

**CHARACTERISTICS OF UNDERWATER SOUND AND NOISE IN
COASTAL AND INLAND WATERS OF TERENGGANU**

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**Thesis Submitted in Fulfillment of the Requirement for the Degree of
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DEDICATION

I dedicate this thesis to
my loving parents for their untiring support and encouragement
and as the main source of motivation and inspiration.

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The characteristics of underwater noise covering ambient, biological and those noises generated by economic activities in waters of Terengganu are studied by using passive acoustics technique. Noise data were collected at several locations in Kuala Terengganu coastal waters including Bidong Island and Merang Jetty. Additional data were also collected from freshwater environment in Kuala Terengganu River and Kenyir Lake for the purpose of comparison to the marine environment. The underwater recording system consists of a hydrophone, amplifier, laptop and processing software. Sound processing and analysis were carried out using *Sound Forge 7.0*, *Raven Pro Ver. 1.3*, *Matlab R2008a* and *Audacity* software to generate noise spectrum and spectrograms.

Results have shown that ocean ambient noise comprises of wideband frequency components and generally varied with the time of the day, and being noisier during the night (by 2 dB). Comparatively the marine environment was the

noisiest environment as the noise sources come from many different sources including biological (fish vocalization, snapping shrimp) and natural activities (wave, current, wind). The ambient noise has high intensity level at frequency below 5 kHz and rapidly decreases at higher frequency range. Snapping shrimps noise is the most predominant sound recorded in coastal waters cover wideband frequency range from 3 kHz to 22 kHz. In contrast, the river and lake environments with slow and stagnant water flows, respectively, indicated almost consistently lower amplitudes in the time domain plot – indicating minimal biological activities. At all sampling locations in the marine environment the noise level (total) has been shown to be 10 dB higher than the river and lake environment.

Nine different types of biological calls have been recognized and are presented in this thesis indicating their unique characteristics. Five different types of calls recorded from coral reefs area consisted of long vocal, croaking, bruping, drumming, whistling like sounds. The other four similar and different calls recorded in the vicinity of FADs were groan, chirp, drumming and rapid clicking sound. These biological sounds mostly produced at frequency range less than 2 kHz. Man-made noise created by moving vessels demonstrate unique noise signature with noise levels relatively higher at low frequency components (<5 kHz).

This research has studied and presents the different characteristics of underwater sound including ambient, biological and anthropogenic origin in Terengganu waters. A sound database has been compiled and established as reference for the future work. The present work has explored the importance of sound as potential tool for monitoring marine life habitat and indicated that much more research is needed in order to understand the effects of man-made noise on marine life.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu
sebagai memenuhi keperluan ijazah Master Sains

**CIRI-CIRI BUNYI BAWAH AIR DAN KEBISINGAN DI SEKITAR
PERAIRAN PANTAI DAN PEDALAMAN TERENGGANU**

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Ciri-ciri bunyi bawah air merangkumi ambien, biologi dan bunyi daripada aktiviti-aktiviti ekonomi di perairan Terengganu telah dikaji menggunakan teknik akustik pasif. Data bunyi telah dikumpulkan daripada pelbagai kawasan di sekitar pesisir pantai Kuala Terengganu termasuk Pulau Bidong dan Jeti Merang. Data tambahan juga telah dikumpulkan daripada persekitaran air tawar di Sungai Kuala Terengganu dan Tasik Kenyir untuk tujuan perbandingan dengan persekitaran marin. Sistem perakam bawah air terdiri daripada hidrofon, penguat bunyi, computer riba dan perisian pemprosesan. Pemprosesan dan analisis bunyi telah dijalankan menggunakan perisian *Sound Forge 7.0*, *Raven Pro Ver. 1.3*, *Matlab R2008a* dan *Audacity* untuk menghasilkan spektrum dan spektrogram bunyi.

Keputusan telah menunjukkan bahawa bunyi ambien laut merangkumi komponen frekuensi yang besar dan secara umumnya berubah-ubah mengikut masa, dan lebih bising pada waktu palam (pada 2 dB). Secara perbandingannya,

persekitaran marin adalah lebih bising kerana sumber-sumber bunyi terhasil daripada pelbagai sumber yang berbeza termasuk sumber biologi (vocal ikan, gertakan udang) dan aktiviti-aktiviti semulajadi (ombak, arus, angin). Kebisingan ambien mempunyai aras yang tinggi pada frekuensi di bawah 5 kHz dan menurun dengan mendadak pada julat frekuensi tinggi. Bunyi gertakan udang adalah bunyi paling dominan yang telah direkod di kawasan pantai merangkumi julat frekuensi besar daripada 3 kHz hingga 22 kHz. Sebaliknya, persekitaran sungai dan tasik dengan aliran air yang perlahan dan tenang, masing-masing, menunjukkan amplitud rendah yang hampir konsisten dalam plot masa – menunjukkan aktiviti biologi yang minima. Di semua lokasi penyempelan persekitaran marin mempunyai aras bunyi (total) seperti yang ditunjukkan ialah 10 dB lebih tinggi daripada persekitaran sungai dan tasik.

Sembilan jenis bunyi biologi telah dikenalpasti dan dipamerkan di dalam tesis ini yang mana ia telah menunjukkan ciri-ciri yang unik. Lima jenis bunyi telah direkod di kawasan batu karang terdiri daripada vokal panjang, bunyi menguak, brup, drum dan bunyi seperti wisel. Empat jenis bunyi sama dan berbeza yang lain telah direkodkan di sekitar kawasan unjam (FAD) adalah bunyi mengerang, mencicip, drum dan bunyi klik yang pantas. Bunyi-bunyi biologi ini terhasil pada frekuensi kurang daripada 2 kHz. Bunyi buatan manusia yang terhasil daripada pergerakan kapal menunjukkan corak bunyi yang unik dengan aras bunyi secara relatifnya tinggi pada komponen frekuensi rendah (<5 kHz).

Kajian ini telah mengkaji dan membentangkan pelbagai ciri bunyi bawah air yang berbeza termasuk ambien, biologi dan antropogen yang terdapat di perairan Terengganu. Satu pengkalan data bunyi telah dikumpulkan dan dibina sebagai rujukan pada masa depan. Kajian ini telah meninjau kepentingan bunyi dan potensinya sebagai alat untuk memantau habitat kehidupan marin dan ia juga telah menunjukkan bahawa banyak kajian perlu dijalankan untuk memahami kesan bunyi terhadap hidupan marin.