UNIVERSITI PUTRA MALAYSIA

DISTRIBUTION OF PELAGIC FISH SPECIES IN THE JAVA SEA FROM REMOTE SENSING DATA

WIJOPRIONO.

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DOCTOR OF PHILOSOPHY
UNIVERSITI PUTRA MALAYSIA
2006
DISTRIBUTION OF PELAGIC FISH SPECIES IN THE JAVA SEA
FROM REMOTE SENSING DATA

By

WIJOPRIONO

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements For the Degree of Doctor of Philosophy

January 2006
DEDICATION

This thesis is dedicated to my beloved parents, wife, and daughter:

Djamin Sastro Suwito and late Widjiati;
Dwi Irianingsih, Siswoyo Budi Priono, Jodi Azhar Priono and Kemala Adi Citra
Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

DISTRIBUTION OF PELAGIC FISH SPECIES IN THE JAVA SEA
FROM REMOTE SENSING DATA

By
WIJOPRIONO

January 2006

Chairman : Professor Kamaruzaman Jusoff, PhD
Faculty : Forestry

Pelagic fishery in the Java Sea is multi-species and dominated by a community of small pelagic species. This study attempted to employ different sources of data in order to determine the distribution of pelagic fish species and to estimate their environmental preferences. Catch per unit effort (CPUE), hydro-acoustic, satellite derived sea surface temperature (SST) and chlorophyll-a data as well as oceanographic in situ measurements data were used to achieve these objectives. CPUE data were collected from commercial fishing records available at the fishing port of Pekalongan, the main pelagic fish landing centre in the north coast of Java. Hydro-acoustic and oceanographic in situ measurements data were collected from hydro-acoustic survey carried out during September-October 2002, while the data of satellite derived SST of AVHRR-NOAA and chlorophyll-a derived from SeaWiFS were collected from the HRPT (High Resolution Picture Transmission) ground receiving station at BPPT (Assessment and Application of Technology Board), Jakarta, and GSFC-NASA (Goddard Space and Flight Center of the National Aeronautics and Space Administration). Correlation analysis, cluster analysis, PCA, spatial analysis and GIS technique were employed in determining abundance and
density distribution of pelagic fish species. Spatial analysis and GIS technique together with GLM were also applied in building the fishery-environment dependent model in order to estimate the environmental preferences of the fishes. Results of the study showed that the Java Sea water was seasonally occupied by oceanic water of the Indonesian Throughflow (ITF). The influence of the ITF was most pronounced in the southeast monsoon when the currents in the Java Sea flow towards the west. The influence is minimum in the northwest monsoon when the currents flow towards the east. The sea has a great thermal stability with a monthly SST average of 28.9 °C and the difference between maximum and minimum (gradient) of 2.0-3.5 °C. The abundance of phytoplankton tends to increase towards the west and towards the coastal areas off north coast of Java, south coast of Kalimantan, and around the small islands spreading over the Java Sea. Correlations between physical and biological oceanographic parameters were exhibited. Pelagic fishery resources in the Java Sea have undergone considerable variations in both their seasonal distributions and abundances. They were relatively low during northwest monsoon (December-March), and increased during southeast monsoon (June-September), with a peak at the end of the monsoon. Abundance of the resources was mostly driven by fluctuations in the abundance of one dominant species, Sardinella spp in the inshore and Decapterus spp in the offshore. The two species make up the average of 36% and 32% of the total CPUE, respectively. GLM model gave evidence that the pelagic fish species have a tolerance limit of temperature of up to 28.5 °C, and below this temperature limit they show a positive trend of relationships with chlorophyll-a concentrations. The model also revealed that oceanographic variables (SST and chlorophyll-a concentrations) contributed 54% to the total variance explained by the GLM predictors, confirming the relative importance of these variables in predicting
pelagic fish catch. However, relationship between sea surface temperature and chlorophyll-a concentrations was weak. The GIS model has demonstrated its capability in delineating spatial patterns of fish density in relation to the environmental variables, especially zooplankton, which was not covered in the GLM model.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**TABURAN SPESIES IKAN PELAGIK DI LAUT JAWA DARI DATA PENDERIAAN JAUH**

Oleh

**WIJOPRIONO**

Januari 2006

Pengerusi : Profesor Kamaruzaman Jusoff, PhD

Fakulti : Perhutanan

pembolehubah-pembolehubah oseanografi (SST dan klorofil-a) menyumbang 54% kepada keragaman yang boleh diterangkan oleh pembolehubah-pembolehubah bebas dalam GLM, mengesahkan pentingnya pembolehubah-pembolehubah oseanografi tersebut dalam meramalkan tangkapan ikan pelagik. Walau bagaimanapun, perhubungan antara SST dan pemusatan-pemusatan klorofil-a adalah lemah. Model GIS menunjukkan kemampuannya bagi menggambarkan pola ruang bagi kepadatan ikan berhubung dengan pembolehubah persekitaran, terutamanya zooplankton, yang tidak dimasukkan dalam model GLM.
ACKNOWLEDGEMENTS

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I certify that an Examination Committee met on 19 January 2006 to conduct the final examination of Wijoprino on his Doctor of Philosophy thesis entitled “Distribution of Pelagic Fish Species in the Java Sea from Remote Sensing Data” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

WIJOPRIONO

Date: 20/3/2006
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vi</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>ix</td>
</tr>
<tr>
<td>APPROVAL</td>
<td>xi</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xvi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xvii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xxi</td>
</tr>
</tbody>
</table>

## CHAPTER

1. **INTRODUCTION**
   1.1 Background of the Study
   1.2 Problems Statement
   1.3 Objectives of the Study

2. **LITERATURE REVIEWS**
   2.1 Interactions Between Fish Stocks and the Environment
   2.2 Impacts of Environmental Variability on the Distribution and Abundance of Pelagic Fish
   2.3 Utilization of Satellite Oceanography in Fisheries Studies
      2.3.1 Satellite Derived Data Applied in Fisheries Studies
      2.3.2 Satellite Sensors
      2.3.3 Ocean Colour Remote Sensing
   2.4 Hydro-acoustic Method For Fish Abundance Estimation
      2.4.1 Target Strength
      2.4.2 Size-Dependence of Target Strength
      2.4.3 Measurement of Target Strength
      2.4.4 Echo Integration

3. **DESCRIPTION OF THE STUDY AREA**
   3.1 Geography and Bathymetry
   3.2 Climate
   3.3 Fisheries
      3.3.1 Fisherman and Fleet Structure
      3.3.2 Landing Places
      3.3.3 Pelagic Fishery Resources and Exploitation
      3.3.4 Fisheries Management and Regulation

4. **GENERAL METHODOLOGY**
   4.1 The Study Framework
   4.2 Fisheries Data
      4.2.1 Commercial Catch Data
      4.2.2 Fisheries Acoustic Data

xvi
4.3 Remote Sensing Data 4.9
   4.3.1 SeaWiFS Derived Water Constituents 4.10
   4.3.2 AVHRR-NOAA Derived Sea Surface Temperature 4.16
4.4 The Modular Ocean Data Assimilation System (MODAS) 4.17
4.5 Oceanographic Data 4.18
4.6 Methods of Analysis 4.21

5 SEASONAL VARIABILITY AND DYNAMICS OF
OCEANOGRAPHIC FEATURES BASED ON REMOTE
SENSING AND IN SITU MEASUREMENT DATA 5.1
   5.1 Introduction 5.1
   5.2 Materials and Methods 5.4
   5.3 Results 5.8
      5.3.1 Seasonal Pattern of the Currents and Water Temperature 5.8
      5.3.2 Biological Productivity 5.19
   5.4 Discussion 5.26

6 DISTRIBUTION AND ABUNDANCE OF SMALL PELAGIC
FISH BASED ON COMMERCIAL FISHING AND
HYDRO-ACOUSTICS DATA 6.1
   6.1 Introduction 6.1
   6.2 Materials and Methods 6.4
   6.3 Results 6.10
      6.3.1 Spatial and Seasonal Distribution of the Fish Species 6.10
      6.3.2 Spatial Pattern of the Fish Distribution 6.22
   6.4 Discussion 6.29

7 ESTIMATING ENVIRONMENTAL PREFERENCES OF
THE JAVA SEA PELAGIC FISH SPECIES USING CATCH SIZE,
REMOTE SENSING AND HYDRO-ACOUSTIC DATA 7.1
   7.1 Introduction 7.1
   7.2 Materials and Methods 7.4
   7.3 Results 7.9
      7.3.1 Models of Pelagic Fish Abundance and Environment 7.9
      7.3.2 Estimation of environmental Preferences of the Fish 7.14
   7.4 Discussion 7.19

8 CONCLUSIONS AND RECOMMENDATIONS 8.1
   8.1 Conclusions 8.1
   8.2 Recommendations 8.5

REFERENCES R.1
APPENDICES A.1
BIODATA OF THE AUTHOR B.1
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>The primary use of SeaWiFS channels</td>
<td>2.18</td>
</tr>
<tr>
<td>2.2</td>
<td>AVHRR/3 channel characteristics and their typical use</td>
<td>2.21</td>
</tr>
<tr>
<td>2.3</td>
<td>Main substances determining the optical properties for case 1 and case 2 waters</td>
<td>2.29</td>
</tr>
<tr>
<td>3.1</td>
<td>Catchments area and volume of some big rivers emptied into the Java Sea</td>
<td>3.4</td>
</tr>
<tr>
<td>3.2</td>
<td>The small pelagic fish species dominantly caught from the Java Sea</td>
<td>3.14</td>
</tr>
<tr>
<td>6.1</td>
<td>Definition of species categories used in the official statistic and landing places data records</td>
<td>6.11</td>
</tr>
<tr>
<td>6.2</td>
<td>Matrix correlation of Pearson’s product moment between six species of main pelagic fishes based on their monthly average CPUE (1998-2002) from six fishing areas</td>
<td>6.20</td>
</tr>
<tr>
<td>7.1</td>
<td>A summary of the parameters used in the GLM analysis</td>
<td>7.7</td>
</tr>
<tr>
<td>7.2</td>
<td>Percentage of variance explained by the GLM parameters</td>
<td>7.11</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>SeaStar spacecraft and SeaWIFS sensor</td>
<td>2.17</td>
</tr>
<tr>
<td>2.2</td>
<td>Composition of spectral radiance variables received by the satellite sensor</td>
<td>2.23</td>
</tr>
<tr>
<td>2.3</td>
<td>Light irradiance and its interaction just below and above the sea surface</td>
<td>2.24</td>
</tr>
<tr>
<td>2.4</td>
<td>Spectral absorption coefficients for pure seawater, chlorophyll a (1 mg/m³) and yellow substances (1 mg/dm³)</td>
<td>2.28</td>
</tr>
<tr>
<td>2.5</td>
<td>The echosounding system</td>
<td>2.44</td>
</tr>
<tr>
<td>2.6</td>
<td>Principle of split-beam echosounder</td>
<td>2.45</td>
</tr>
<tr>
<td>2.7</td>
<td>Principles of echo integration</td>
<td>2.47</td>
</tr>
<tr>
<td>3.1</td>
<td>Geographic location of the Java Sea, Indonesia</td>
<td>3.2</td>
</tr>
<tr>
<td>3.2</td>
<td>Profile of bathymetry of the Java Sea</td>
<td>3.3</td>
</tr>
<tr>
<td>3.3</td>
<td>Winds vector derived from QUICKSCAT</td>
<td>3.6</td>
</tr>
<tr>
<td>3.4</td>
<td>The principal fishing fleet of small pelagic fishery in the Java Sea</td>
<td>3.9</td>
</tr>
<tr>
<td>3.5</td>
<td>Landing places for small pelagic fishing fleet in the north coast of the Java Sea</td>
<td>3.11</td>
</tr>
<tr>
<td>3.6</td>
<td>Development of the fishing grounds extension of small pelagic fishery in the Java Sea</td>
<td>3.13</td>
</tr>
<tr>
<td>3.7</td>
<td>The small pelagic fish species dominantly caught from the Java Sea</td>
<td>3.15</td>
</tr>
<tr>
<td>4.1</td>
<td>Framework of the study</td>
<td>4.2</td>
</tr>
<tr>
<td>4.2</td>
<td>Tracks of hydro-acoustic survey in September-October 2002</td>
<td>4.7</td>
</tr>
<tr>
<td>4.3</td>
<td>General steps for processing different levels of SeaWiFS data</td>
<td>4.11</td>
</tr>
<tr>
<td>4.4</td>
<td>Maps of the sampling sites during oceanographic cruises</td>
<td>4.19</td>
</tr>
<tr>
<td>4.5</td>
<td>Oceanographic parameters data collection</td>
<td>4.20</td>
</tr>
</tbody>
</table>
5.1 CTD-Current meter Valeport 308 used for measuring temperature, salinity, currents and depth profiles

5.2 Surface currents and sea surface temperature (SST) of the Java Sea derived from MODAS

5.3 Currents direction and velocity at the surface layer and 10 m depth layer, derived from \textit{in situ} measurement during pre-northwest monsoon (October 2002)

5.4 Currents direction and velocity at 20 m depth layer and 30 m depth layer, derived from \textit{in situ} measurement during pre-northwest monsoon (October 2002)

5.5 Sea surface temperature in 11 January 2002 and 8 July 2002 derived from AVHRR-NOAA with 1 km spatial resolution

5.6 Sea surface temperature in 2 April 2002 and 22 October 2002 derived from AVHRR-NOAA with 1 km spatial resolution

5.7 Result of regression (matched up) analysis between SST satellite derived data and SST derived from \textit{in situ} measurement in the Java Sea

5.8 Monthly sea surface temperature of the Java Sea derived from AVHRR-NOAA pathfinder 5.0 with spatial resolution of 4 km

5.9 Contours of vertical temperature of the Java Sea during pre-northwest monsoon (October 2002)

5.10 Vertical profiles of temperature in selected stations measured during the cruise of September-October 2002

5.11 SeaWiFS derived LAC data with spatial resolution of 1 km showing the distribution of chlorophyll-a on 2 August 2001

5.12 Monthly GAC data derived from SeaWiFS with spatial resolution of 5 km showing the distribution of chlorophyll-a in September 2001 and November 2002

5.13 Result of regression (matched up) analysis between chlorophyll-a satellite derived data and chlorophyll-a derived from \textit{in situ} measurement in the Java Sea

5.14 Distribution of chlorophyll-a concentration derived from \textit{in situ} measurement in October 2002 and SeaWiFS GAC data in October 2001

5.15 Distribution of phytoplankton in October 2002 mapped by classed interval and contour plot
5.16 Distribution of Zooplankton in October 2002 mapped by classed interval and contour plot

5.11 Horizontal distribution of pelagic fish resources in the depth layers 10-25m

6.1 Geographical location of sampling sites and the main fishing areas of the fleets (purse seiners)


6.13 Seasonal variation of CPUE of each pelagic fish species in the area offshore and inshore, averaged from 1998-2002

6.14 Percentage of CPUE of each pelagic fish species relative to the total species in the area offshore and inshore averaged from 1998-2002.

6.15 Map and surface plot showing the main fishing areas and seasonal relative abundance of pelagic fishes according to fishing area and season (month)

6.16 Surface plots showing the seasonal relative abundance of Decapterus spp, Sardinella spp, Rastrelliger spp, according to fishing area and season (month)

6.17 Surface plots showing the seasonal relative abundance of S. crumenophthalms, A. sirm, A. thazard and E. affinis, according to fishing area and season (month)

6.18 Hierarchical clustering, based on Euclidean distance, of the six species of main pelagic fishes combined from six fishing areas

6.19 Species ordination, based on principal component analysis (PCA) upon catch weights (monthly average CPUE 1998-2002), of main pelagic fishes combined from six fishing areas

6.20 Horizontal distribution of pelagic fish resources within the entire water column in the Java Sea in September-October 2002

6.21 Horizontal distribution of pelagic fish resources in the depth layers 10-25m

6.22 Horizontal distribution of pelagic fish resources in the depth layers 25-50m

6.23 Horizontal distribution of pelagic fish resources in the depth layers 50-75m

6.24 Vertical distribution of pelagic fish resources along the two meridional transects western and eastern parts of the survey area
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Bivariate GLMs showing the relationships of response and individual predictors</td>
<td>7.10</td>
</tr>
<tr>
<td>7.2</td>
<td>GIS model showing spatial relations between fish density distributions and: (a) sea surface temperature, (b) zooplankton</td>
<td>7.12</td>
</tr>
<tr>
<td>7.3</td>
<td>GIS model showing spatial relations between fish density distribution and: (a) phytoplankton, (b) chlorophyll-a.</td>
<td>7.14</td>
</tr>
<tr>
<td>7.4</td>
<td>Mean seasonal variability of pelagic fish catches in the Java Sea</td>
<td>7.15</td>
</tr>
<tr>
<td>7.5</td>
<td>Relationship between pelagic fish catches and SST in the different ranges of SST</td>
<td>7.16</td>
</tr>
<tr>
<td>7.6</td>
<td>Relationship between pelagic fish catches and chlorophyll-a in different ranges of SST</td>
<td>7.17</td>
</tr>
</tbody>
</table>
LIST OF ABBREVIATIONS

ACS                Attitude Control System
ADEOS              Advanced Earth Observation Satellite
AVHRR              Advanced Very High Resolution Radiometer
BURS               Bradford University Remote Sensing
C                  Celsius
CDA                Command and Data Acquisition
CDOM               Colored Dissolved Organic Matter
CPUE               Catch per Unit Effort
CRISP              Centre for Remote Imaging, Sensing and Processing
CSIRO              Commonwealth Scientific and Industrial Research Organization
CTD                Conductivity Temperature Depth
CZCS               Coastal Zone Color Scanner
EMR                Electromagnetic Radiation
ESDU               Elementary Sampling Distance Unit
FAD’s              Fish Aggregating Devices
GAC                Global Area Coverage
GIS                Geographic Information System
GLI                Global Imager
GLM                General Linear Model
GNP                Gross National Product
GOSSTCOMP          Global Operational Sea Surface Temperature Composite
GPS                Global Positioning System
GRT                Gross Registered Tonnage
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSFC</td>
<td>Goddard Space Flight Center</td>
</tr>
<tr>
<td>HRPT</td>
<td>High Resolution Picture Transmission</td>
</tr>
<tr>
<td>ITCZ</td>
<td>Inter-Tropical Convergence Zone</td>
</tr>
<tr>
<td>ITF</td>
<td>Indonesian Throughflow</td>
</tr>
<tr>
<td>JPL</td>
<td>Jet Propulsion Laboratory</td>
</tr>
<tr>
<td>LAC</td>
<td>Local Area Coverage</td>
</tr>
<tr>
<td>$l_c$</td>
<td>Length at first capture</td>
</tr>
<tr>
<td>$l_m$</td>
<td>Length at first maturity</td>
</tr>
<tr>
<td>m</td>
<td>Meter</td>
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<tr>
<td>MCSST</td>
<td>Multi-channel Sea Surface Temperature</td>
</tr>
<tr>
<td>MERIS</td>
<td>Medium Resolution Imaging Spectrometer</td>
</tr>
<tr>
<td>mg</td>
<td>Milligram</td>
</tr>
<tr>
<td>MODAS</td>
<td>Modular Data Assimilation System</td>
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<tr>
<td>MODIS</td>
<td>Moderate Resolution Imaging Spectroradiometer</td>
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<tr>
<td>MSY</td>
<td>Maximum Sustainable Yield</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NIR</td>
<td>Near Infrared</td>
</tr>
<tr>
<td>nm</td>
<td>Nautical Mile</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>NRL</td>
<td>Naval Research Laboratory</td>
</tr>
<tr>
<td>NW</td>
<td>Northwest</td>
</tr>
<tr>
<td>OCTS</td>
<td>Ocean Color and Temperature Scanner</td>
</tr>
<tr>
<td>$p$</td>
<td>Probability</td>
</tr>
<tr>
<td>PCA</td>
<td>Principal Component Analysis</td>
</tr>
<tr>
<td>PODAAC</td>
<td>Physical Oceanography Data Active Archive Center</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>POES</td>
<td>Polar-orbiting Operational Environmental Satellite</td>
</tr>
<tr>
<td>R/V</td>
<td>Research Vessel</td>
</tr>
<tr>
<td>SE</td>
<td>Southeast</td>
</tr>
<tr>
<td>SeaDAS</td>
<td>SeaWiFS Data Analysis System</td>
</tr>
<tr>
<td>SeaWiFS</td>
<td>Sea-Viewing Wide Field of View Sensor</td>
</tr>
<tr>
<td>SSH</td>
<td>Sea Surface Height</td>
</tr>
<tr>
<td>SST</td>
<td>Sea Surface Temperature</td>
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<tr>
<td>ST</td>
<td>Station</td>
</tr>
<tr>
<td>TAC</td>
<td>Total Allowable Catch</td>
</tr>
<tr>
<td>TS</td>
<td>Target Strength</td>
</tr>
<tr>
<td>TVG</td>
<td>Time Varied Gain</td>
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