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Response of Anchovy (*Engraulis ringens*) off Northern Chile to the 1997-1999 El Niño - La Niña Sequence

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The coastal ocean of northern Chile has a strong wind-driven upwelling during almost the whole year. It is strongest in summer and weakest in winter. This area presents a regime of high-nutrient and high-chlorophyll concentrations, with nutrient availability often exceeding the phytoplankton requirement. Anchovy and sardine are the dominant fish species and they alternate in predominance on a decadal time scale. Since 1984 anchovy has been the dominant specie. Its latitudinal distributions are associated with the intensity of upwelling fronts. Anchovy are known to be strongly dependent on environmental conditions over their life cycle, with El Niño events producing extremely adverse effects on the population. The 1997-1999 El Niño-La Niña sequence presented an excellent opportunity to observe their response to large-scale changes in oceanographic conditions off northern Chile.

The onset of El Niño conditions off Northern Chile during May 1997 and August 1998 affected food availability.

Effect on distributions

Wind along the coast decreased in intensity and coastal upwelling was weak. Sea surface temperature and salinity in December 1997 were 4°C and 0.6 psu higher than normal. The thermocline, represented by the 15°C isotherm, and oxycline were up to 50 m deeper than the long-term means, with peaks in June and December 1997. The deepening of isolines was produced by kelvin waves generated in the equatorial area by the strong anomaly of westerly wind.

The deepening of the thermocline reduces the supply of nutrients to the coastal regions. This should cause a decrease in the primary production level which adversely affects other trophic components.

Phytoplankton pigment levels measured and estimated from satellite data were low from May 1997 to August 1998.

The unusual development of the El Niño 97-98 produced the warmest winter observed in this area, reaching temperature anomalies of over 3°C in the first 200 km off the coast.

After the maximum in December the anomalies diminished to reach normal values by August 1998. The region then passed into a cold phase in which the system is highly productive.

Effect on anchovy

At the beginning of the El Niño, the anchovy responded by concentrating along the coast where they were more vulnerable to commercial fisheries. During this time mortality was high because of the effective fishery (high landings) and environmental stress was high because of El Niño conditions.

Later the anchovy moved southward along the coast, and deeper in search of the food and colder water that they prefer (14 to 20°C). They were located between 40 m and 80 m depth (20 to 40 m deeper than normal) reaching, in some areas, up 120 m, near the bottom and far out of range of the commercial fishing nets.

They remained at the deeper more southern location until the conditions returned to normal in August 1998. When the anchovy reappeared at their normal fishery locations, the biomass was relatively high. This suggests that with the onset of upwelling during La Niña period, the stock began their slow recuperation.