Abstract of Thesis Submitted to the Senate of Universiti Putra Malaysia in Fulfillment of the Requirement of the Degree Master of Science

HYDROACOUSTIC ASSESSMENT OF PELAGIC FISH AROUND BIDONG ISLAND, TERENGGANU, MALAYSIA

By

MUSSE GABOBE HASSAN

FEBRUARY 1999

Chairman : Khalid Bin Samo, Ph.D

Faculty : Faculty of Applied Science and Technology

The first phase of this study investigates the average dorsal aspect (side) target strength of three commercially important fish species, namely *Rastrelliger kanagurta*, *Atule mate* and *Thunnus tonggol*, which are mostly captured by commercial fishermen in waters around Bidong Island. Target strength experiments were carried out in a controlled tank at Universiti Putra Malaysia Terengganu by using a digital transducer split beam echo sounder at 200 kHz.

Fish size for this experiment varied from 13.6 to 24.5 cm total length (avg. 18.8 cm) for *Rastrelliger kanagurta,* 13.8 to 27.5 cm (avg. 20.0 cm) for *Atule mate* and 28.5 to 52.0 cm (avg. 39.6 cm) for *Thunnus tonggol*. Significant differences ($\alpha = 0.05$) were observed between fish total length and weight of all species tested.

The average dorsal aspect target strength results of *Rastrelliger kanagurta* of 18.8 cm (92.5 g.), *Atule mate* of 20.0 cm (109 g.) and *Thunnus tonggol* of 39.6 cm (981 g.) were found to be - 42.0 dB, - 42.0 dB and - 37.0 dB respectively.

The average dorsal aspect target strengths for *Rastrelliger kanagurta*, *Atule mate* and *Thunnus tonggol* showed linear relationship with length. Determination coefficients, (r^2) for target strength and total length of these species were observed to be 0.88, 0.78 and 0.80 respectively. The significant differences ($\alpha = 0.05$) were observed between fish target strength and total length.

The general target strength and length equations for *Rastrelliger kanagurta*, *Atule mate* and *Thunnus tonggol* are presented as follows:

Rastrelliger kanagurta	(Avg. TL = 18.8cm):	TS (dB) = 20 log TL – 67.5
Atule mate	(Avg. TL = 20.0cm):	TS (dB) = 24 log TL – 72.4
Thunnus tonggol	(Avg. TL = 39.6cm):	TS (dB) = 20 log TL – 68.9

The second phase, by using the results obtained from the controlled tank as a scaling factor, attempts to estimate the fish population in small area near Bidong Island were performed. The surveys were carried out in July and August in 1997 using the same equipments but were fitted on board UNIPERTAMA III.

The survey area was subdivided into 22 Elementary Statistical Sampling Rectangle (ESSR) along the acoustic track. A total of 790 independent single fish images were extracted along the track. Calculations were performed using the average *in situ* target strength of the individual fish detected along the survey track. The total

fish population in the study area was estimated to be 380 tones with an average density of 6.3 tones/km^2. The average *in situ* target strength determined during the acoustic surveys was -43.9 dB where the average volume back scattering strength observed was -64.1 dB. The results of *in situ* target strength of individual fish match well with the target strength measurements made in tank conditions. This thesis critically discusses the concept and implications of fish target strength and its application in acoustic stock assessment for fisheries management.

Abstrak tesis yang dikemkakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

PENILAIAN HYDROAKUSTIC KEATAS IKAN PELAGIK DI SEKITAR PULAU BIDONG, TERENGGANU, MALAYSIA

Oleh : MUSSE GABOBE HASSAN

FEBRUARY 1999

Pengerusi : Khalid Bin Samo, Ph.D

Fakulti : Fakulti Sains Gunaan dan Teknologi

Fasa pertama dalam kajian ini adalah untuk mengkaji purata keupayaan memantul aspek dorsa (bahagian dorsal) bagi 3 spesies ikan komersial yang penting iaitu *Rastrelliger kanagurta, Atule mate* dan *Thunnus tonggol* di mana ianya merupakan spesies yang biasa ditangkap oleh nelayan di sekitar perairan Pulau Bidong. Eksperimen keupayaan memantul telah dijalankan di dalam tangki kawalan di Universiti Putra Malaysia Terengganu dengan menggunakan echo sounder pada halaju gelombang 200 kHz.

Saiz ikan yang digunakan dalam eksperimen ini berukuran di antara 13.6 hingga 24.5 sm panjang (purata 18.8 sm) bagi *Restrelliger kanagurta,* 13.8 hingga 27.5 sm (purata 20.0 sm) bagi *Atule mate* dan 28.5 hingga 52.0 sm (purata 39.6 sm) bagi *Thunnus tonggol*. Perbezaan bererti (α = 0.05) telah ditunjukkan di antara jumlah panjang ikan dan berat bagi semua jenis spesies yang diuji.

Keputusan purata keupayaan memantul aspek dorsal bagi *Rastrelliger kanagurta* yang berukuran 18.8 sm (92.5 g), 20.0 sm bagi *Atule mate* (109 g) dan 39.6 sm bagi *Thunnus tonggol* (981 g) masing-masing adalah -42.0 dB, -42.0 dB dan -37.0 dB.

Keputusan merunjuktan purata kenpayaan memantul aspek dorsal bagi *Rastrelliger kanagurta*, *Atule mate* dan *Thunnus tonggol* adalah behubungan linear dangan panjang. Pengukuran koeffisien, (r^2) bagi keupayaan memantul dan jumlah panjang bagi ketiga-tiga jenis spesies ikan masing-masing adalah 0.87, 0.78 dan 0.80. Perbezaan bererti ($\alpha = 0.05$) telah ditunjukkan di antara keupayaan memantul ikan dan jumlah panjang.

Secara amnya, persamaan bagi keupayaan memantul dan panjang bagi *Rastrelliger kanagurta*, *Atule mate* dan *Thunnus tonggol* adalah seperti berikut :

Rastrelliger kanagurta (min panjang TL = 18.8 sm): TS (dB) = 20 log TL - 67.5

Atule mate (min panjang TL = 20.0 sm): TS (dB) = 24 log TL - 72.4

Thunnus tonggol (min panjang TL = 39.6 sm): TS (dB) = 20 log TL - 68.9

Fasa kedua pula telah dilakukan di sekitar perairan Pulau Bidong sebagai percubaan untuk mengukur populasi ikan berdasarkan keputusan yang diperolehi daripada tangki kawalan sebagai faktor pengukuran. Kajian telah dijalankan dalam bulan Julai dan Ogos 1997 dengan menggunakan peralatan yang sama tetapi diletakkan di atas bot UNIPERTAMA III.

Kawasan kajian telah dibahagikan kepada 22 'Elementary Statistical Sampling Rectangle' (ESSR) di sepanjang laluan akustik. Sejumlah 790 imej individu ikan telah dirakamkan sepanjang laluan tersebut. Pengukuran telah dilakukan menggunakan purata keupayaan memantul secara *in situ* terhadap individu ikan yang dikesan sepanjang laluan kajian. Jumlah populasi ikan yang dianggarkan di dalam kawasan kajian adalah 380 tan dengan anggaran kepadatan iaitu 6.3 tan/km^2. Purata keupayaan memantul secara *in situ* yang diukur semasa kajian akustik dijalankan adalah -44.3 dB di mana purata jumlah keupayaan memantul diperolehi adalah -64.4 dB. Keputusan secara *in situ* keupayaan memantul individu ikan adalah lebih baik berbanding dengan keupayaan memantul yang diukur di dalam tangki. Laporan ini membincangkan secara kritikal konsep dan implikasi keupayaan memantul ikan serta penggunaannya ke atas penaksiran stok akustik untuk pengurusan perikanan.