

EL-NINO AND DISTRIBUTION HORSE MACKEREL (TRACHURUS MURPHYI) IN THE OPEN PART (OUTSIDE 200-MILE ZONE) OF THE SOUTH-EASTERN PACIFIC OCEAN

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The data have been collected in 1978-1991 outside a 200-mile zone of Peru and Chile by results of large-scale fishery of USSR and scientific vessels. Formation of horse mackerel *Trachurus murphyi* aggregations outside 200-mile zone from 5° to 20°S (North subarea) is determined by two factors. Firstly, by the condition of these species stocks in the coastal zone including the entire economic zone of Peru. Secondly, the hydrologic conditions, which facilitate the species migration into the open ocean waters.

For the Northern subarea a seasonal pattern of commercial fish aggregations formation is characteristic. They are forming from May - June to November - December. A necessary condition, promoting occurrence of commercial fish aggregations is the outflow of relatively cold waters of the Peruvian current outside the Peruvian economic zone boundaries. These aggregations stability is determined by the spatial - temporary stability of outflows. The basic locations of cold water penetration outside the economic zone boundaries are between parallels 8-10°, 14-15° and 17-20°S. Water temperature in the fish aggregation regions varies from 16 to 23° C, while the more intensive migrations are found at the temperature of 18° C. The cold waters penetrate westwards on distance up to 400 miles from the coast and fish aggregations are distributed mainly within 100-mile band from Peruvian zone. In a southern part of the Northern subarea, in the field of the Peruvian current, divergence the centres of water upwelling are forming which also contribute the formation of a high productivity zone.

More than ten-year experience of the fishery has shown, that in years of the maximum El-Nino development (1982-1983; 1987-1988) in the Northern subarea commercial aggregations of horse mackerel outside 200-mile zone are actually absent (1983; 1987). In the years, when El-Nino development occurred (1982) and in the subsequent years (1984, 1985) the scales of aggregations migration from the zone were insignificant. In these years the area of horse mackerel aggregations is smaller than in other fishing periods.

Period 1978-1981 may be considered as a favourable one for commercial aggregations outside Peruvian zone, when horse mackerel catch depended only on the level of fishing effort. The catch in 1981 amounted to 403500 tons while available to fishery biomass was up to 4,3 mln.t. Horse mackerel distributed along the entire zone of Peru (from 6° up to 17°30') and up to 20°S. The average effective years of fishery were 1982, 1988-1990. Horse mackerel catches in these years were within 97500 - 125400 tons, while available commercial biomass varied from 0,8 mln.t in 1982 to 2,7 mln.t in 1988 (the catch rate was 15,8 and 4,3% respectively). In the same years horse mackerel distribution is characterized as continuous one along the sea zone.

In 1984-1985 after one of the most intensive El-Nino for the latest decades, the catches constituted less than 30000 tons (23400 and 27900 tons respectively) with insignificant areas of fish concentration and total biomass of 0,6-1,2 mln.t.

The highest values of horse mackerel biomass and catch in the ocean part of the sub-area correspond to the maximum values of this species stock estimated by the Institute of the Sea of Peru (IMARPE) on the basis of echosurveys in 200-mile zone. It was the period from 1978 to 1983 when horse mackerel the maximum biomass in the zone was 8,9 mln.t, mackerel 1,8 mln.t, sardine 4,8 mln.t. During 1988-1990 in "zonal" waters the high values of these species stocks were observed - horse mackerel biomass 7,5 mln.t, mackerel 1,5 mln.t, sardine 8,5 mln.t.

According to IMARPE data in the "zonal" part of the area after El-Nino events of 1982-1983, in 1984-1985, the reduction horse mackerel and mackerel biomass was noted (Muck, Sanchez, 1987) . These data agree with the information on fish aggregations that migration outside the zone based on the fishery results in the ocean part of this subarea (in these years the total annual catch of these species did not exceed 28000 tons) and peculiarities of fish aggregations distribution and available fishing biomass in the grounds of the Soviet Union fleet operation.

When arranging researches and fishery special attention should be paid to the time of fish migration into the open sea areas accessible to fishing vessels. The data of figure 1 show, that fish aggregations in the ocean part are forming in May - June or July - August. Formation of fish aggregations in May - June 1980 and 1981, 1985 and 1986, is evidently caused by the cool Peruvian current strengthening. These years are characterized by negative SST anomalies (-1°) in the area 5-10°S during the first half of the year and are not related to the strong El-Nino events (Climate Diagnostics Bulletin, 1991). Formation of fish aggregations in July - August (1979, 1984, 1989-1991) coincides with a situation when in the first half-year positive SST anomalies or their alternation with insignificant (up to - 0,5°) negative anomalies are observed. The years of intensive El-Nino ending (1983, 1988) are the exceptions. Prediction of

events, determining migration of fish aggregations outside the zone is the element of El-Nino forecast.

Thus, the time of pelagic fishes migration into the open part of the subarea and the area of fish aggregations is determined by the fish stocks size within 200-mile zone of Peru and hydrologic conditions. The prediction of periodically repeating strong El-Nino is of special importance..

On the basis of AtlantNIRO research data, horse mackerel observed outside Peruvian zone and horse mackerel distributing off Chilean zone belong to different groups. The observed genetic heterogeneity of horse mackerel is caused by reproduction separation of the groups (1040;lekseev, 1985; 1050;1086;val, 1981; 1984).

Distribution of horse mackerel in the region located southwards of 25° S outside Chilean 200-mile zone (South subarea) insignificantly depends on the phenomenon El-Nino. El-Nino events in 1982-1983 resulted in water temperature increase by 1° C in this region during 1983 as compared to the average long-term level. This is obviously related to penetration of modified water mass of subtropical origin into the location at 30-35° S. It is possible to consider the occurrence of juvenile horse mackerel of age 1+ together with fish of age 2+-5+ at 37-43°S as a consequence of the above said events. After El-Nino, in 1984, at the same latitude no fish of age 1 + were observed. It is possible to assume, that fish of this age group were distributed further northwards.

Distribution of eggs, larvae and spawning fish during spawning season 1983/84 and up to 1988/89 is shown. It is evident, that westward of 85°W in 1983/84; 1984/85 the spawning occurred in more southern locations. Besides, the analysis of horse mackerel age structure in commercial catches for 1979-1991 based on VPA has shown the absence of strong year-classes after spawning in 1983/1984 and 1984/1985. The strong year-classes appeared after spawning season 1985/1986. Presented data on distribution of various age groups during different quarters of 1983 and 1984, as well as ichthyoplankton and spawning fish distribution show, that in the open sea area southwards of 30 °S horse mackerel at all life cycle stages distribute and these fish are able to provide recruitment for its reproduction. These data allow to define the horse mackerel status in this area as one large population with the distribution area from the coast of Chile to New Zealand, and horse mackerel from different parts of the area contribute the stock reproduction .