Management of Scombroid Fisheries

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Validation of Potential Fishing Zone advisories in Minicoy region of Lakshadweep with special reference to skipjack tuna

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ABSTRACT

ıtensive validation programme of Potential Fishing Zone (PFZ) advisories carried ut by the Central Marine Fisheries Research Institute around Minicoy island re-ealed positive relationship between PFZ and occurrence/abundance of skipjack ına (*Katsuwonus pelamis*). The usefulness of PFZ advisories for the tuna pole and ne fishing fleet around Minicoy island especially for reducing the searching time or tuna shoals and thereby effecting an overall reduction in the cost of fishing op-rations is highlighted.

INTRODUCTION

Studies made by various authors have thrown light on the possible elationship between selected oceanographic parameters and skipjack tuna ishery around Lakshadweep island. These waters are particularly interest-ıg to oceanographers because of the presence of the submarine ridge, the .accadives-Chagos ridge, which exercises great influence on the circulation f water masses and contributes, to some extent, to the enrichment of sur-ace waters. Patil and Ramamirtham (1963) have reported significant circu-ıtion in the northern areas near Bitra (cyclonic) and Agatti and Kiltan (an-cyclonic) during winter. Pillai and Perumal (1975) based on studies con-ucted around Agatti island during winter reported NW and NNW surface urrents leading towards the island on its southern tip and diverging into wo branches one on the eastern side and other on the western side. George nd Shanmugham (1983) reported that Lakshadweep is the only area in In-ia where an organised tuna fishing is in vogue. Skipjack tuna (*Katsuwonus elamis*) forms the major fishery in these waters. The possibilities of evolv-ıg a prediction system for skipjack tuna fishery around Lakshadweep is-ınds by monitoring the formation and shifting of divergence zones around ıe islands during the period November-March, the season for skipjack tuna ishery assume special significance.

Studies conducted by different agencies both within the country and broad revealed that sea water temperature, dissolved oxygen levels, salin-y, phytoplankton and zooplankton concentrations play an important role in ontrolling the distribution and abundance of fishery resources, especially, elagic resources. Monitoring these parameters in space and time is time onsuming and prohibitively expensive and a real time picture of any one of ıese parameters or a combination of the above becomes almost an impossi-

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bility. Indirect method of monitoring selected parameters such as Sea Surface Temperature and phytoplankton pigments (Chlorophyll - *a*) at sea surface from satellites is found very ideal as it provides high repetivity and large spatial coverage.

RESULTS AND DISCUSSION

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 the 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 areas of current boundaries, upwelling etc. where forage organisms for tunas accumulate.

In Lakshadweep waters, far away from the mainland, 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‰. Pillai and Perumal (1975) reported surface salinity in the range 34.8 to 35.02‰ around Agatti island during December. They also reported maximum concentration of skipjack tuna shoals in areas of higher salinities.

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^{-1}) during winter. Sharp (1979) presented an estimate of boundary conditions for dissolved oxygen for skipjack tuna as follows:

$$\frac{\text{10 minutes tolerance}}{\text{O}_2 \text{ minimum for small fish (50-75 cm long)}} = 2.5 \text{ to } 3 \text{ ml l}^{-1}$$

Sharp (1979) presented zones where 2.5 ml l^{-1} dissolved oxygen level rose to depths between 50 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.

Rao and Jayaraman (1966) reported upwelling around Minicoy island due to divergence currents 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 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 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 quite 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 locale 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.

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 required.

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 tunas, especially skipjack and yellowfin. The National Remote Sensing Agency (NRSA), Hyderabad is bringing out maps showing Potential Fishing Zone (PFZ) based on thermal boundaries prepared from Sea Surface Temperature (SST) values received through satellite infra red imageries two times a week during the period, November to May (cloud free months). Separate maps for Lakshadweep islands secto-

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 Minicoy 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, is expected to have better correlation with PFZ maps generated out of SST data provided by satellite infra red imageries. For tuna pole and line fishing for skipjack tuna around Minicoy island, the average catch/boat varied between 83 kg and 28 kg for PFZ and non-PFZ areas respectively. An average increase of 300% in skipjack tuna catches for pole and line fishing activity was observed in the PFZ. Evolving a suitable prediction system helped the island 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 by means of saving both fuel which is expensive in the island territory and also valuable human effort.

CONCLUSIONS

Studies made in the past revealed the behaviour characteristics of skipjack tuna to concentrate in areas of divergence, 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. Tolerance levels with regard to dissolved oxygen concentrations are also known. Since the divergent zones which lead to favourable environment is known to shift from one area to another depending on the direction and velocity of prevailing currents, geographical location of the islands and bottom topography of the atolls, monitoring the location of these zones on the basis of indices such as thermal fronts assume special significance. Satellite imageries on sea surface temperature supported by sea truth data would provide the required scientific data base to evolve an effective prediction system for the skipjack tuna fishery in the coming years.

REFERENCES

Jayaraman, R., C.P. Ramamirtham and K.V. Sundaraman. 1959. The vertical distribution of dissolved oxygen in the deeper waters of the Arabian sea in the neighbourhood of Laccadives during the summer of 1959. *J. mar. biol. Ass. India*, 1(2): 206-211.

Jayaraman, R., C.P. Ramamirtham, K.V. Sundaraman and C.P. Aravindakshan Nair. 1960. Hydrography of the Laccadives offshore waters. *J. mar. biol. Ass. India*, **2**(1): 24-34.

Patil, M.R. and C.P. Ramamirtham. 1963. Hydrography of the Laccadives offshore waters – a study of the winter conditions. *J. mar. biol. Ass. India*, **5** (2): 161-169.

Laevastu, T. and H. Rosa Jr. 1963. Distribution and relative abundance of tuna in relation to their environment. *FAO Fish. Rep.*, **6** (3): 1835-1851.

Gangadhara Rao, L.V. and R. Jayaraman. 1966. Upwelling in the Minicoy region of the Arabian sea. *Curr. Sci.*, **35** (1): 378.

Nakagome, J. 1973. Study for forecast of catch of tuna and marlin on the basis of variation of sea conditions (Personal communication).

Uda, M. and Y. Nakamura 1973. Hydrography in relation to tuna fisheries in the Indian ocean. *J. mar. biol. Ass. India, Spl.Publication dediated to Dr. N.K. Panikkar*, 276 p.

Narayana Pillai, V. and M.C. Perumal 1975. A note on tuna fishery around Agatti island (Lakshadweep) in relation to hydrographic conditions leading to the phenomenon of upwelling. *Curr. Sci.*, **44** (1): 17-18.

Sharp, G.D. 1979. Areas of potentially successful exploitation of tunas in the Indian ocean with emphasis on surface methods. *IOP, IOFC/DEV/79/47*, FAO, Rome, 55 p.

Silas, E.G. and P.P. Pillai. 1982. Resource of tunas and related species in the Indian ocean, *Bull. Cent.Mar. Fish.Res.Inst.*, **32**, 174 p.

George Varghese and P. Shanmugham 1983. The status of tuna fishery in Agatti island in Lakshadweep. *J. mar. biol. Ass. India*, **25** (1&2): 190-201.