UNIVERSITI PUTRA MALAYSIA

THE DISTURBUTIONS OF PELAGIC FISHERY RESOURCES IN THE STRAITS OF MALACCA AND THEIR RELATIONS TO CHANGES IN TEMPERATURE

MUSSE GABOBE HASSAN.

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By

MUSSE GABOBE HASSAN

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

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DEDICATION

THIS WORK IS ENTIRELY DEDICATED TO MY BELOVED FAMILY:

UBAH NUR GESIE;

KHALID MUSSE GABOBE;

KHADAR MUSSE GABOBE

KHADRA MUSSE GABOBE;

AND

KHULUUD MUSSE GABOBE

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in Fulfilment of the requirement for the Degree of Doctor of Philosophy

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By

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Chairman : Professor Mohd. Ibrahim Bin Hj. Mohamed, Ph.D.

Faculty : Science and Environmental Studies

The pelagic fishery of Malaysia is of major economic importance because of its significant contribution to the country's fish production. This study employed four different sets of data in order to effectively model the impact of spatio-temporal characteristics of oceanographic changes on pelagic fishery in the Straits of Malacca (SOM). The study was divided into three components: (i) investigating the variations of temperature, salinity and dissolved oxygen; (ii) determining the status of small pelagic fishery resources; and (iii) modeling the impact of oceanographic changes, mainly the impacts of sea surface temperature (SST), on the distribution and abundance of pelagic fishery resources in the SOM.

The first component of this study investigated the spatio-temporal variability of physical oceanographic features, mainly sea temperature, salinity and dissolved

oxygen. Data sets from five Malacca Straits Research and Development Centre (MASDEC) oceanographic cruise expeditions conducted in the Straits of Malacca from 1998 to 2002 were rigorously analyzed. The sea surface temperature, salinity and dissolved oxygen in the SOM were found to respectively vary from 27.4 to 30.8 °C with mean ($\bar{x}$) of 29.1 °C, 27.6 to 33.5 ppt with mean ($\bar{x}$) of 31.6 ppt and 4.1 to 7.7 mg/L with mean ($\bar{x}$) of 6.12 mg/L.

The second component of this research investigated the status of small pelagic fishery resources in the Straits of Malacca. Fish landing reflect fluctuating patterns in the catch trends. Such patterns can be categorized into: (a) fisheries which have shown increasing trends, including indian and indo-pacific mackerel (*Rastrelliger* spp.), selar scads (*Selar* spp.), Jack-cavalla-travelly (*Carangoides* spp.), mullets (*Mugilidae*), longtail tuna and kawakawa (*Thunnus tongol* and *Euthynnus affinis*), pomfrets (*Formio niger, Pampus* spp), and hairtails (*Trichiuridae*) (b) fisheries which have shown decreasing trends, including round scads (*Decapterus* spp.), anchovies (*Stolephorus* spp.), sardine (*Sardinella* spp.), hardtail scads (*Megalaspis cordyla*), spanish mackerel (*Scomberomorus* spp.), barracuda (*Sphyraena* spp.) and, wolf herring (*Chirocentrus dorab*). Moreover, despite some fluctuating trends, species like hardtail scads (*Megalaspis cordyla*), anchovies (*Stolephorus* spp.), spanish mackerel (*Scomberomorus* spp.), mullets (*Mugilidae*) and wolf herring (*Chirocentrus dorab*) have been decreasing right from the determined period whereas, species like Jack-cavalla-travelly (*Carangoides* spp.) showed declining trends only in the late 1990s.

The third component of the study determined the impacts of oceanographic changes, mainly the SST, on the distributions and abundance of pelagic fishery resource in the SOM. The annual fluctuations of the availability of pelagic fishery resources in relation to SST and Southern Oscillation Index (SOI) variations have been established. The natural environmental variations, known as El Niño Southern Oscillation (ENSO) events were identified as warmer than normal temperatures and with low negative values of the SOI. The periods 1979/80, 1982/83, 1987/88, 1991/92, 1993 and 1997/98 were identified as El Niño years whereas 1978, 1984/85, 1986, 1988/89, 1995/96 and 1999/2001 were identified as La Niña years.

Barracudas, round scads, Jack-cavalla-trevally, anchovies, hardtail scads and indian mackerel showed relatively low catch values during El Niño episodes. However, the catch of wolf herring and spanish mackerel were found to be comparatively high during El Niño episodes whereas mullets, selar scads, pomfrets, sardine, longtail tuna and hairtails did not show any significant difference during the El Niño/La Niña episodes. Annual landing of purse seine net operated in the SOM from 1980-2001 showed a significant ($p<0.05$) correlation with SOI whereas the catch from trawl net did not show any apparent relationship.

Annual variability patterns between SST and Catch Per Unit Effort (CPUE) over the years showed a significant correlation indicating the CPUE to be high when the SST is high and vice versa. The results from the general linear modeling of the impacts of different SST levels and rainfall distribution on CPUE indicated that the SST was

found to be significantly ($p<0.01$) correlated with the CPUE for both purse seine and trawl nets.

The physical oceanographic phenomenon has a significant impact on the variations of fish catches, CPUE and fish density. The concept and implications of SST variability and ENSO on distributions and abundance of pelagic fishery resources in the SOM were identified and critically discussed. Based on statistical analysis, the null hypothesis that oceanographic factors have no effect on pelagic fishery resources was subsequently rejected and the alternative hypothesis was accepted. The findings obtained from this research could be very useful for not only further development and management of pelagic fishery resources in the SOM but also all in tropical waters.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

TABURAN SUMBER PERIKANAN PELAGIK DI PERAIRAN SELAT MELAKA DAN PERKAITANNYA DENGAN PERUBAHAN SUHU

Oleh

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Perikanan pelagik Malaysia mempunyai kepentingan ekonomi yang besar kerana ia adalah salah satu sumbangan kepada pengeluaran ikan negara. Kajian ini menggunakan empat set data yang berbeza-beza untuk pemprosesan yg efektif terhadap kesan ciri-ciri spatio-temporal daripada perubahan oseanografik ke atas perikanan pelagik di Selat Melaka. Kajian ini terbahagi kepada tiga komponen iaitu: (i) menyelidik variasi daripada suhu, saliniti dan oksigen terlarut; (ii) menentukan status sumber perikanan pelagik kecil, dan (iii) menghasilkan model bagi kesan perubahan oseanografik, terutamanya kesan suhu permukaan air laut, terhadap taburan dan kelimpahan sumber perikanan pelagik di Selat Melaka.

Komponen pertama kajian ini telah mengkaji variabiliti spatio-temporal ciri-ciri fizik oseanografik, sebahagian besar mengenai suhu air, saliniti dan kandungan oksigen

terlarut. Lima ekspedisi laut MASDEC (Pusat Penyelidikan dan Pembagangunan Selat Melaka) yang dijalankan dari tahun 1998 hinga 2002 telah menganalisis kaedah-kaedah ini secara menyeluruh. Suhu permukaan air laut, saliniti dan oksigen terlarut di Selat Melaka masing-masing antara 27.4 °C hingga 30.8°C dengan purata ($\bar{x}$) 29.1°C; 29.3 hingga 33.1 ppt dengan purata ($\bar{x}$) 30.4 ± 1.0 ppt, dan 4.1 hingga 7.7 dengan purata ($\bar{x}$) 6.12 mg/L.

Komponen kedua kejian ini telah mengkaji status sumber perikanan pelagic kecil di Selat Malaka. Ciri-ciri *dorata* ikan menunjukkan pola yang turunaik dalam tren tangkapan. Pola sedemikian dapat dikategorikan kepada (a) Perikanan yang menunjukkan tren peningkatan, termasuklah kembong (*Rastrelliger* spp.), aya (*Thunnus tongol* and *Euthynnus affinis*), selar kuning (*Selar* spp.), cermin (*Carangoides* spp.), belanak (*Mugilidae*), bawal hitam (*Formio niger, Pampus* spp) dan timah (*Trichiuridae*) dan (b) Tangkapan yg menunjukkan tren penurunan termasuklah selayang (*Decapterus* spp.), bilis/bunga air (*Stolephorus* spp.), tamban sisek (*Sardinella* spp.), cencaru (*Megalaspis cordyla*), tenggiri (*Scomberomorus* spp.), alu-alu (*Sphyraena* spp.) dan parang- parang (*Chirocentrus dorab*). Tamban pula, walaupun terdapat kadar turunaik yang tidak menentu, spesies seperti belanak (*Mugilidae*), cencaru (*Megalaspis cordyla*), bilis (*Stolephorus* spp.), parang- parang (*Chirocentrus dorab*) dan tenggiri (*Scomberomorus* spp.) telah menunjukkan penurunan dari awal lagi dalam tempoh kajian manakala spesies seperti cermin dan selar hanya menunjukkan penurunan pada akhir tahun 1990an.

Komponen ketiga kajian pula mengkaji kesan perubahan oseanografik, terutamanya suhu permukaan, taburan dan kelimpahan sumber perikanan pelagik di Selat Melaka. Turun naik tahunan padi keterdapatan sumber perikanan pelagik sehubungan dengan perubahan pada suhu permukaan air laut dan Index Hayunan Selatan (SOI) telah ditentukan. Perubahan semulajadi alam sekitar yang dikenali sebagai peristiwa Hayunan Selatan El Niño (ENSO) telah dikenal pasti sebagai suhu persekitaran yang lebih tinggi dari suhu persekitaran normal dan dengan nilai negatif rendah Index Hayunan Selatan (SOI). Yang rendah dan negative jangkamasa 1979/80, 1982/83, 1987/88, 1991/92, 1993, dan 1997/98, telah dikenalpasti sebagai jangkamasa El Niño manakala jangkamasa 1978, 1984/85, 1986, 1988/89, 1995/96 dan 1999/2001 telah dikenalpasti sebagai jangkamasa La Niña.

Alu-alu, selayang, cermin, bilis, cencaru dan kembong secara relatifnya mempunyai kadar tangkapan yang rendah semasa berlakunya fenomena El Niño. Namun tangkapan ikan jenis parang-parang dan tenggiri adalah lebih tinggi semasa episod El Niño tetapi belanak, selar kuning, bawal, tamban sisik, aya (tongkol/hitam) dan timah tidak menunjukkan sebarang perubahan ketara dalam sepanjang episod El Niño atau La Niña. 'Pukat jerut' yang beroperasi di Selat Melaka dari tahun 1980-2001 menunjukkan korelasi yang ketara dengan SOI sedangkan tangkapan pukat tunda pula tidak menunjukkan sebarang hubungkait yang jelas.

Sejak bertahun-tahun membuat kajian mengenai pola perubahan bermusim antara suhu permukaan air laut dan Usaha Tangkapan Per Unit (CPUE), ia menunjukkan kolerasi yang ketara di mana apabila nilai CPUE tinggi maka suhu permukaan juga

turut tinggi dan sebaliknya jika suhu permukaan rendah. Keputusan pemodelan linear umum terhadap kesan mod suhu yg berbeza-beza permukaannya dan kadar taburan hujan ke atas CPUE menunjukkan bahawa suhu permukaan mempunyai kolerasi statistik yang ketara dengan CPUE untuk kedua-dua pukat jerut ('purse seine net') dan pukat tunda. Perbandingan hanya dilakukan untuk melihat kesan terhadap variasi tahunan suhu permukaan dan dari sini dapat dibuat kesimpulan bahawa hipotesis hubungan TPUU dengan suhu permukaan adalah kukuh. Walaupun begitu, pada masa ini, mekanisma hipotetikal yang menerangkan hubungan tersebut tidak dapat dijelaskan.

Fenomena oseanografik fizikal didapati mempunyai kesan penting terhadap variasi dalam penangkapan ikan, Usaha Tangkapan Per Unit (TPUU) dan kepadatan ikan. Konsep dan implikasi perubahan suhu permukaan laut dan Hayunan Selatan El Niño ke atas taburan dan kelimpahan perikanan pelagik yang dinamik di Selat Melaka telah berjaya dikenal pasti dan dibincangkan secara kritikal. Berdasarkan kepada analisis statistik, terdapat hipotesis yang kurang jelas yang menyatakan faktor-faktor oseanografik tidak memberi kesan ke atas sumber perikanan pelagik telah berjaya dibuktikan secara tidak sahih dan hipotesis alternatif telah diterima. Hasil yang diperolehi dari kajian ini amatlah berguna dalam perikanan pelagik di Selat Melaka.

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