1. Publication Nº	2. Version	3. Date	5. Distribution
INPE-2599-PRE/245		Nov., 1982	☐ Internal ☒ External ☐ Restricted

4. Origin: DME/DAM — Program: SERE/PESCA

6. Key words - selected by the author(s)
TUNA FISH CATCH
SEA SURFACE TEMPERATURE
SMS-2 SATELLITE

7. U.D.C.: *528.711.7:551.463.6:639.227*

8. Title *INPE-2599-PRE/245*

A STUDY OF THE RELATIONSHIP BETWEEN SURFACE TEMPERATURE AND TUNA FISH CATCH DATA IN SOUTH AND SOUTHEAST OF BRAZIL USING OCEANOGRAPHIC AND SATELLITE DATA

10. Nº of pages: *35*

11. Last page: *34*

12. Revised by *Hector M. I. Villagra*

13. Authorized by *Nelson de Jesus Parada*, *Director*

9. Authorship *Myrian Moura Abdon*

Responsible author Myrian de Moura Abdon

14. Abstract/Notes

The principal objective of this study was de delimitation of favorable zones for the fishing of three species (Thunnus albacares, Thunnus alalunga and Thunnus obesus) in the waters southeast and south os Brazil utilizing oceanographic and SMS-2 satellite data. The oceanographic and fishery data were worked by monthly mean and 5^o X 5^o squares. Correlations were made between oceanographic data of surface temperature and fish catch (CPUE) data. Surface temperature intervals corresponding to larger fish catch for each species were determined. After that, these intervals were transformed into data corresponding to that registered by the SMS-2 through regression lines constructed with coastal stations (fixed) and SMS-2 data. These intervals were located in the satellite images and related to the water masses present in the study area. The results showed that temperature cannot be considered by itself as the only indicator of the presence of tuna in specified regions. It is necessary to work with more precise sea surface temperature and CPUE data, collected in real time, in order to relate the last ones to oceanographic and environmental conditions at greater depths, where the studied tuna species are found.

15. Remarks *This paper was presented at the International Symposium on Utilization of Coastal Ecosystems: Planning, Pollution and Productivity, em Rio Grande - RS, November 22-27, 1982.*

A STUDY OF THE RELATIONSHIP BETWEEN SURFACE TEMPERATURE AND TUNA FISH CATCH DATA IN SOUTH AND SOUTHEAST OF BRAZIL USING OCEANOGRAPHIC AND SATELLITE DATA

Myrian Moura Abdon

Instituto de Pesquisas Espaciais - INPE
Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq
12200 - São José dos Campos, SP, Brasil

Abstract

The principal objective of this study was the delimitation of favorable zones for the fishing of three species (Thunnus albacares, Thunnus alalunga and Thunnus obesus) in the waters southeast and south of Brazil utilizing oceanographic and SMS-2 satellite data. The oceanographic and fishery data were worked by monthly mean and 5^{0} X 5^{0} squares. Correlations were made between oceanographic data of surface temperature and fish catch (CPUE) data. Surface temperature intervals corresponding to larger fish catch for each species were determined. After that, these intervals were transformed into data corresponding to that registered by the SMS-2 through regression lines constructed with coastal stations (fixed) and SMS-2 data. These intervals were located in the satellite images and related to the water masses present in the study area. The results showed that temperature cannot be considered by itself as the only indicator of the presence of tuna in specified regions. It is necessary to work with more precise sea surface temperature and CPUE data, collected in real time, in order to relate the last ones to oceanographic and environmental conditions at greater depths, where the studied tuna species are found.

1. Introduction

Some authors made observations to determine the sea water temperature intervals that propitiate the tuna fishery (Laevastu and Rosa, 1962; Squire Jr., 1963; Evans, 1980).

This work is an atempt to define temperature ranges and, consequently, areas where the tuna fisheries are favourable. Fish catch data, satellite data and information on the sea surface temperature collected in the study area were utilized.

The study area is located in waters south and southeast of Brazil, between the latitudes 20^{o}00'S and 34^{o}00'S and longitudes 35^{o}00'W and 54^{o}00'W. These waters are influenced by the Subtropical Convergence that contributes to their fertility. This area is considered the largest potential fishing ground of Brazil.

The species Thunnus albacares (Bonnaterre, 1788), (yellowfin tuna); Thunnus alalunga (Bonnaterre, 1788) (albacore), and Thunnus obesus (Lowe, 1839) (bigeye tuna); which are found in the study area (Zavala-Camin, 1978 a, b, c) were selected for this work.

2. Material and Methods

2.1 - Tuna Fish Catch Data

Information about catch of the species Thunnus albacares, Thunnus alalunga and Thunnus obesus, related to the longlige fishery from 1974 to 1980, were supplied by the

Superintendência do Desenvolvimento da Pesca (SUDEPE) and by the Instituto de Pesca de São Paulo, Divisão de Pesca Marítima de Santos.

Each species was treated separately; the data were divided into 5^o x 5^o squares encompassing the study area which can be identified in "Figure 1". After that, the data were treated separately within each square. The values referring to fishing effort (number of hooks put into the sea) and catches (kg) were separated by month and added. Having the total value of catch within each month, the CPUE values (catch per unit effort) in units of 100 kg/100 hooks, representing each month and each 5^o x 5^o square, were calculated. The calculated values are found in "Tables 1-3".

2.2 - Oceanographic Station Data

All historical temperature data (^oC) that exist in the Banco Nacional de Dados Oceanográficos (BNDO) at Diretoria de Hidrografia e Navegação (DHN) until 1980, referring to Marsden squares 376 (20°00'S to 30°00'S and 40°00'W to 50°00'W), 412 (30°00'S to 40°00'S and 40°00'W to 50°00'W) and 413 (30°00'S to 40°00'S and 50°00'W to 60°00'W) were utilized.

Mean monthly surface temperatures were calculated for each 5^o x 5^o square of the study area. The values are shown in "Táble 4".

2.3 - Fixed Station Data

Information about sea surface temperature from the fixed coastal stations of Brazil were utilized for correlation with SMS-2 satellite data. Only the information collected in the interval 09:00h to 15:00h, the closest possible time to recorded SMS-2 images, were utilized. The fixed coastal stations where the data were obtained are shown in "Table 5".

2.4 - SMS-2 Satellite Data

2.4.1 - Image Treatment on the Multispectral Image Analyzer System (GE I-100 System)

Abdon (1982 a) has adapted methodologies for automatic treatment of SMS-2 images for fishing studies applications. These methodologies have the objective of dividing the study area into sea surface temperatures ranges corresponding to the grey level intervals on the infrared images, using the Multispectral Image Analyzer System. For this, the following programs were utilized: "Contrast Stretch" which increases the contrast between images grey levels; "Cluster Synthesis" which identifies the similar grey levels in the study area; and the program "Gercor" which creates standard colors for distinct grey level intervals (Dutra et al., n.d.). The analyzed images were on the following dates: February 13, March 27, April 23, May 28, June 20, and July 24, all for 1980. An example of the above described procedure can be observed in "Figure 2", for the image of July 24, 1980.

2.4.2 - Accuracy of the SMS-2 Satellite Data

Due to the following phenomena: absorption of the infrared radiation by the atmosphere, heat flux, evaporation, reflection, cloud contamination and atmospheric humidity, the surface temperature of the sea water registered by satellite tends to be different from the real temperature (Maul, 1981).

In order to relate the real sea temperature data with the temperature yielded by the SMS-2 satellite, fixed station data and corresponding SMS-2 pixels were utilized, for the day and hour of the information collected. The correlation between them was calculated and, after that, the regression equation for each correlated data series was determined. The regression equations are shown in "Table 6", where "Tre" is the real sea surface temperature value "Tsms" is the sea surface temperature value obtained by the SMS-2 satellite, "r" is the correlation coefficient and "N" is the number of observations.

2.5 - Correlation Between Fish Catch Data and Surface Temperature at the Oceanographic Stations

According to some authors (Laevastu and Rosa Jr., 1962; Squire Jr., 1963; Radovich, 1963; Blackburn, 1969; Laurs and Lynn, 1977; Evans, 1980) temperature has an influence on the distribution of the tuna species considered in this work.

As the objective is the determination of the optimuns surface temperature intervals where a large concentration of each species is present, a criterion for the study of this relationship was established. Each species was treated separately. The representative CPUE values for each month were arranged and the sea surface temperature values calculated with oceanographic station data. The correlation between them was calculated according to Panofsky and Brier (1965) with "r" (correlation coefficient), "P" (significance level) and "N" (number of observation) values shown in "Table 7".

3. Results and Discussions

The CPUE values for each tuna species were arranged in intervals of 30 kg/100 hooks and related to mean sea temperature intervals calculated with oceanographic station data as can be observed at "Tables 8 to 10". "I.LIM." and "S.LIM." are the values of the inferior and superior limits respectively, for the calculated means, for a confidence intervals of 95%.

Each specie was analized separately because of their different distribution characteristics in time and space.

3.1 - Yellowfin Tuna

The squares 20040, 25040 and 25045 were selected to relate the largest CPUE intervals with sea surface temperature ranges ("Table 11") because the square 20040 presented the greatest CPUE values of the yellowfin tuna during the year and the other ones presented the greatest correlation coefficients.

According to Sverdrup et al. (1942), Emilson (1961) and Thomsen (1962) the relation the yellowfin tuna and the water