I. INTRODUCTION

During the 1920's and 1930's, the west coast sardine industry was this nation's largest fishing industry. Unfortunately, the boom did not last and by the end of 1945 the total sardine catch had decreased by roughly 80%. The Californian economy suffered and in 1949, the state instituted the California Cooperative Ocean Fisheries Investigation (CALCOFI). CALCOFI researchers examined the physical and biological properties of the California Current System in hopes of finding the answer to the sardine's disappearance.

The California Current System (CCS) is a classic eastern ocean upwelling system that forms the eastern limb of the North Pacific Gyre. It is a complex system of poleward and equatorward flows described by three current subsystems. The equatorward flowing California Current (CC) and California Inshore Current (CUC) transport sub arctic waters that are relatively cool and fresh. Their poleward flowing counterpart, the California Under Current (CUC), transports relatively warm and salty tropical waters. The area to the west of the CC is best described as a transition zone where sub arctic waters mix with the slightly warmer Central North Pacific water. The region is highly dynamic and interactions between the different currents, coast and seafloor topography produce a mixture of mesoscale eddies, counterflows, squirts, jets and filaments (figure 1). Wind-driven Ekman transport away from the coast produces areas of upwelling, predominantly near Cape Mendocino and Punta Baja.

II. Data and Methods

In October 2000, a NAVOCEANO funded cruise sampled various stations along the central Californian coast. Figure 2 depicts the locations sampled using a Seabird

Conductivity Temperature Depth (CTD) instrument. The purpose of this project is to gain an understanding in the use and manipulation of operational CTD data. Additionally, the temperature (T), salinity (S), and depth (P) of sampled stations will be used in order to determine the locations of currents and to calculate geostrophic velocities (Vg).

A. Calculations

The entire data set was broken into seven matrices based on line number (line 1 southernmost to line 7 northernmost). Those stations that were not uniformly spaced where eliminated from the data set. These include stations shoreward of the first continuous northwest to southeast-orientated line. The resulting data set, figure 3, was then input into MATLAB in order to produce cross-shore contours in T and S. Calculations of the geopotential height anomaly and Vg where performed using the Seawater MATLAB routines, sw_gpan and sw_gvel, that were developed by the Commonwealth Scientific and Research Organization (CSIRO).

B. Data Limitations

At first glance, the modified CALCOFI grid appears to have uniformly spaced points in the cross and along shore directions. However, the distances do vary slightly in both directions. Thus, the mean of the cross and along shore distances were used in the contour plots. This may have caused slight interpolation errors that potentially resulted in the elongation of certain features.

The bathymetry rapidly increases with depth as the distance from the coast increases. A majority CTD casts were performed to 1000m depth. Those that were shallower than 1000m were artificially assigned a not a number (NaN) value so that contouring could be

performed. Thus, some contours seem to end rather than continue towards the coast or into seafloor topography.

III. Results and Discussion

A. First Look

In order to gain to obtain a general overview of the region's water properties, a standard set of "dot" plots were produced. These were the easiest to produce as they were developed from the original data set (figures 4a,b). These "dot" plots were useful in determining the overall T and S conditions and in verifying the accuracy of the more program intensive contour plots. Inspection of the "dot" plots reveals that the warmer Central Pacific waters are seaward of the cooler CC and the more saline, nutrient rich waters appear near the coast. Evidence of filaments or other mesoscale processes are present despite the coarseness of the plot. Further inspection of the salinity "dot" plots indicates that there appears to be a few erroneous data points. Rainsqualls, cold core eddies, meanders in the fresh CC or CTD errors could be responsible for these erroneous readings.

B. Cross-shore Temperature and Salinity Plots

Temperature and salinity waterfall plots by line are shown in figures 5a-5g. Rather than discuss each plot individually several generalizations and interesting features will be discussed. First, the temperature tends to increase seaward from the coast as expected. The deepest mixed layer depths are at those stations furthest from the coast. Temperature varies less than salinity for all lines and stations. Station 4 at lines 1,4,6 and 7 depict a possible extension of the CC where the salinities decrease rapidly to a minimum value

near a depth of 30m. A similar trend is found at station 6, line 7 which is most likely an extension of the CIC.

The isotherms in figures 6a-6n show a generally slope upwards towards the coast. The CC shows up rather well in the salinity contours (figures 7a-7n) where a relative salinity minimum exists near 30m depth. Looking at the T and S contours for line 1, there is a definite core of low salinity water near 30m depth at -122.6 longitude. Comparing this location to the T contour, we notice that there is hill in the isotherms, indicating a relative minimum of T. A similar pattern exists in line 7 T and S data. Unfortunately, the low salinity and temperature signature was not evident throughout all lines. This is mostly likely due to the characteristic meander of the CC.

C. Geostrophic Velocity

The geostrophic velocities were calculated using a Seawater MATLAB routine and were referenced to 500m and then 1000m. The inputs into the algorithm were: geopotential anomaly (calculated using another Seawater algorithm whose inputs were S, T and P integrated from the surface to 1000m), latitude and longitude (figures 8a-8g). The 500m and 1000m contours reasonably correspond to one another although the former tends to decrease the aerial extent of velocity contours. The CC shows up quite well in lines 1,2 and 7 while the CUC is shown to follow the shelf slope at 200m depth. Geostrophic velocities at line 3 exhibit a break in the pattern and could be attributed to the presence of an anticyclonic eddy.

IV. Conclusions

Some features of the California Current System are displayed quite well in the T and S contour plots. Unfortunately, some of the finer details of the region are lost in the largely

spaced sampling stations and the poor contouring ability of MATLAB. Additionally, the time it takes one ship to complete the entire grid is rather long, which adds temporal error to the contours as features may be advected across several track lines. Advances in remote sensing technology have allowed researchers to study surface phenomena real time. Although the California Current System is a highly complex environment that is difficult to describe with a series of largely spaced track lines, generalizations about current features can be made. Specific studies can only be made by combining remote sensors and reduced spatial and temporal sampling intervals.