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The Newport line off Oregon – Studies in the North East Pacific

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Abstract

The Newport Hydrographic (NH) Line along 44.65°N off central Oregon was sampled seasonally during two epochs: 1961–1971 through the TENOC program and 1997–2003 through the GLOBEC Northeast Pacific Long Term Observations Program (LTOP); some observations are available for 2004 and 2005. During TENOC, the line extended 305 km offshore to 128°W, with stations 18 km apart over the continental shelf and 36 km offshore. During LTOP, the line was shorter (to 126°W) with closer station spacing over the continental shelf (9 km apart) and slope (18 km apart). LTOP cruises included biochemical sampling and underway current measurements. During both TENOC and LTOP, the seasonal cycle is very strong (accounting for >50% of the variance in surface layer properties), with rapid transitions in spring and fall. The summer regime is subject to coastal upwelling driven by southward winds, equatorward surface currents, and advection of low-salinity waters from the Columbia River. The winter regime off Newport is subject to coastal downwelling and poleward surface currents driven by northeastward winds. Comparison between TENOC and LTOP summer regimes shows the near-surface layer (0–100 m) at most locations is significantly warmer and fresher during LTOP than TENOC, and steric heights over the continental margin are significantly higher. Comparison of LTOP and TENOC winters shows that average differences at most locations were not statistically significant, but that the variance of steric height and shelf-break temperatures was significantly higher during LTOP than TENOC. Interannual variability of climate indices is also stronger during LTOP, which included a rare Subarctic invasion in 2002 as well as the strong 1997–1998 El Niño. During both TENOC and LTOP, interannual variability of steric height is closely related to the El Niño/La Niña cycle. Nutrient concentrations and nitrate-to-phosphate ratios of upwelling-source waters vary inversely with halocline temperature. Both reflect alongshore advection by coastal currents: southward currents bring cool, nitrate-rich waters in summer (especially during the Subarctic invasion), and northward currents bring relatively warm, nitrate-poor waters to the NH line in winter (especially during El Niño). Seasonal and interannual variations in the nutrient level of upwelling-source water are reflected in time series of vertically-integrated chlorophyll over the LTOP survey region (about 150 km by 300 km). Seasonal variations in chlorophyll and currents are congruent with seasonal variations in copepod biomass and diversity. We were not successful in establishing a clear connection between chlorophyll levels and interannual variations in copepod biomass or diversity, nor in explaining the large decrease in the survival rate of coho salmon between TENOC (6%) and LTOP (3%).

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1. Introduction

Newport Line oceanographic sampling started later and has ventured less far offshore than CalCOFI and Line-P, its sisters to the South and North. Its origin was not a response to an immediate societal need (the collapse of a fishery or the need for an ocean weather station) but rather to ''newly available funds'' seeking a use. In 1958 the Office of Naval Research prepared the ''TENOC'' report (The Next Ten Years of Oceanography) as a plan to increase research funding and ship construction. Wayne Burt at Oregon State College responded immediately, obtained funds to construct the R/V ACONA (the first vessel designed and constructed for oceanographic research in the US since World War II) and started oceanographic sampling of Oregon coastal waters. Coastal oceanography was an obvious task for a new oceanographic institution with an 80-foot vessel. As Wayne V. Burt (cited by Burt and Ludwig, 1998) wrote in 1958: ''In general, coastal oceanography out to the 1000 fathom depth has been neglected. This is particularly true of our west coast... Oregon State College is in a unique position to carry out a research program of vital importance to the nation''.

Although sampling over the continental shelf off Newport had started in 1958 using US Coast Guard vessels stationed at Newport, we take 1961 as the start of the Newport Line time series. On 26 June 1961, the newly commissioned R/V ACONA began a survey along latitude 44°39.1′N out to 165 nautical miles making hydrographic casts to 1000 m with Nansen bottles and reversing thermometers. This line (Fig. 1) came to be known as the Newport Hydrographic Line (NH); sampling along this latitude, and at the same stations, continued almost bi-monthly for 11 years. We refer to the 1961–1971 period of regular sampling as the TENOC

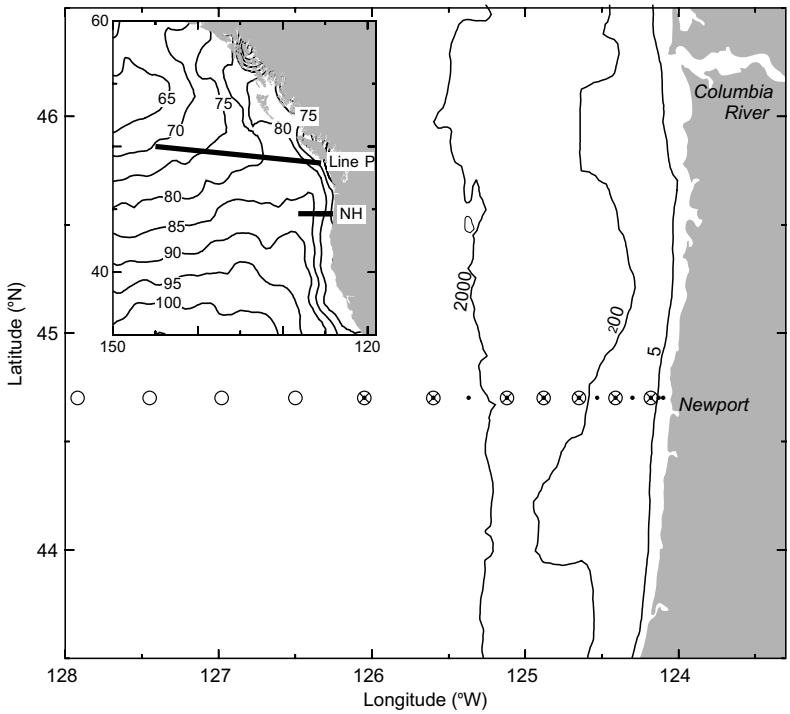

Fig. 1. Map showing NH line stations with the 50, 200 and 2000 m isobaths: circles indicate TENOC stations (discrete bottle casts, 1961–1971); dots indicate LTOP stations (CTD, 1997–2005); and crosses indicate LTOP rosette sampling for chlorophyll and nutrients. Inset shows location of the NH line with respect to Line P; contours of the July–August sea surface elevation in cm (Strub and James, 2002) indicate that the NH line and the inshore end of Line P intersect the California Current in summer.