NOAA Technical Memorandum NMFS

SEPTEMBER 2000

THE PHYSICAL OCEANOGRAPHY OFF THE CENTRAL CALIFORNIA COAST DURING MARCH-APRIL AND MAY-JUNE, 1990: A SUMMARY OF CTD DATA FROM PELAGIC JUVENILE ROCKFISH SURVEYS

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NOAA-TM-NMFS-SWFSC-299

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

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ABSTRACT

Hydrographic conditions were summarized from a 7-day period in March-April and three periods of approximately ten days each from May-June during 1990 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. A total of 87 conductivity-temperature-depth (CTD) casts were obtained during the *David Starr Jordan* cruise DSJ9003, while 312 standard casts were taken during cruise DSJ9005 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 480 m; and (4) temperature, salinity and σ_θ along four cross-shelf vertical transects in the survey region.

INTRODUCTION

The current regime off central California is hydrodynamically complex, composed of both geostrophic and wind-driven forces. The California Current provides the backdrop for large-scale, seasonal circulation patterns (Hickey 1979), while coastal upwelling 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 add further complexity to the circulation regime.

Since 1983, the National Marine Fisheries (NMFS) Southwest Fisheries Science Center's (SWFSC) Santa Cruz Laboratory (at that time located in Tiburon, CA) has worked on developing a recruitment index for rockfish (*Sebastes* spp.) within the hydrographic region off central California. Annual juvenile rockfish surveys aboard the National Oceanic and Atmospheric Administration (NOAA) research vessel (R/V) *David Starr Jordan* (DSJ) 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;* and bocaccio, *S. paucispinis*). Moreover, extreme interannual fluctuations in abundance have occurred, with combined back-transformed mean $\log_e$ catches ranging from 0.1-78.6 juvenile rockfish/tow (Adams 1995[1]).

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 NMFS SWFSC Santa Cruz Laboratory's annual juvenile rockfish surveys. The staff of the NMFS SWFSC Pacific Fisheries Environmental Laboratory (PFEL) subsequently began analyzing the CTD data to assist 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 1990. 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), 1989 (DSJ8904), 1991 (DSJ9102 and DSJ9105), 1992 (DSJ9203 and DSJ9206), 1993 (DSJ9304 and DSJ9307), 1994 (DSJ9403 and DSJ9406), 1995 (DSJ9506), 1996 (DSJ9606), and 1997 (DSJ9707) have been published (Schwing et al. 1990; Johnson et al. 1992; Sakuma et al. 1994a; Sakuma et al. 1994b; Sakuma et al. 1995a; Sakuma et al. 1995b; Sakuma et al. 1996; Sakuma et al. 1997; Sakuma et al.

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[1]Adams, P. B. (editor). 1995. Progress in rockfish recruitment studies. SWFSC Admin. Rep. T-95-01, 51 p., unpublished report.

1999). A companion volume (Schwing and Ralston 1990[2]) 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. 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

Surface data were obtained from four NOAA National Data Buoy Center (NDBC) moored buoys located within the rockfish survey region. These four buoys are 46013 (Bodega Bay; 38°12'N, 123°18'W), 46026 (Farallones; 37°48'N, 122°42'W), 46012 (Half Moon Bay; 37°24'N, 122°42'W) and 46042 (Monterey Bay; 36°48'N, 122°24'W) (Appendix 2). Daily averages of sea surface temperature (SST) and the east and north wind components were calculated from hourly mean buoy measurements. The angle of the alongshore wind component, relative to north, was determined by a principal component analysis (PCA) of the daily-averaged wind data from each buoy. This angle can be thought of as the predominant direction toward which the wind blows.

Annual climatologies and variance were determined for SST and the alongshore wind component at each buoy with a biharmonic analysis of all daily mean data over the buoy's entire operating period. These operating periods were 1981 to 1996 for buoy 46013, 1982 to 1996 for buoy 46026, 1980 to 1996 for buoy 46012, and 1987 to 1996 for buoy 46042. The annual cycles were estimated by a least squares regression of the data to an annual and semiannual harmonic signal of the form

$$SST(t) = A_0 + A_1 \cos(2\pi t) + B_1 \sin(2\pi t) + A_2 \cos(4\pi t) + B_2 \sin(4\pi t)$$

where t is the Julian Day/365 and the A_i and B_i are coefficients determined by regression at each buoy. The fits were not improved significantly by including higher harmonics. Standard errors were calculated for each Julian day, then fit with the same biharmonic model.

Juvenile Rockfish Survey Design

Annual cruises aboard the NOAA R/V 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. During 1990, an

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[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.

additional single sweep was conducted during March-April. Starting in 1987, a CTD cast was conducted at each trawl station occupied. In addition, daytime activities were restructured to permit sampling of a new grid of standard CTD stations (Appendix 2). 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.

Collection of CTD Data at Sea

All CTD data from the 1990 rockfish surveys presented in this report were collected with two Sea-Bird Electronics, Inc. SEACAT-SBE-19 profilers[3]. The first unit contained 64K of memory, while the second unit contained 256K. Both units were rated to a depth of 600 m. 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. The profilers were recalibrated annually by Sea-Bird Electronics, Inc. prior to their use at sea.

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 at least one minute to allow the conductivity and temperature sensors to equilibrate. The rate of descent was 60 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 cast index number, (5) the trawl station number (when appropriate), (6) latitude, (7) longitude, (8) bucket temperature, and (9) bottom depth in meters. Position fixes were obtained using LORAN-C. Bucket temperatures were obtained from a continuous flow of surface water pumped into one of the vessel's laboratory sinks where a thermometer was submerged in a collection container. All 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.

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

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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.

and &&& is the three-digit consecutive cast index number. After uploading, the profiler was reinitialized and the *.HEX files on the personal computer were backed-up on diskette.

Data Processing

The first step in data processing was to convert the uploaded CTD *.HEX files to ASCII files. This was accomplished using the SEASCII program supplied by Sea-Bird Electronics, Inc. (SEASOFT Version 3.4[4]). The data were then analyzed with a FORTRAN program that performed the following functions: (1) removal of the equilibration phase from the data stream; (2) removal of the upcast or retrieval phase from the data stream; (3) removal of extreme outliers (i.e., data spikes); (4) correcting phase differences in sensor response by reverse-lagging temperature data

$$\text{(i.e., } T_i = T_i + 0.9[T_{i+1} - T_i]\text{)}$$

(5) smoothing conductivity and temperature values using {1,4,6,4,1} weighting; (6) computing salinity and density for each scan using algorithms adapted from programs supplied by Sea-Bird Electronics, Inc. (SEASOFT, version 3.4[6]); (7) averaging temperature, salinity, and density values into one m depth bins, and ; (8) smoothing these using {1,2,3,2,1} weighting. A detailed discussion of the rationale behind these procedures may be found in the SEACAT-SBE-19 Conductivity, Temperature, Depth Recorder Operating and Repair Manual[5] [see also UNESCO (1988)]. Data were converted to their final ASCII format using a SAS[6] macro. All data were subsequently transferred to a SUN file server.

Each CTD ASCII file was manually edited to remove outliers (i.e. data spikes) in salinity and/or density, which had not been removed by the FORTRAN program. These outliers often occurred near the surface and at the thermocline.

Processed hydrographic data were summarized, by cruise and sweep, in a series of horizontal maps and vertical transects, and are presented in this report. Although additional CTD casts were done during DSJ9005, 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 5). This was done in an attempt to generate a relatively synoptic picture for each individual sweep and to allow for sweep to sweep comparisons of hydrographic features. The offshore extent of casts used in the vertical transects is shown in Appendix 6. Contouring of CTD data for horizontal maps and vertical transects was done using SURFER FOR WINDOWS graphics

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[6]CTD Data Acquisition software, SEASOFT Version 3.4, September 1990, 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.

[7]SEACAT-SBE-19 Conductivity, Temperature, Depth Recorder Operating and Repair Manual, Serial Number 24, 30 March 1987, 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.

[8]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.

software[7], which estimates values throughout a specified region based on the available data. Kriging was selected as the optimal interpolation method used for the algorithm grid (cf., Cressie 1991).

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: Lists of CTD Stations Summarized from Cruises DSJ9003 and DSJ9005

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 DSJ9003 (March 29-April 4) includes 87 stations (casts 1-87). Cruise DSJ9005, Sweep 1 (May 13-21) includes 102 standard stations (casts 1-106), Sweep 2 (May 22-30) includes 106 standard stations (casts 110-227), and Sweep 3 (June 1-10) includes 104 standard stations (casts 233-337).

Appendix 2: CTD Stations and Bathymetric Maps of Survey Region with Locations of the NDBC Buoys

The locations of the CTD stations for DSJ9003 and the standard CTD stations for DSJ9005 along with the locations of the NDBC buoys, the place names, and the bottom bathymetry of the survey areas are shown.

Appendix 3: Meteorological Time Series

Time series of daily-averaged SST and alongshore wind are presented for January-June 1990 based on data available from the four NOAA NDBC buoys located within the survey region. In each plot, the bold solid line represents the daily-mean values of the parameter. The bold dotted line represents the biharmonic fit to the climatology derived from daily data over the operating period of the buoy to date. The gray shaded envelope about the biharmonic fit line is ±1 standard error of the daily values on each Julian day. Negative values denote southward (upwelling-favorable) winds. The "PCA direction" on the alongshore wind plots represent the direction of the alongshore wind relative to north, which was derived from a principal component analysis.

Appendix 4: Horizontal Maps of CTD Data

Horizontal maps of temperature (°C), salinity (psu) 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 480 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

[9]SURFER FOR WINDOWS, Golden Software, Inc., 809 14th Street, Golden, Colorado 80401. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

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 0.5°C, 0.05 psu and 0.1 kg/m^3, respectively for depths 2-100 m. For the 200- to 480-m depths, the contour intervals were lowered to 0.1°C, 0.02 psu, and 0.02 kg/m^3.

Appendix 5: Vertical Transects

Vertical transects of temperature, salinity and density are presented for four cross-shelf transects off Pt. Reyes, the Farallones, Pescadero, and Davenport for DSJ9003 and DSJ9005. 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 psu for salinity, and 0.2 kg/m^3 for density.

Synopsis of Hydrographic Conditions

A series of strong southward (upwelling-favorable) wind events preceded the March-April 1990 survey (DSJ9003). However wind forcing during the cruise was very weak. Buoy SSTs were unseasonably cool in the months prior to this survey, but rose rapidly under these weak winds to near-normal by the end of the survey.

Ocean conditions indicated the effects of the recent winds. In the upper 100-150 m, the dominant ocean pattern was a strong alongshore gradient separating recently upwelled cool, saline water along the coast from the relatively warm and fresh offshore water associated with the southward flowing core of the California Current. This gradient is consistent with a generally southward flow over the entire survey region. The front created by the convergence of these two water types was deflected offshore by two upwelling jets off Half Moon Bay (37°N) and the Gulf of the Farallones, south of Pt. Reyes (37.5°N). The weak winds enhanced the relaxation of offshore water toward the coast, resulting in warmer and fresher conditions and a stronger front. Upper ocean salinities were 0.2-0.3 psu lower than for a mid-April 1988 survey (Johnson et al. 1992), but temperatures were similar. The relative lack of active upwelling during the survey is demonstrated by the flat isolines in the vertical sections. There was no surface signal of San Francisco Bay discharge. This is not surprising given that the preceding winter was abnormally dry. At 200 m and deeper, the most distinct feature is a warm, lower salinity eddy off Monterey Bay. A clockwise circulation is implied, consistent with that in the upper ocean.

Coastal upwelling was highly variable prior to and during the May-June 1990 survey (DSJ9005). Stronger than normal upwelling (southward) winds during sweep 1 produced unseasonably cool (10-11°C) buoy SSTs. These warmed steadily from sweep 1 (10-11°C) until early in sweep 3 (ca. 14°C), in response to several days of northward (downwelling) and weak southward winds. Southward winds returned during sweep 3, leading to cooler SSTs again late during the final sweep.

The cumulative effect of seasonal coastal upwelling is illustrated by relatively cool, saline water along the coast. This water flows offshore in a series of upwelling jets. The largest of these extends to the southwest off Pt. Reyes. This flow kept SSTs in the Gulf of the Farallones over 1°C cooler than normal during the entire survey (Baltz 1997). A second is visible in sweeps 1 and 2 as a bifurcated flow; the offshore branch is between Half Moon Bay and Pt. Año Nuevo (ca. 37°N) and the alongshore branch flows south into Monterey Bay. The pattern is typical of the southern portion of the survey region during the upwelling season (Rosenfeld et al. 1994). This feature is not seen during sweep 3, when the effects of downwelling (illustrated by the very warm buoy SSTs) were still evident. The upwelling jets are separated by a series of clockwise rotating eddies or meanders, identified by Baltz (1997) as persistent features in this region containing relatively warm, fresh water from the California Current.

Compared to the March-April survey, the range of temperature and salinity values was much greater, and the alongshore front was correspondingly much stronger and convoluted. This was especially apparent in sweep 3. The coolest and most saline upper ocean waters were seen near Pt. Reyes in the final sweep, during the strongest upwelling winds experienced for this survey. Robust upwelling also was suggested during sweep 1 in the southern half of the survey area.

A more subtle, but important characteristic of the spring 1990 survey is that water in the upper 100 m was fresher than usual (Baltz 1997). The implication is that the upper ocean contained a higher than normal percentage of California Current water during 1990. Baltz's principal component analysis of ten years of spring survey CTD data showed that the spatial pattern of the component associated with these low salinities resolves the Pt. Reyes jet and the adjacent offshore eddies quite well. The impression given by his analysis that a strong Pt. Reyes jet helped strengthen the clockwise flow of the offshore eddies and entrain a higher percentage of California Current water in them. These eddies intruded well into the continental shelf/slope region, bringing relatively fresh water onshore. The amplitude time series of this component was correlated with interannual variability in the total *Sebastes* juvenile abundance, and specifically the relatively low abundance in 1990. Baltz concluded that the temporal variability of this component "is a proxy for important environmental linkages to the fisheries ecosystem [that] play a significant role in determining year-class strength and distribution in fish species." Deeper water characteristics implied a stronger northward California Undercurrent.

ACKNOWLEDGEMENTS

The authors greatly acknowledge the officers and crew of the R/V *David Starr Jordan* and the researchers who participated in the pelagic juvenile rockfish surveys. Ralph Larson wrote the original FORTRAN program to process the CTD data. Additional thanks to Brian Jarvis for his continued maintenance of the CTDs and Gareth Penn for reviewing this document. Partial support for producing the document was provided by the US GLOBEC Northeast Pacific Project, with support from the NSF Division of Ocean Sciences and the NOAA Coastal Ocean Program Office.

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APPENDIX 1.1: LIST OF CTD STATIONS SUMMARIZED FROM CRUISE DSJ9003

DSJ9003

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
1	29MAR90	1:14	36 46.2	121 54	271
2	29MAR90	2:07	36 44.1	121 58.9	404
3	29MAR90	4:14	36 41.8	121 53.9	163
4	29MAR90	4:46	36 38.5	121 51.6	33
5	29MAR90	6:21	36 38.1	122 03.4	914
6	29MAR90	7:30	36 39.9	122 10	1139
7	29MAR90	8:15	36 40	122 15	1353
8	29MAR90	9:10	36 40	122 21.7	1646
9	29MAR90	10:00	36 34.9	122 21.5	2195
10	29MAR90	10:55	36 34.9	122 16.1	2195
11	29MAR90	11:49	36 35.5	122 10.1	2195
12	29MAR90	12:35	36 35	122 06.2	1280
13	29MAR90	13:20	36 35.1	122 02	402
14	29MAR90	16:53	36 30	122 04	896
15	29MAR90	17:55	36 30	122 10	1280
16	29MAR90	19:56	36 34.9	122 10.5	2231
17	29MAR90	23:20	36 35.7	122 02	124
18	29MAR90	23:54	36 39.5	121 57.2	77
19	30MAR90	1:56	36 40	122 04.6	790
20	30MAR90	2:41	36 42	122 06.4	1920
21	30MAR90	5:03	36 46.7	122 10.5	914
22	30MAR90	6:00	36 44.5	122 16.1	945
23	30MAR90	7:00	36 44.4	122 22.1	1573
24	30MAR90	7:42	36 44.5	122 27	2012
25	30MAR90	8:40	36 48.9	122 29.5	2103
26	30MAR90	9:50	36 48.9	122 35.9	1829
27	30MAR90	19:12	36 58.9	122 12.7	42
28	30MAR90	21:07	36 58.9	122 18.6	91
29	30MAR90	21:42	36 58.9	122 22.3	128
30	31MAR90	0:38	36 59	122 28	457
31	31MAR90	1:34	36 59	122 35.6	823
32	31MAR90	6:10	37 07.4	122 23.9	38
33	31MAR90	7:30	37 06.3	122 37.2	110
34	31MAR90	8:51	37 08.1	122 50.6	468
35	31MAR90	10:00	37 08	123 00	677
36	31MAR90	11:10	37 08	123 09.9	1829
37	31MAR90	12:30	37 16.4	123 10.1	1143
38	31MAR90	13:44	37 23.5	123 01.2	640
39	31MAR90	14:35	37 23.6	122 55.9	439
40	31MAR90	15:27	37 23.5	122 48.9	91
41	31MAR90	16:09	37 23.5	122 42.9	86
42	31MAR90	16:50	37 23.5	122 37.5	69
43	31MAR90	18:47	37 16.3	122 29	62
44	31MAR90	20:45	37 15.9	122 36.3	91
45	31MAR90	21:13	37 16.5	122 39.1	97
46	01APR90	1:13	37 16.2	122 51.1	238
47	01APR90	3:07	37 16.7	122 59	543
48	01APR90	6:30	37 24.6	122 59.1	481
49	01APR90	8:03	37 34.9	122 55.1	101
50	01APR90	9:39	37 35	123 07.5	1024
51	01APR90	11:11	37 39.6	123 23.5	2377
52	01APR90	12:40	37 47.2	123 21.5	485
53	01APR90	13:35	37 47.8	123 25.9	1463
54	01APR90	14:49	37 53	123 33.2	2195
55	01APR90	17:35	37 53	123 06.8	90
56	01APR90	20:26	37 38.7	123 03.4	112
57	01APR90	22:33	37 39.7	123 13.7	1244
58	02APR90	8:45	37 44.1	123 09.1	64

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
59	02APR90	1:10	37 48	123 21.6	88
60	02APR90	2:05	37 53	123 19.1	75
61	02APR90	5:56	37 51	123 30.9	1463
62	02APR90	9:10	38 04.9	123 02.7	66
63	02APR90	10:10	38 05.1	123 11	102
64	02APR90	11:10	38 05	123 19.8	146
65	02APR90	11:50	38 04.9	123 28.3	115
66	02APR90	12:43	38 09.9	123 28.6	287
67	02APR90	13:35	38 14.9	123 28.6	329
68	02APR90	14:40	38 14.6	123 20.7	128
69	02APR90	15:45	38 15	123 11.2	91
70	02APR90	16:30	38 15.2	123 03.3	55
71	02APR90	20:45	38 09.9	123 00.1	55
72	02APR90	22:10	38 09.6	123 05.6	80
73	02APR90	23:00	38 10	123 09.9	102
74	03APR90	0:57	38 08.9	123 18.9	128
75	03APR90	1:30	38 10	123 22	194
76	03APR90	6:55	37 55.6	123 34.2	2067
77	03APR90	14:20	37 58.8	123 21.3	112
78	03APR90	15:20	38 00.3	123 10	91
79	03APR90	17:00	37 47.8	123 03.7	59
80	03APR90	20:12	37 58.6	122 56.6	55
81	03APR90	21:47	37 55.7	122 50.9	46
82	03APR90	22:30	37 51.6	122 47.1	40
83	04APR90	0:36	37 46.8	122 54.3	57
84	04APR90	1:27	37 42	122 57.6	46
85	04APR90	1:57	37 41.6	122 55.1	57
86	04APR90	4:02	37 38	122 44.7	48
87	04APR90	4:32	37 35.9	122 42.7	48

APPENDIX 1.2: LIST OF CTD STATIONS SUMMARIZED FROM CRUISE DSJ9005

DSJ9005 Sweep 1

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
1	13MAY90	17:10	36 49	122 05	102
2	13MAY90	18:03	36 54	122 05	55
3	13MAY90	18:53	36 53	121 56	37
4	13MAY90	19:25	36 50.8	121 59	90
5	13MAY90	23:14	36 45.6	121 52.9	84
6	13MAY90	23:55	36 44.5	121 58.6	271
7	14MAY90	2:15	36 42.9	121 55.6	95
9	14MAY90	3:50	36 39.5	121 52.1	57
10	14MAY90	5:42	36 39.3	121 57	82
11	14MAY90	7:08	36 40	122 10	1134
12	14MAY90	8:30	36 49	122 11	549
13	14MAY90	9:27	36 49	122 17	1280
14	14MAY90	10:52	36 40	122 15	1134
15	14MAY90	11:55	36 40	122 21.5	1646
16	14MAY90	12:51	36 34.9	122 21.5	2286
17	14MAY90	13:42	36 35	122 16	2286
18	14MAY90	14:56	36 35	122 06	1372
19	14MAY90	15:50	36 30	122 04.1	896
20	14MAY90	16:45	36 30	122 10	1280
21	14MAY90	17:41	36 30	122 16.2	1353
22	14MAY90	18:40	36 30	122 22.5	1609
23	14MAY90	22:09	36 54	122 11	91
24	14MAY90	23:37	36 54	122 17	316
26	15MAY90	19:40	36 35	122 10.5	2323
27	16May90	0:37	36 34.7	122 03.3	786
28	16MAY90	1:28	36 38.8	122 03.1	732
29	16MAY90	3:43	36 42.7	122 07.2	1756
30	16MAY90	4:38	36 46.4	122 09	914
31	16MAY90	6:24	36 44.4	122 16	945
32	16MAY90	7:15	36 44.4	122 22	1591
33	16MAY90	8:05	36 44.4	122 27	2012
34	16MAY90	9:01	36 49	122 29.5	2103
35	16MAY90	9:56	36 49.5	122 36	1829
36	16MAY90	11:07	36 54	122 30	1134
37	16MAY90	12:01	36 54	122 36	1554
38	16MAY90	13:05	36 59.1	122 40.1	569
39	16MAY90	14:30	37 08	122 36.1	106
40	16MAY90	15:15	37 08	122 30	86
41	16MAY90	15:58	37 08	122 22.5	40
42	16MAY90	20:14	36 58.9	122 12.5	37
43	16MAY90	22:55	36 58.9	122 18.5	88
45	16MAY90	23:40	36 59	122 22.5	115
46	17MAY90	3:27	36 55.9	122 26.8	549
47	17MAY90	5:23	36 57.4	122 34.6	560
48	17MAY90	7:25	37 08	122 43	216
49	17MAY90	8:13	37 08	122 50	459
50	17MAY90	9:00	37 08	122 55.5	567
51	17MAY90	10:38	37 08	123 10	1829
52	17MAY90	12:00	37 16.5	123 10	1116
53	17MAY90	13:09	37 23.5	123 09.9	956
54	17MAY90	14:10	37 23.5	123 01.4	781
55	17MAY90	15:02	37 23.5	122 54.9	444
56	17MAY90	15:55	37 23.5	122 49	106
57	17MAY90	16:34	37 23.5	122 43	86
58	17MAY90	17:10	37 23.5	122 37.4	71
59	17MAY90	17:56	37 23.5	122 30	44
60	17MAY90	20:05	37 16.5	122 29	48
61	17MAY90	23:05	37 15.2	122 32.4	79

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
62	18MAY90	0:03	37 16.5	122 39.1	95
63	18MAY90	2:42	37 14.5	122 46.3	165
64	18MAY90	5:38	37 16.6	122 59.8	565
65	18MAY90	8:47	37 35	122 55	97
66	18MAY90	9:34	37 35	123 01.5	283
67	18MAY90	10:22	37 35	123 07.5	1079
68	18MAY90	11:57	37 39.5	123 17.5	1737
69	18MAY90	13:30	37 48	123 20	600
70	18MAY90	14:30	37 47.9	123 26	1372
71	18MAY90	15:37	37 53	123 25	271
72	18MAY90	16:44	37 53	123 15	101
73	18MAY90	17:54	37 48	123 12.5	90
74	18MAY90	20:45	37 37.9	122 46	53
75	18MAY90	23:15	37 42.5	122 54.9	55
76	18MAY90	23:40	37 42	122 58	49
77	19MAY90	0:35	37 47.5	122 52	55
78	19MAY90	2:45	37 50.1	122 46	38
79	19MAY90	3:40	37 54.9	122 51.6	48
80	19MAY90	4:20	37 58	122 56	49
81	19MAY90	11:30	37 53	123 07	90
82	19MAY90	12:20	37 47.4	123 03.5	71
83	19MAY90	20:10	37 39.4	123 02.5	106
84	19MAY90	23:15	37 40.7	123 12.7	1244
85	20MAY90	0:05	37 45	123 07.8	62
86	20MAY90	7:43	38 05	123 28.5	144
87	20MAY90	8:25	38 10	123 28.4	357
88	20MAY90	9:11	38 15	123 28.6	327
89	20MAY90	9:51	38 14.9	123 23.5	174
90	20MAY90	10:25	38 14.9	123 18.5	121
91	20MAY90	10:59	38 15	123 13.5	101
92	20MAY90	11:33	38 14.8	123 08.5	86
93	20MAY90	12:13	38 15.1	123 02.5	49
94	20MAY90	13:31	38 04.9	123 05.7	60
95	20MAY90	14:15	38 04.9	123 08.6	82
96	20MAY90	14:52	37 59.9	123 08.5	84
97	20MAY90	15:28	37 59.9	123 13.6	106
98	20MAY90	16:11	38 05	123 13.5	110
99	20MAY90	16:47	38 05	123 18.5	135
100	20MAY90	17:20	38 04.9	123 23.7	157
101	20MAY90	20:00	38 10	123 00	55
102	20MAY90	22:36	38 10.1	123 06.1	77
103	20MAY90	23:07	38 10	123 10	91
104	21MAY90	1:06	38 09.4	123 18.9	132
106	21MAY90	3:47	38 09.6	123 23.2	229

DSJ9005 Sweep 2

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
110	22MAY90	10:06	36 39.9	122 21.5	1646
111	22MAY90	10:56	36 39.9	122 15	1353
112	22MAY90	11:37	36 40	122 10	1134
113	22MAY90	12:36	36 34.9	122 05.9	1372
114	22MAY90	13:54	36 34.9	122 16	2286
115	22MAY90	14:47	36 35	122 21.6	2249
116	22MAY90	15:41	36 29.8	122 22.5	1609
117	22MAY90	16:32	36 30	122 16	1353
118	22MAY90	17:20	36 29.9	122 10	1280

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
119	22MAY90	18:10	36 30	122 04	896
120	22MAY90	19:55	36 35	122 10.5	2323
121	23MAY90	0:25	36 36.7	122 01.7	549
122	23MAY90	1:05	36 38.8	122 03.1	1152
123	23MAY90	3:06	36 43.5	122 06.7	1573
124	23MAY90	4:30	36 47.5	122 08.8	512
125	23MAY90	5:07	36 49	122 11	549
126	23MAY90	5:58	36 49	122 17	1280
127	23MAY90	6:52	36 54	122 17	329
128	23MAY90	7:38	36 54	122 11	91
129	23MAY90	8:18	36 54	122 04.4	51
130	23MAY90	9:05	36 52.9	121 56	33
131	23MAY90	10:17	36 44.5	122 02.5	732
132	23MAY90	20:00	36 39.3	121 56.8	79
133	23MAY90	23:25	36 39.4	121 51.9	55
134	24MAY90	0:05	36 42.6	121 54.7	88
135	24MAY90	2:05	36 44.2	121 57.1	104
136	24MAY90	2:43	36 46.1	121 51.9	69
137	24MAY90	4:40	36 50.1	121 57.8	113
138	24MAY90	6:30	36 44.4	122 16	945
139	24MAY90	7:21	36 44.4	122 22	1591
140	24MAY90	8:08	36 44.4	122 27	2012
141	24MAY90	9:03	36 49	122 29.6	2103
142	24MAY90	9:51	36 53.9	122 28.9	1134
143	24MAY90	10:43	36 54	122 36	1554
144	24MAY90	11:48	36 59	122 40	571
145	24MAY90	13:23	37 08	122 36	106
146	24MAY90	14:00	37 08.1	122 29.9	86
147	24MAY90	14:38	37 08	122 23.5	40
148	24MAY90	20:20	36 59	122 12.5	35
149	24MAY90	22:40	36 57.7	122 16.4	86
150	24MAY90	23:20	36 59	122 22.6	121
151	25MAY90	2:38	36 56.5	122 27.2	823
152	25MAY90	3:50	36 59	122 35.6	384
153	25MAY90	6:28	37 08	122 43	210
154	25MAY90	7:16	37 08	122 50	457
155	25MAY90	8:01	37 08	122 55.5	558
156	25MAY90	9:30	37 08	123 10	1829
157	25MAY90	10:38	37 16.5	123 10	1116
158	25MAY90	11:38	37 23.5	123 10	951
159	25MAY90	12:44	37 23.5	123 01.5	585
160	25MAY90	13:35	37 23.5	122 54.7	441
161	25MAY90	14:18	37 23.5	122 48.9	106
162	25MAY90	14:54	37 23.5	122 42.9	86
163	25MAY90	15:27	37 23.5	122 37.4	71
164	25MAY90	14:10	37 23.5	122 30	44
165	25MAY90	20:20	37 16.3	122 28.9	49
166	25MAY90	22:25	37 16.7	122 35.5	88
167	25MAY90	23:00	37 16.5	122 39	95
168	26MAY90	2:25	37 15.5	122 49.2	274
169	26MAY90	4:05	37 16.9	122 59.9	536
170	26MAY90	5:14	37 23.5	122 55	454
171	26MAY90	6:43	37 35	122 55	97
172	26MAY90	7:24	37 35	123 01.5	280
173	26MAY90	8:27	37 35	123 07.5	1079
185	27MAY90	4:56	37 39.5	123 23.5	2377
186	27MAY90	5:45	37 39.5	123 17.5	1737
187	27MAY90	7:08	37 48	123 12.5	82
188	27MAY90	7:58	37 48	123 20	768
189	27MAY90	8:51	37 48	123 26	1372

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
190	27MAY90	9:58	37 53	123 33	2213
191	27MAY90	11:05	37 53	123 25	265
192	27MAY90	12:12	37 52.9	123 14.9	93
193	27MAY90	13:03	37 52.8	123 07.1	91
194	27MAY90	14:00	37 47.5	123 03.4	73
195	27MAY90	20:17	37 39.5	123 02.4	101
196	27MAY90	23:20	37 38.9	123 10.9	1244
197	28MAY90	0:21	37 44.7	123 08.4	75
198	28MAY90	3:02	37 51.9	123 18.1	108
199	28MAY90	4:15	37 53	123 30	1463
200	28MAY90	5:12	37 52	123 28.6	1414
201	28MAY90	7:10	38 05	123 28.5	143
202	28MAY90	7:56	38 10	123 28.5	357
203	28MAY90	8:49	38 15	123 28.5	324
204	28MAY90	9:51	38 15	123 23.5	172
205	28MAY90	10:24	38 15	123 18.5	119
206	28MAY90	10:56	38 15	123 13.5	97
207	28MAY90	11:30	38 15	123 08.4	82
208	28MAY90	12:06	38 14.9	123 02.4	48
209	28MAY90	13:14	38 04.9	123 02.6	60
210	28MAY90	14:00	38 05	123 08.6	80
211	28MAY90	14:40	37 59.9	123 08.5	84
212	28MAY90	15:15	38 00	123 13.6	108
213	28MAY90	15:57	38 05	123 13.5	110
214	28MAY90	14:31	38 05	123 18.5	135
215	28MAY90	17:06	38 04.9	123 23.7	157
216	28MAY90	20:00	38 10	123 22	183
217	29MAY90	0:27	38 09.2	123 15.7	115
218	29MAY90	1:07	38 09.9	123 09.9	91
219	29MAY90	3:35	38 08.7	123 02.8	69
220	29MAY90	4:40	38 10.4	123 01.2	64
221	29MAY90	20:51	37 38	122 46	53
222	29MAY90	23:29	37 43.3	122 54.5	53
223	29MAY90	23:50	37 42	122 57.7	49
224	30MAY90	0:43	37 47.4	122 51.9	55
225	30MAY90	3:00	37 52.6	122 46.9	95
226	30MAY90	3:31	37 55	122 51.7	48
227	30MAY90	4:10	37 58	122 56	51

DSJ9005 Sweep 3

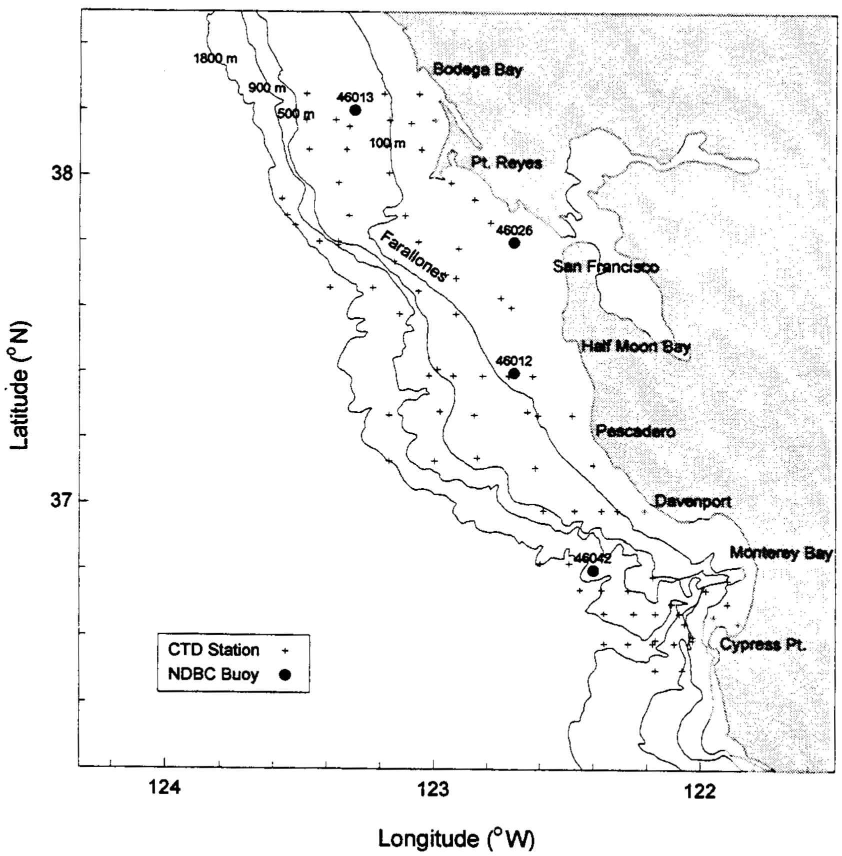
CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
233	01JUN90	11:15	36 54	122 17	291
234	01JUN90	12:00	36 49	122 17	1280
235	01JUN90	12:55	36 49	122 10.9	443
236	01JUN90	13:51	36 54	122 11	91
237	01JUN90	14:35	36 54	122 04.4	51
238	01JUN90	15:15	36 48.9	122 05.1	102
239	01JUN90	15:55	36 44.4	122 02.5	732
240	01JUN90	18:47	36 53	121 56	35
241	01JUN90	19:55	36 50.9	121 59	84
242	01JUN90	22:55	36 45	121 51.8	60
243	01JUN90	23:44	36 44.4	121 58.7	326
244	02JUN90	1:51	36 41.2	121 54.9	86
245	02JUN90	2:30	36 38.6	121 51.1	48
246	02JUN90	4:57	36 39.4	121 57.8	91
247	02JUN90	6:12	36 40	122 10	1134

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
248	02JUN90	6:55	36 40	122 15	1353
249	02JUN90	7:47	36 40	122 21.5	1646
250	02JUN90	8:56	36 37.6	122 31	2377
251	02JUN90	10:10	36 35	122 21.5	2195
253	02JUN90	12:08	36 35.1	122 05.9	1372
254	02JUN90	15:05	36 30	122 04.2	914
255	02JUN90	16:00	36 30	122 10	1280
256	02JUN90	16:54	36 30	122 16	1353
257	02JUN90	17:45	36 30	122 22.5	1609
258	02JUN90	20:05	36 34.9	122 10.6	2323
259	03JUN90	0:17	36 33.2	122 01.7	869
260	03JUN90	1:30	36 38.9	122 03.2	914
261	03JUN90	3:30	36 40.9	122 06.7	1920
262	03JUN90	5:07	36 45.2	122 08.8	914
263	03JUN90	12:48	36 44.4	122 16.1	933
264	03JUN90	1:45	36 44.4	122 22.1	1017
265	03JUN90	2:35	36 44.4	122 27.1	2012
266	03JUN90	15:33	36 49	122 29.6	2012
267	03JUN90	16:30	36 49	122 36	1829
268	03JUN90	17:25	36 54.1	122 36.1	1554
269	03JUN90	20:12	36 58.8	122 12.4	35
270	03JUN90	22:50	36 57.3	122 16.6	91
271	04JUN90	0:29	36 59.8	122 22.6	117
272	04JUN90	2:13	36 57.2	122 25.1	243
273	04JUN90	4:54	36 57	122 35.1	636
274	04JUN90	5:55	36 54	122 30	1084
275	04JUN90	8:25	37 08	122 23.5	40
276	04JUN90	9:10	37 08	122 30	84
277	04JUN90	9:51	37 08	122 36.8	104
278	04JUN90	10:40	37 08	122 43	214
279	04JUN90	19:58	36 59	122 30	174
280	05JUN90	6:00	37 08	122 50	457
281	05JUN90	10:02	37 35	122 33	51
282	05JUN90	13:08	37 42	122 58.1	49
283	05JUN90	15:35	37 55	122 51.6	46
284	05JUN90	20:31	37 58	122 56	49
285	05JUN90	22:59	37 51.2	122 46.3	40
286	06JUN90	0:04	37 47.5	122 52	55
287	06JUN90	1:55	37 40.9	122 53.4	57
288	06JUN90	2:43	37 37.9	122 45.9	51
289	06JUN90	5:13	37 23.4	122 30	44
290	06JUN90	6:05	37 23.5	122 37.5	69
291	06JUN90	6:45	37 23.5	122 43	86
292	06JUN90	7:25	37 23.5	122 49	106
293	06JUN90	8:05	37 23.5	122 55	454
294	06JUN90	9:00	37 23.5	123 01.6	812
295	06JUN90	10:04	37 23.5	123 10	978
296	06JUN90	11:09	37 16.5	123 10	1042
297	06JUN90	12:19	37 07.9	123 10	1829
298	06JUN90	13:48	37 08	122 55.5	550
299	06JUN90	14:37	37 08.1	122 49.9	448
300	06JUN90	20:29	37 16.4	122 29	46
301	06JUN90	21:32	37 16.5	122 34	84
302	06JUN90	23:28	37 14.9	122 38.5	95
303	07JUN90	0:35	37 16.6	122 49	176
304	07JUN90	4:07	37 16.7	122 59.5	547
305	07JUN90	6:38	37 35	122 55	97
306	07JUN90	7:20	37 35	123 01.5	262
307	07JUN90	8:06	37 35	123 07.5	1079
308	07JUN90	9:30	37 39.1	123 17.7	1737

CAST	DATE	TIME	LATITUDE	LONGITUDE	DEPTH(M)
309	07JUN90	10:25	37 39.5	123 23.5	2377
310	07JUN90	12:08	37 47.9	123 20.1	624
311	07JUN90	13:07	37 47.9	123 26	1372
312	07JUN90	14:40	37 52.8	123 33.1	2213
313	07JUN90	15:45	37 53	123 25	293
314	07JUN90	17:05	37 53	123 15	97
315	08JUN90	6:40	38 05	123 02.5	59
316	08JUN90	7:25	38 05	123 08.5	82
317	08JUN90	8:02	38 00	123 08.5	84
318	08JUN90	8:38	38 00	123 13.5	104
319	08JUN90	9:32	38 05	123 13.5	110
320	08JUN90	10:12	38 05	123 18.5	134
321	08JUN90	10:55	38 05	123 23.5	157
322	08JUN90	11:37	38 05	123 28.5	141
323	08JUN90	12:31	38 10	123 28.6	358
324	08JUN90	13:31	38 14.9	123 28.5	326
325	08JUN90	14:15	38 14.9	123 23.5	172
326	08JUN90	14:53	38 14.9	123 18.6	123
327	08JUN90	15:29	38 14.9	123 13.6	99
328	08JUN90	16:04	38 15	123 08.5	88
329	08JUN90	16:42	38 15	123 02.5	51
330	09JUN90	20:31	37 39.4	123 02.4	106
331	09JUN90	23:19	37 38.8	123 10.8	1244
332	10JUN90	0:25	37 45	123 08	62
333	10JUN90	3:25	37 51.2	123 18.3	108
334	10JUN90	5:16	37 53.2	123 30.6	1463
335	10JUN90	20:36	38 10	123 00	51
336	10JUN90	22:49	38 09.9	123 05.8	79
337	10JUN90	23:25	38 10	123 09.9	91

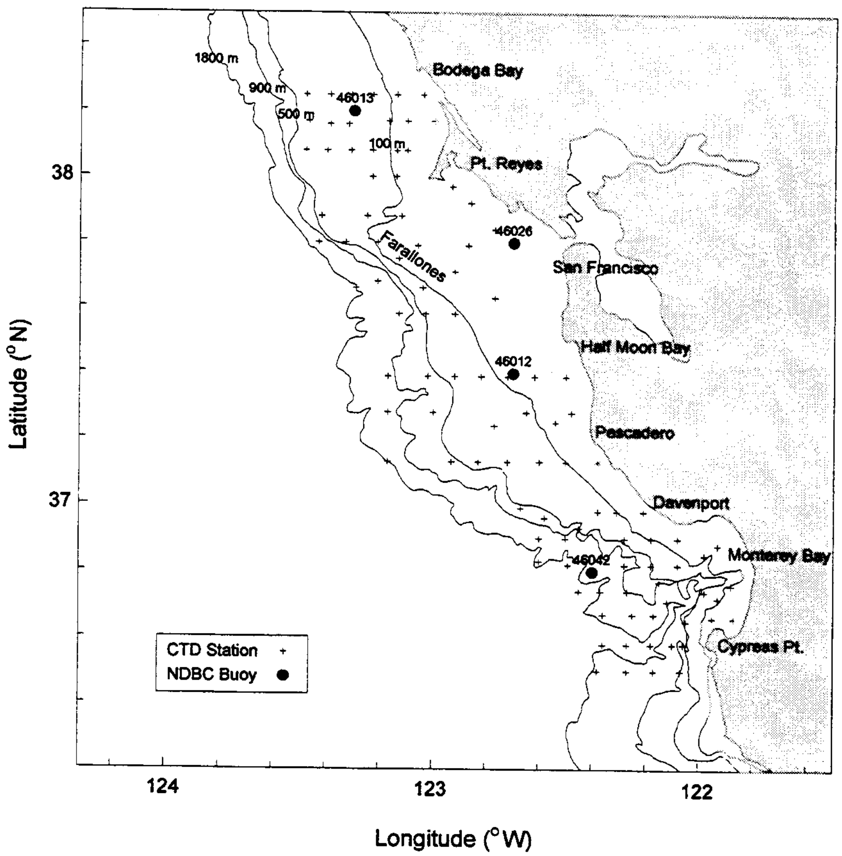
APPENDIX 2.1: DSJ9003 CTD STATIONS AND BATHYMETRIC MAP OF SURVEY REGION WITH LOCATIONS OF THE NDBC BUOYS

DSJ9003 CTD Station Locations



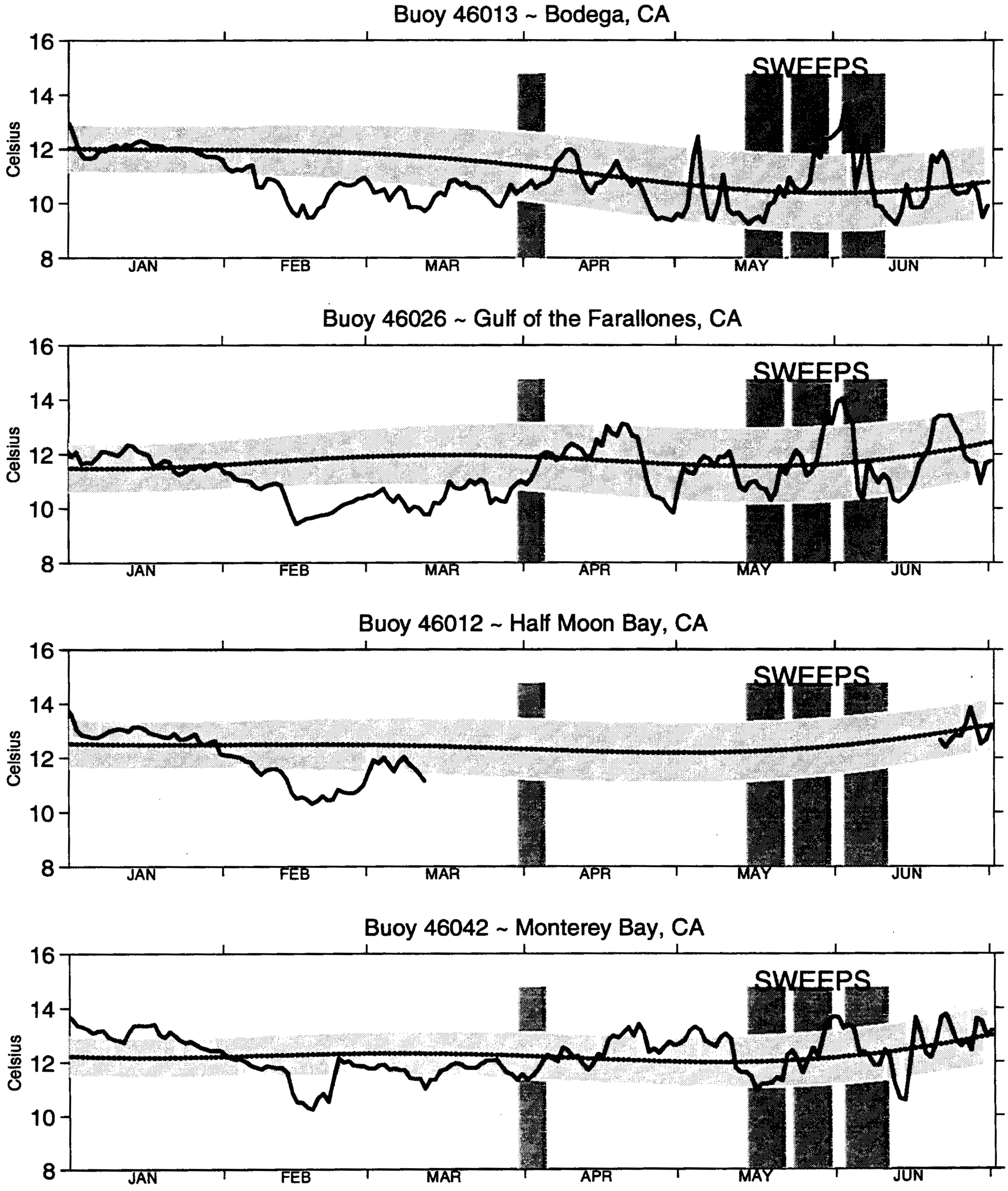
APPENDIX 2.2: DSJ9005 CTD STATIONS AND BATHYMETRIC MAP OF SURVEY REGION WITH LOCATIONS OF THE NDBC BUOYS

DSJ9005 CTD Station Locations

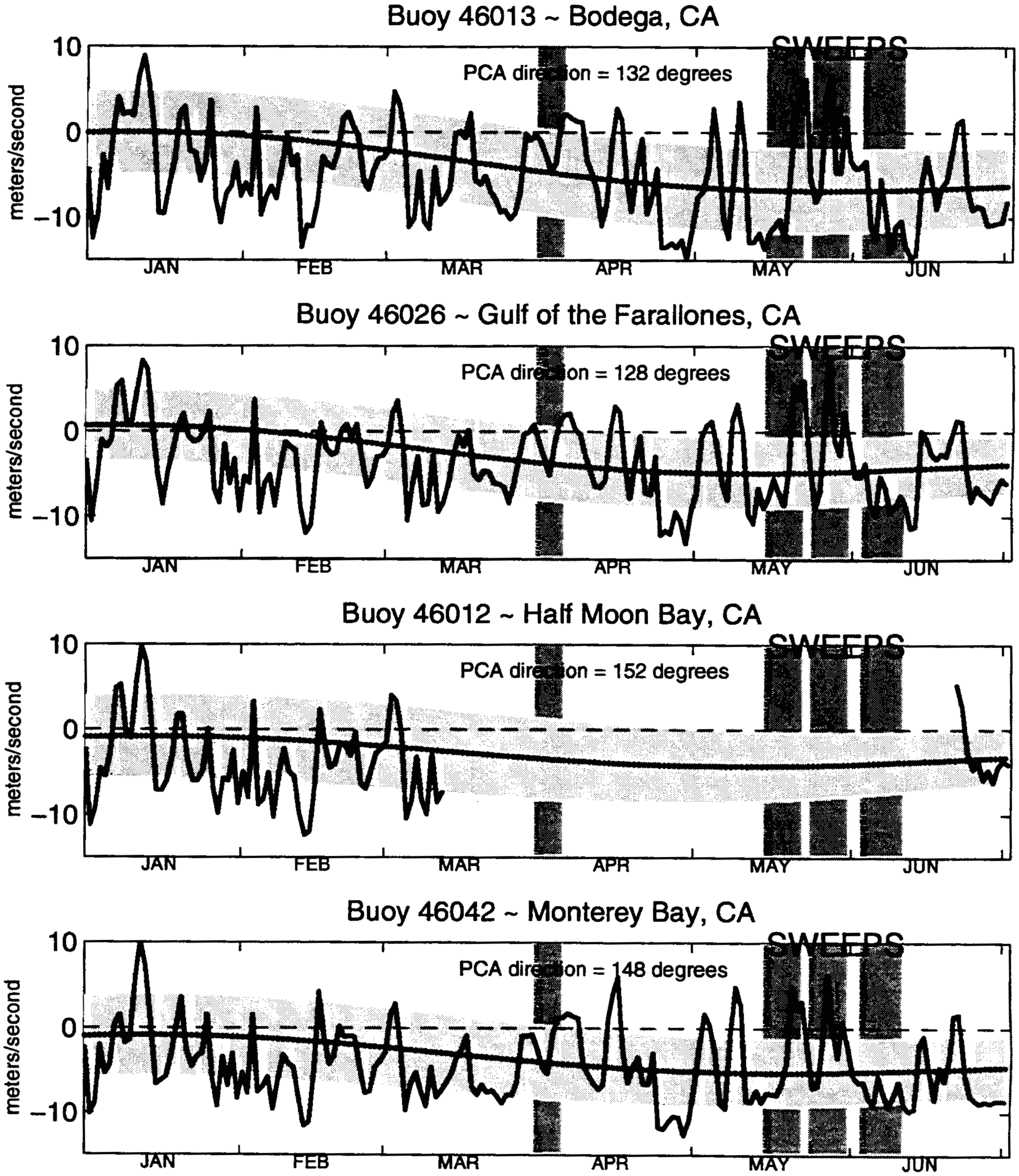


APPENDIX 3: METEOROLOGICAL TIME SERIES

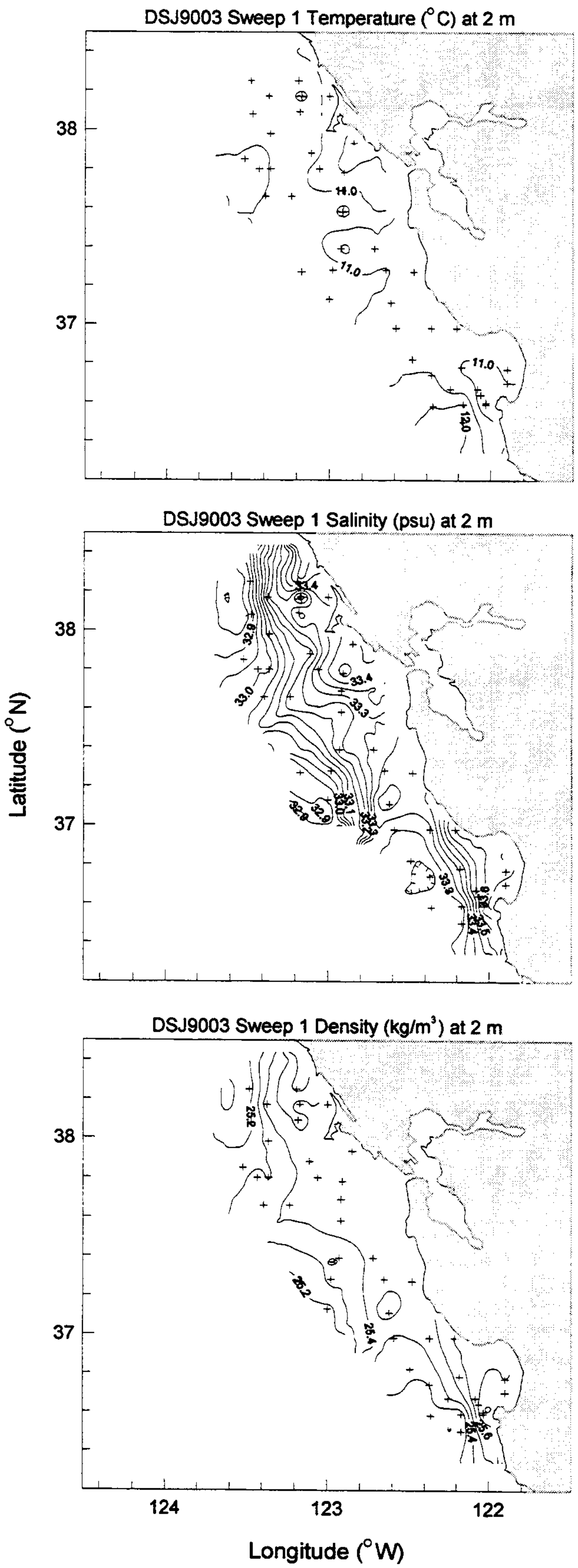
Sea Surface Temperatures from NOAA NDBC Buoys ~1990

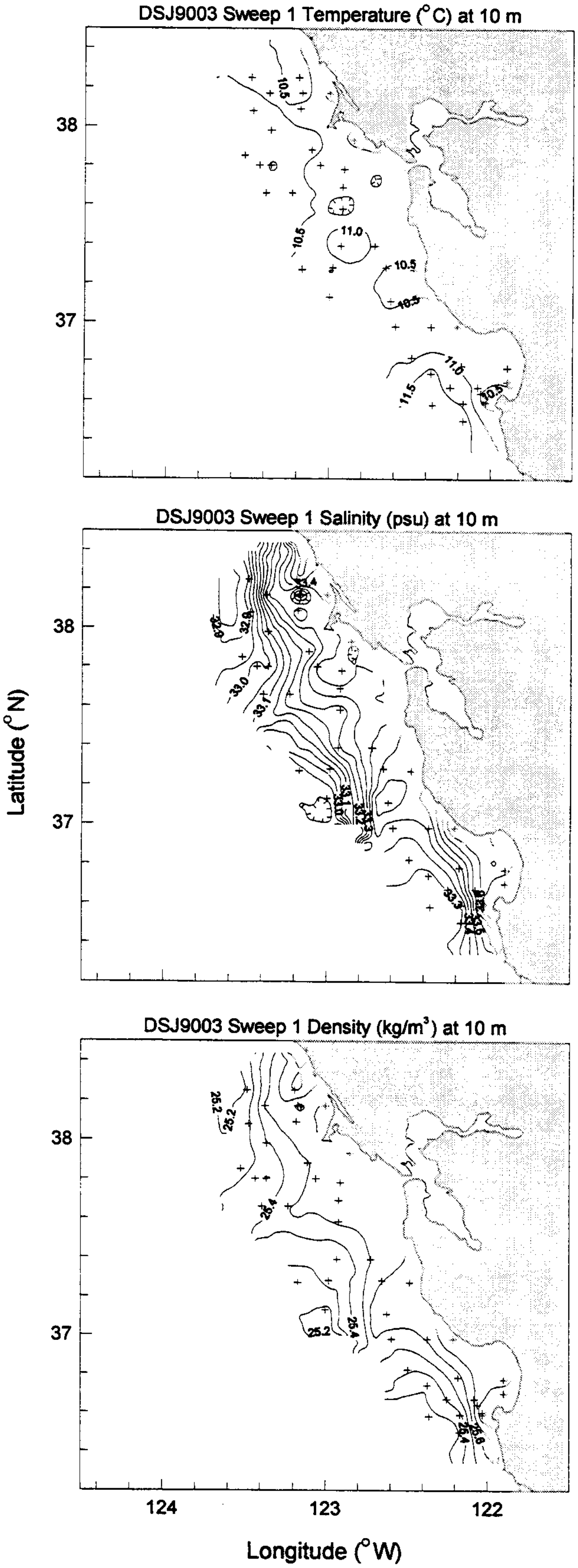


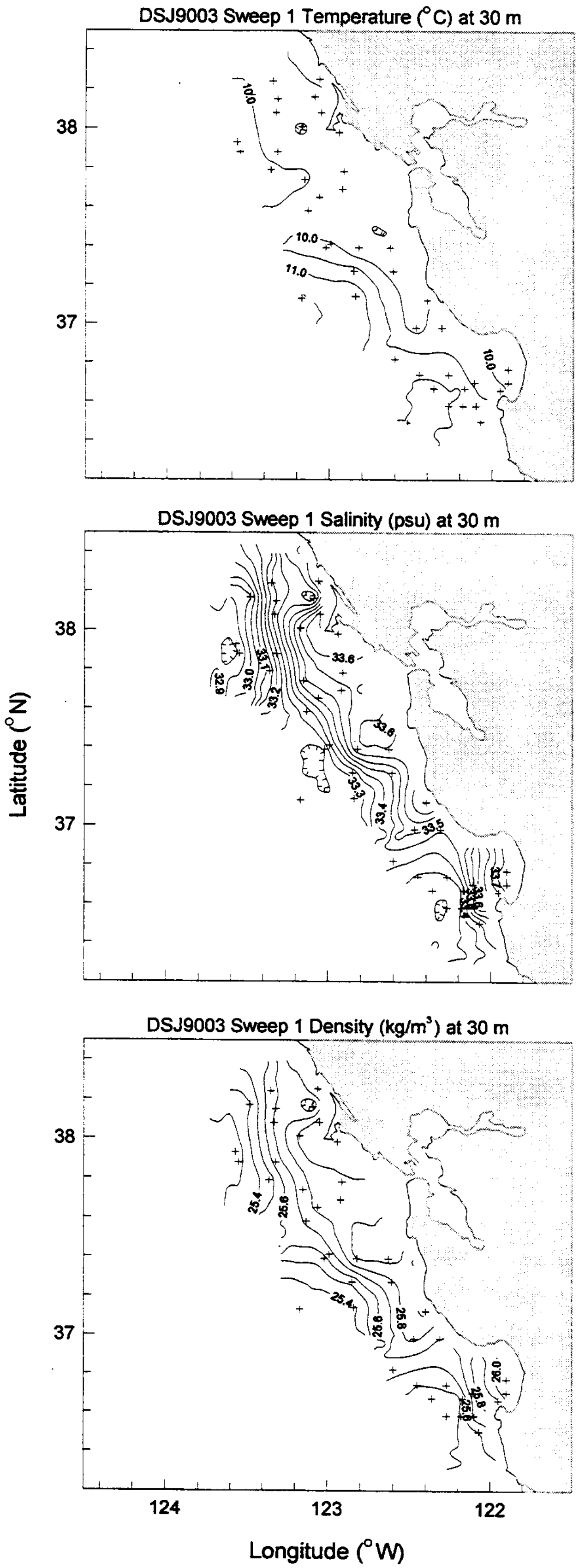
Alongshore Winds from NOAA NDBC Buoys ~ 1990

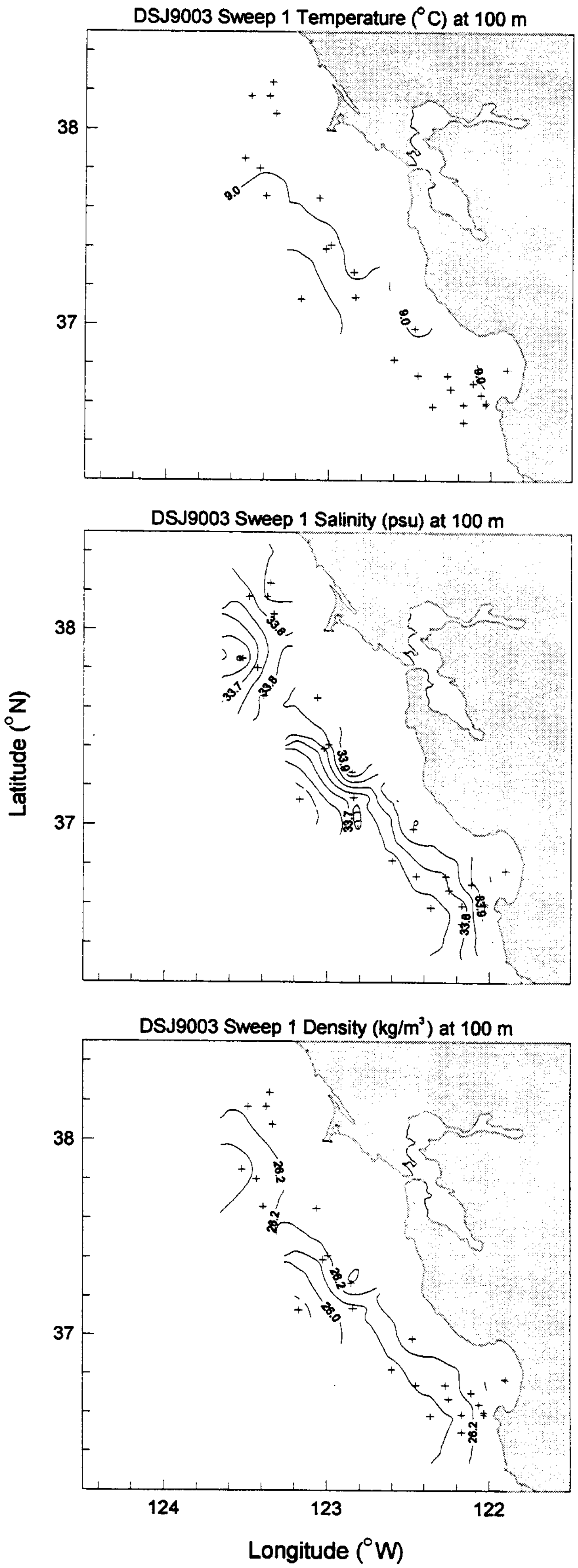


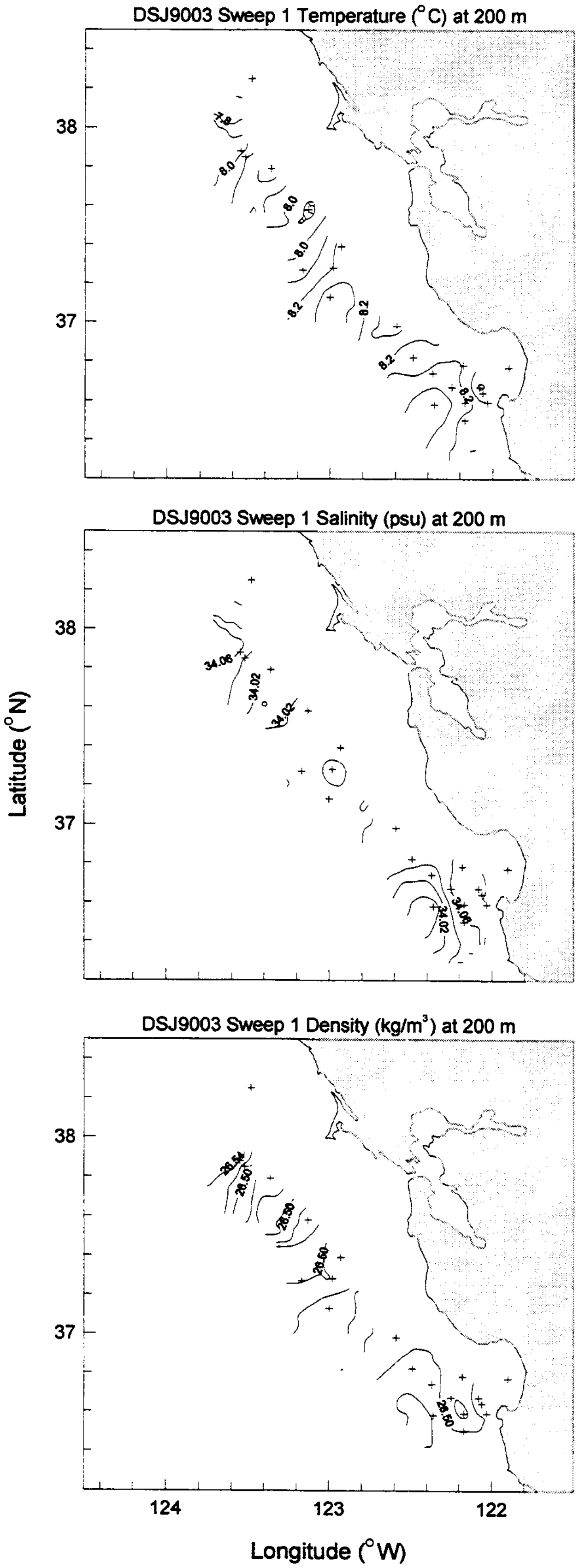
APPENDIX 4.1: HORIZONTAL MAPS OF CTD DATA FOR DSJ9003

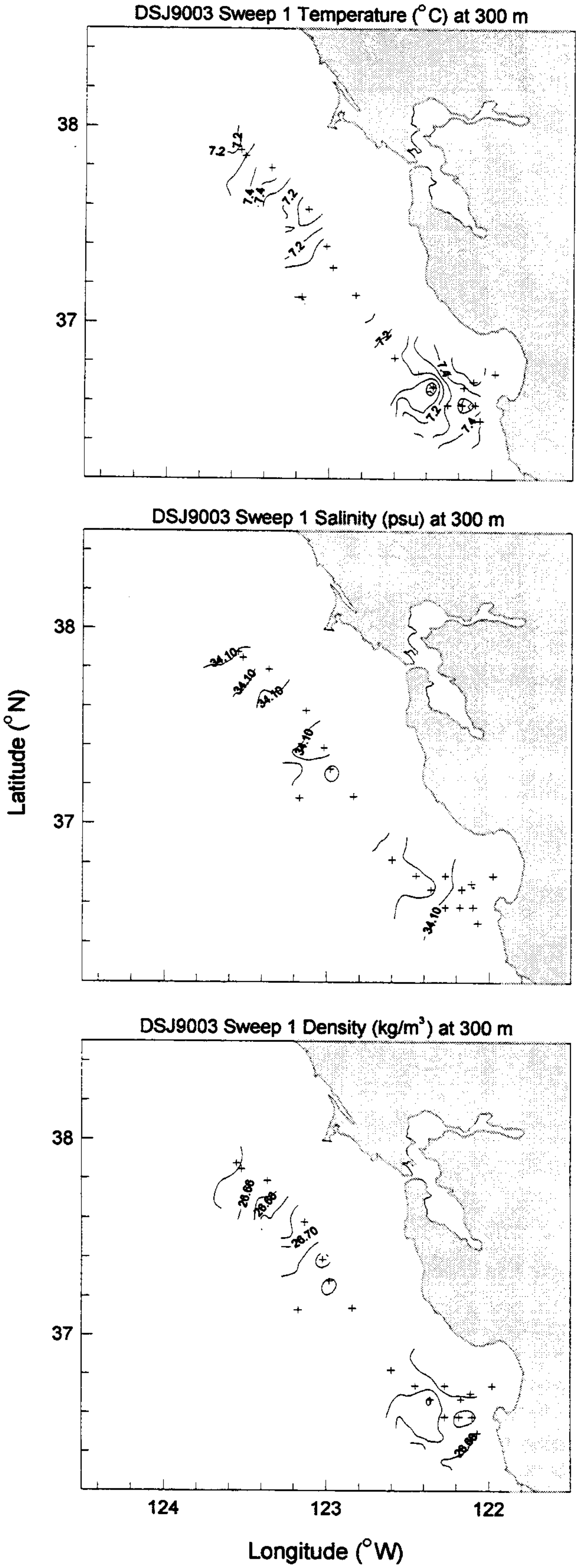

DSJ9003 Sweep 1 Temperature (°C) at 2 m
14.0
11.0
11.0
12.0
DSJ9003 Sweep 1 Salinity (psu) at 2 m
33.4
32.9
33.4
33.0
33.3
32.8
32.9
33.0
33.1
33.2
33.3
33.6
33.4
DSJ9003 Sweep 1 Density (kg/m³) at 2 m
25.2
25.2
25.4
25.6
25.4
38
37
Latitude (°N)
124
123
122
Longitude (°W)


DSJ9003 Sweep 1 Temperature (°C) at 10 m
DSJ9003 Sweep 1 Salinity (psu) at 10 m
DSJ9003 Sweep 1 Density (kg/m³) at 10 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)

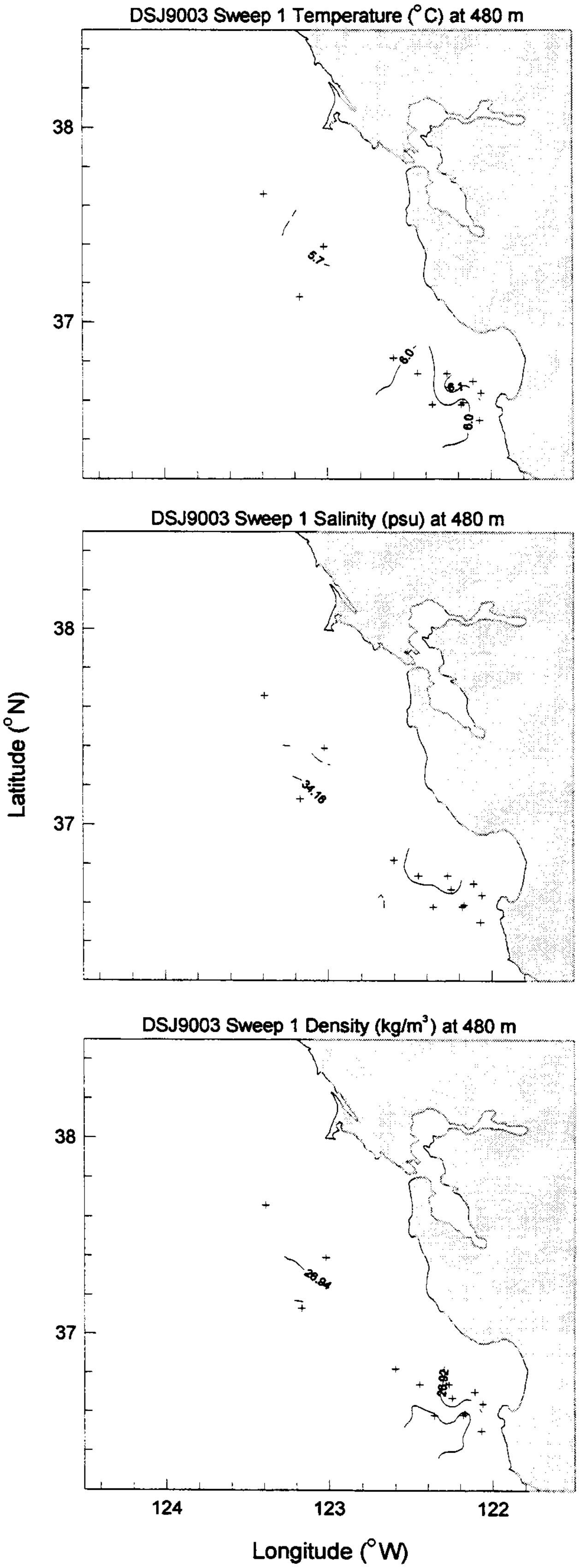

DSJ9003 Sweep 1 Temperature (°C) at 30 m
10.0
11.0
DSJ9003 Sweep 1 Salinity (psu) at 30 m
33.6
32.9
33.0
33.1
33.2
33.3
33.4
33.5
33.7
DSJ9003 Sweep 1 Density (kg/m³) at 30 m
25.4
25.6
25.8
26.0
38
37
Latitude (°N)
124
123
122
Longitude (°W)


DSJ9003 Sweep 1 Temperature (°C) at 100 m
DSJ9003 Sweep 1 Salinity (psu) at 100 m
DSJ9003 Sweep 1 Density (kg/m³) at 100 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)

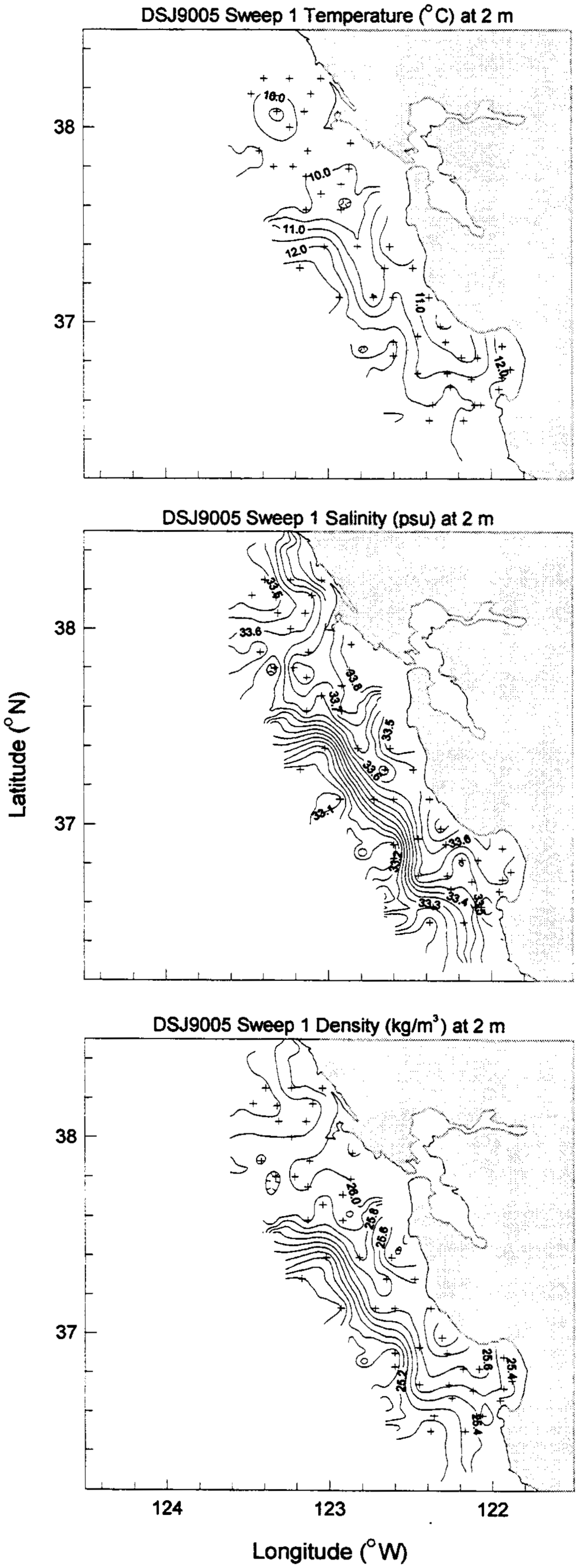

DSJ9003 Sweep 1 Temperature (°C) at 200 m
DSJ9003 Sweep 1 Salinity (psu) at 200 m
DSJ9003 Sweep 1 Density (kg/m³) at 200 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)

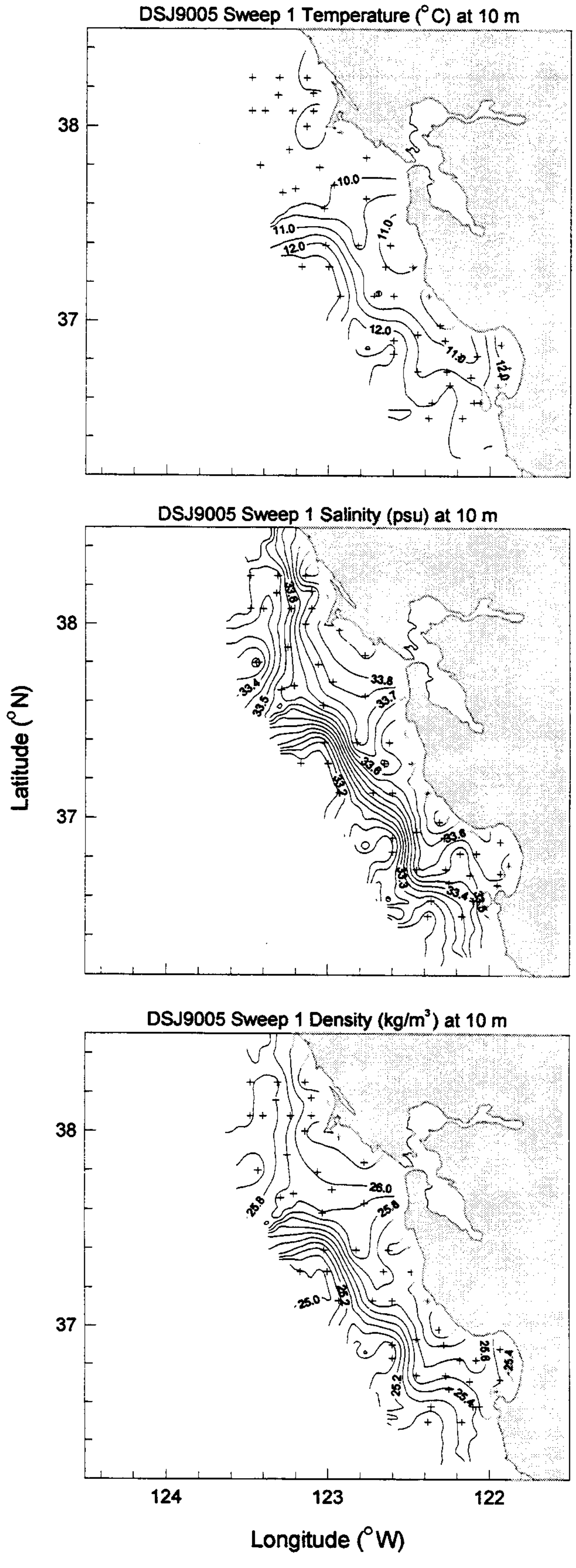


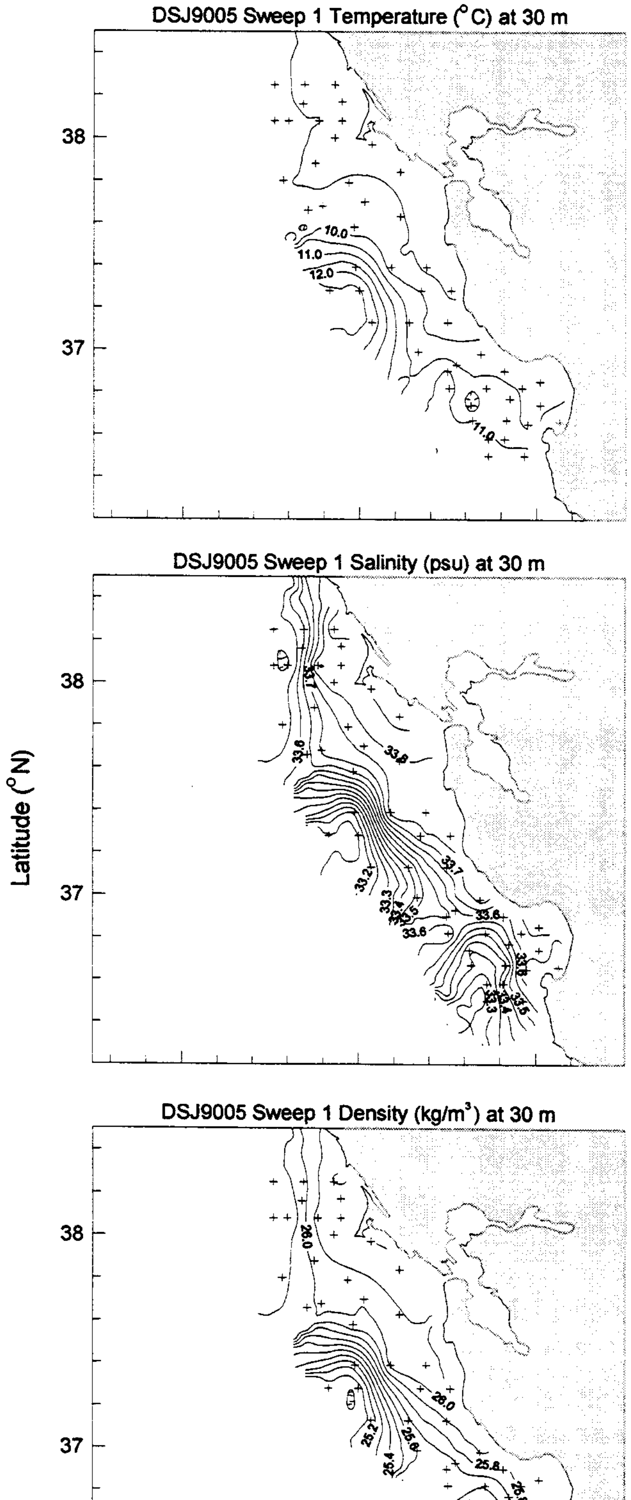
DSJ9003 Sweep 1 Temperature (°C) at 300 m
DSJ9003 Sweep 1 Salinity (psu) at 300 m
DSJ9003 Sweep 1 Density (kg/m³) at 300 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122

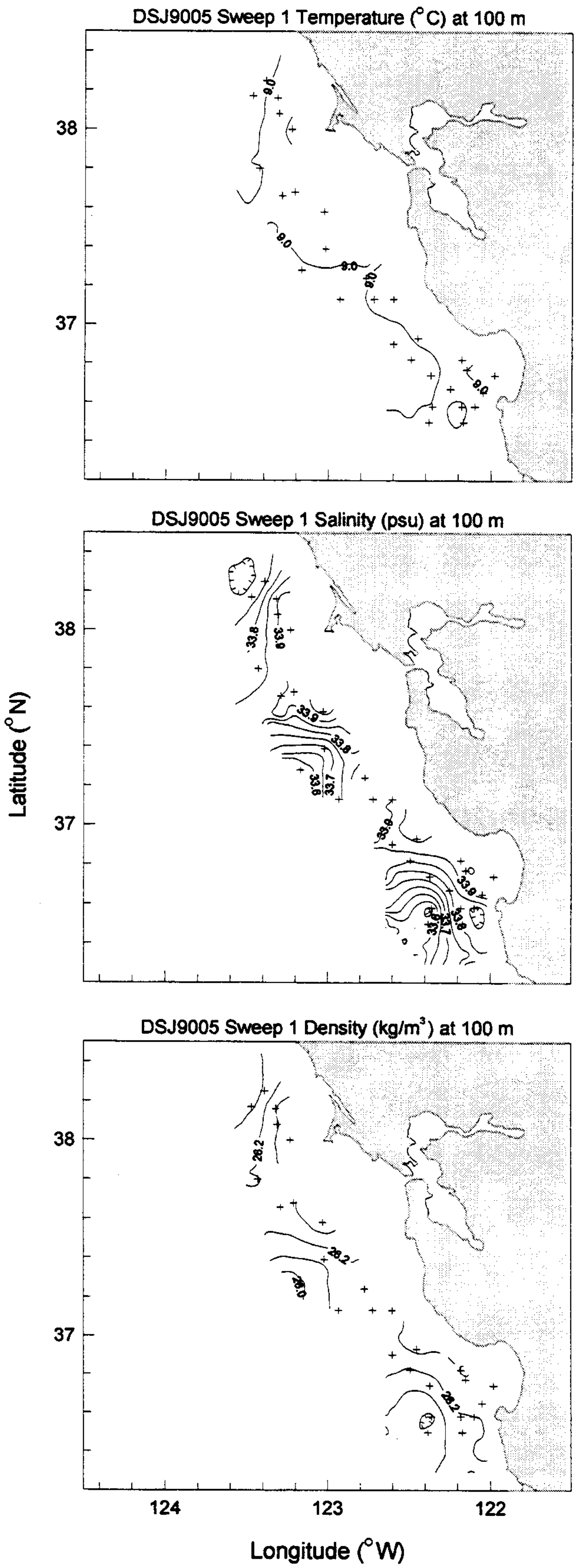

DSJ9003 Sweep 1 Temperature (°C) at 480 m
DSJ9003 Sweep 1 Salinity (psu) at 480 m
DSJ9003 Sweep 1 Density (kg/m³) at 480 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)

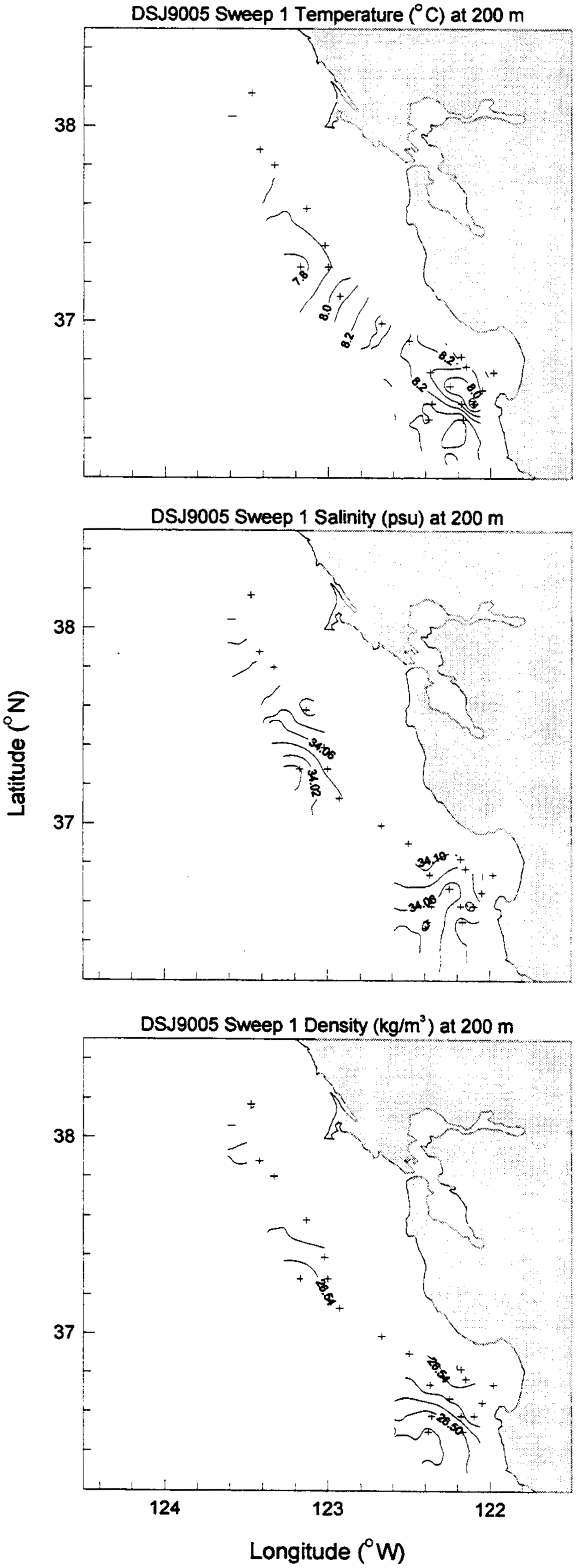
APPENDIX 4.2: HORIZONTAL MAPS OF CTD DATA FOR DSJ9005, SWEEP 1

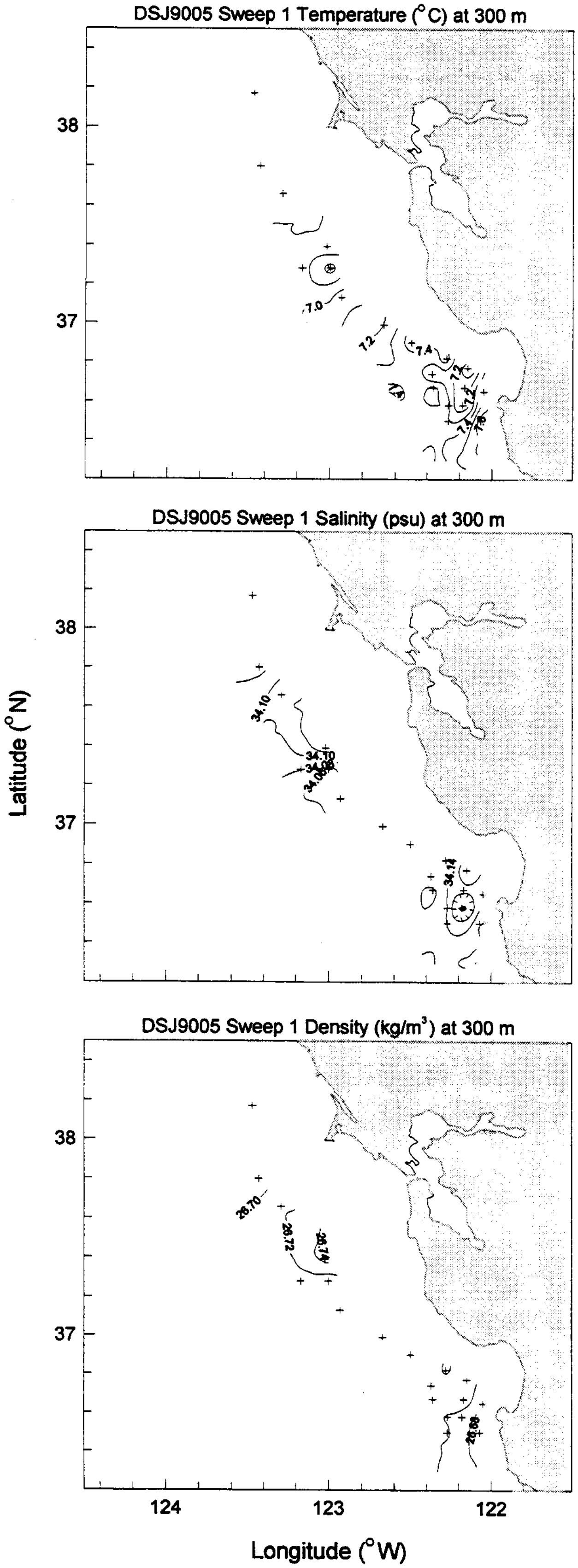

DSJ9005 Sweep 1 Temperature (°C) at 2 m
DSJ9005 Sweep 1 Salinity (psu) at 2 m
DSJ9005 Sweep 1 Density (kg/m³) at 2 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)

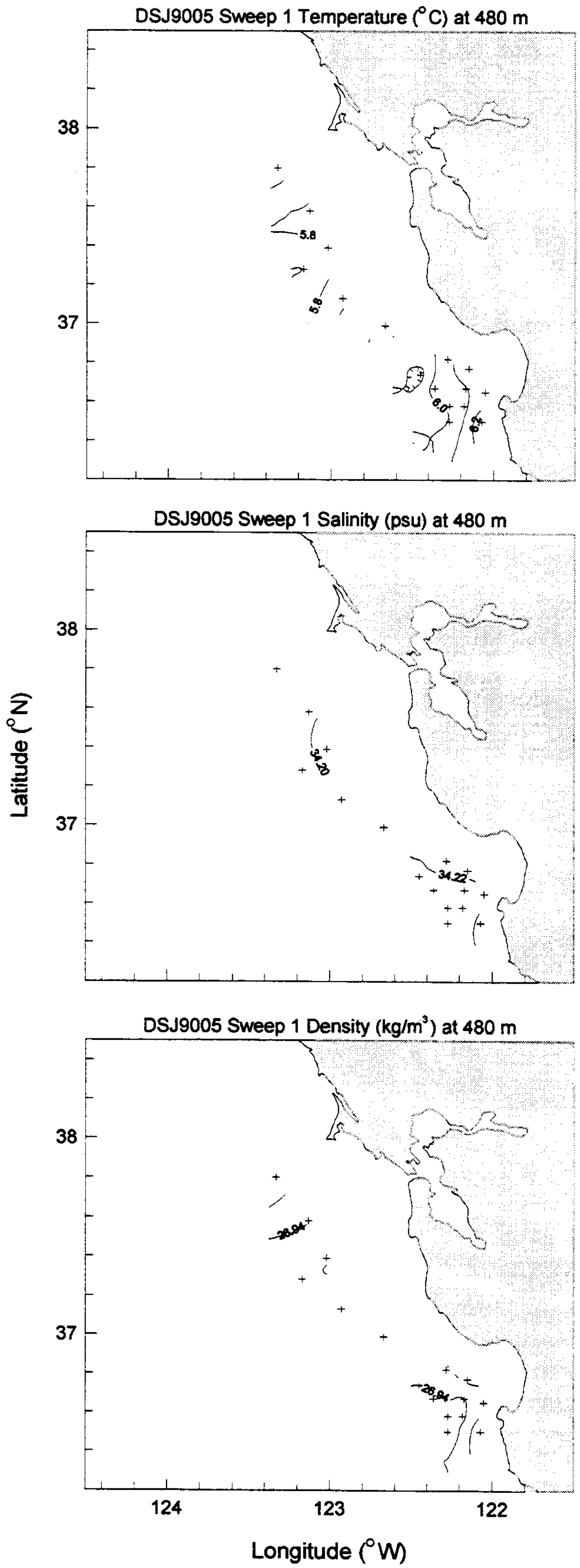

DSJ9005 Sweep 1 Temperature (°C) at 10 m
DSJ9005 Sweep 1 Salinity (psu) at 10 m
DSJ9005 Sweep 1 Density (kg/m³) at 10 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)


DSJ9005 Sweep 1 Temperature (°C) at 30 m
10.0
11.0
12.0
11.0
DSJ9005 Sweep 1 Salinity (psu) at 30 m
33.7
33.6
33.8
33.2
33.3
33.4
33.5
33.6
33.7
33.8
DSJ9005 Sweep 1 Density (kg/m³) at 30 m
26.0
25.2
25.4
25.6
25.8
Latitude (°N)
38
37
124
123
122
Longitude (°W)

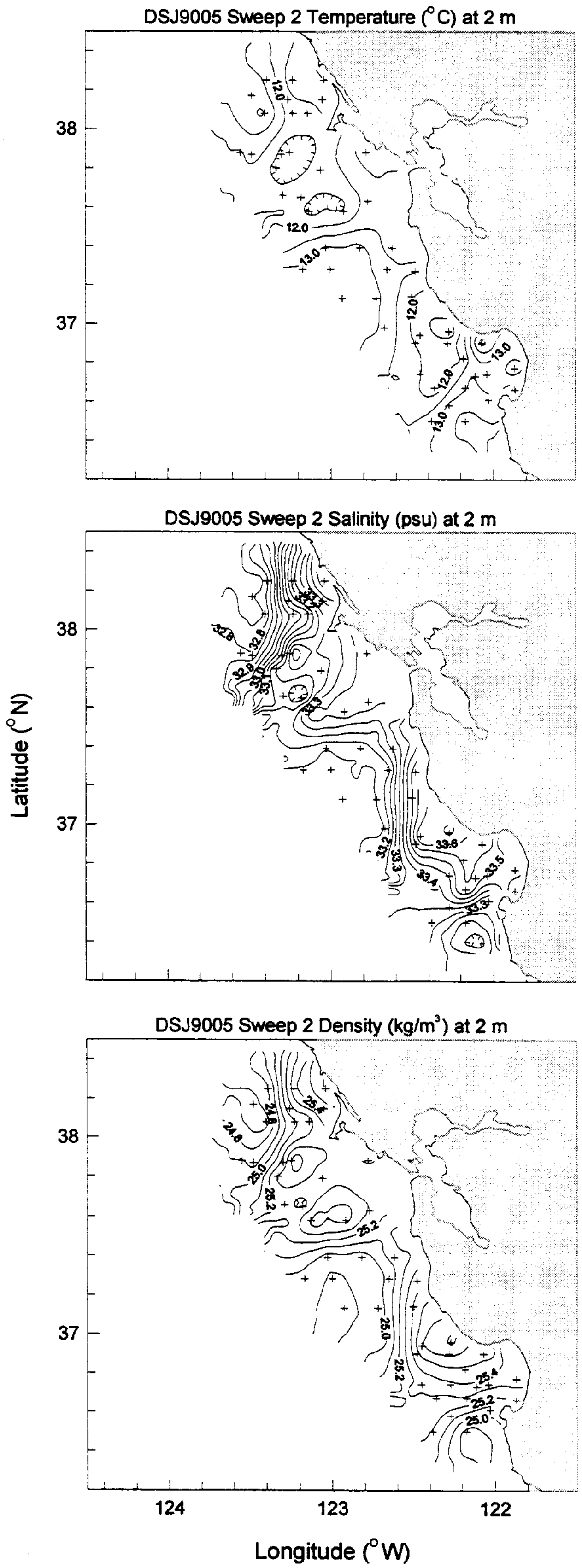

DSJ9005 Sweep 1 Temperature (°C) at 100 m
DSJ9005 Sweep 1 Salinity (psu) at 100 m
DSJ9005 Sweep 1 Density (kg/m³) at 100 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)

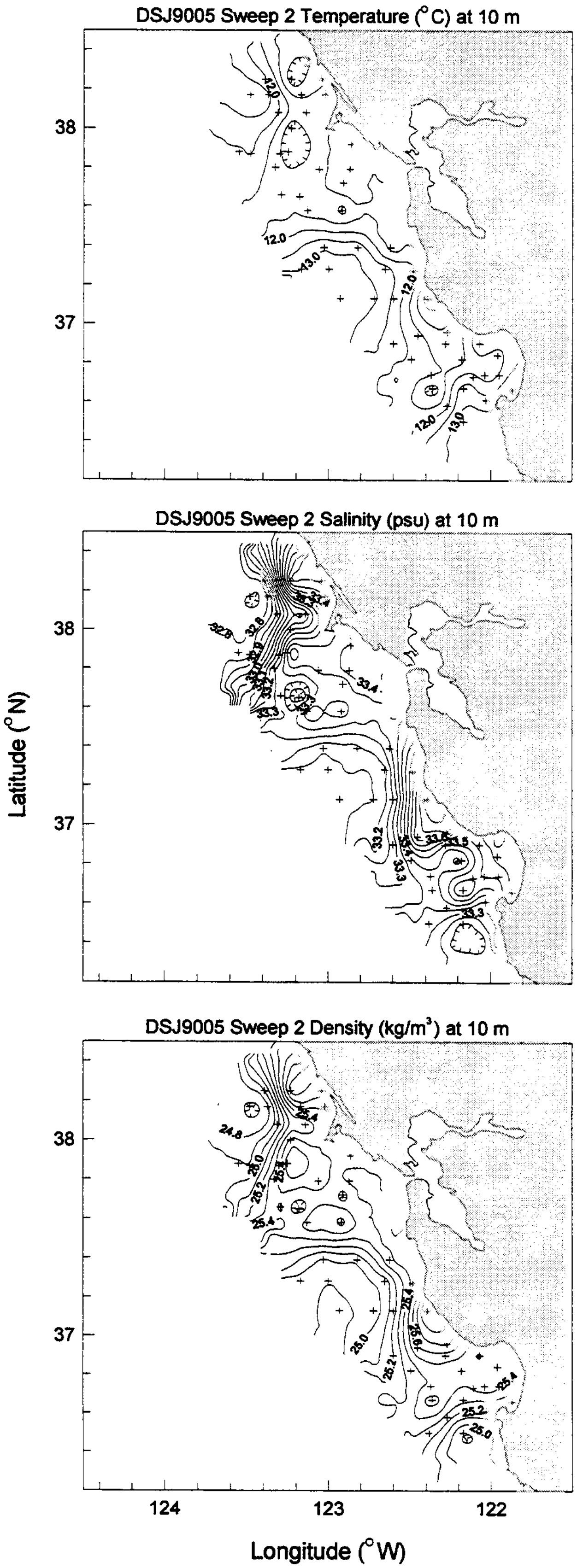

DSJ9005 Sweep 1 Temperature (°C) at 200 m
DSJ9005 Sweep 1 Salinity (psu) at 200 m
DSJ9005 Sweep 1 Density (kg/m³) at 200 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)

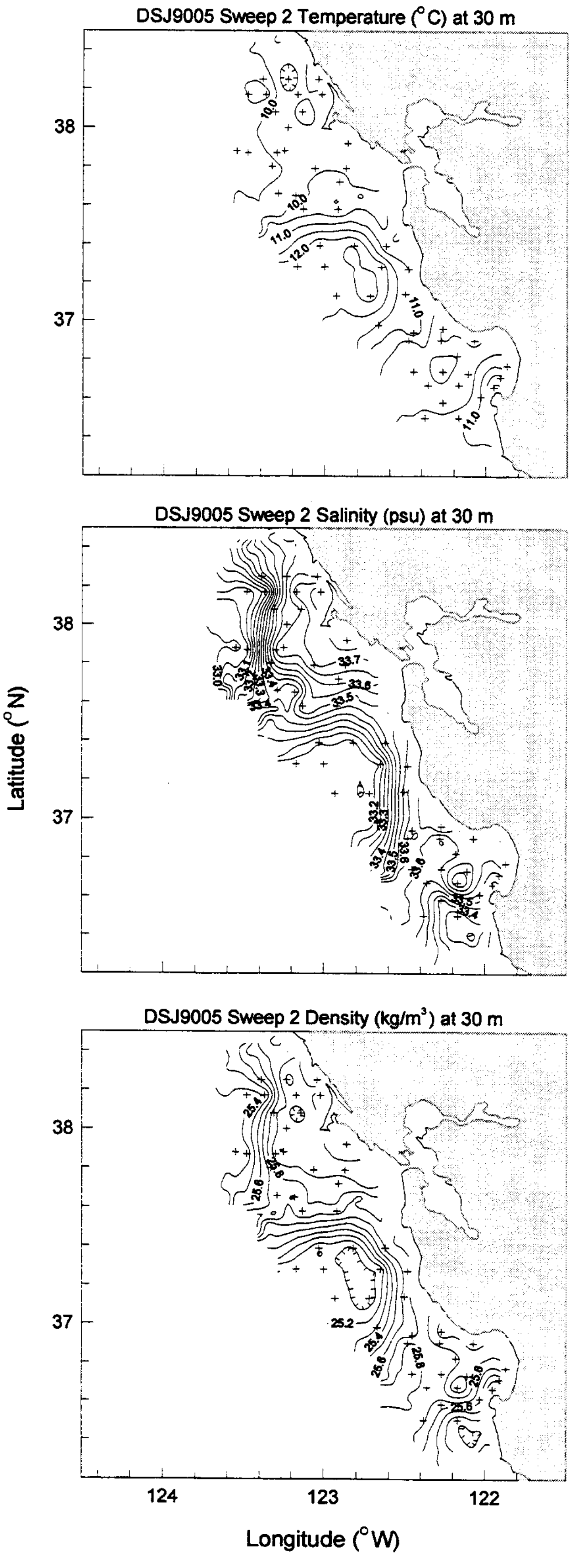

DSJ9005 Sweep 1 Temperature (°C) at 300 m
38
37
7.0
7.2
7.4
DSJ9005 Sweep 1 Salinity (psu) at 300 m
Latitude (°N)
38
37
34.10
DSJ9005 Sweep 1 Density (kg/m³) at 300 m
38
37
26.70
26.72
124
123
122
Longitude (°W)


DSJ9005 Sweep 1 Temperature (°C) at 480 m
5.8
5.8
6.0
6.2
DSJ9005 Sweep 1 Salinity (psu) at 480 m
34.20
34.22
DSJ9005 Sweep 1 Density (kg/m³) at 480 m
26.94
26.94
38
37
Latitude (°N)
124
123
122
Longitude (°W)

APPENDIX 4.3: HORIZONTAL MAPS OF CTD DATA FOR DSJ9005, SWEEP 2

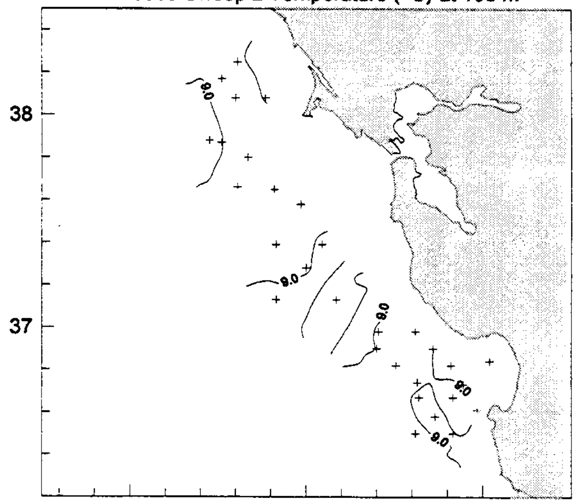

DSJ9005 Sweep 2 Temperature (°C) at 2 m
DSJ9005 Sweep 2 Salinity (psu) at 2 m
DSJ9005 Sweep 2 Density (kg/m³) at 2 m
Latitude (°N)
Longitude (°W)
38
37
124
123
122


DSJ9005 Sweep 2 Temperature (°C) at 10 m
DSJ9005 Sweep 2 Salinity (psu) at 10 m
DSJ9005 Sweep 2 Density (kg/m³) at 10 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)

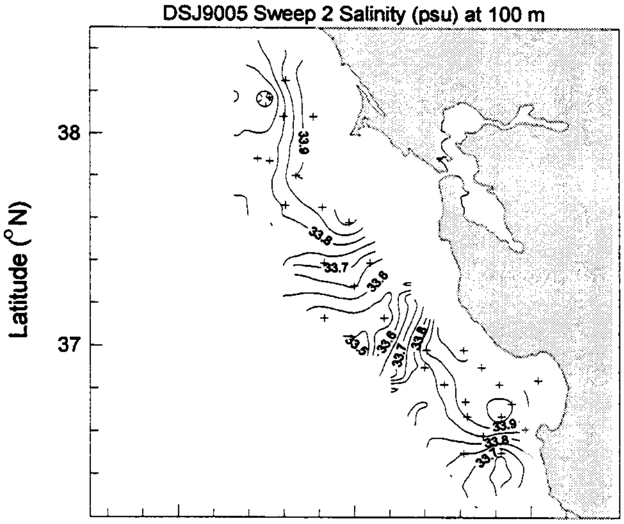


DSJ9005 Sweep 2 Temperature (°C) at 30 m
DSJ9005 Sweep 2 Salinity (psu) at 30 m
DSJ9005 Sweep 2 Density (kg/m³) at 30 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)

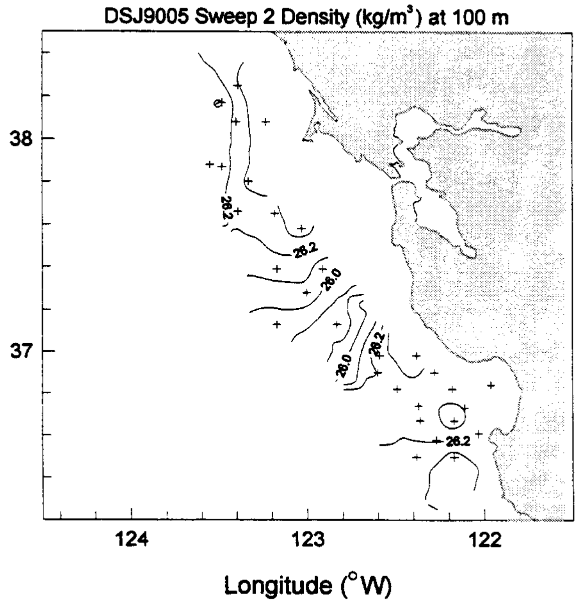
DSJ9005 Sweep 2 Temperature (°C) at 100 m

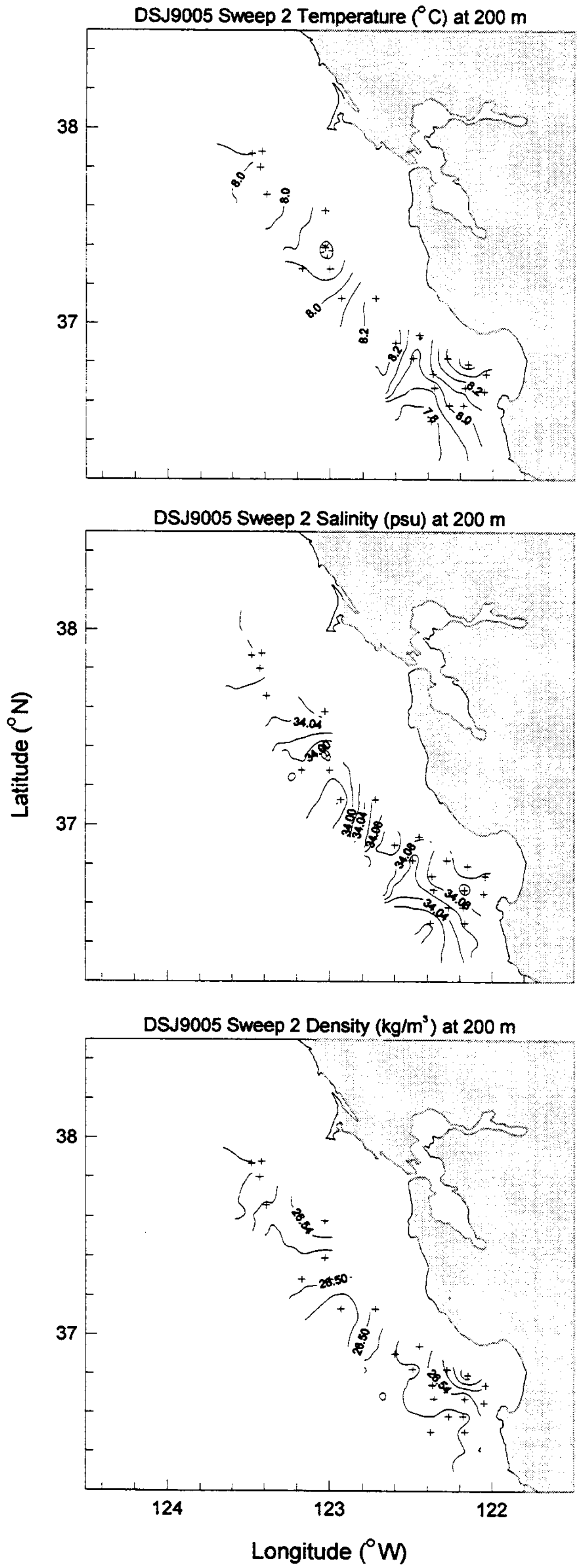


DSJ9005 Sweep 2 Salinity (psu) at 100 m

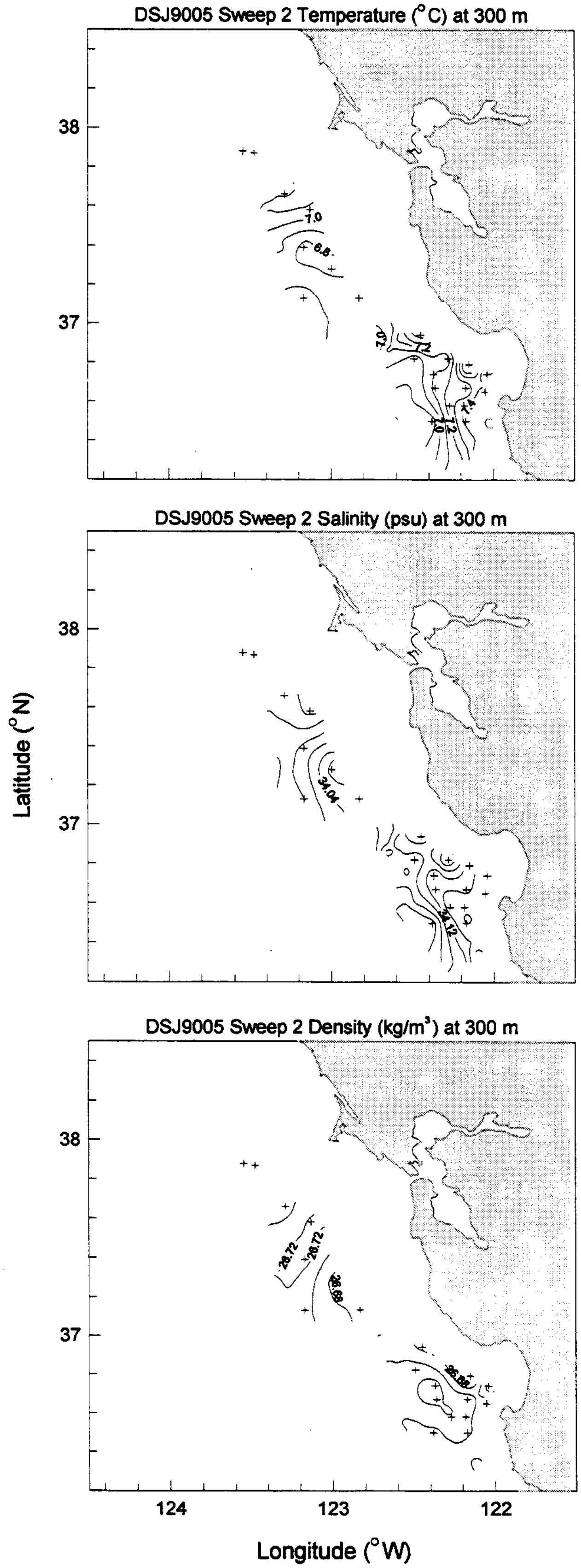


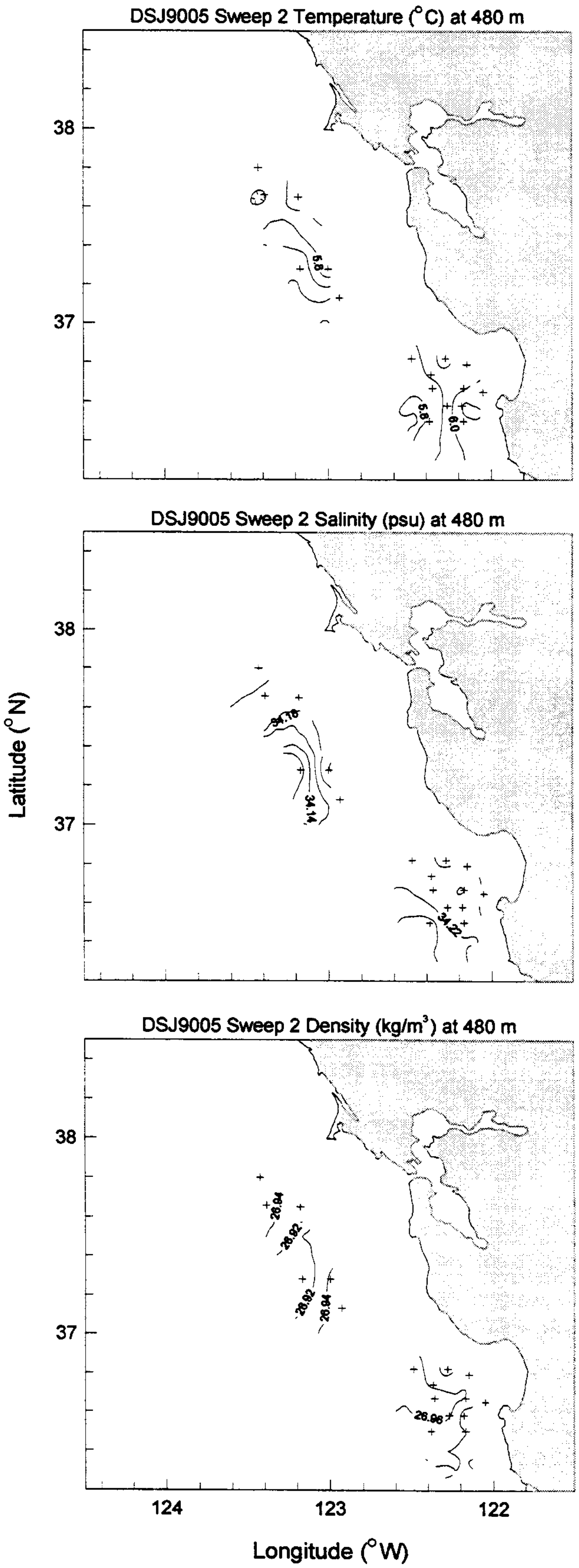
DSJ9005 Sweep 2 Density (kg/m³) at 100 m



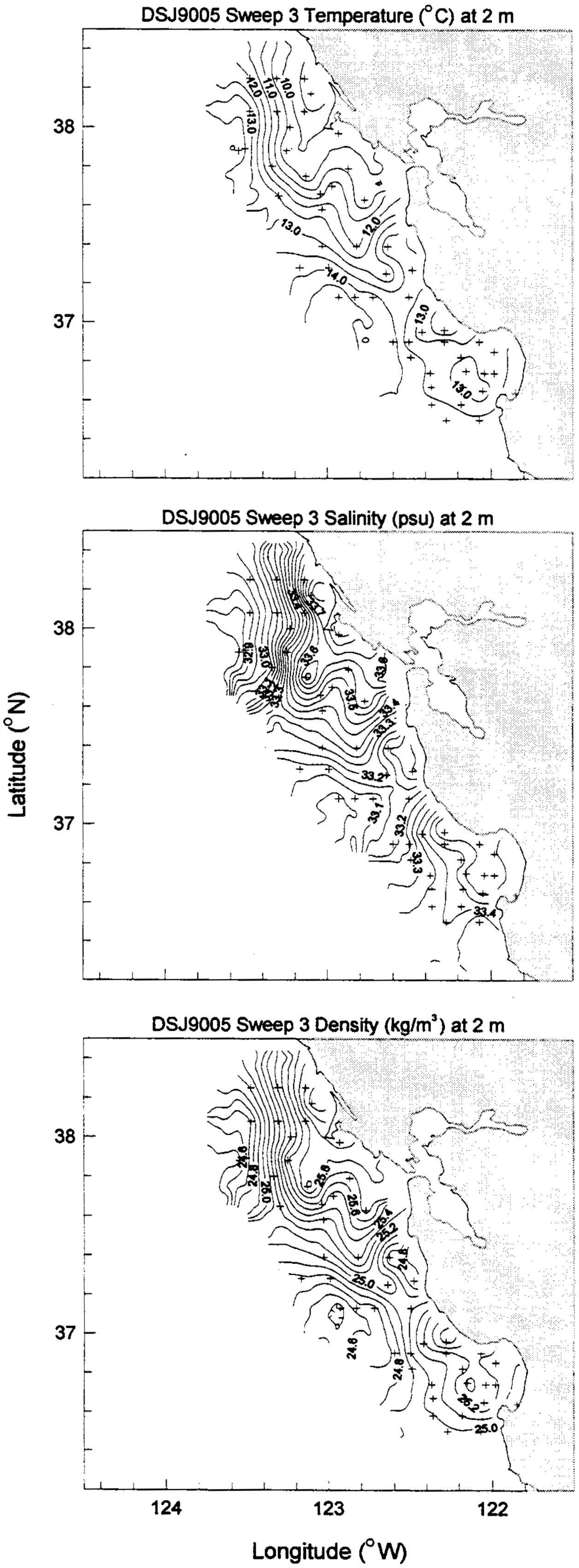


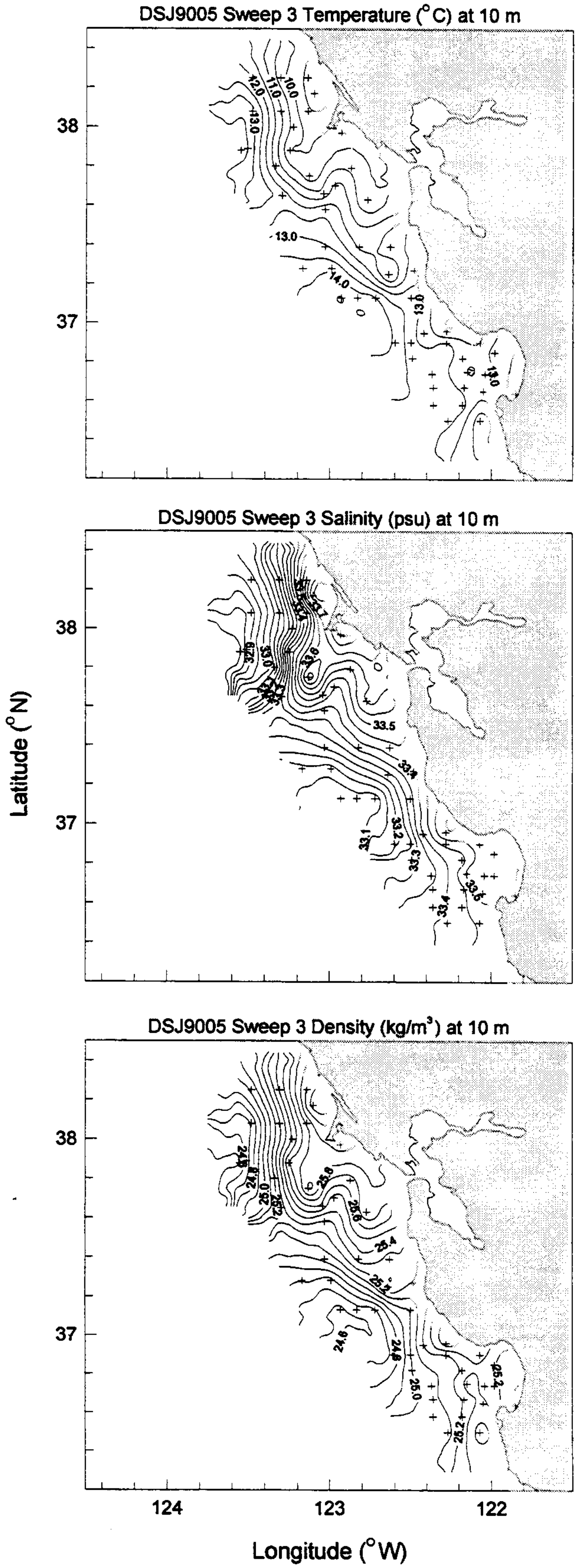
DSJ9005 Sweep 2 Temperature (°C) at 200 m
8.0
8.0
8.0
8.2
8.2
8.2
8.0
7.8
DSJ9005 Sweep 2 Salinity (psu) at 200 m
34.04
34.00
34.04
34.08
34.08
34.08
34.04
DSJ9005 Sweep 2 Density (kg/m³) at 200 m
26.54
26.50
26.50
26.54
38
37
Latitude (°N)
124
123
122
Longitude (°W)

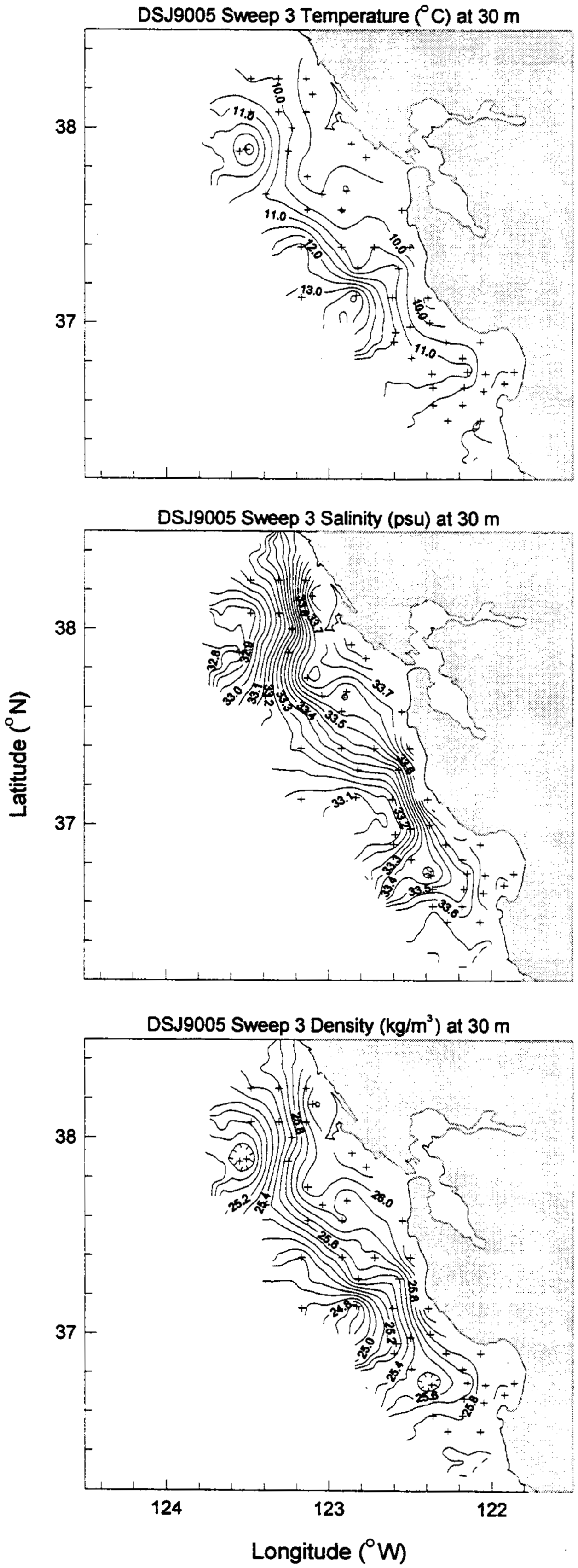

DSJ9005 Sweep 2 Temperature (°C) at 300 m
DSJ9005 Sweep 2 Salinity (psu) at 300 m
DSJ9005 Sweep 2 Density (kg/m³) at 300 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)
7.0
6.8
7.2
34.04
34.12
26.72
26.68

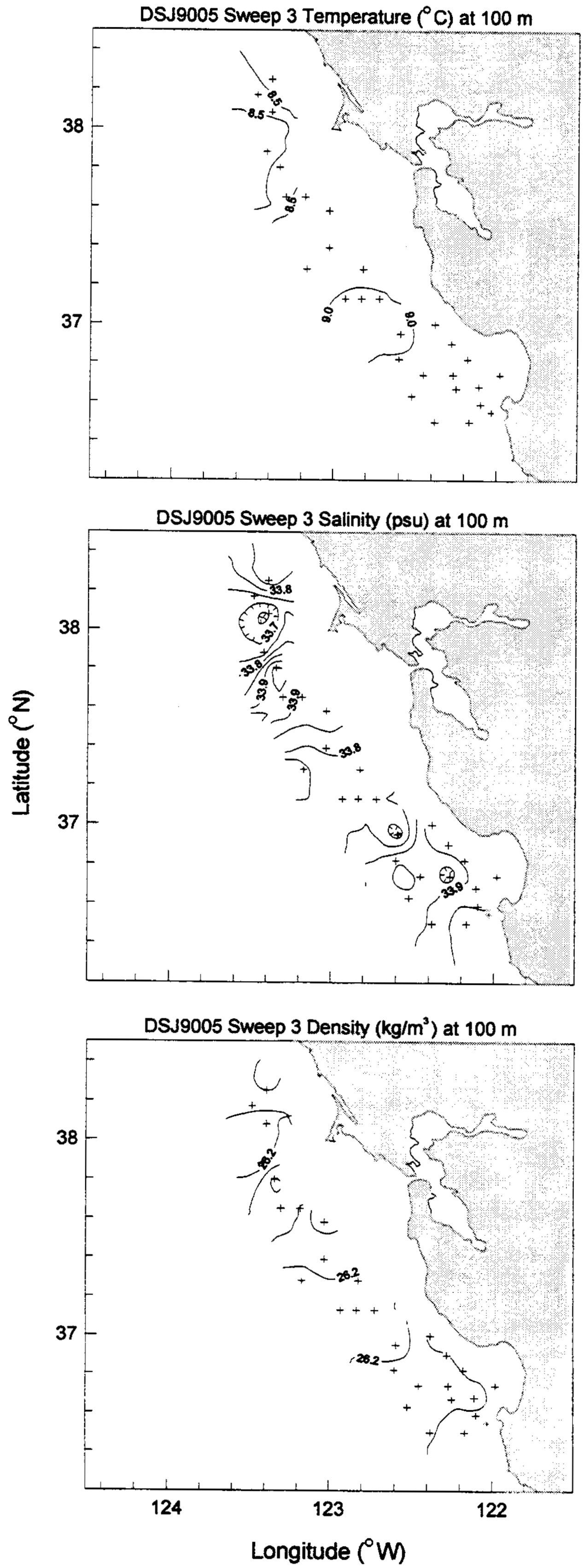

DSJ9005 Sweep 2 Temperature (°C) at 480 m
6.8
6.8
6.0
DSJ9005 Sweep 2 Salinity (psu) at 480 m
34.18
34.14
34.22
DSJ9005 Sweep 2 Density (kg/m³) at 480 m
26.94
26.92
26.92
26.94
26.96
38
37
Latitude (°N)
124
123
122
Longitude (°W)

APPENDIX 4.4: HORIZONTAL MAPS OF CTD DATA FOR DSJ9005, SWEEP 3

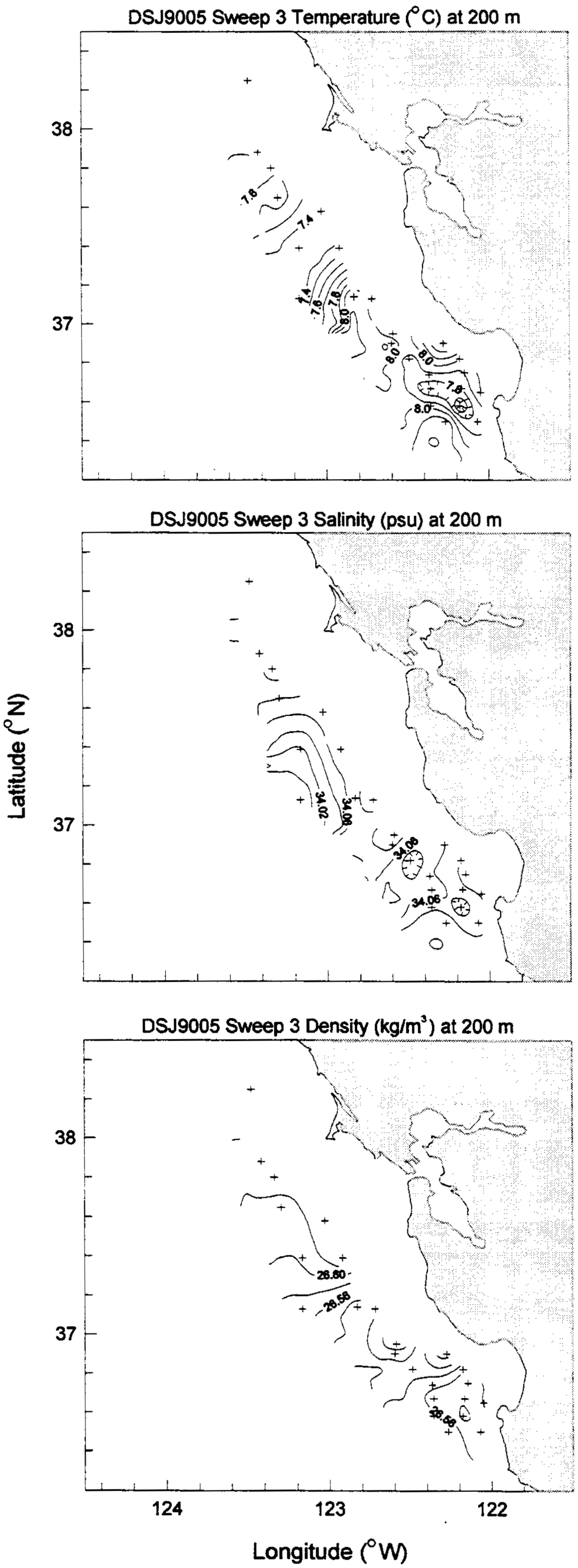

DSJ9005 Sweep 3 Temperature (°C) at 2 m
DSJ9005 Sweep 3 Salinity (psu) at 2 m
DSJ9005 Sweep 3 Density (kg/m³) at 2 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)

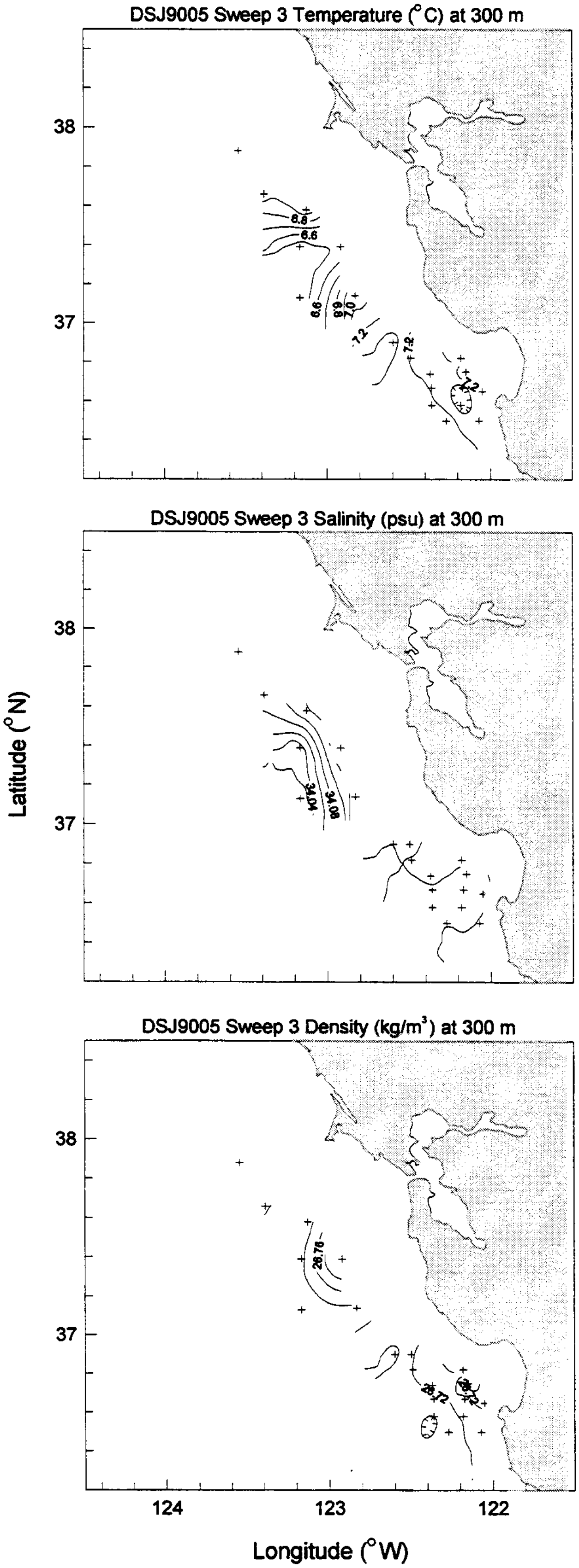

DSJ9005 Sweep 3 Temperature (°C) at 10 m
DSJ9005 Sweep 3 Salinity (psu) at 10 m
DSJ9005 Sweep 3 Density (kg/m³) at 10 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)

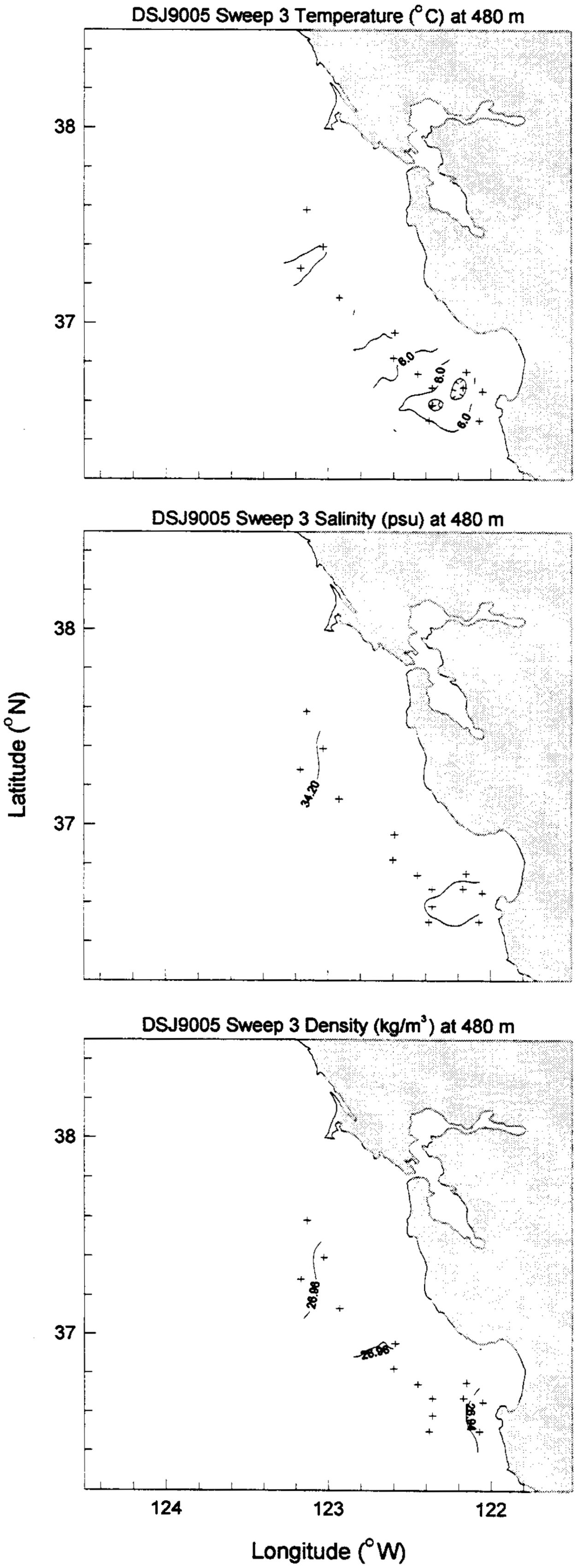

DSJ9005 Sweep 3 Temperature (°C) at 30 m
DSJ9005 Sweep 3 Salinity (psu) at 30 m
DSJ9005 Sweep 3 Density (kg/m³) at 30 m
Latitude (°N)
38
37
124
123
122
Longitude (°W)



DSJ9005 Sweep 3 Temperature (°C) at 100 m
8.5
8.5
8.6
9.0
8.0
38
37
DSJ9005 Sweep 3 Salinity (psu) at 100 m
33.8
33.7
33.8
33.9
33.9
33.8
33.9
38
37
Latitude (°N)
DSJ9005 Sweep 3 Density (kg/m³) at 100 m
26.2
26.2
26.2
38
37
124
123
122
Longitude (°W)

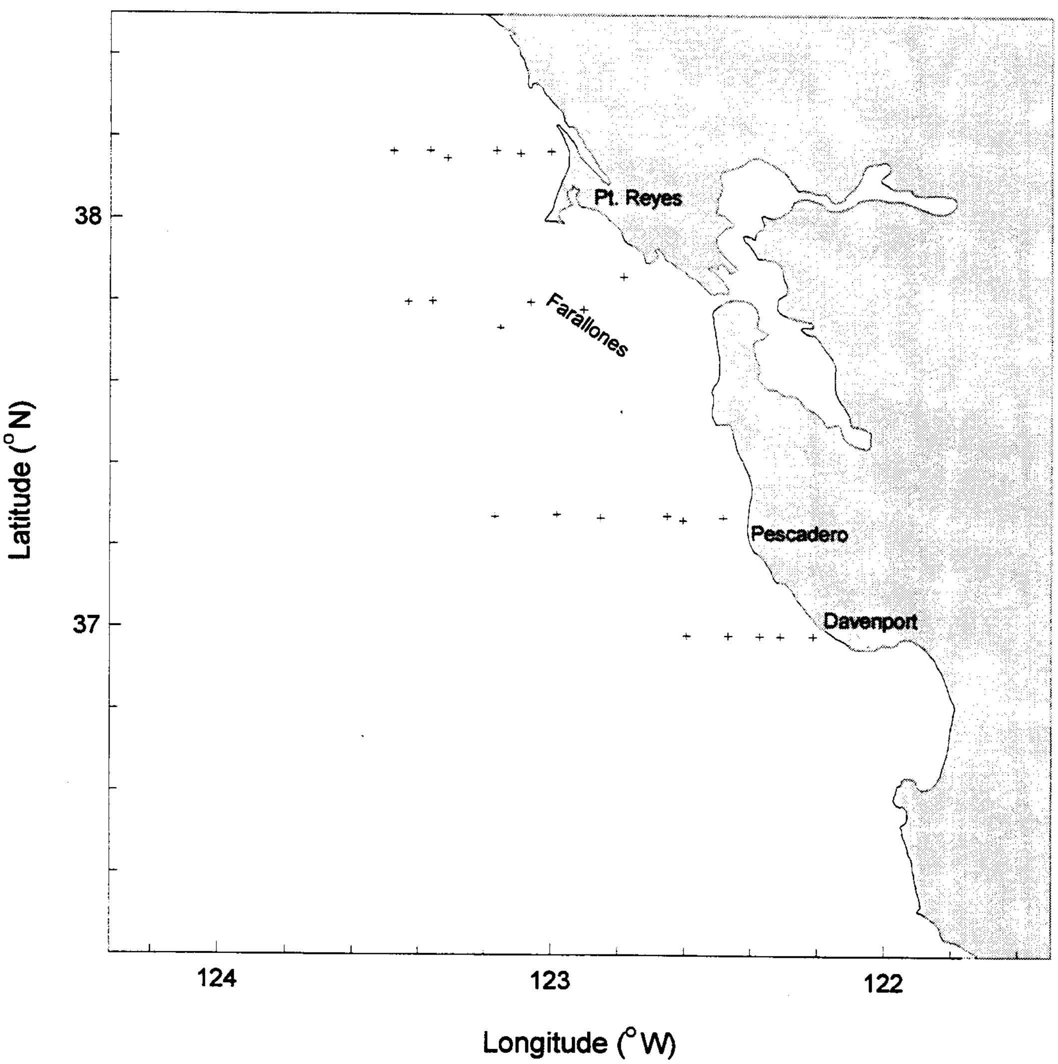

DSJ9005 Sweep 3 Temperature (°C) at 200 m
DSJ9005 Sweep 3 Salinity (psu) at 200 m
DSJ9005 Sweep 3 Density (kg/m³) at 200 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)
7.8
7.4
8.0
34.02
34.06
26.60
26.56

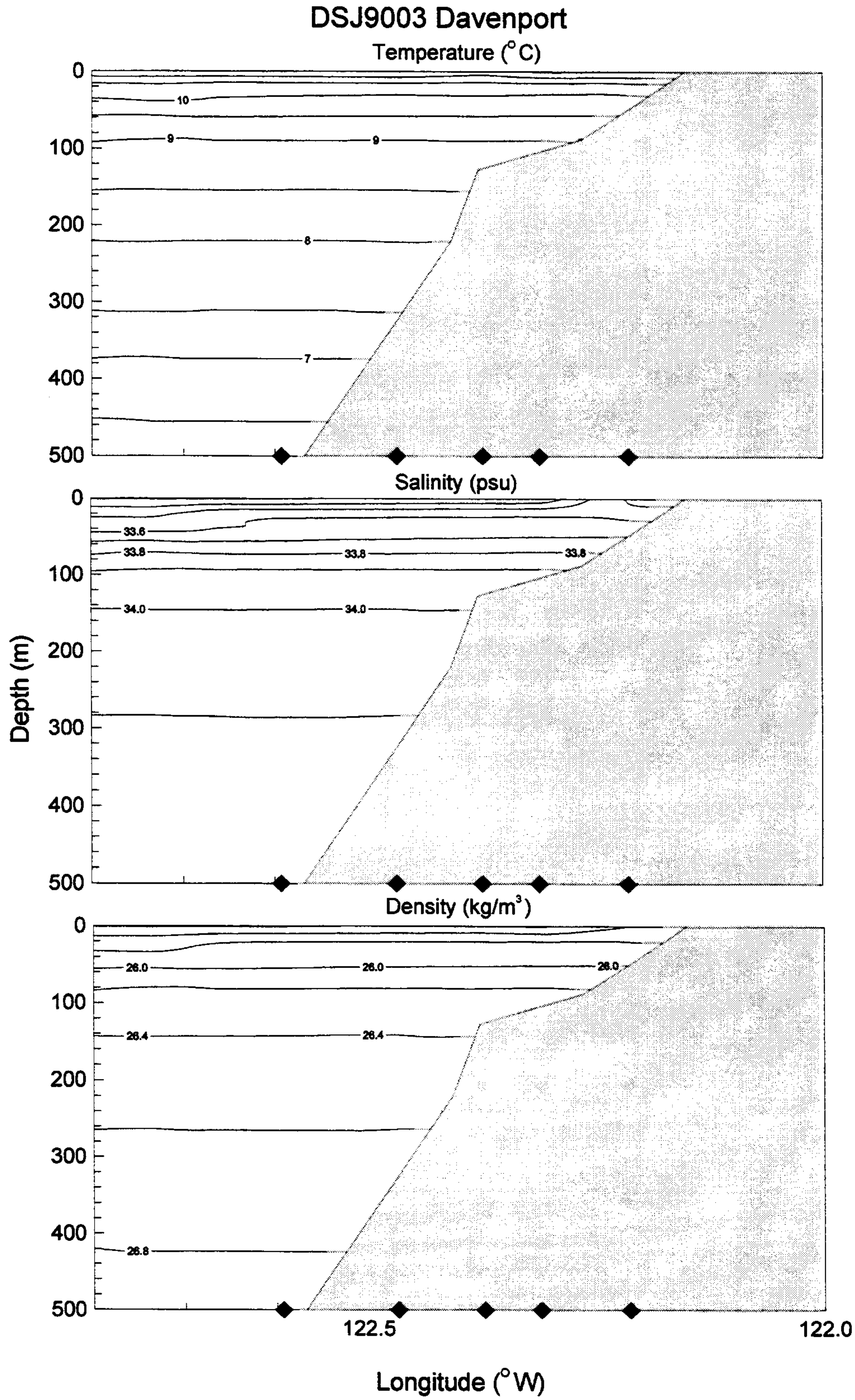

DSJ9005 Sweep 3 Temperature (°C) at 300 m
DSJ9005 Sweep 3 Salinity (psu) at 300 m
DSJ9005 Sweep 3 Density (kg/m³) at 300 m
Latitude (°N)
38
37
Longitude (°W)
124
123
122
6.8
6.6
7.0
7.2
34.04
34.08
28.76
28.72


DSJ9005 Sweep 3 Temperature (°C) at 480 m
6.0
DSJ9005 Sweep 3 Salinity (psu) at 480 m
34.20
DSJ9005 Sweep 3 Density (kg/m³) at 480 m
38
37
Latitude (°N)
124
123
122
Longitude (°W)

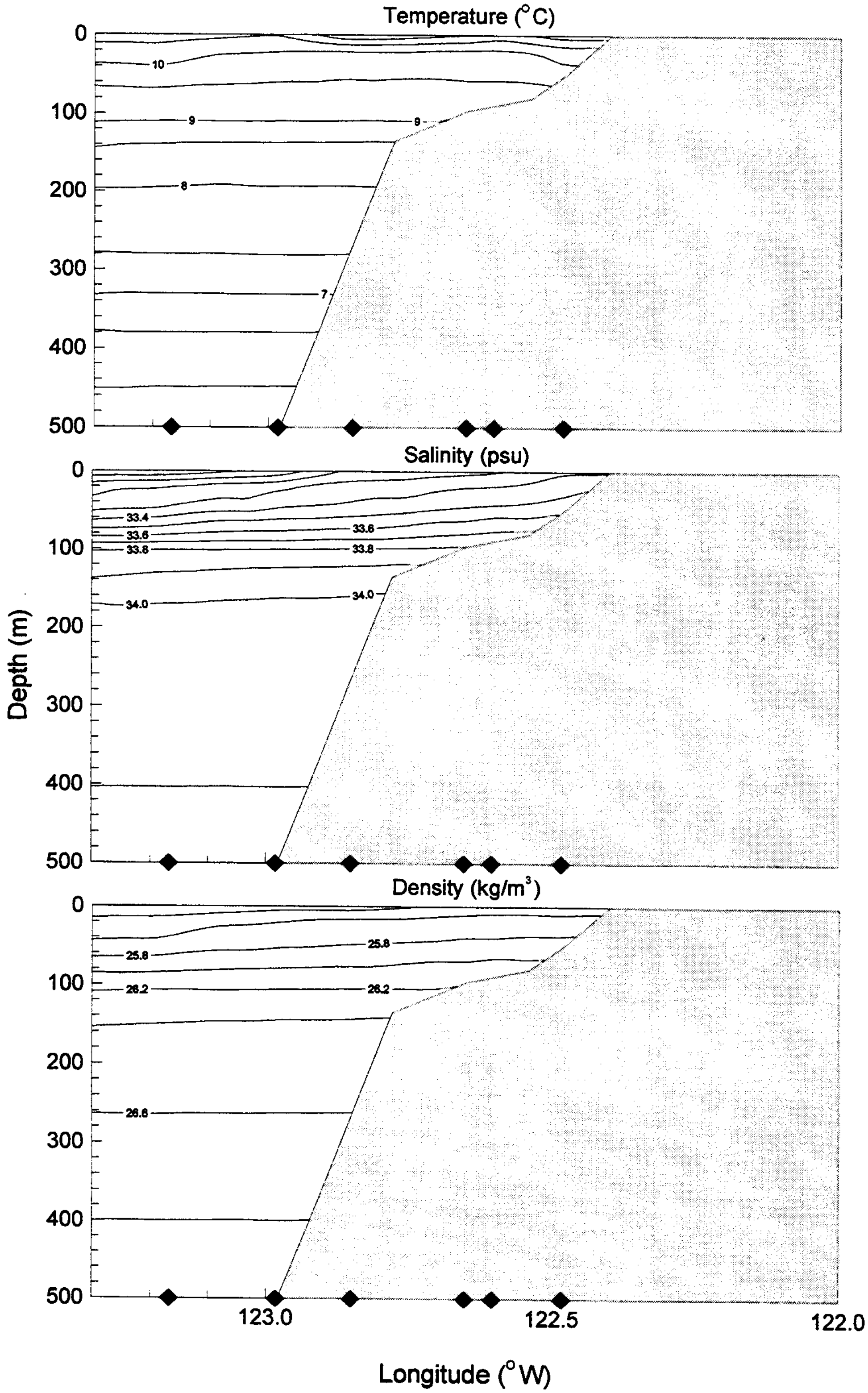
APPENDIX 5.1: VERTICAL TRANSECTS FOR DSJ9003

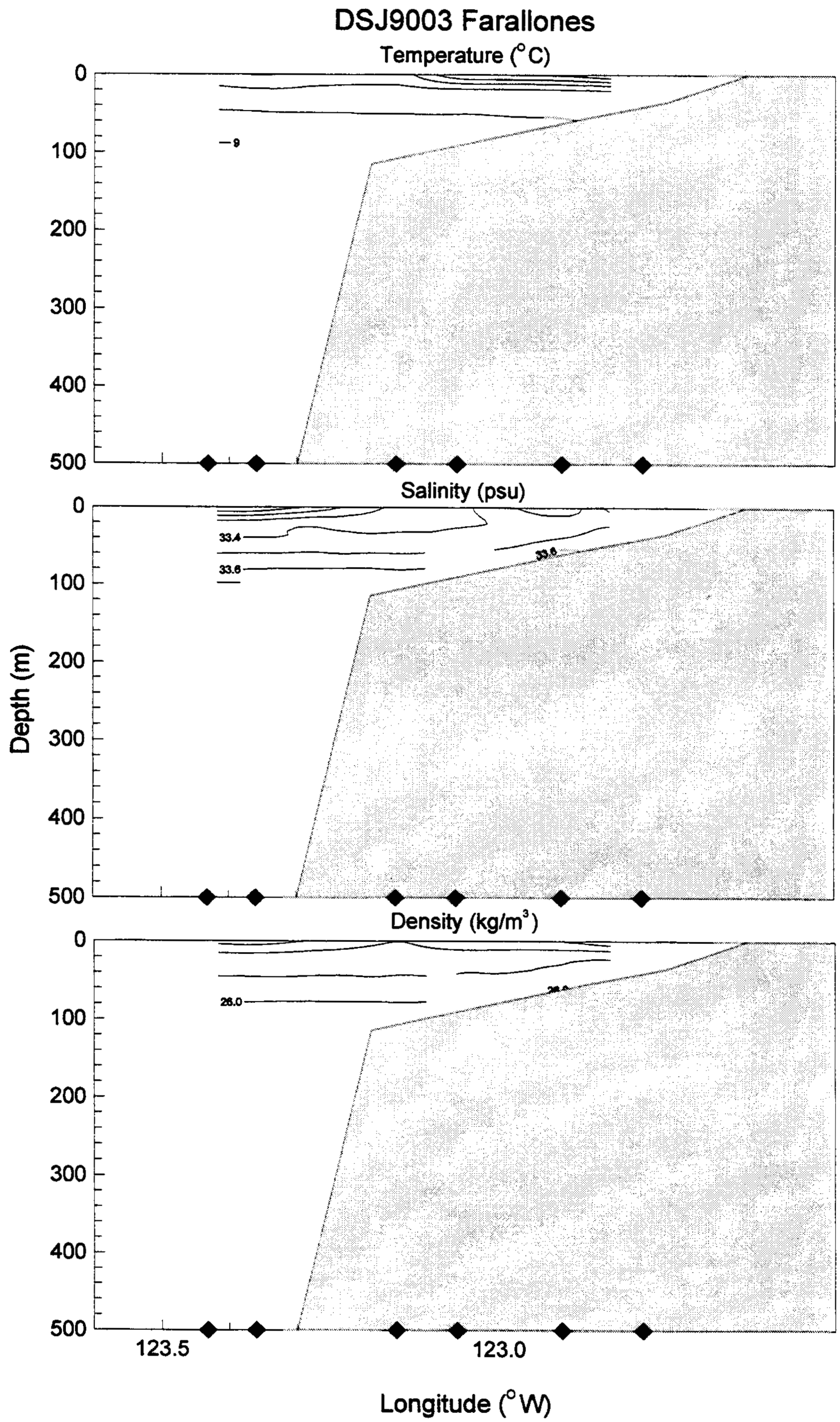
DSJ9003 Vertical Transect Stations

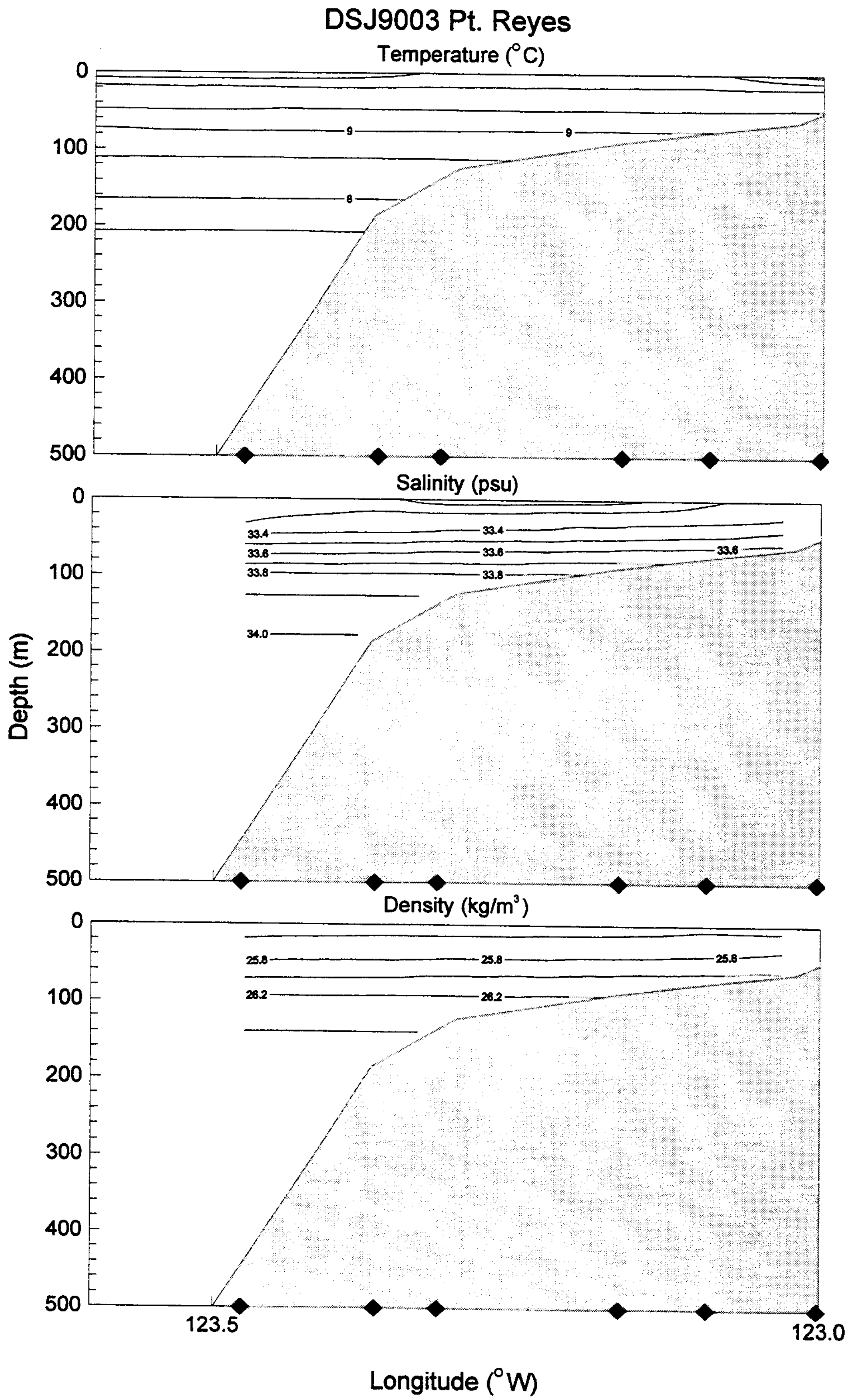



DSJ9003 Davenport
Temperature (°C)
Salinity (psu)
Density (kg/m³)
Depth (m)
Longitude (°W)
122.5
122.0
0
100
200
300
400
500
10
9
8
7
33.6
33.8
34.0
26.0
26.4
26.8

DSJ9003 Pescadero

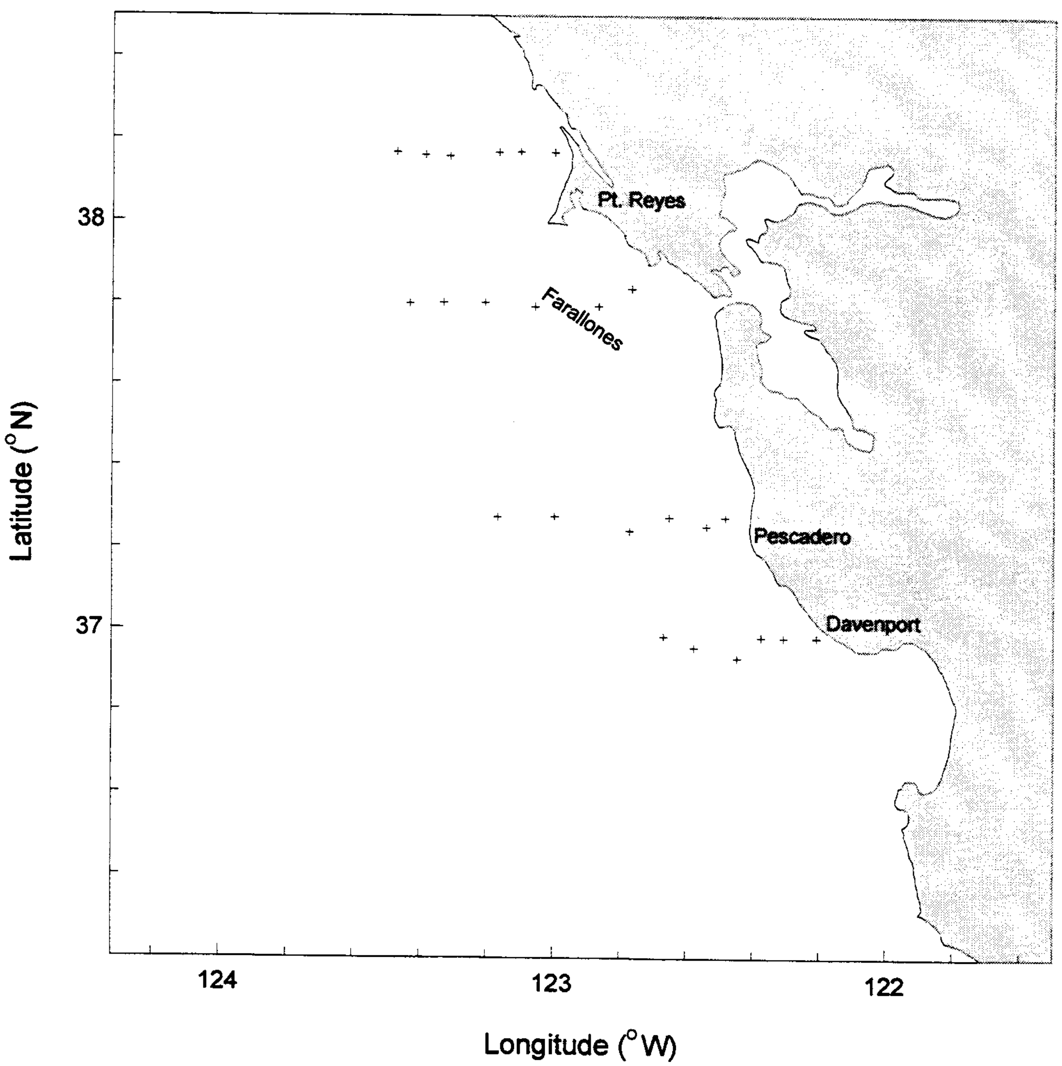



DSJ9003 Farallones
Temperature (°C)
Salinity (psu)
Density (kg/m³)
Depth (m)
0
100
200
300
400
500
9
33.4
33.6
26.0
123.5
123.0
Longitude (°W)

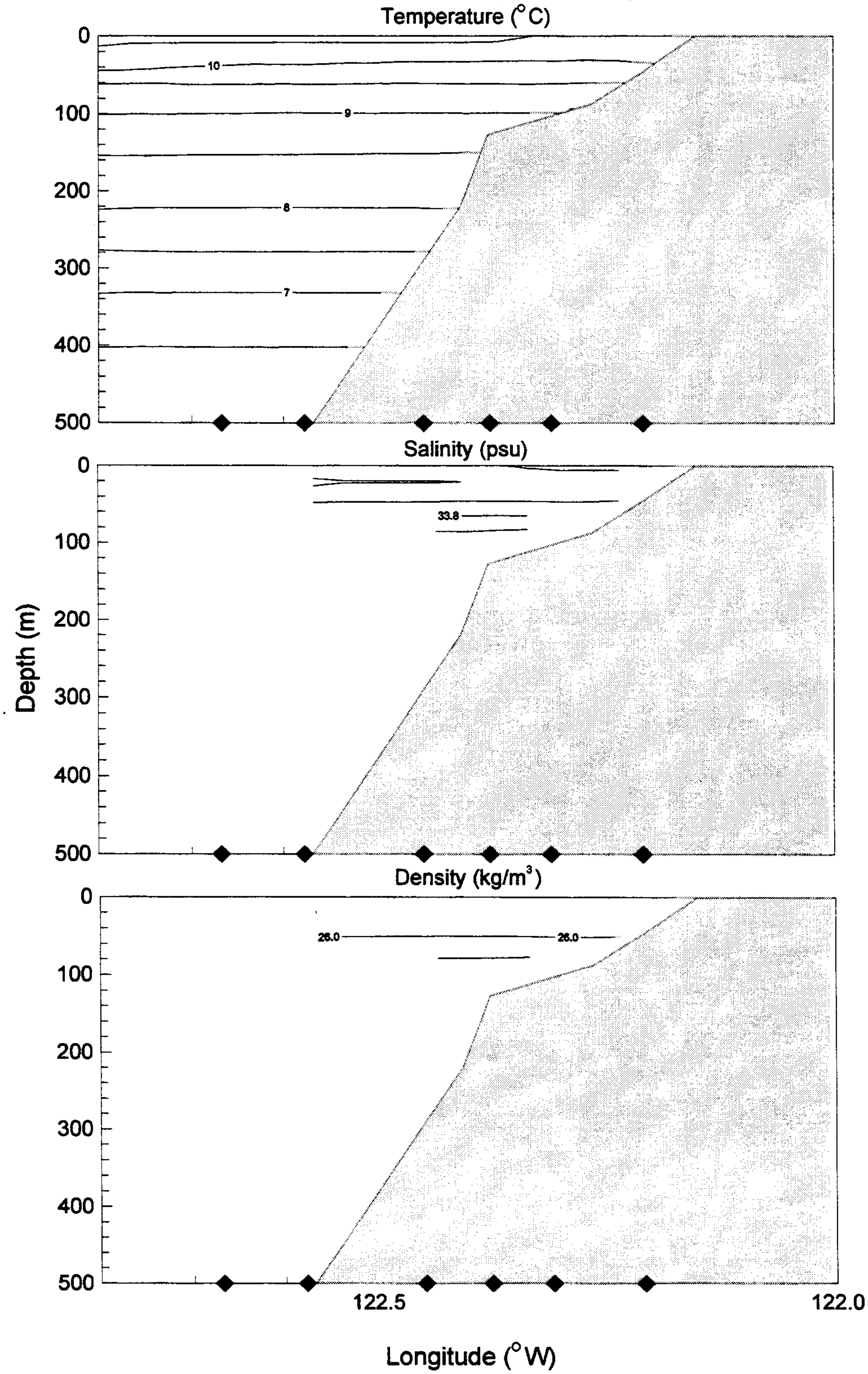

DSJ9003 Pt. Reyes
Temperature (°C)
Salinity (psu)
Density (kg/m³)
Depth (m)
0
100
200
300
400
500
9
8
33.4
33.6
33.8
34.0
25.8
26.2
123.5
123.0
Longitude (°W)

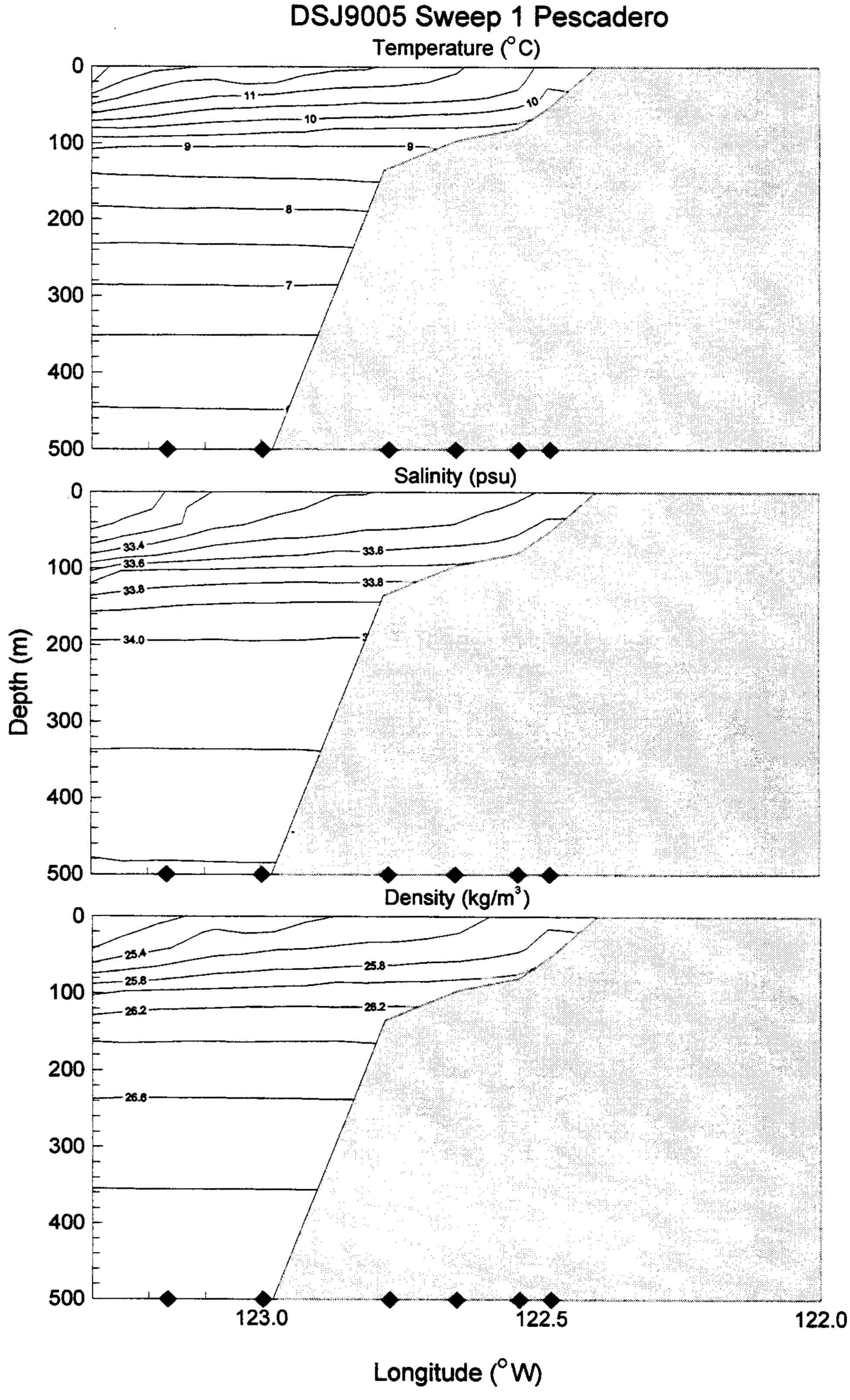
APPENDIX 5.2: VERTICAL TRANSECTS FOR DSJ9005

DSJ9005 Sweep 1 Vertical Transect Stations

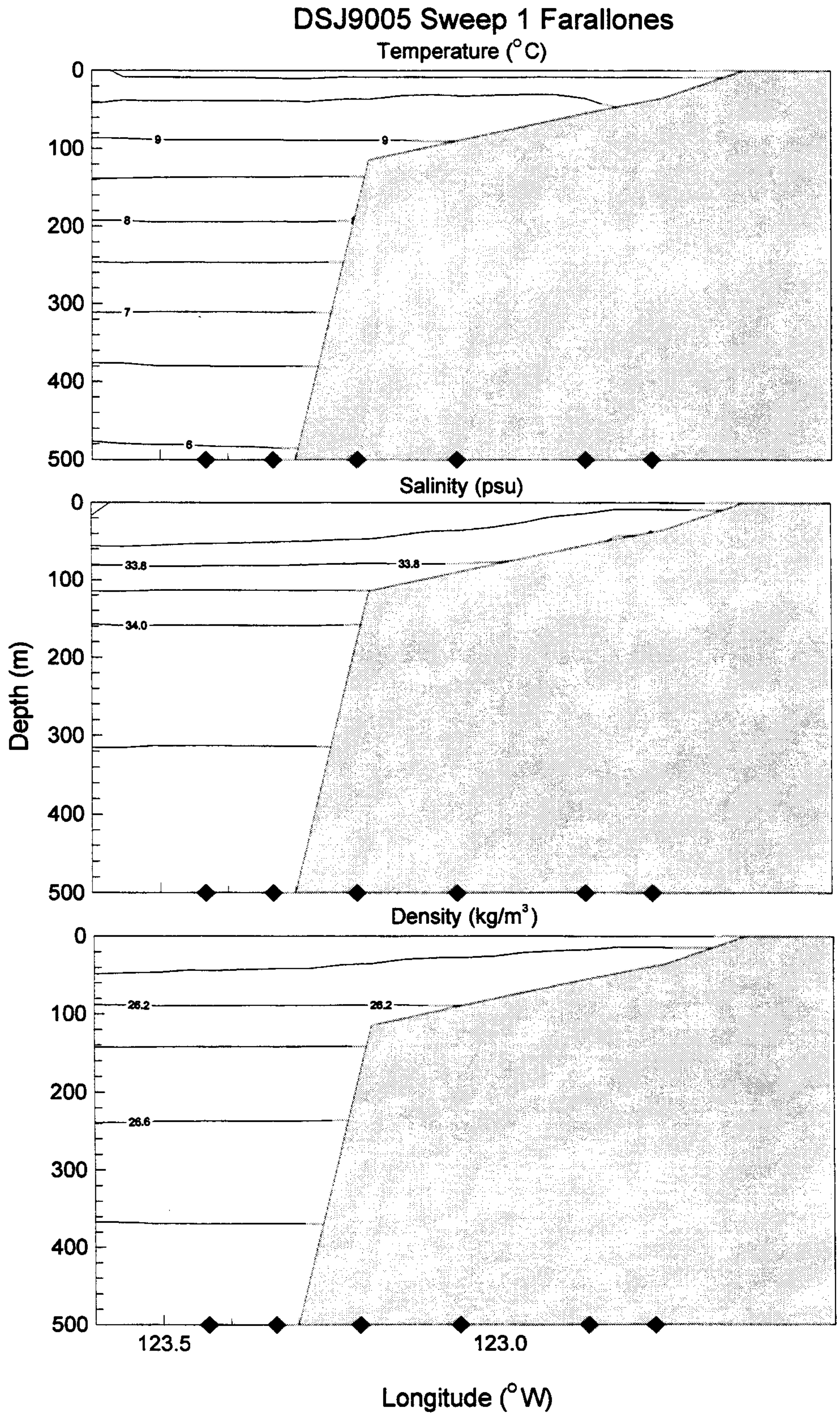


DSJ9005 Sweep 1 Davenport

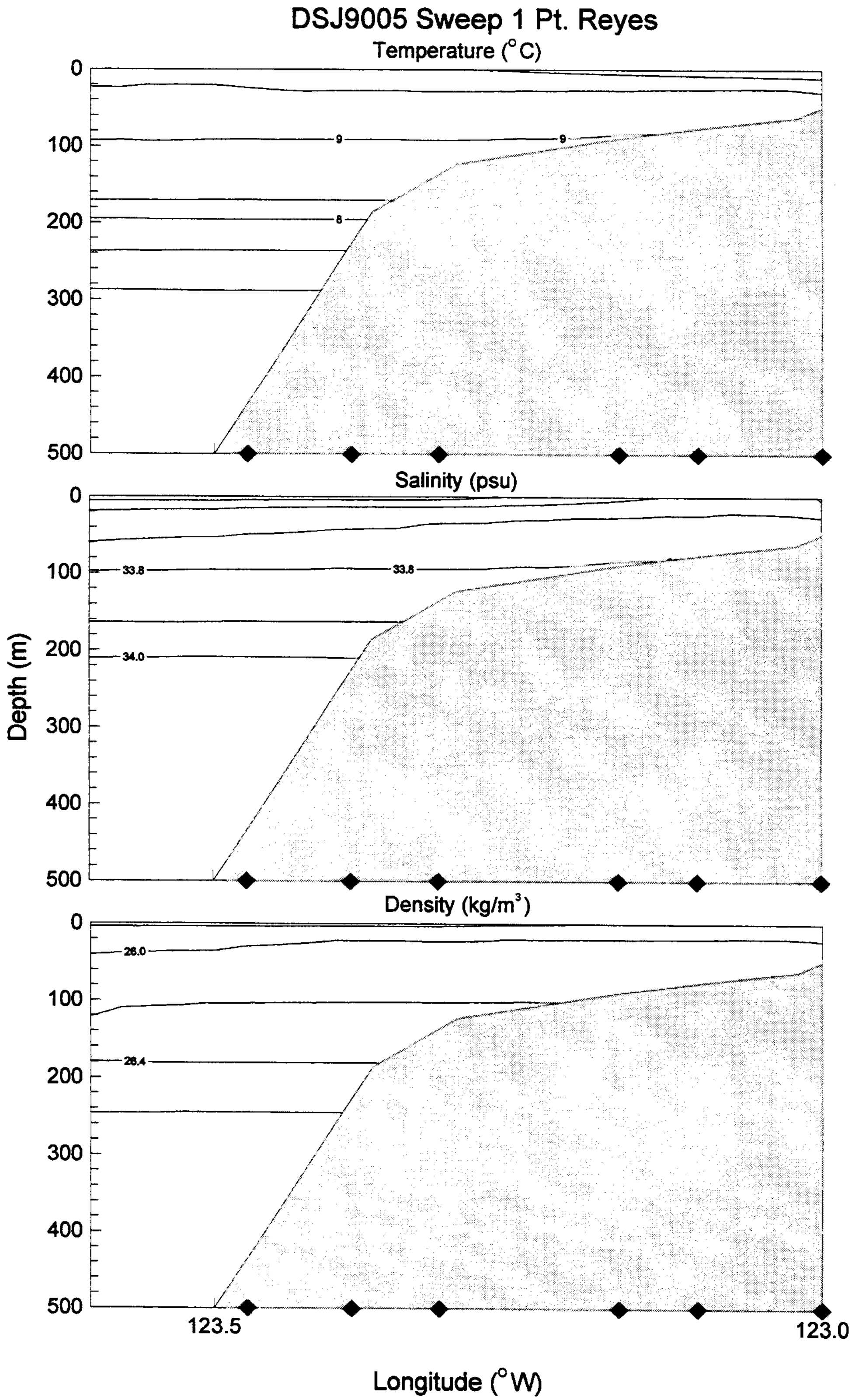




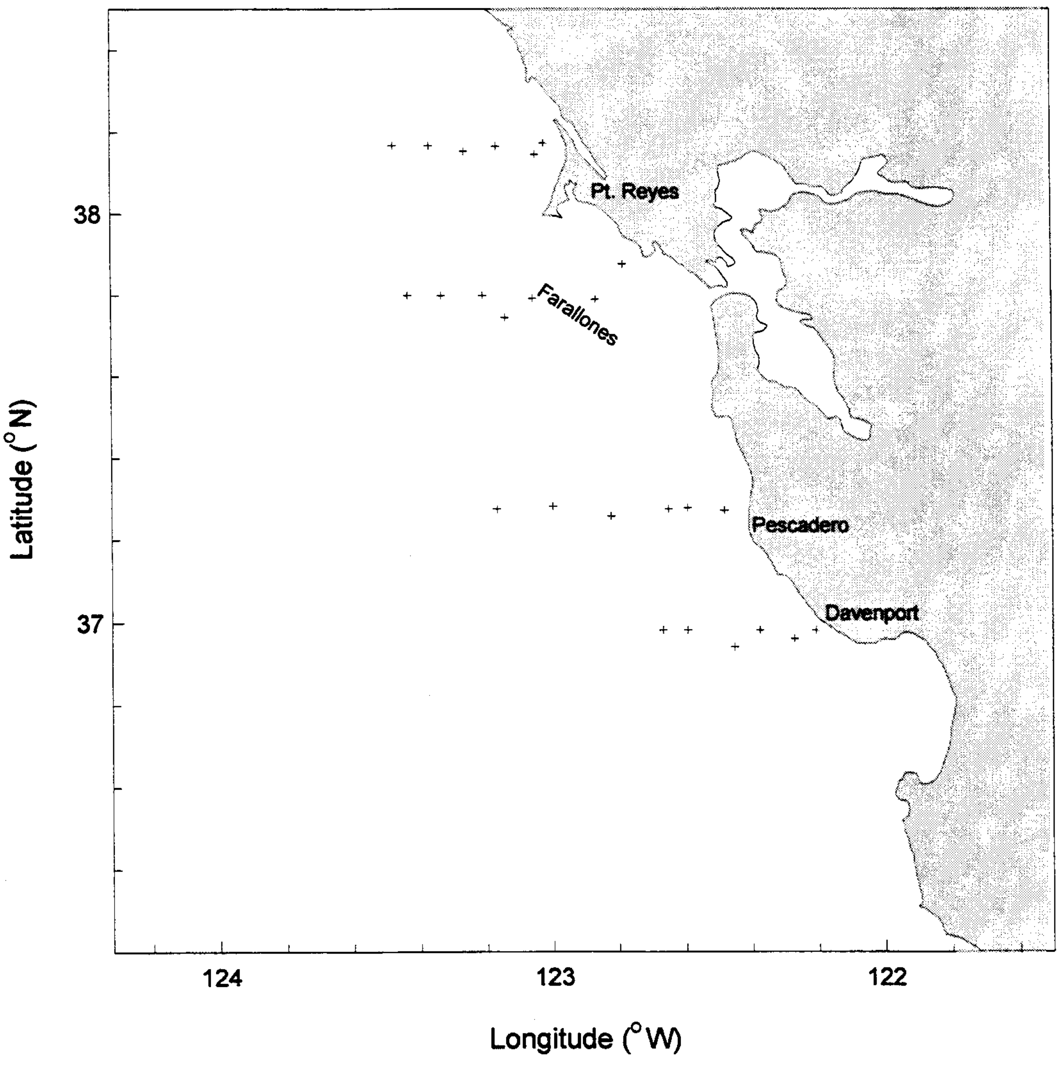
DSJ9005 Sweep 1 Pescadero
Temperature (°C)
Salinity (psu)
Density (kg/m³)
Depth (m)
Longitude (°W)
0
100
200
300
400
500
123.0
122.5
122.0
11
10
9
8
7
33.4
33.6
33.8
34.0
25.4
25.8
26.2
26.6



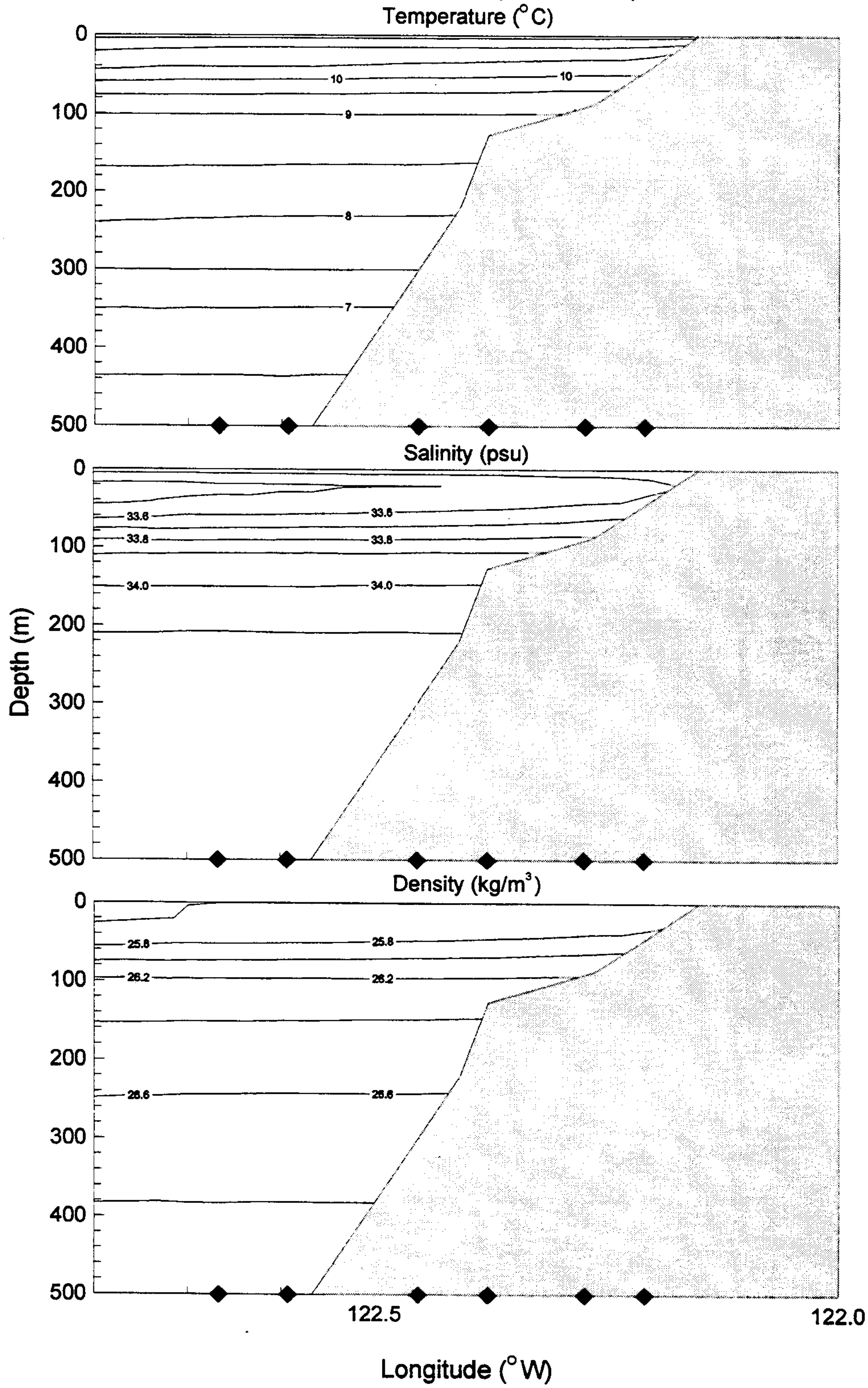
DSJ9005 Sweep 1 Farallones
Temperature (°C)
Salinity (psu)
Density (kg/m³)
Depth (m)
0
100
200
300
400
500
9
8
7
6
33.8
34.0
26.2
26.6
123.5
123.0
Longitude (°W)

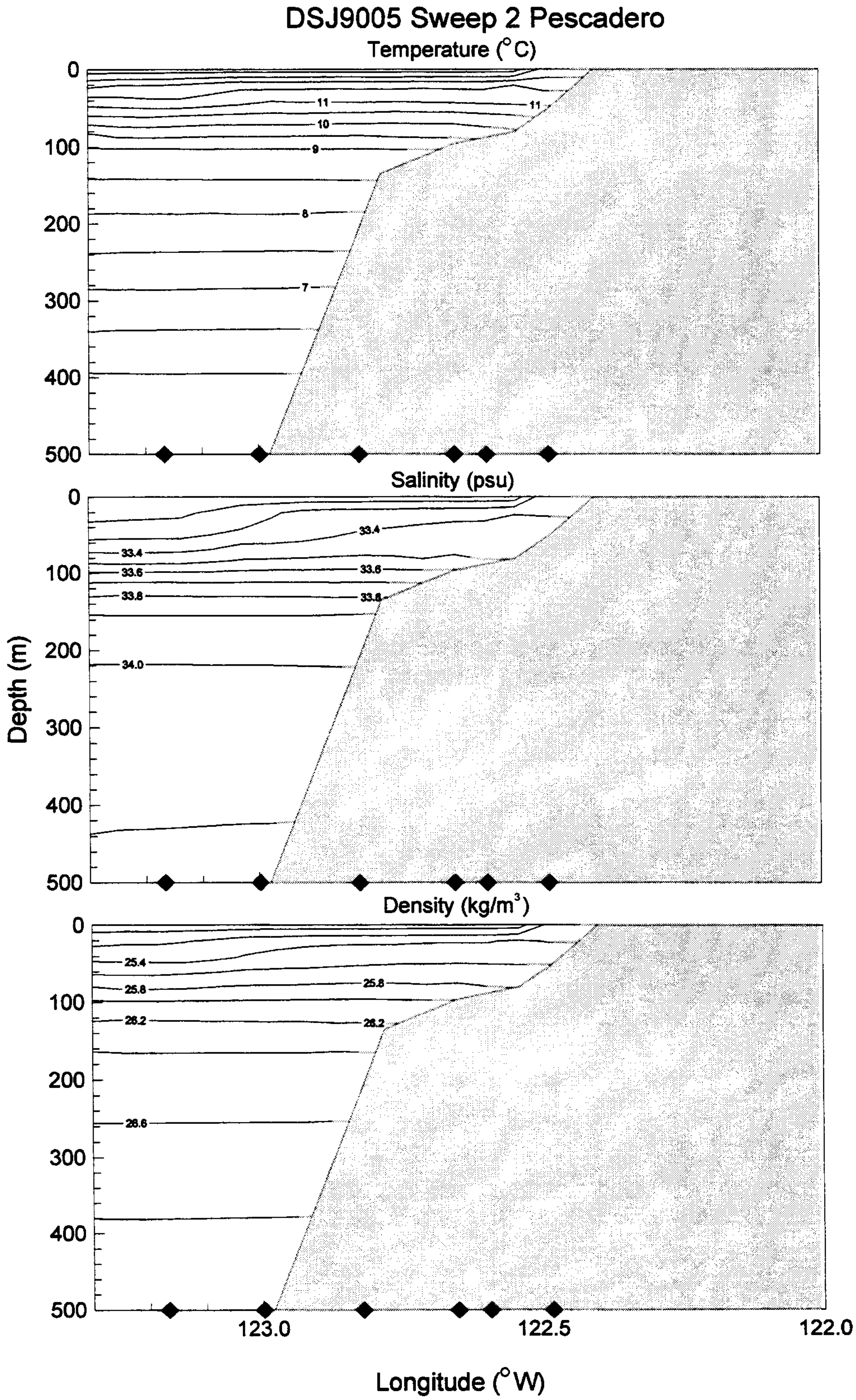

DSJ9005 Sweep 1 Pt. Reyes
Temperature (°C)
9
9
8
Salinity (psu)
33.8
33.8
34.0
Density (kg/m³)
26.0
26.4
Depth (m)
0
100
200
300
400
500
123.5
123.0
Longitude (°W)

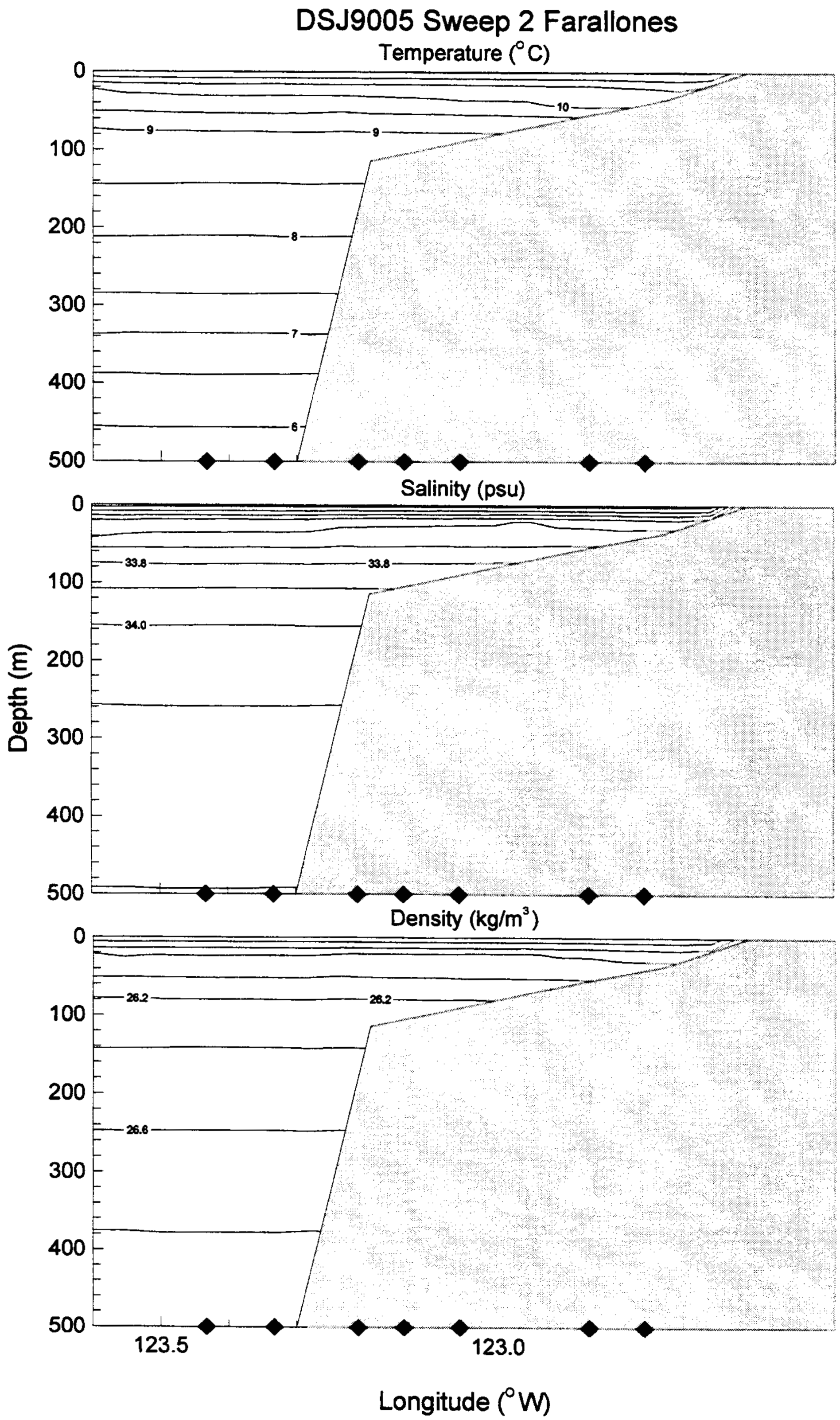
DSJ9005 Sweep 2 Vertical Transect Stations

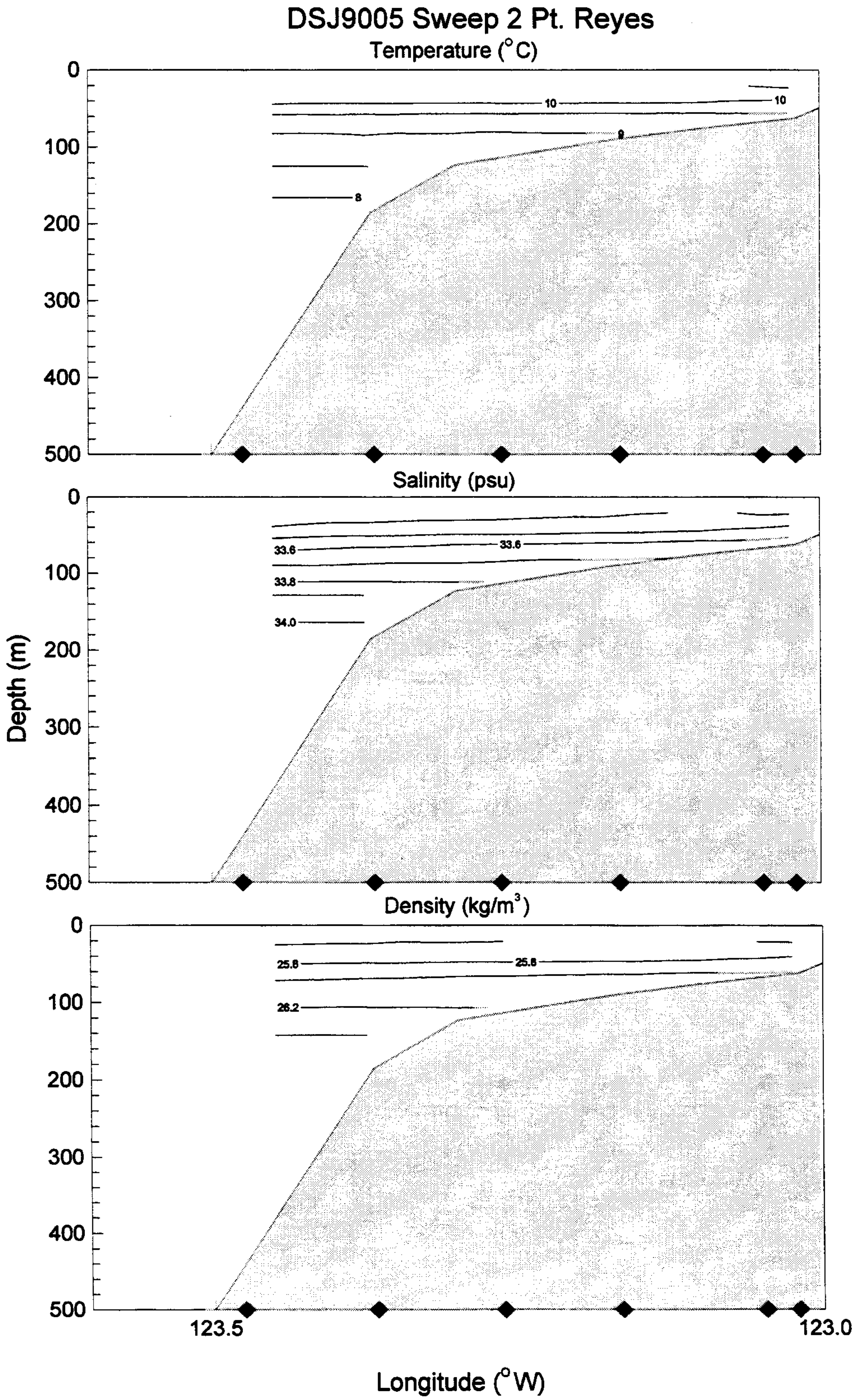


DSJ9005 Sweep 2 Davenport

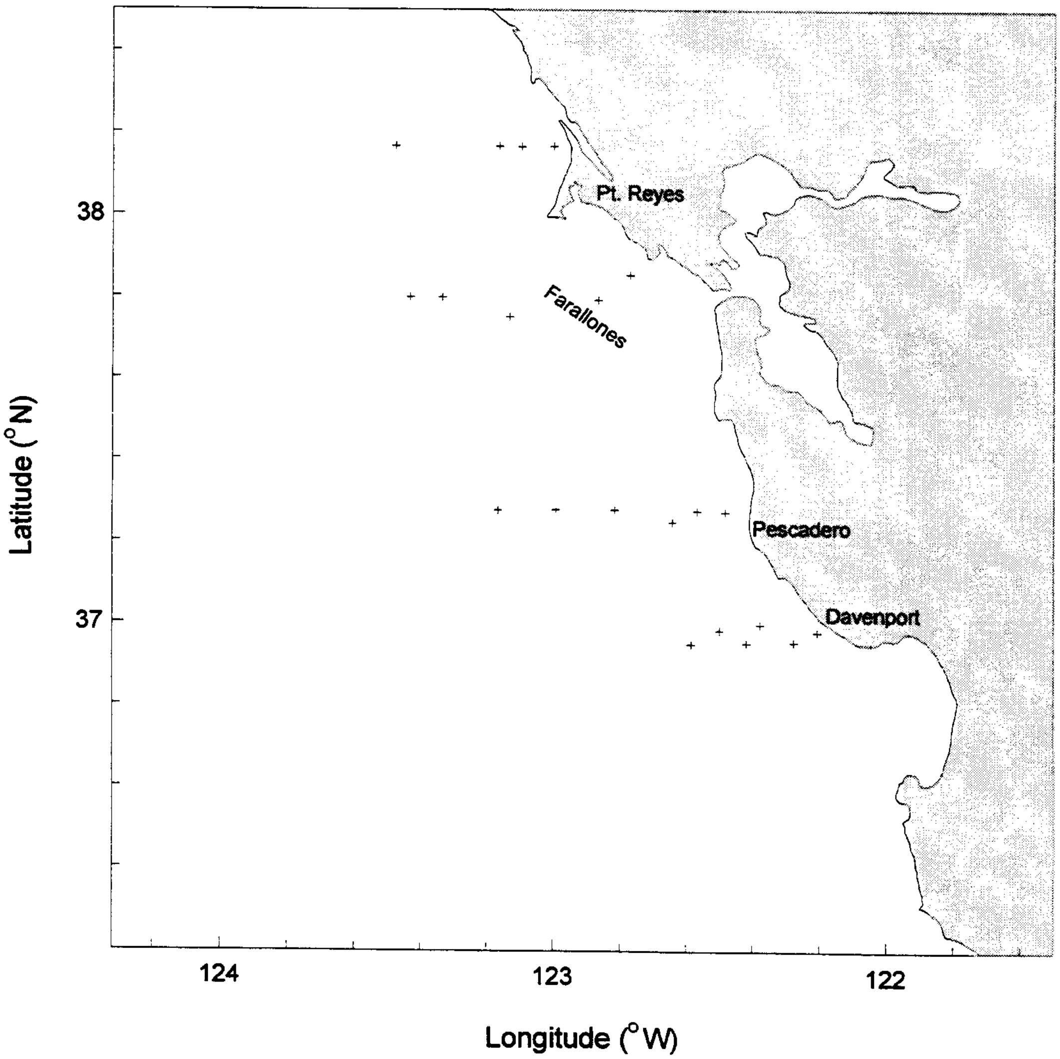


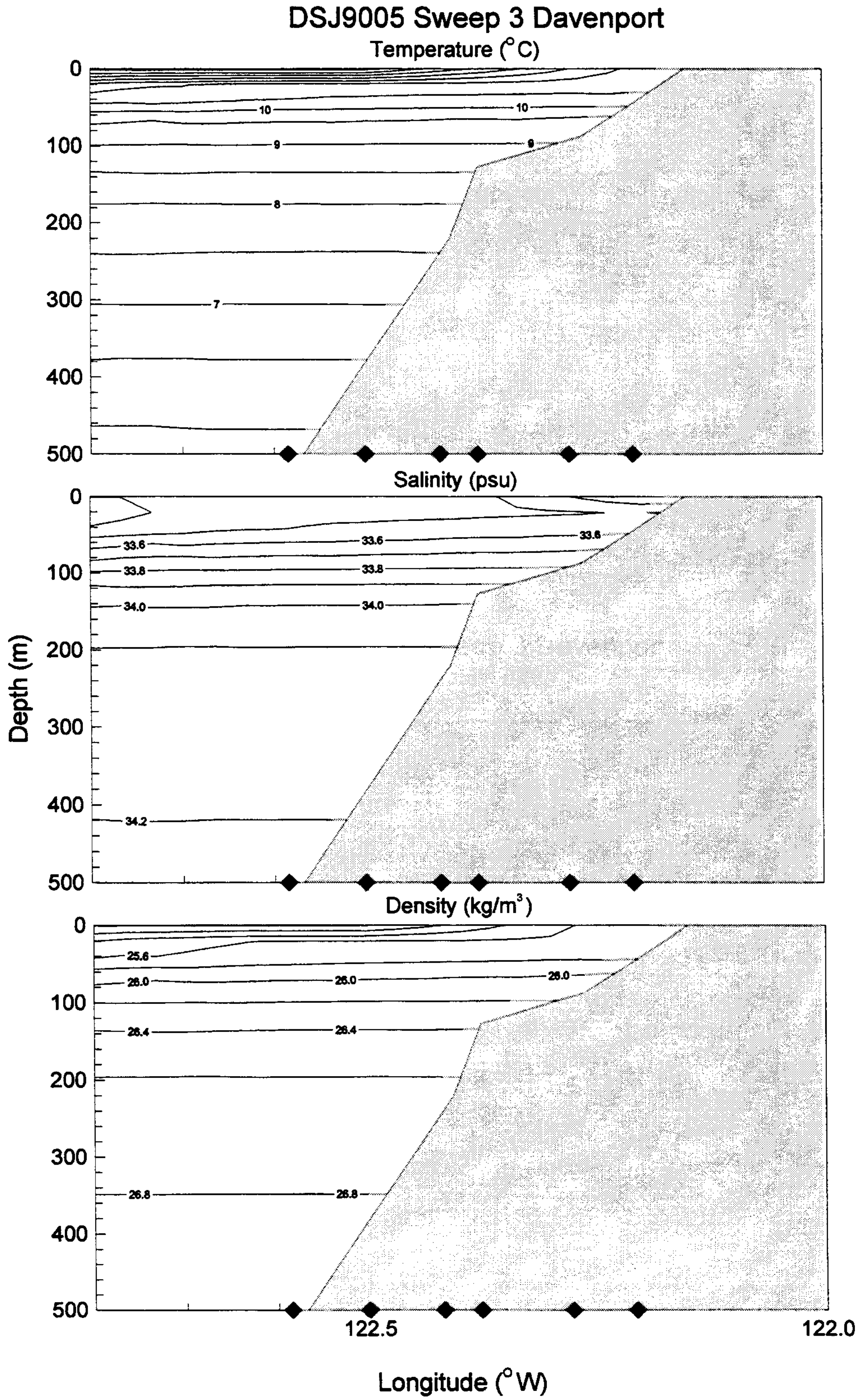

DSJ9005 Sweep 2 Pescadero
Temperature (°C)
11
11
10
9
8
7
Salinity (psu)
33.4
33.4
33.6
33.6
33.8
33.8
34.0
Density (kg/m³)
25.4
25.8
25.8
26.2
26.2
26.6
Depth (m)
0
100
200
300
400
500
123.0
122.5
122.0
Longitude (°W)


DSJ9005 Sweep 2 Farallones
Temperature (°C)
Salinity (psu)
Density (kg/m³)
Depth (m)
Longitude (°W)
0
100
200
300
400
500
10
9
8
7
6
33.8
34.0
26.2
26.6
123.5
123.0

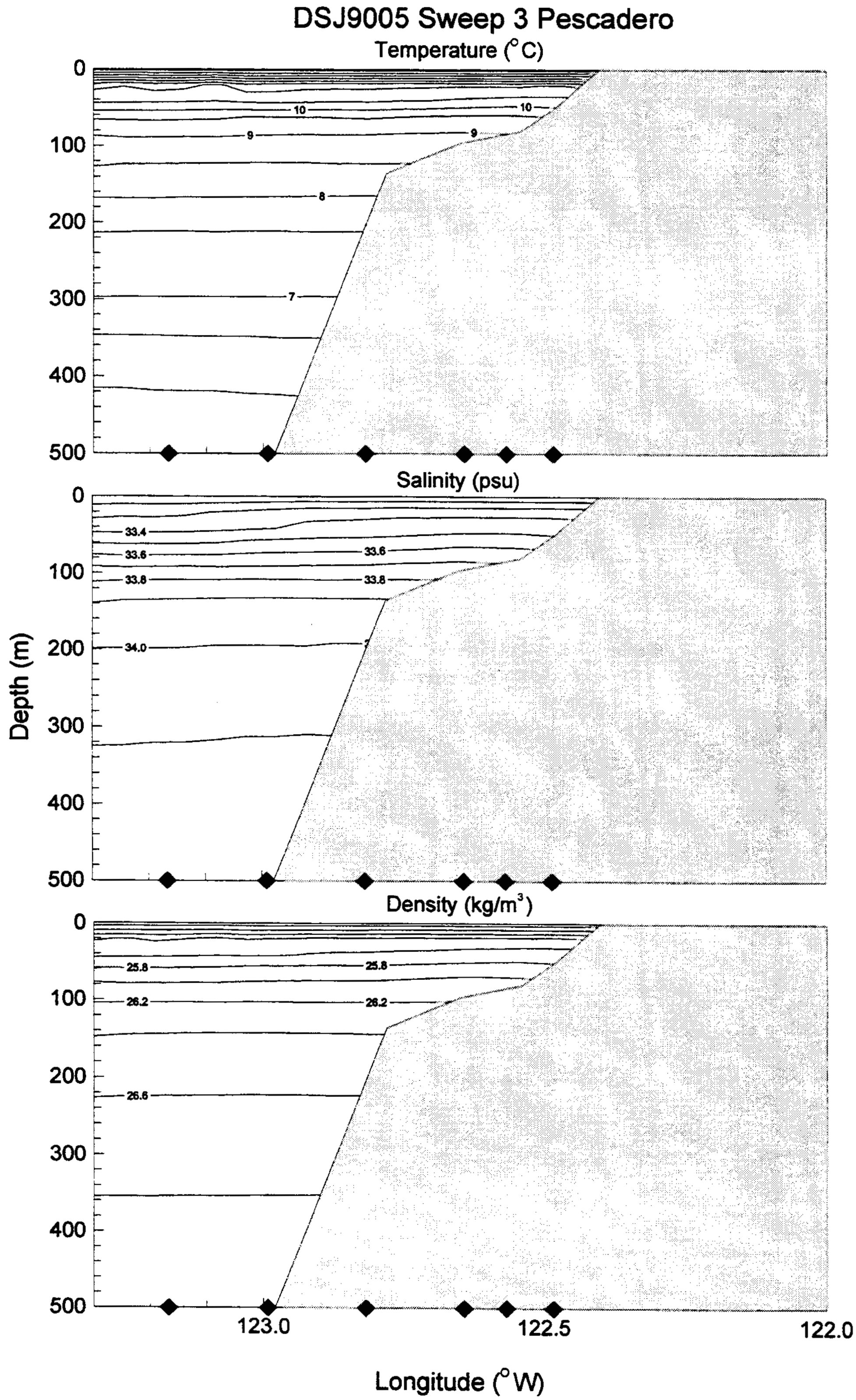

DSJ9005 Sweep 2 Pt. Reyes
Temperature (°C)
10
10
9
8
Salinity (psu)
33.6
33.6
33.8
34.0
Density (kg/m³)
25.8
25.8
26.2
Depth (m)
0
100
200
300
400
500
123.5
123.0
Longitude (°W)

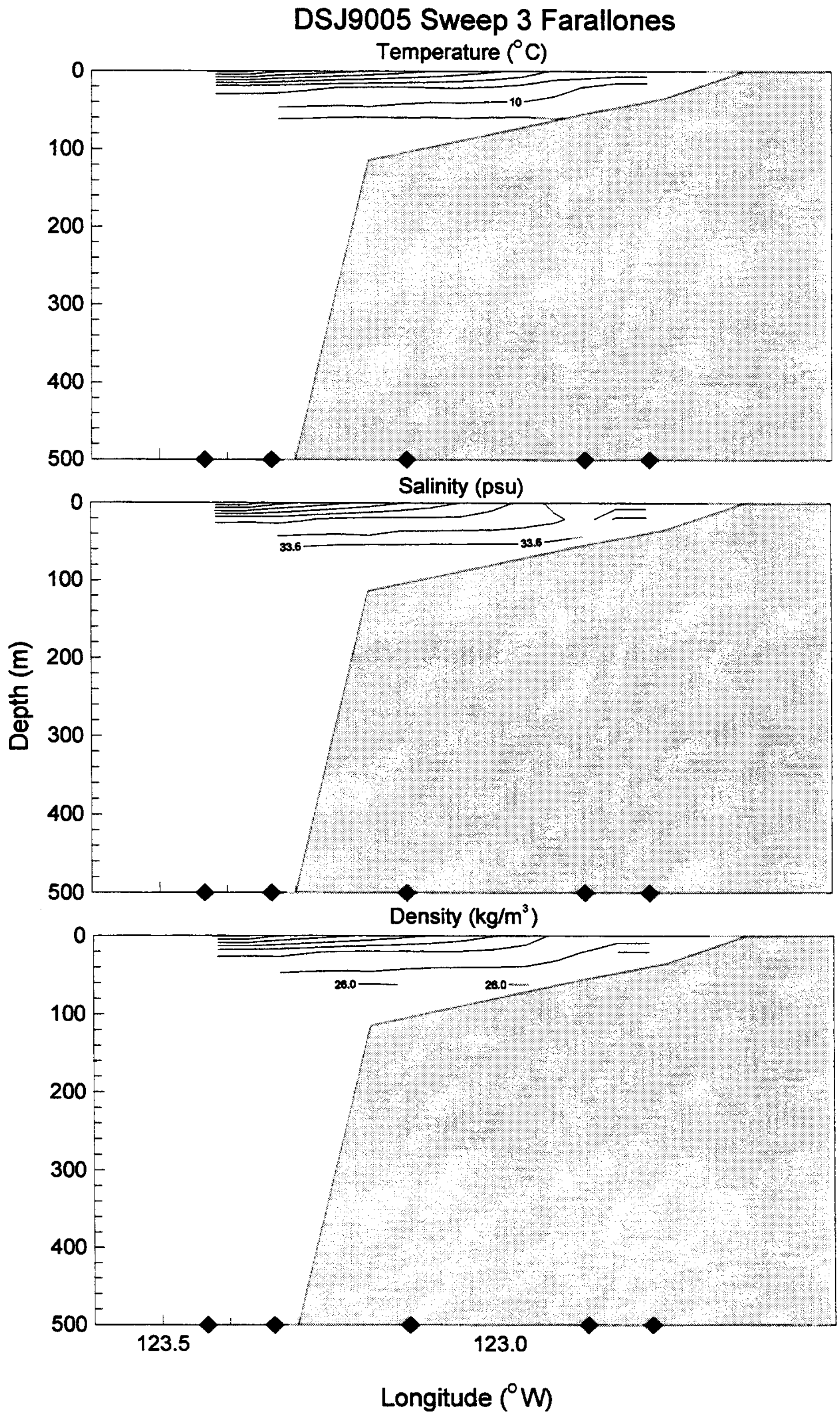
DSJ9005 Sweep 3 Vertical Transect Stations

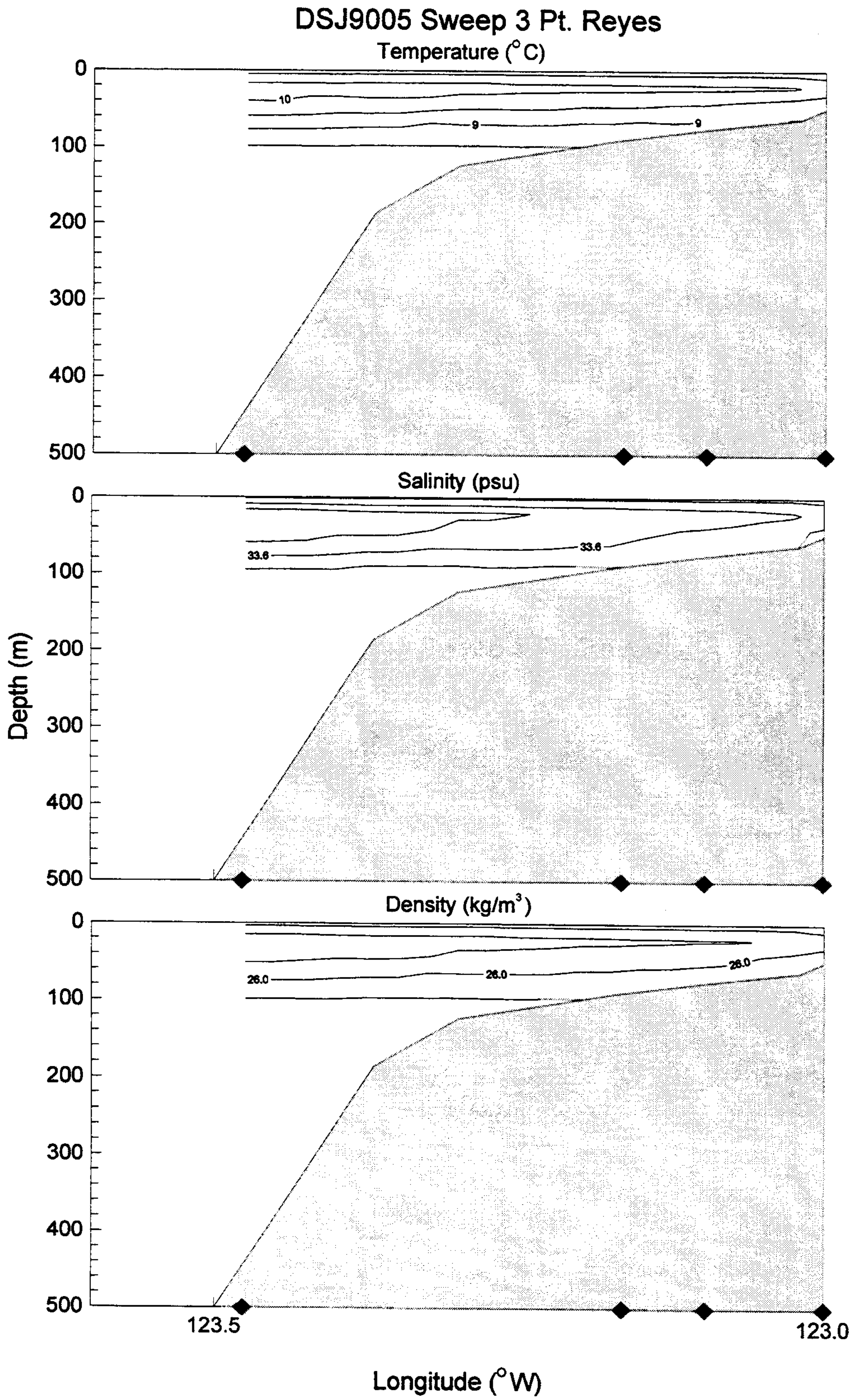




DSJ9005 Sweep 3 Davenport
Temperature (°C)
10
10
9
9
8
7
Salinity (psu)
33.6
33.6
33.6
33.8
33.8
34.0
34.0
34.2
Density (kg/m³)
25.6
26.0
26.0
26.0
26.4
26.4
26.8
26.8
Depth (m)
0
100
200
300
400
500
122.5
122.0
Longitude (°W)


DSJ9005 Sweep 3 Pescadero
Temperature (°C)
Salinity (psu)
Density (kg/m³)
Depth (m)
Longitude (°W)
0
100
200
300
400
500
123.0
122.5
122.0
10
9
8
7
33.4
33.6
33.8
34.0
25.8
26.2
26.6


DSJ9005 Sweep 3 Farallones
Temperature (°C)
10
Salinity (psu)
33.6
33.6
Density (kg/m³)
26.0
26.0
Depth (m)
0
100
200
300
400
500
123.5
123.0
Longitude (°W)


DSJ9005 Sweep 3 Pt. Reyes
Temperature (°C)
Salinity (psu)
Density (kg/m³)
Depth (m)
0
100
200
300
400
500
10
9
33.6
26.0
123.5
123.0
Longitude (°W)

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