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Effects of environmental variability on trophic interactions and food web structure in a pelagic upwelling ecosystem

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ABSTRACT: The dietary compositions of 18 species of pelagic nekton were examined from purse seine collections made during 4 (1981 to 1984) oceanographically contrasting summers in the coastal upwelling zone off Oregon and Washington, USA. Euphausiids, hyperiid amphipods, decapod larvae, pteropods, and larval and juvenile fishes were the dominant prey categories consumed during all years by this assemblage of nekton, although their relative proportions varied among the years. Considerable differences were observed in food habits, diet overlap, and food web structure depending upon the prevailing oceanographic conditions. The moderate to low upwelling year of 1981 showed a generally high overall trophic diversity and a low level of diet overlap and food web complexity. During the relatively strong upwelling year of 1982, euphausiids were the dominant food consumed, resulting in high dietary overlap and low trophic diversity and food web complexity. During the warm and low productivity El Niño year of 1983, marked changes were observed in the taxonomic composition of the diet of many species. The diets contained many species of southern origin leading to a high diversity of prey and low overall dietary overlap. A late occurrence of strong upwelling in 1984 resulted in a trophic diversity and overlap that were intermediate to the other years. Although some species preyed on species of lower trophic level during strong upwelling conditions, the overall trophic level was lowest during 1983 and 1984 due to the influx of large numbers of pelagic zooplanktivores.

INTRODUCTION

Trophic interactions occurring in pelagic coastal ecosystems of temperate upwelling regions are poorly understood. This is rather surprising in light of the high biomass and fishery production which characterize these regions (Ryther 1969). There is presently some debate as to how different these ecosystems are compared to other mid-latitude ecosystems with respect to overall productivity and trophodynamics (Cushing 1971, Barber & Smith 1981). Walsh (1981) has estimated that both primary production and fish yield were virtually identical in the upwelling ecosystem off Oregon and the non-upwelling system off the East Coast of the USA; both these areas were substantially less productive than the upwelling system off Peru. Despite some similarities among them, there appears to be no 'typical' upwelling ecosystem due to complexities in the physical, chemical and biological interactions occurring within each system (Barber & Smith 1981).

Spatial and temporal distributions of the standing stocks of the lower trophic levels in the coastal upwelling regime off Oregon and Washington in the Northeast Pacific have been studied, including those for primary producers (Anderson 1964, Small & Menzies 1981), primary consumers such as zooplankton (Lorz & Pearcy 1975, Lough 1975, Peterson & Miller 1975, 1977, Landry & Lorenzen 1989, Brodeur 1990) and ichthyoplankton (Richardson & Pearcy 1977, Shenker 1988), as well as intermediate-level predators such as macrozooplankton and micronekton (Laurs 1967, Day 1971, Pearcy 1976, Shenker 1984, 1988). However, the utilization of the lower trophic levels by higher-level pelagic

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