UNIVERSITI PUTRA MALAYSIA

TARGET STRENGTH AND SCHOOL SIZE ASSESSMENT OF SCADS USING HYDROACOUSTIC

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By

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for the Degree of Master of Science in the
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DEDICATION

This work is dedicated to my late father Haji Thoyib Suparman (deceased during my study in Universiti Putra Malaysia, *Innalillahi wa inna ilaihirraji'un*).

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The study has been conducted with two phases. The first phase involving laboratory experiment on fish target strength measurements of three commercially important pelagic fish species of the scads namely Round scad (*Decapterus maruadsi*), Ox-eye scad (*Selar boops*) and Yellow-banded scad (*selaroides leptolepis*). The second phase include both *in situ* side aspect target strength and fish schools estimation attracted around fish aggregating light.

Fish physical characteristics such as total length, fork length, standard length, and weight were recorded in order to study relationship of TS to fish size. The samples sizes of Round scad, Ox-eye scad and Yellow-banded scad ranged from 11.40 to 20.50 cm, 10.0 to 20.7 cm and 7.0 to 15.6 cm (standard length), respectively.

The data for each angle of insonification at 0°, 30° (side aspect), 60° (in between dorsal and side aspect), 90° (dorsal aspect), 120° (in between dorsal and broad side aspect), 150° and 180° (broad side aspect) were recorded by running the data acquisition software.

Six hundred and sixteen target strength experiments were performed in the controlled tank (4.0 x 2.0 x 1.4 m) by using a scientific digital acoustic system (BioSonic DT6000) equipped with a 200 kHZ digital split beam transducer.

Results of the average side and dorsal aspects target strength of Round scad, measured in the controlled tank was observed to be nearly similar. The average of side aspect TS was -41.4 ±2.3 dB and dorsal aspect TS was -42.5 ±2.4 dB. While for Ox-eye scad there was small variation with side aspect which was -42.3 ±3.5 dB being stronger than dorsal aspect, -43.2 ±3.7 dB. However the side aspect target strength of Yellow-banded scad showed larger variations compared to the average target strength characteristic of Round scad with the value of -45.4 ±3.0 dB and -49.8 ±2.1dB for side and dorsal aspect, respectively. Results of this study showed that the average all aspects target strength of the three fish species of scad increases as fish length increases.

The target strength characteristics of the three species when expressed in term of target strength equation (TS = a log L – b), showed that the constant 'a' value vary between 15 to 36. While, the 'b' is – 86.99 to – 68.44 and tends to be

species specific. This study showed that Ox-eye Scad gave lower 'b' constant than Yellow-banded Scad.

The second phase of the study have been done with the purpose to apply side aspect target strength for quantifying the size of fish schools gathered around and bellow fish aggregating light by comparing them with the actual catch. The *in situ* side aspect target strength values was found varied from -38.1 to -47.5 dB with the average of -44.7 ±3.3 dB. From the seven attempts the target strength was computed to be –2.4 dB lower than that found under laboratory conditions. However, volume back scattering strength varied from –43.8 to –51.2 dB with the average of –47.9 ±3.1 dB. It was found that the average schooling density ranged between 0.19 to 3.18 fish/m^3. The acoustic estimate of fish quantity ranged from 28.6 to 497.3 kg with the actual catch ranged from 26.4 to 418.1 kg. The results of analysis on the true catch showed that Ox-eye scad was the dominant species (80% of the true catch).

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TARGET STRENGTH DAN PENGANGGARAN TERHADAP SAIZ KUMPULAN IKAN (SCADS) MENGGUNAKAN HIDROAKUSTIK

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Kajian ini telah dijalankan dengan dua fasa. Fasa pertama adalah eksperimen di makmal iaitu pengukuran terhadap nilai pantulan isyarat akustik (target strength, TS) bagi tiga spesies ikan pelagik dari jenis ikan selayang (*Decapterus maruadsi*), Lolong (*Selar boops*) dan Selar kuning (*Selaroides leptolepis*). Fasa kedua meliputi kajian TS pada bahagian sisi yang dilakukan di *in situ* dan anggaran terhadap saiz kumpulan ikan di sekitar api unjam.

Ciri-ciri fizikal ikan yang dikaji seperti panjang penuh, panjang cabang, panjang piawai dan berat adalah direkodkan untuk mendapatkan hubungan antara TS terhadap saiz ikan. Panjang piawai sampel ikan adalah berjulat diantara 11.40 – 20.50 cm, 10.00 – 20.7 dan 7.0 – 15.6 cm masing-masing bagi ikan Selayang, Lolong dan Selar kuning.

Data TS bagi setiap sudut pancaran 0°, 30° (bahagian sisi kanan), 60° (di antara bahagian dorsal dan sisi kanan), 90° (bahagian dorsal), 120 (diantara bahagian dorsal dan sisi kiri), 150° dan 180° (bahagian sisi kiri) telah direkodkan dengan menggunakan sistem perisian data akustik.

Sebanyak 616 eksperimen telah dijalankan di dalam tangki kawalan bersaiz 4.0 x 2.0 x 1.4 m dengan menggunakan alat akustik digital saintifik (BioSonic DT6000) yang dilengkapkan dengan "digital split beam transducer" berfrekuensi 200 kHz.

Keputusan yang diperolehi untuk purata TS pada bahagian sisi dan bahagian dorsal bagi ikan Selayang (*Decapterus maruadsi*) yang diukur dalam tangki kawalan menunjukkan purata yang hampir sama. Purata bagi bahagian sisi adalah –41.4 ±2.3 dB yang mana ianya tidak menunjukkan variasi yang besar dengan bahagian dorsal, iaitu –42.5 ±2.4 dB. Manakala TS ikan Lolong (*Selar boops*) menunjukan nilai variasi yang kecil di antara semua bahagian tetapi lebih kuat pada bahagian sisi iaitu –42.3 ±3.5 dB berbanding bahagian dorsal dengan nilai iaitu –43.2 ±3.7 dB. Bagaimanapun, nilai TS pada bahagian sisi bagi Selar kuning menunjukkan variasi yang besar jika dibandingkan dengan purata TS ikan Selayang dengan nilai pada bahagian sisi dan bahagian dorsalnya masing-masing adalah –45.4 ±3.0 dB dan –49.8 ±2.1 dB. Keputusan bagi ketiga-tiga spesies didalam kajian ini menunjukkan purata TS keseluruhan bahagian meningkat sekiranya panjang ikan meningkat.

Pada kajian ini ciri-ciri TS bagi ketiga-tiga spesies apabila dinyatakan dalam persamaan target strength (TS = a log L – b), dimana ianya menunjukkan bahawa nilai konstant 'a' berubah dinatara 15 hingga 36, manakala 'b'adalah – 86.99 hingga –64.44 tergantung kepada spesies. Pada kajian ini ikan lolong memberikan nilai b yang rendah berbanding ikan selar kuning.

Fasa kedua kajian ini adalah bertujuan untuk mendapatkan TS pada bahagian sisi bagi menganggarkan kuantiti ikan yang berkumpul disekitar api unjam dan membandingkan anggaran akustik ini dengan tangkapan sebenar. Nilai TS pada bahagian sisi di *in situ* adalah bervariasi daripada –38.1 hingga –47.5 dB dengan nilai min –44.7 ±3.3 dB. Daripada 7 percubaaan akustik nilai TS *in situ* adalah -2.4 dB iaitu didapati lebih rendah daripada kajian di makmal. Walau bagaimanapun pantulan isipadu " volume back scattering strength" berjulat daripada –43.8 hingga –51.2 dB dengan purata –47.9 ±3.1 dB. Kajian ini juga mendapati nilai purta kepadatan ikan berjulat diantara 0.19 hingga 3.1 kg/m^3. Anggaran akustik terhadap kuantiti ikan berjulat daripada 28.6 – 497.3 kg manakala tangkapan sebenar adalah berjulat daripada 26.4 – 418.1 kg. Analisis keputusan menunjukkan bahawa ikan Lolong (*Selar boops*) merupakan spesies ikan dominan iaitu lebih kurang 80 % daripada tangkapan sebenar.

CHAPTER I

INTRODUCTION

Back ground of the study

The seas adjacent to four coastal states, namely Johor, Pahang, Terengganu, and Kelantan are very rich in fishery resources. It has a coastline extending from Tanjung Penawar (Lat. 1°30' N, Long. 104°17' E) to Kuala Besar (Lat. 6°13' N, Long. 102°14'). The South China Sea covers a total area of approximately 3.4 million sq. kilometer, consisted of two wide continental shelves, the Mainland Shelf in the North and the Sunda Shelf in the South. The seas in relatively shallow with depth of 40 to 100 m.

Marine fisheries in the East Coast of Peninsular Malaysia is virtually a capture type which is typically dominated by small-scale fisheries and predominantly inshore in nature consisting of pelagic and demersal fisheries.

Pelagic species are dominated by scads, *Decapterus spp.*; trevallies, *Selar spp.* (Carangidae); Indo-pasific mackerels, *Rastrelliger spp.* (Scombridae); sardines, *Sardinella spp.* (Clupeidae); and anchovies, *Stolephorus spp.* (Engraulidae). They are mainly caught by purse seine net. One of the most important species is Scads. It was rank first in total values and catch in Malaysia (Malaysia, 1994).

Other fishing gears employed in fishing include, trawl net, gill net, lift net, hooks and lines, and traps. The most important and widely used gear in pelagic fisheries is the purse seine, whereas the trawl nets for demersal fisheries.

Among of the state in the East Coast of Peninsular Malaysia, the state of Terengganu has the largest number of boats operating purse seine net, and the largest number of fishermen. In 1994, there were 4,908 boats operate in the East Coast, 45% were registered in the State of Terengganu and about 9,247 fishermen are engaged directly in fishing activity in Terengganu.

Purse seine fish landings by main species in Malaysia (1994) consisted of: Selayang (Round Scad) 31%, Kembong (Indian Mackerel) 19%, Tamban (Sardine) 15%, Selar Kuning (Yellow Striped Trevally, Yellow-banded Scad) 10%, Aya/Tongkol (Tuna) 6%, Pelata Selar (Selar Scad) 7%, Ikan Baja (Trash Fish) 3%, and others 9%.(Malaysia, 1994).

In order to aggregate fish school such as Scads, most fishermen in the East Coast of Peninsular Malaysia use artificial light for night operation and fish aggregating devices ('unjam') during the day. The sizes of fish schools are generally check through visual observation from a small boat. For daytime operation a diver ('juru selam') will dive to ensure the species and size of the fish schools. A number of fishermen are beginning to use SONAR to locate fish schools before operating the net.

Although modern equipment such as echo sounder and SONAR are available, the introduction in purse seine fisheries in Malaysia has been slow probably due to the lack of skill and the high cost of the equipment.

Target strength research at UPMT first started in late 1996 and was the first in Malaysia. The first experiment was to investigate the target strength (TS) of two species of tuna and squid caught in Terengganu waters (Fadzilah, 1997; Shah, 1997).

A Review of previous acoustic surveys showed that no detail study of fish target strength had been conducted in near coastal water. Altogether 5 survey had been conducted beginning 1980 until 1996 and largely covered the offshore waters (Amin et al., 1984; Leong and Yasin, 1984). Therefore acoustic information of local commercial pelagic fish species in the coastal area such as Terengganu waters is not known. Research at UPMT therefore primary aimed to compile information on fish target strength found in the coastal areas so as to provide sufficient TS information for future survey. It was funded by IRPA and started in late 1996.

This research constitutes a small part of the overall objectives and it was formulated to have more specific purpose with greater depth covering with laboratory and field trials.

Laboratory experiment was conducted at UPMT laboratory tank while

field trials conducted at Pulau Bidong and Pulau Kapas using pelagic fish of Scads Family, which are important to local purse seine fisheries.

The conduct of study provides opportunity for UPMT to collaborate with local fishermen.

Objectives of the Study

The main objectives of this study are as follows:

1. To determine the target strength characteristics of the Scads: Round Scad (*Decapterus maruadsi*), Ox-eye Scad (*Selar boops*), and Yellow-banded Scad (*Selaroides leptolepis*) of varies sizes.

2. To determine and compare the side aspect target strength of the Scads determined in the experimental tank and *in situ* around fish aggregating light.

3. To assess schooling size hydroacoustically using the side aspect TS for comparison with the actual fish quantity caught by purse seine.

CHAPTER II

LITERATURE REVIEW

Conventional Techniques for Fish School Detection

Good fishing ground is one of the most important aspects of fishing to fishermen for operating any kind of fishing gear especially purse seine net. Fishing ground not only should be rich in fish but also allow fishermen to operate their gear safely.

Several methods of finding fish schools were defined by Nomura and Yamazaki (1977) i.e., direct or indirect finding by the sense of sight, observation of sea indication, judgement by use of trial fishing, observation by scientific instruments and equipment, such SONAR, fish finder, and airplane scouting.

Early techniques relies on observation of jumping fish, bird flying, floating wood, shark swimming and dolphin playing are signs or indications of the existence of fish. The existence of fish schools such as sardine, skipjack, swordfish, flying fish, etc. observed from the top of the mast or a special fish finding tower, equipped especially in the purse seiners. In gill net fishing, when there were no fish finder facilities, the fishermen use a trial nets which is a very small gill net compared to normal gill nets, and examine how the place where trial net is used would be worth for fishing or not.