Acoustic Strength Comparison between Green Turtle and Fish Using Echo Sounder

Sunardi[1], A.Mahfurdz[1], H.Ahmad[1], Syed Abdullah[2], Nazuki[2]

[1] Faculty of Electrical and Electronics Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia
Email: sunardi@ump.edu.my

[2] Turtle and Marine Ecosystem Center, Malaysia Fisheries Department, 23050 Dungun, Terengganu, Malaysia
Email: syedabdmfrdmd@yahoo.com

Abstract— **Acoustic power measurement using dual frequency echo sounder operated 200 kHz were conducted on Green Turtle and fish. The echo signal from Sensitivity Time Control (STC) output was digitized at a sampling rate 1MHz using multifunction DAQ device (Measurement Computing USB1208HS). The animal's position in the water was set in horizontal position toward to the transducer and the measurement was conducted at different orientation of the animals. The data was analyzed in both frequency and time domain. The transmit pulse of the signal has been remove first to ensure it's not affect the result. The finding demonstrated, there are significant different echo strength between Green Turtle and fish. The shell and plastron is the part that gives the highest value for both turtles, meanwhile lateral side contributed high echo compared to other side of fish. Through analysis, positive progress has been made toward the understanding of the unique scattering by sea turtle and fish. These findings are considered important in enriching the acoustic detection, especially to determine the best method to distinguish sea turtle and fish.**

Index Terms—Echo sounder, echo power, TED, Green Turtle, Indian Mackerel, Bygeye Scad

I. INTRODUCTION

Sea turtles are marine reptile's species that inhabit all of the world oceans. There are seven species sea turtle recorded in the world and classified in to two families. The hard shell species categorized in *Chelonidae* families and Latherback species categorized in *Dermochelyidaee* families. All seven turtle are included on the Convention on International Trade in Endangered Species (CITES) appendixes and the world conservation Unions (IUCN) read data book list [1].

By catch of sea turtles in shrimp vessel in tropical areas has attract more public concern. The National Academy of Science Panel (NASP) estimate that 70 to 80 percent of stranded turtle may have been caught and kill in shrimp trawl [1].

The research conducted in Mexico found that most species related to mortality is Loggerhead and Kemp's Ridley [2]. Meanwhile in Malaysia species from Green and Hawksbill is frequently trapped in fishing net [3].

This issue has been influences impacts on global shrimp fisheries and trade [4]. National Marine Fisheries Service (NMFS) suggested larger shrimp trawler need to use turtle excluder devices (TED) to overcome this issue [2].

A method to separate turtles from shrimps in trawl was introduced by United State early 1980[5]. A TED basically consists of metal mesh that has been attached in a trawl to enable sea turtles to exit safely out of the net through a trapdoor [6].

Although the device can gives the solution to protect sea turtle but this method may reduce number of commercial fish catches [7][8]. The observation conducted in the pacific region found that, 38% of the shrimp lost, mainly due to high amount of logs and organic debris has been trapped in TED device [7].

The Metal grids TED have been seen as a not effective device for use in trawl activities. Therefore, improvements are required to ensure that the device can be used for turtles protecting and at the same time it won't effect on fishing activities.

Recently, there are few studies have been conducted to prevent the turtles trapped in fishing net by using ultrasound. The repellent device has been installed to dispel turtles from approaching nets [9].

The device was developed base on turtle hearing range. In addition, study on several type of sound found that LFM sound can give reaction on Green Turtle behavior. The turtle will swim away when sound emitted [10].

Although using ultrasound can avoid turtles from approaching the fishing net, sound must be emitted all the time. This situation will contribute noise production in the water and could disrupt other marine life. Other than that this method can't ensure whether the turtle already swim away or still moving to the fishing net.

Therefore, to overcome this problem the new system should be designed, which able detect the presence of sea turtles earlier. Through this method, the sound repellent will be controlled and not released all the time. One of the best methods to detect underwater object is using acoustic techniques.

The turtle detection in water is very limited in previous study. Therefore, the turtle identification using acoustic in this study becomes important on designing effective turtle repellent device.

Sunardi, A.Mahfurdz, H.Ahmad are with Faculty of Electrical and Electronics Engineering, Universiti Malaysia Pahang, 26600 Pekan,Pahang, Malaysia

Syed Abdullah and Nazuki are with Turtle and Marine Ecosystem Center, Malaysia Fisheries Department, 23050 Dungun, Terengganu, Malaysia.

II. Marine Life Detection Using Sound

Acoustic methods are widely used to locate and identify objects in the sea. The applications include submarine detection, shipwreck finding, and underwater imaging. Acoustics is the most effective tool in water application because of its ability to propagate in long range [11]. The device used to observe marine animal is called echo sounder. These devices have been used for many years to study marine animals.

This device has become a major tool in the study of fish distribution. Basically, the echo sounder was designed to operate in a certain frequency range. Two of the commonly used frequency is 38 and 120 kHz [12].

Marine organisms are complicated scatter by their nature shape. One important factor is the size of the animal, smaller animals have a lower echo strength and larger animals have a higher echo strength [13][14]. Echo intensities of fish have complex functions and involve a several factors including size, shape, orientation, swim bladder and so on [15]

The Swim bladder presence in the fish body is the main factor influencing the total return echoes [16]. Comparative studies between the two species of fish, found that although *Gadoids* and *Mackerel*, have similarities in their gross anatomy and fusiform shape but different acoustic value is expected from the swimbladder scattering strength [17]. Other than that, the study of three species of fish, found that *Megalapis cordyla* even smaller body produce more acoustic power than *Selar boops* but less than *Alepes djedaba* species [18].

Acoustic observations on the species of the Barents Sea capelin during autumn season found that the acoustic intensity is much lower than the current estimate of the current measurement. This situation may be due to the high fat content in the autumn [19].

The acoustic studies on mammals such as whales and dolphins may depend on lung and fat layer. The findings show that Humback and Right whales have different acoustic values. A possible reason is the presence of a thick layer of blubber on right whales and assumes that the lung is the main reflector [20]. Furthermore, Spinner dolphins have a combination of unique scattering characteristics that makes it possible to separate them from other animal [21].

Zooplanktons have a variety of body shapes and physical properties, so their acoustic characteristics sometimes very complicated. Acoustic value of those animals may depend on the size, shape, orientation and material properties [22].

The acoustic strength of elastic animals may characterized by their hard shell [23]. Other than that, research on sound scattering by a shell covered seafloor discovered that shellfish is a major reflector [24].

Studies on the sea turtle detection using sound are very limited because there are no researches have been carried out previously. So the investigation echo strength of sea turtle in this study is become important especially to separate them from fish and also to enrich acoustic characteristic of shell animals.

III. Experiment Procedure

The species of sea turtle use in this study is Green Turtle (*Chelonia Mydas*). Meanwhile two species of fish namely Indian Mackerel and Bygeye Scad has been selected, in order to compare echo strength. The animals involved in this study are depicted in Table I.

TABLE I.
ANIMAL INVOLVED IN EXPERIMENT

Animal	Age	Weight	Carapace size
Turtle	12 years	27kg	61cmx56cm
	18 years	60kg	71cmx61cm
	Species		**Body Size**
Fish	Indian Mackerel		19cmx4.5cm
	Bigeye Scad		21.5cmx5.2cm

The acoustic measurement was conducted in Turtle and Marine Ecosystem Center hatchery, Rantau Abang Terengganu, Malaysia. The experiment conducted in a 13m x 2.4m rectangular tank contained saline water. Prior the measurement, turtle flipper was wrapped using tape, in order to avoid struggling to get free in water. All the animals were tied at the middle of the wooden frame as shown in Fig. 1.

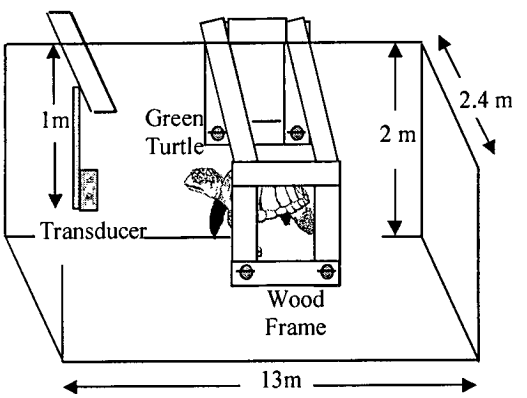

Figure 1. Sea turtle attach with wooden frame

The frame was designed to make sure it is able to record echo from animals at various angle. The angle of animals in water has been set at horizontal position and echo was recorded for 4m and 5m distances. Before experiment, the water profile in tank was measure. This is important to ensure it is similar to turtle natural habitat. The parameter interest is salinity, water pH, temperature, conductivity and total dissolved solid as depicted in Table II.

The echo strength measurements of sea turtles have been conducted on the head, tail, side, carapace and plastron angle, meanwhile head, lateral and tail angle for fish. During experiment, sea turtles will be lifted to the

water surface every 15 minutes to breathe, it is important to avoid drowning in the water.

Modified dual frequency echo sounder V1082 was used in this research. The signal is taken from sensitivity time control (STC) output and connected to the multifunction DAQ device (Measurement Computing USB-1208HS). The amplitude of the echo was digitized at a sampling rate 1MHz using echo recording program created in Matlab software. The total 6525 random samples in Excel file has been saved in laptop.

IV. Result and Analysis

The analysis in this study has been carried out in the time and frequency domains. Before conducting the main measurement, an experiment has been done towards the empty frame. This approach is very important to avoid echoes of the wood frame can affect the results. The example of empty frame signal in the time domain and power spectrum is shown in Fig. 2 and Fig. 3 respectively. In addition, before the FFT analysis was done, the transmit effect will be remove from the signal. This is to avoid the values obtained are not interfering the finding.

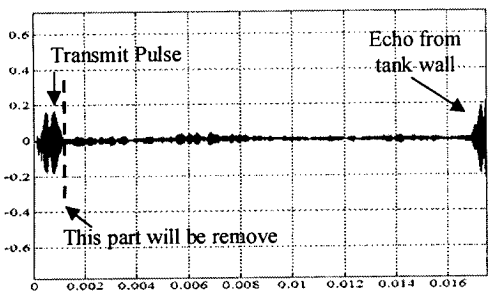

Figure 2. The empty frame signal in time domain

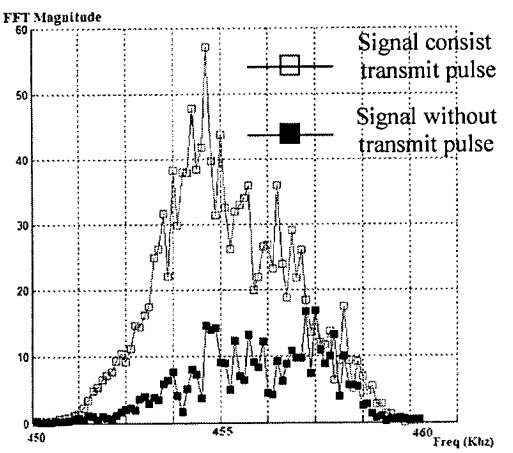

Figure 3. Power spectrum comparison between signal consist transmit pulse and signal without transmit pulse.

The total 8192 point was calculated in FFT function. The value is taken from 450 kHz to 460 kHz. The scatter plot of echo strength of sea turtle is shown in Fig. 4 and Fig. 5. Data demonstrated most of the value for Green Turtle is located above 1000. The results also showed significant differences between each of the turtle body. The shell and plastron is the part that gives the highest value for both turtles. One of the reasons that can be highlighted is that the part has a larger surface than the other. The greater the area covered by the sound, the higher echo intensity received. In addition, other possibilities that could be considered are because the shell and plastron have a hard surface.

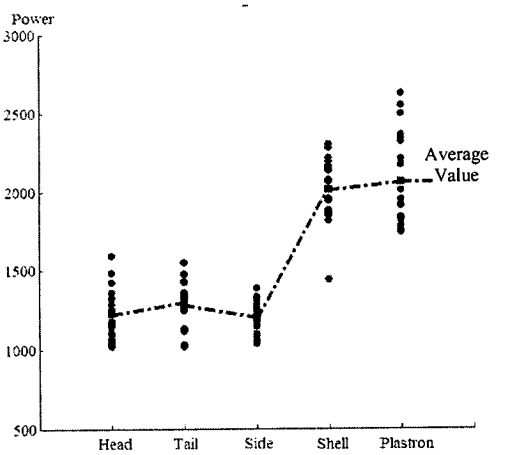

Figure 4. The Echo power of 18 years Green Turtle

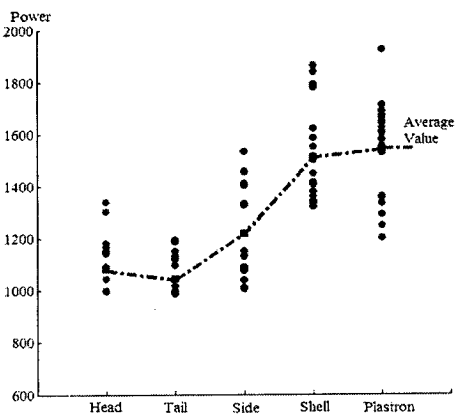

Figure 5. The Echo power of 12 years Green Turtle

In this study two species of fish has been selected for comparison with Green Turtle. The selection is considered as existing commercial species in the Malaysia Ocean. The echo power comparison for fish as depicted in Fig. 6. The dash dot line is representing the average value at each angle measurement. Based on the

graph, found that lateral side contributed high echo compared to other side. The possible reason of this finding is sound emitted perpendicular towards the swimbladder of fish. Other than that, comparison on average value demonstrated that the lowest echo strength is from tail side. However, measurement from head not showed a good pattern. This situation may be due to the surface of the fish head that is more complicated and has invited inconsistent values obtained.

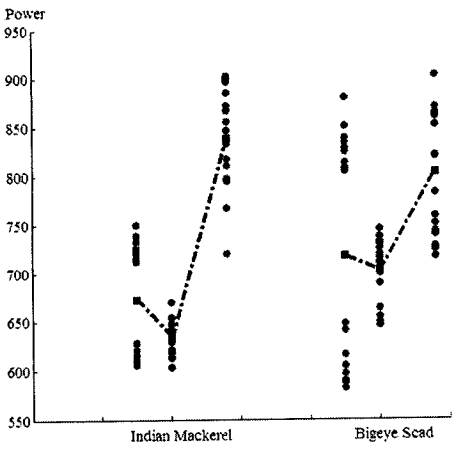

Figure 6. The Echo power comparison of fish

The overall combination of animals is shown in Fig. 7. The graph demonstrated that there are significant different between Green turtle and fish. Based on the result, found that most of the value of Green turtle located above 1000 and the high value obtained from plastron side. Meanwhile, the acoustic powers of the fish are in the range 500-900. Therefore clear here that fish and turtles can be distinguished by acoustic methods.

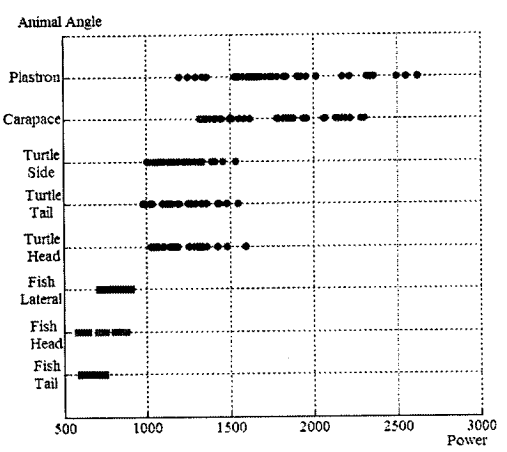

Figure 7. The echo power comparison of Green Turtle and fish

V. CONCLUSIONS

The echo power data with both the marine animals described here and indicated sea turtle have unique scattering strength. There are significant different between Green Turtle and fish. Although, the result showed not much different between head, tail and side for both turtle but shell and plastron showed result otherwise.

The finding demonstrated that the scattering of the two animals is highly dependent on the angle of measurement. Although the study showed positive result, but advance research must be conduct for different species of fish and turtle. This step very important, in order to ensure there are no overlap value between sea turtle and fish. This study only focused measurement in the fiber tank, which is limited space and distance. In addition, the measurement performed in this study is only done when the turtle is in a static condition. Therefore, other studies should be carried out in natural behavior, where turtle can swim freely.

In conclusion, through analysis and echo power value scatter, positive progress has been made toward the understanding of the unique scattering by sea turtle. This finding is considered important in acoustic detection, especially determining the best method of distinguish sea turtle and fish.

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