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OCEANOGRAPHIC ASPECTS OF LAKSHADWEEP WATERS IN RELATION TO SKIPJACK TUNA FISHERIES

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ABSTRACT

The variations noticed on important oceanographic parameters such as surface currents, seawater temperature, salinity and dissolved oxygen content of waters around Lakshadweep group of islands are discussed in brief. An attempt is made to correlate selected parameters with the occurrence/abundance of Skipjack tuna catches in and around the islands. It is observed that apart from factors such as sea water, temperature and salinity, the resultant effect of the phenomenon of 'upwelling' mainly caused by diverging current systems contribute towards concentration of Skipjack tuna in certain localities. It may be possible that fishing areas for Skipjack tuna could be predicted sufficiently in advance by monitoring the formation and shifting of divergence zones around these islands during the period, November - March, the season for the Skipjack tuna fishery. The possibilities of utilising Satellite Remote Sensing data to locate thermal boundaries, resulting out of divergence, is also suggested.

INTRODUCTION

That part of Arabian Sea around the Lakshadweep group of islands spreading over an area of approximately four lakh sq km is the Lakshadweep waters. There are no rivers originating in any of these 36 small coral islands. The sea bottom steeply descends to great depths immediately beyond the coral reefs with a very narrow continental shelf, the total area covered by the shelf being around 7770 sq km (George Varghese, 1990).

The Lakshadweep waters are particularly interesting to oceanographers because of the presence of the submarine ridge, the Laccadive-Chagos ridge, which exercises great influence on the circulation of water masses and contributes, to some extent, to the enrichment of surface waters as has been suggested by Cooper (1957). Patil and Ramamirtham (1963) have reported significant circulation in the northern areas near Bitra (cyclonic), Agatti and Kiltan (anticyclonic) during winter. Pillai and Perumal (1975) based on studies conducted around Agatti island during winter reported NW and NNW surface currents leading towards the island on its southern tip and diverging into two branches one on the eastern side and other on the western side. George Varghese and Shanmugham (1983) reported that Lakshadweep is the only area in India where an organised tuna fishing is in vogue. Skipjack tuna (Katsuwonus pelamis) forms the major fishery in these waters. Out of an annual production of about 6000 tonnes of tuna from these islands forming almost 20% of the total tuna landings in India, 46% is caught around Agatti island.

Studies made by various authors have thrown light on possible relationship between selected oceanographic parameters and skipjack tuna fishery around these islands. An attempt is made to summarise the findings of relevant studies undertaken during the past decades. The possibilities of evolving a prediction system for skipjack tuna fishery around Lakshadweep islands by monitoring the formation and shifting of divergence zones around the islands during the period November - March, the season for skipjack tuna fishery are discussed. The possibilities of utilising satellite remote sensing data (thermal boundaries) are also discussed

DISCUSSION

Sea surface currents :

The surface currents, which form part of the monsoon circulation in the northern Arabian sea are, in general, southerly during the SW monsoon season (June - September) reverses its direction to northerly during NE monsoon season (November - February). Depending on the geographical location of individual island, these currents are deflected and become NW to NNW during winter and SE to SSE during summer.

Sea water temperature :

Jayaraman et al, (1960) reported a well formed surface mixed layer extending up to depths of 50 m during April with a strong thermocline between 75 m and 100 m. Patil and Ramamirtham (1963) found the surface mixed layer extending up to 80 m during winter and the thermocline extending up to 150 m. The monthly mean SST varied between 28^0 C (winter) and 30^0 C (summer). Laevastu and Rosa (1963) have reported the temperature range for skipjack tuna to be between 17^0 C and 28^0 C and temperature range for the fishery between 19^0 C and 23^0 C. Sharp (1979) reported the temperature preference for skipjack tuna in the range 20^0 C to 32^0 C and also projected the location of 20^0 C isotherm in southern Indian Ocean which is the normal lower boundary for skipjack tuna. Silas and Pillai (1982) opined that in the tropical areas localised differences in the SST also may point to locate areas of current boundaries, upwelling etc, where forage organisms for tunas accumulate.

Salinity :

In Lakshadweep waters, far away from the mainalnd, seasonal fluctuations in salinity are very little due to absence of rivers in these islands. Slight changes in salinity are caused by the influence of currents and divergences. Jayaraman et al, (1960) reported salinity maximum at 100 m during April. Patil and Ramamirtham (1963) found salinity maximum at 75 m during December with the surface salinities in the range 34.2 to 36.2% around Agatti island during December. They also reported maximum concentration of skipjack tuna shoals in areas of higher salinities.

Dissolved oxygen concentration :

Jayaraman et al. (1959) found uniform oxygen concentrations at surface layers up to 50 m in April beyond which the concentration decreased to 150 m. The oxygen minimum layer was found at depths of 700 m and once again the concentration increased towards 1000 m depth. Patil and Ramamirtham (1963) reported low oxygen concentrations (0.2 to 0.5 ml/l) during winter. Sharp (1979) presented an estimate of boundary conditions for dissolved oxygen for skipjack tuna as follows :

$$\frac{\text{10 minutes tolerance}}{\text{02 minimum for small fish (50-75 cm long)}} = \text{2.5 to 3 ml/l}$$

Sharp (1979) presented zones where 2.5 ml/l dissolved oxygen level rose to depths between 50 m and 80 m. It was observed that along the SW coast of India including Lakshadweep area oxygen levels were very low near the surface in the months of June and July excluding tunas from such regions. It was also observed that these areas have very little oxygen for skipjack tuna to survive at depths less than 50 m during June - July.

Divergence and upwelling :

Rao and Jayaraman (1966) reported upwelling around Minicoy island due to divergence in the vicinity of the island during late November and suggested that the phenomenon may have considerable impact on the peak tuna landings in the region between December and March. Pillai and Perumal (1975) observed that surface currents which head towards the island of Agatti in December on its southern tip diverge into two branches one on the eastern side and the other on the western side. The comparatively low temperature and high salinity waters found at surface levels on the southern side of the island indicated presence of upwelled water. According to them, the concentration of skipjack tuna shoals on the southern side may perhaps indicate a possible relationship between skipjack tuna and upwelling zones.

It is well known that tuna gather around areas of upwelling and in areas where the thermocline is shallower (Nakagome, 1973). Uda and Nakamura (1973) have observed the region of maximum hooking rate localised either in the marginal area, water boundaries or along oceanic fronts.

According to Pillai and Perumal (1975), it seems likely that the divergence zone which leads to a favourable environment is shifting from one area to another depending on the direction and velocity of prevailing currents, geographical locations of the islands, bottom topography of the atolls etc. They have also opined that probable fishing areas for skipjack tuna in Lakshadweep waters could be predicted sufficiently in advance by keeping a constant watch on the formation and shifting of divergence zones around the islands during the period September - April, the season for Skipjack tuna fishery.

Evolving a possible prediction system for skipjack tuna fishery based on the formation of thermal boundaries/divergences/upwelling :

Thermal boundaries, diverging currents and the phenomenon of upwelling can be observed by monitoring various hydrographic parameters such as direction and velocity of currents, sea water temperature, salinity and dissolved oxygen content (both in the horizontal and vertical plane) in space and time. Unless continuous monitoring of these parameters is carried out in and around all these islands using research vessel facilities, one may not be able to draw conclusions with regard to the occurrence, continuance/shifting of the above mentioned phenomena. Such surveys are time consuming and expensive in view of the vessel facility requirement.

Silas and Pillai (1982) indicated possibilities of utilising satellite imageries for locating oceanic features such as ocean temperature, chlorophyll distribution, current boundaries, slicks and ocean fronts to understand likely areas of concentration of tuna, especially skipjack tuna and yellowfin tuna.

The National Remote Sensing Agency (NRSA), Hyderabad is bringing out maps showing Potential Fishing Zone (PFZ) based on thermal boundaries prepared form Sea Surface Temperature values received through satellite infrared imageries, two times a week during the period November to May. Separate maps for Lakshadweep islands sector indicating the period of validity is released at the above mentioned periodicity. These maps clearly give indications of the presence of thermal boundaries originating out of divergences and resultant upwelling, current boundaries etc.

The Central Marine Fisheries Research Institute has already initiated steps to evolve a prediction system based on correlations between the PFZ and the actual tuna fish catches around individual island in collaboration with NRSA and the Directorate of Fisheries, Lakshadweep. These maps have the added advantage of real time coverage of the entire island territory. Skipjack tuna fishery being pelagic in nature, mainly employing a single fishing method viz tuna pole and line fishing, is expected to have better correlation with PFZ maps generated out of SST data provided by satellite infrared imageries. Evolving a suitable prediction system will help the local fishermen to reduce the searching time for skipjack tuna shoals and thereby effecting an overall reduction in the cost of operation of tuna pole and line fishing vessels.

CONCLUSIONS

Studies made in the past revealed the behaviour characteristics of skipjack tuna to concentrate in areas of divergences, resultant upwelling and current boundaries in the Lakshadweep waters. Factors such as the vertical extent of the surface mixed layer and also the temperature ranges within this layer are known to contribute towards concentration of shoals in specific localities. Tolerence levels with regard to dissolved oxygen concentrations are also known. Since the divergence zones, which lead to a favourable environment is known to shift from one area to another depending on the direction and velocity of prevailing currents, geographical location of these zones on the basis of indices such as thermal fronts assume special significance. Satellite imageries on SST, supported by sea truth data, would provide the required scientific data base to evolve a possible prediction system for the skipjack tuna fishery in the coming years.

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