25.8
26.2
26.6



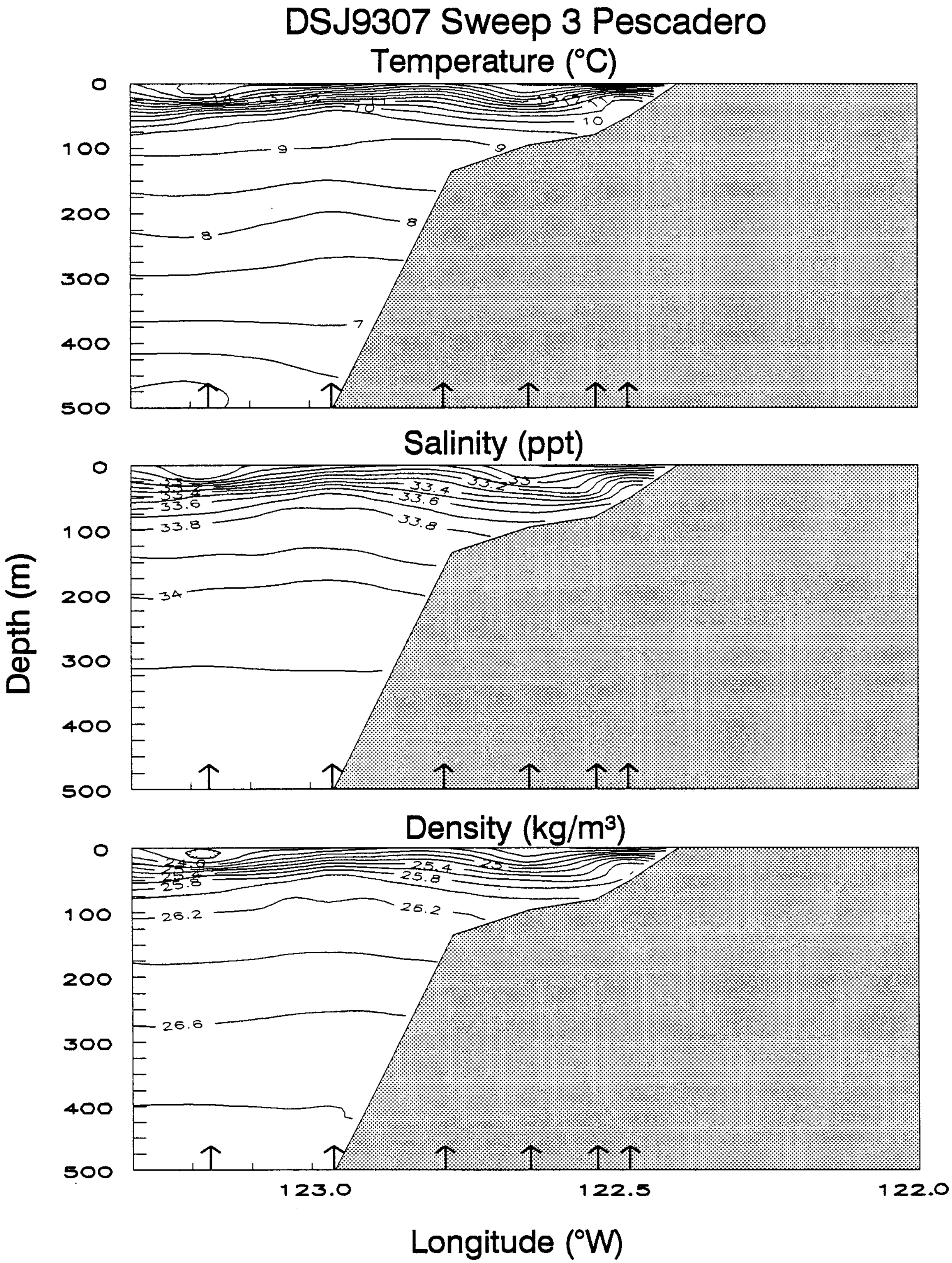
DSJ9307 Sweep 2 Pt. Reyes
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
0
100
200
300
400
500
124.0
123.5
123.0

DSJ9307 Sweep 3
Vertical Transect CTD Stations

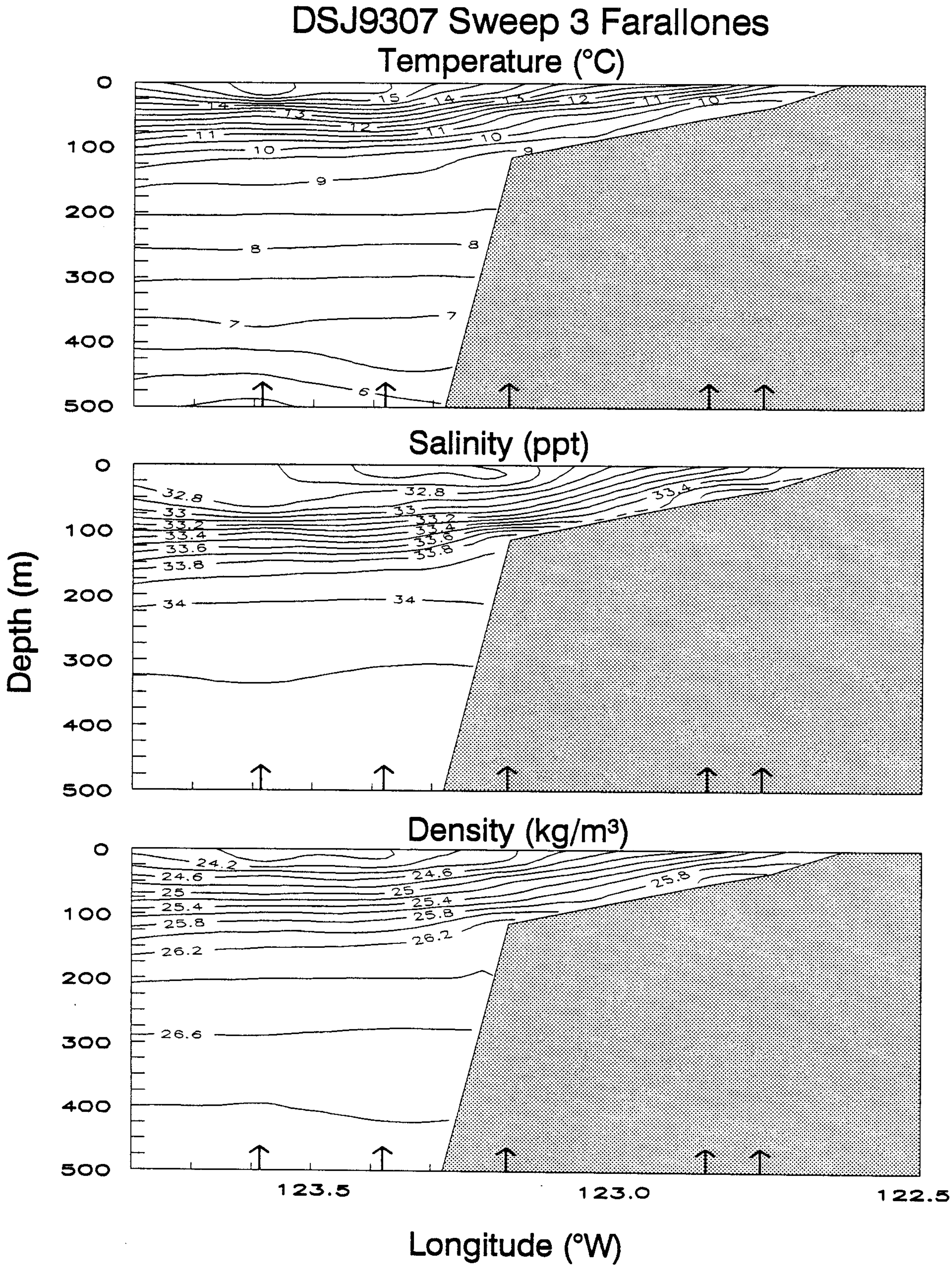


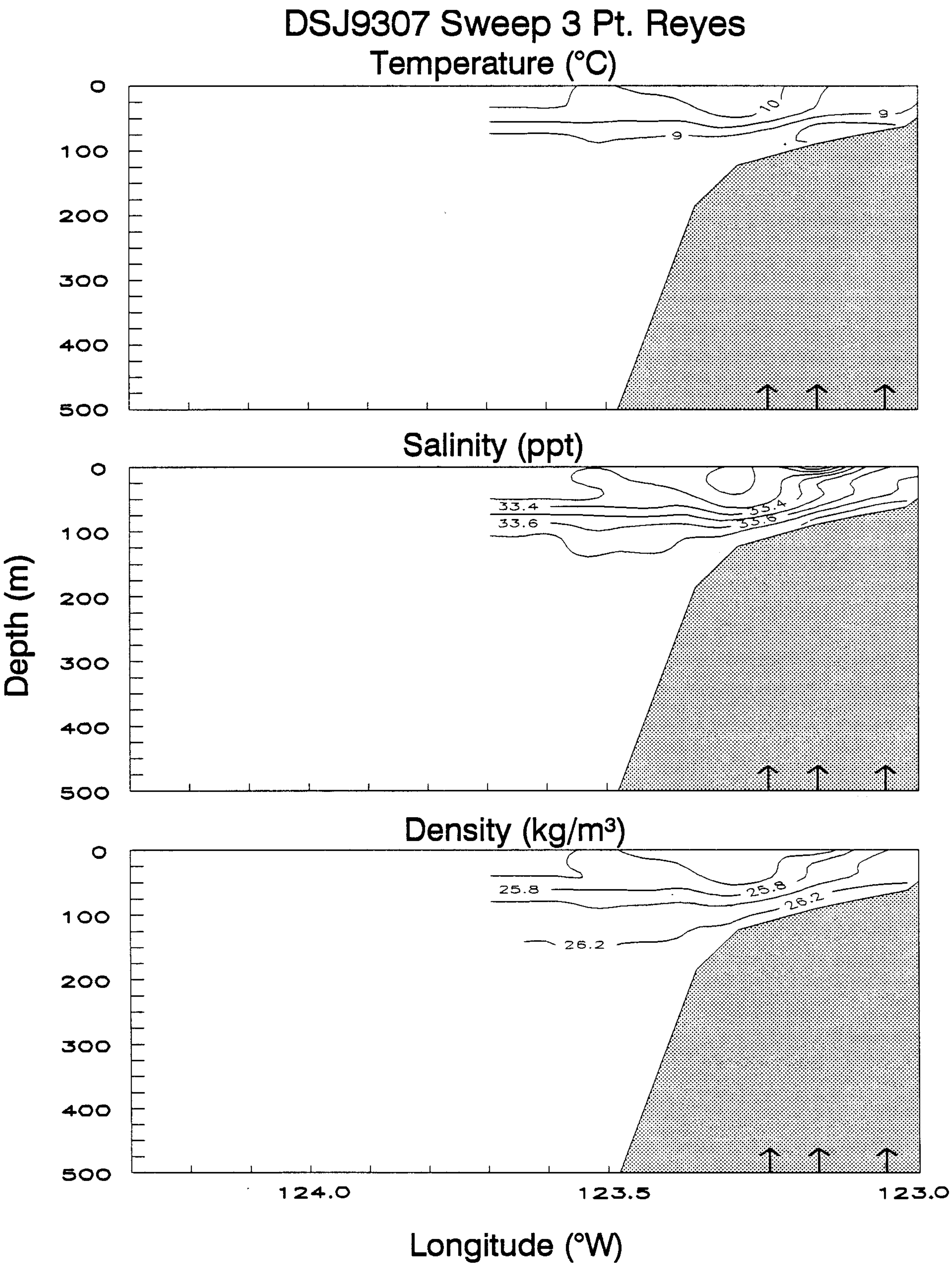


DSJ9307 Sweep 3 Davenport
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
123.0
122.5
122.0
0
100
200
300
400
500

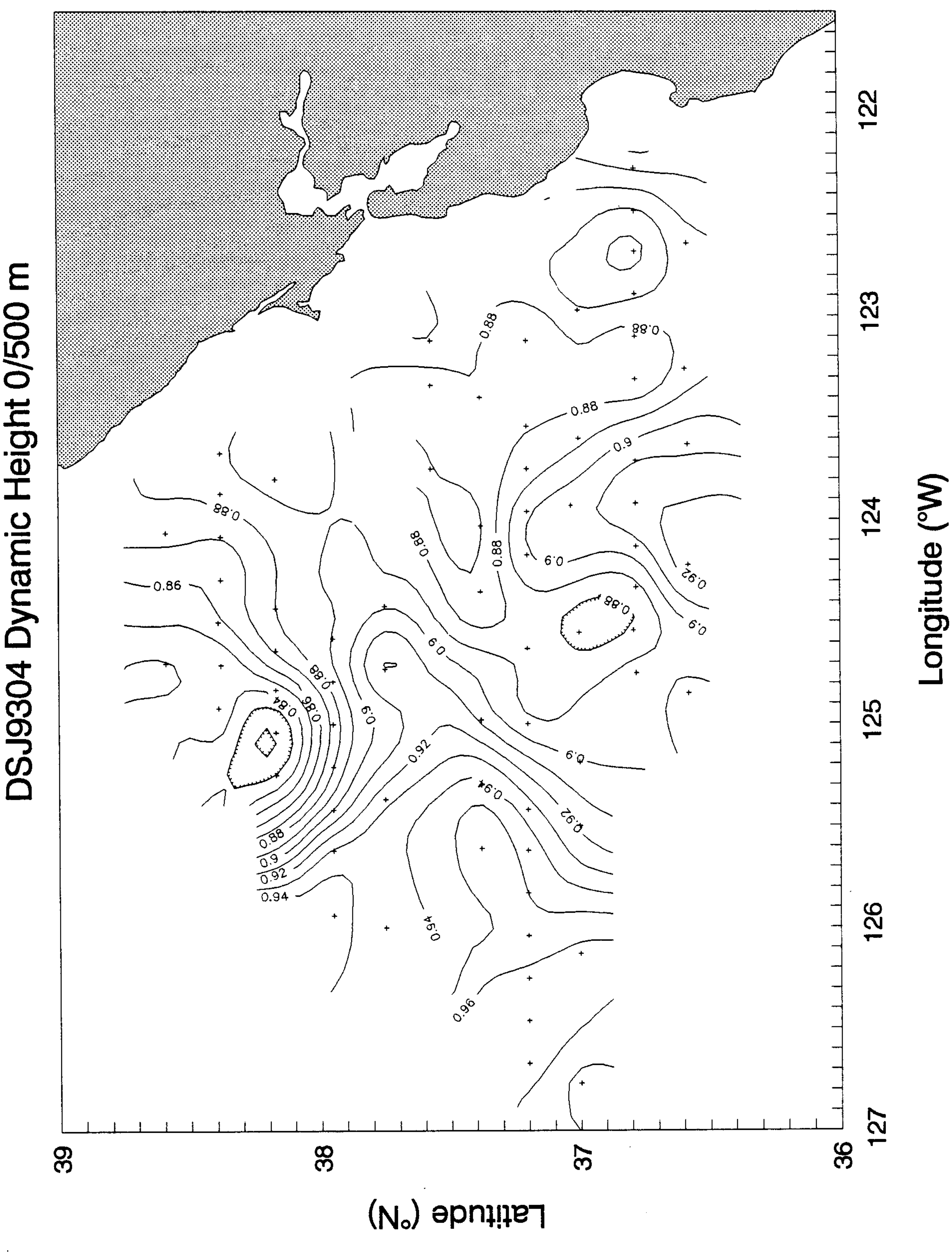


DSJ9307 Sweep 3 Pescadero
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
Longitude (°W)
0
100
200
300
400
500
123.0
122.5
122.0
9
8
7
10
33.4
33.6
33.8
34
33.2
33
26.2
26.6
25.4
25.8

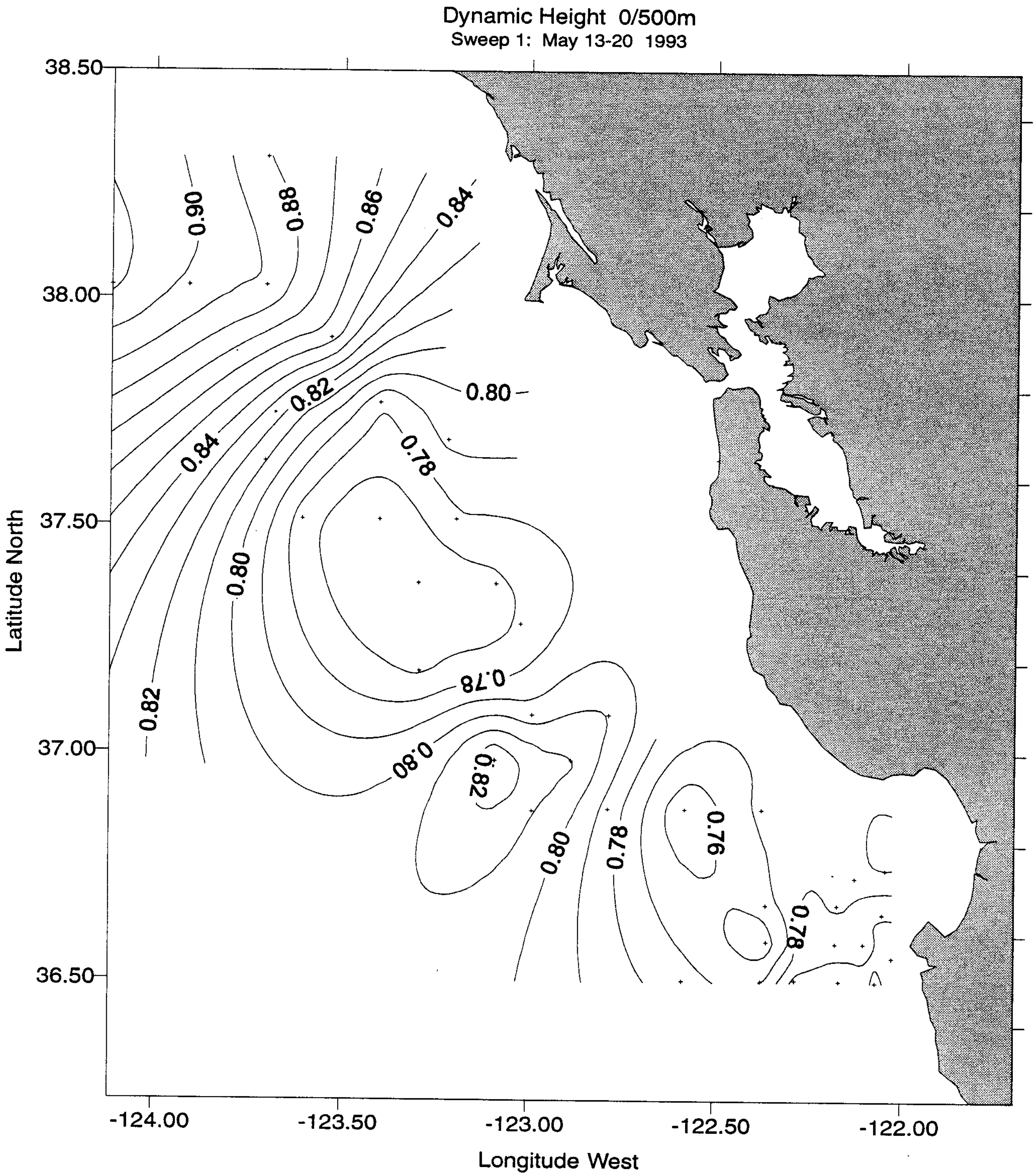

DSJ9307 Sweep 3 Farallones
Temperature (°C)
Salinity (ppt)
Density (kg/m³)
Depth (m)
0
100
200
300
400
500
123.5
123.0
122.5
Longitude (°W)
15
14
13
12
11
10
9
8
7
6
32.8
33
33.2
33.4
33.6
33.8
34
24.2
24.6
25
25.4
25.8
26.2
26.6


DSJ9307 Sweep 3 Pt. Reyes
Temperature (°C)
10
9
9
Salinity (ppt)
33.4
33.6
33.4
33.6
Density (kg/m³)
25.8
25.8
26.2
26.2
Depth (m)
0
100
200
300
400
500
124.0
123.5
123.0
Longitude (°W)

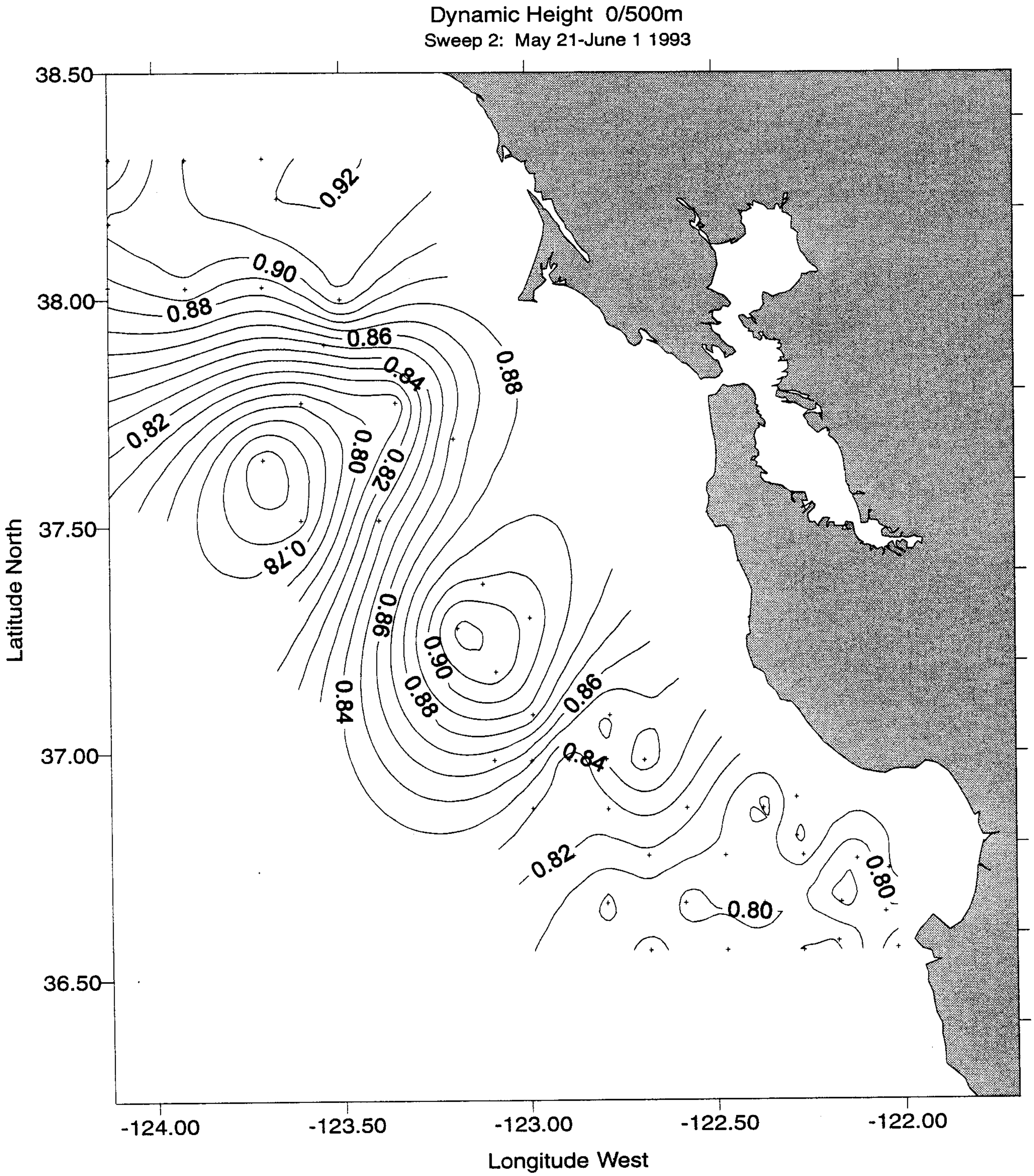
APPENDIX 8: MAPS OF DYNAMIC HEIGHT TOPOGRAPHY FOR DSJ9304 AND DSJ9307



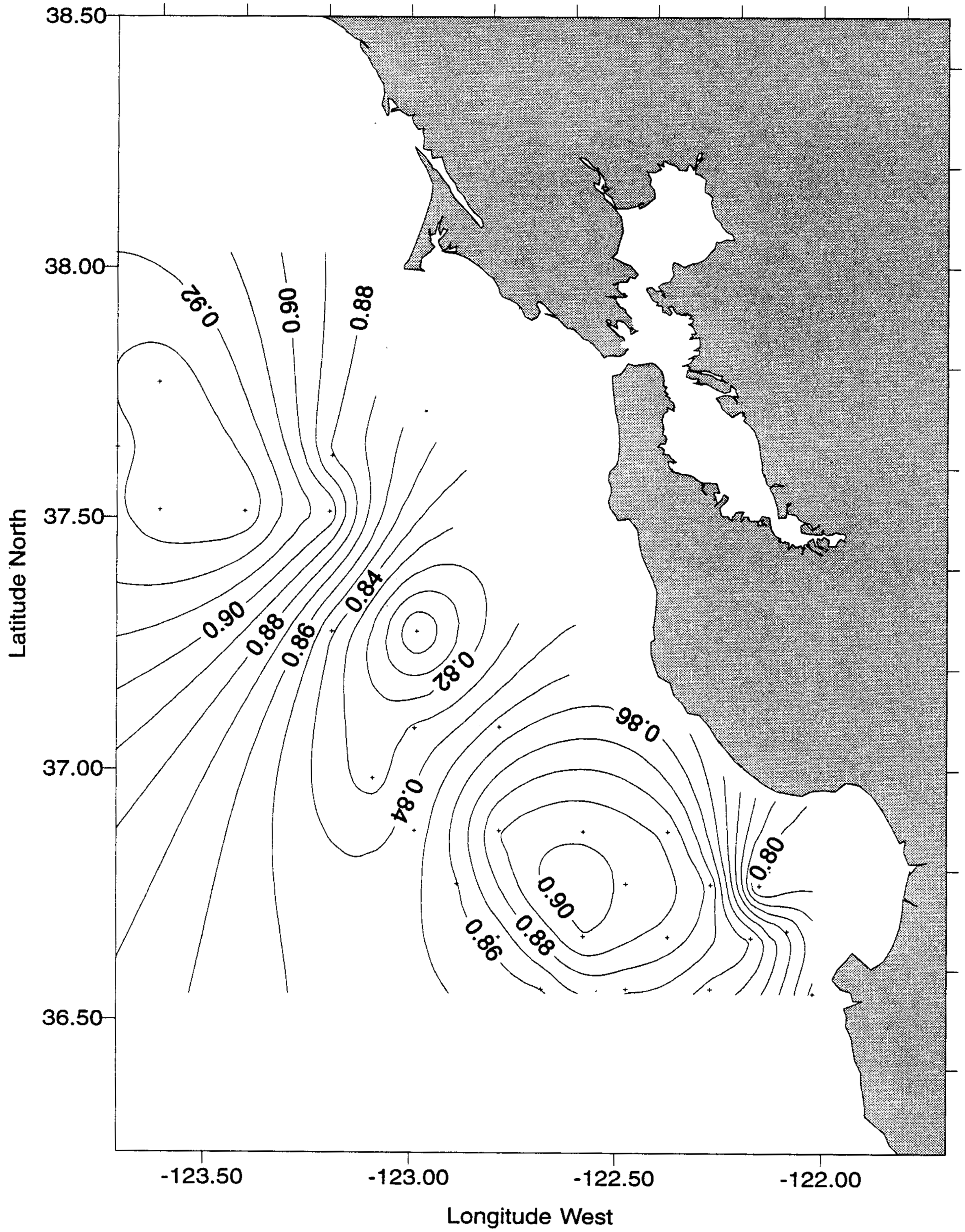
DSJ9304 Dynamic Height 0/500 m
Longitude (°W)
Latitude (°N)
39
38
37
36
127
126
125
124
123
122



Dynamic Height 0/500m
Sweep 1: May 13-20 1993
38.50
38.00
37.50
37.00
36.50
Latitude North
-124.00
-123.50
-123.00
-122.50
-122.00
Longitude West
0.90
0.88
0.86
0.84
0.82
0.80
0.84
0.78
0.80
0.82
0.78
0.80
0.82
0.80
0.78
0.76
0.78


Dynamic Height 0/500m
Sweep 2: May 21-June 1 1993
38.50
38.00
37.50
37.00
36.50
Latitude North
-124.00
-123.50
-123.00
-122.50
-122.00
Longitude West
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78

Dynamic Height 0/500m
Sweep 3: June 3-13 1993



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