Oceanographic Conditions off California to Vancouver Island in the Summer of 1977

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INTRODUCTION

An extensive United States-Poland cooperative fishing-oceanographic survey along the west coast of the United States (California-Oregon-Washington) and along Vancouver Island, Britsh Columbia, was carried out from 12 August to 22 September 1977. The personnel were from the NMFS Northwest and Alaska Fisheries Center (NWAFC) in Seattle, Wash., and from the Polish Sea Fisheries Institute (SFI) in Gdynia.

Daily fishing operations were carried out aboard the NOAA Research Vessel *Miller Freeman* and the Polish Research Vessel *Profesor Siedlecki* (Fig. 1) to assess the biomass of rockfish, genus *Sebastes*, and Pacific hake, *Merluccius productus*, using comparable hydroacoustic and trawling techniques. Each night, special fishing studies and expendable bathythermograph releases were carried out aboard the *Miller Freeman*. Oceanographic data (Nansen bottle casts, salinity-temperature-oxygen-depth sensor lowerings, and plankton samples) were obtained aboard the *Profesor Siedlecki*.

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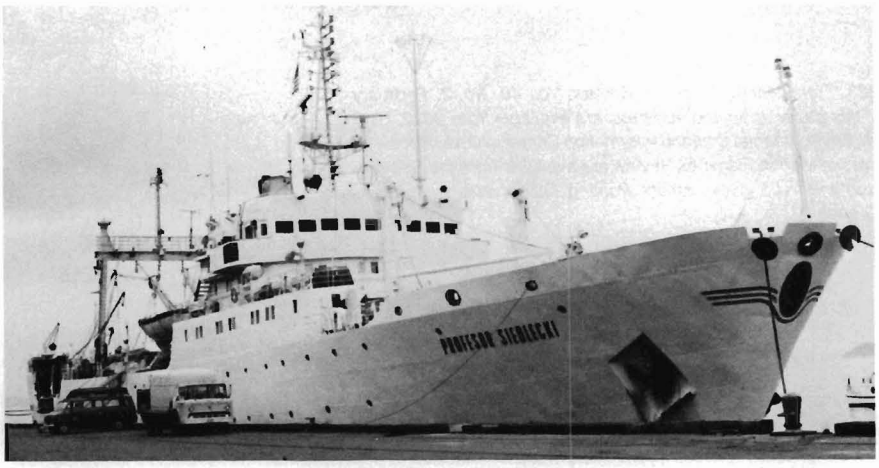
This report gives a preliminary assessment of the physical-chemical data obtained aboard the *Profesor Siedlecki*. As the vessel proceeded northward from lat. 39°N along the California coast to Vancouver Island following a series of zig-zag cruise tracks across the continental shelf, 23 lines of oceanographic stations normal to the coast were conducted at roughly 50-km (30-mile) intervals (Fig. 2A). These 163 stations provide the most complete and quasi-synoptic data ever obtained in this area.

Because there was time for only 5-7 oceanographic stations each night, these were positioned near the 75, 100, 150 200, 500, and 1,000 m isobaths to investigate conditions along the upper continental slope as well as over the shelf. Oceanographic data were tabulated aboard ship and are available at NWAFC and at SFI. Exhaustive descriptive analyses will be forthcoming from SFI personnel. C. M. Love served as Field Party Chief of the U.S. research team board the *Profesor Seidlecki* and assisted in the oceanographic studies.

Figure 1.—The Polish research vessel *Profesor Siedlecki* at Seattle, Wash.



COASTAL CURRENTS

Geostrophic currents derived from geopotential topographies provide an indication of flow relative to a selected reference level. Although a deep level (preferably one at which no flow occurs) is desirable, it is becoming increasingly apparent that predominant surface flow patterns can be obtained by this method even though reference levels of 100 to several hundred decibars (db) are used.

Surface currents referred to 100 db (approximately 100 m) (Fig. 2B) were similar to those referred to 500 db, but the choice of the shallower depth provides more detail of flow over a wider expanse of the shelf. Surface flow was generally southward all along the coast, except for sporadic eddies and a fairly

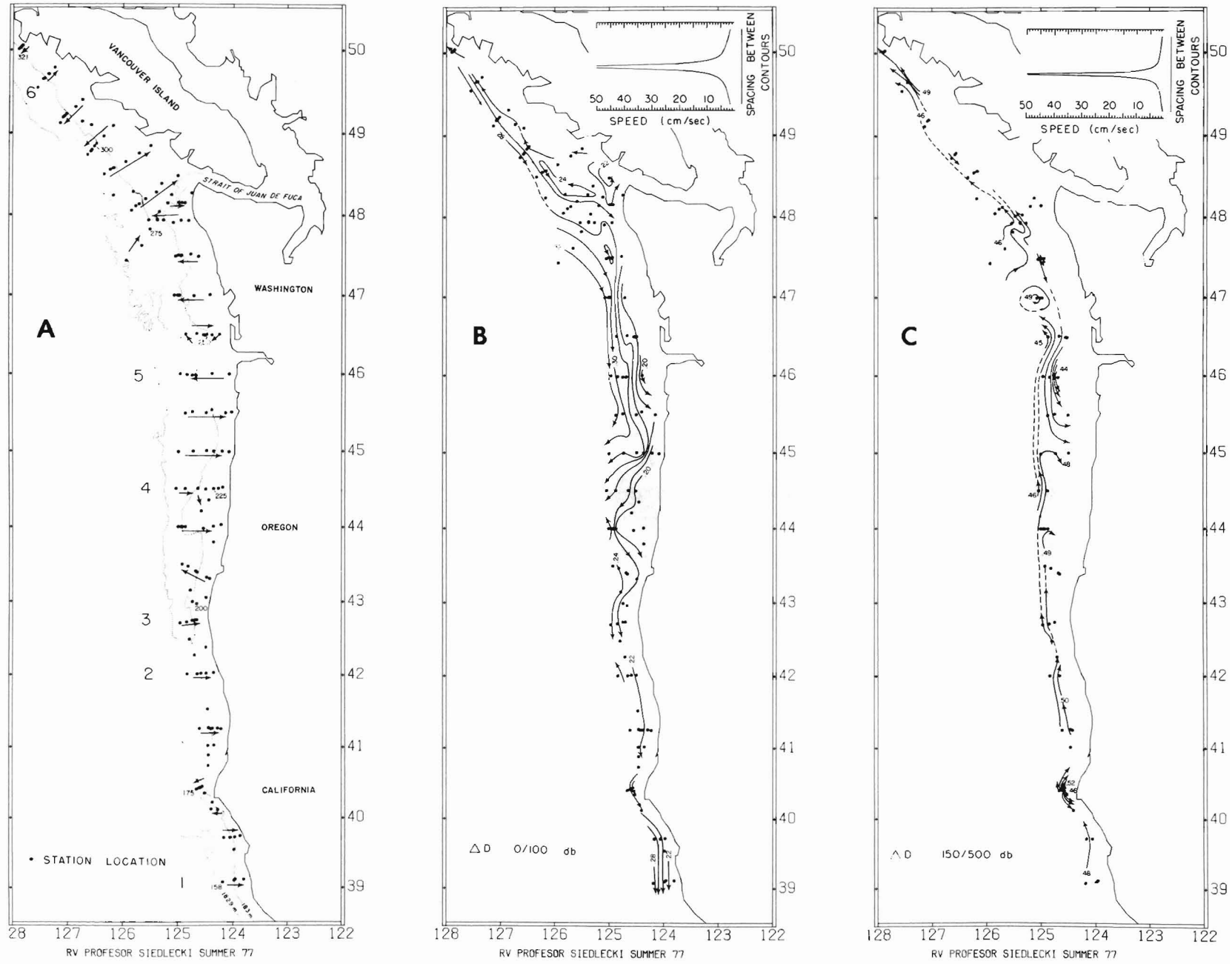


Figure 2.—Track of the research vessel *Profesor Siedlecki* and stations where data on coastal currents were obtained. Large numbers refer to locations of vertical sections in Figure 4.

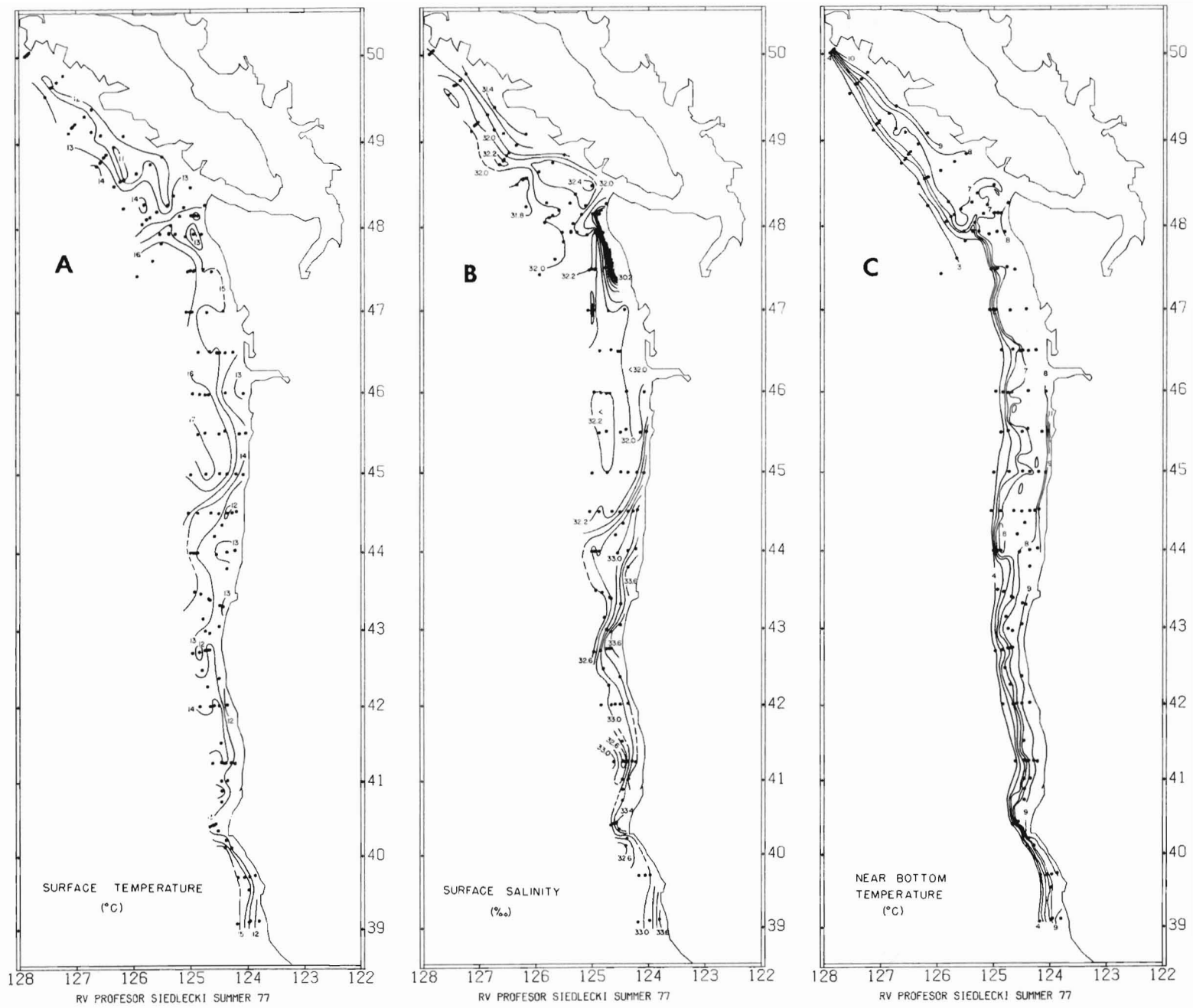


Figure 3.—Track of the research vessel *Profesor Siedlecki* and stations where temperature and salinity data were obtained.

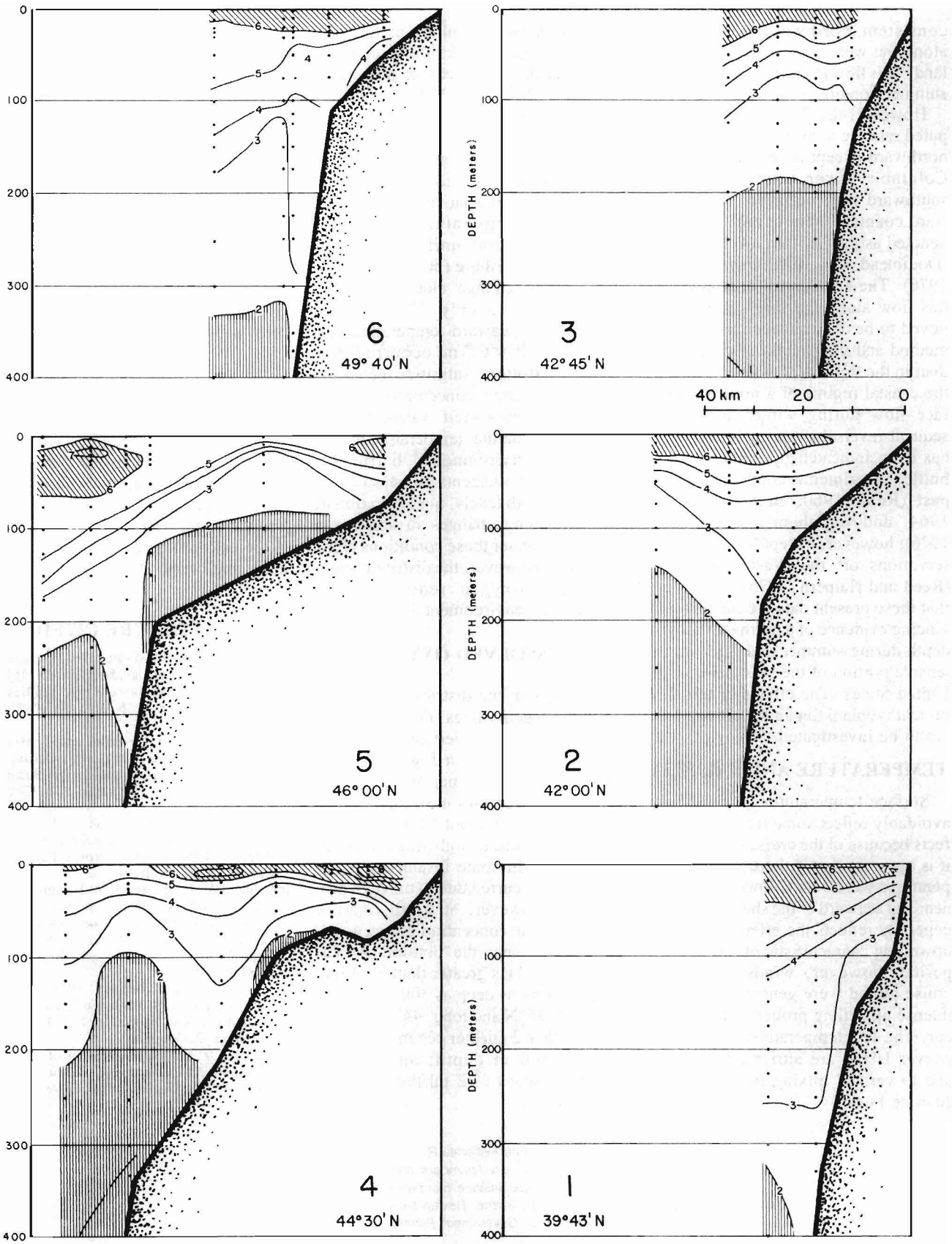


Figure 4.--Distributions of dissolved oxygen (milliliters/liter) at latitudes shown.

consistent northward flow inshore along the west coast of Vancouver Island. This flow is fairly characteristic of summer conditions along this coast.

However, the flow at 150 db (computed relative to 500 db) was generally northward except in the vicinity of the Columbia River where an inshore southward flow occurred. This northward countercurrent at depth has been denoted as the California Undercurrent (Dodimead et al., 1963; Favorite et al., 1976). The apparent discontinuities in this flow along the shelf edge are believed to be due to inadequacies in the method and the paucity of data, rather than in the flow itself. The existence in the coastal regime of a northward surface flow during winter and a subsequent reversal in spring and summer has been indicated by numerous drift bottle experiments conducted in the past (Reid, 1960; Burt and Wyatt, 1964; and Ingraham and Hastings, 1976); however, except for limited observations off the Washington coast (Reed and Halpern, 1976), we believe that these present data are the first convincing evidence of a northward flow at depth during summer over such an extensive portion of the west coast of the United States. The effects of this flow on ichthyoplankton and adult fish have yet to be investigated.

TEMPERATURE AND SALINITY

Surface temperatures (Fig. 3A) unavoidably reflect some time-change effects because of the cruise duration, but it is apparent that inshore surface temperatures were 3°-4°C lower than those near and seaward of the shelf edge. This generally reflects the effects of coastal upwelling characteristic of the summer period; however, winds during the cruise period were generally light and intense upwelling probably did not occur. The low temperatures along Vancouver Island are attributed to runoff and to vertical mixing in the Strait of Juan de Fuca.

Low surface salinities in this area generally reflect river runoff, and high salinities indicate areas of upwelling. The low salinities (<32‰) along Vancouver Island and Washington are due to river runoff, whereas the high salinities (<33‰) south of lat. 46°N clearly indicate upwelling extended at least as far south as lat. 39°N (Fig. 3B).

Bottom temperatures (Fig. 3C) reflect a general uniformity along isobaths, the inshore (50-100 m depth) temperature change along the entire coastline being only 2°C (7°-9°C). Conversely, seaward temperature gradients of 0.4°C/km occurred frequently. Bottom salinities generally reflect the same concentration along shelf and across shelf waters; thus, it appears that neither temperature nor salinity are environmental barriers to alongshore movements of fish stocks at constant depth levels, nor any rationale for explaining changes in abundance that occur under these conditions along the coast. However, the distributions of dissolved oxygen reflect marked changes in environmental conditions.

DISSOLVED OXYGEN

Changes in the distributions of dissolved oxygen values along the coast are reflected in six vertical sections at locations indicated in Figure 4. Near the surface occasional inversions of oxygen concentration occurred with local maxima at about 10 m depth that are probably due to high primary (plant) production; in some instances, supersaturation occurred due to the high production. However, at depth, marked fluctuations in concentrations occurred, particularly near the bottom. At lat. 49°40′N, values greater than 3 ml/liter were present as deep as 300 m; whereas, at lat. 46°N and long. 44°30′W values less than 2 ml/liter occurred as shallow as 100 m depth; and, at lat. 39°43′N values of 2 ml/liter occurred below 400 m.

It is not known what percentage of saturation values represent an undesirable environment or even a lower threshold for Pacific hake or other fish stocks. Such studies should be undertaken. Further, it is also apparent that such large variations in dissolved oxygen values may also affect the distribution of forage organisms and thus indirectly the distribution and abundance of fish. Results of studies of resource/environmental relations will be forthcoming as the extensive masses of data collected during the survey are compiled and correlated.

ACKNOWLEDGMENTS

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