

Bioacoustics-Underwater biological noise measurement and its characterization

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Abstract

Study of sound made by marine species aid in ambient noise studies and its characterization. Open sea measurements were conducted off Erwadi (near Ramanathapuram, Tamil Nadu) to study biological noise. The sound of shallow water lobsters (*Panulirus Homarus*) has been studied in detail using the noise measurements made in open ocean environment and the results was compared with measurements taken in a controlled environment in laboratory. It has been shown that the lobsters produce sound like musical instruments having their own fundamental harmonic frequency components.

Key words: Ambient Noise, Lobster Noise, Spectrum.

I. INTRODUCTION

Sound produced by marine animals contribute to ambient noise in the ocean and it extends in a wide band from very low frequencies to very high frequencies. Identification of noise made by specific species is an important task in ambient noise characterization. In order to improve the signal to noise ratio of underwater acoustic based instruments the characterization of the ambient noise field is necessary and to do so the classification of marine animal noise is a primary requirement.

Many researchers have carried out studies on the sounds produced by different marine species[1-5]. Enough information on classification of underwater noises with details on each type of noise, their sources, and their impacts are dealt with by Wenz[1]. Cato[2] measured ambient noise in the Timor Sea of Australia and identified a few frequency tones and their harmonics whose sources were not known. It is evident from the literature that identification of a biological source causing the background noise is possible only if the specific species with their noise spectrum level is known *a priori*.

Patek[6] has identified the sound produced by spiny lobsters to match with that of a musical instrument. She has studied the physical mechanism by which the sound is produced in lobsters and found that it is similar to that in a violin. A preliminary work on shallow water lobsters has been carried out by latha *et. al* [7].

This paper presents the work carried out in open ocean environment on sound made by different species of lobsters and also the results of research conducted in controlled environment at NIOT. A comparative study is made between the open ocean and controlled environment. First, the extensive work on the analysis of sound made by spiny lobsters at Erwadi is presented.

Second, the measurement and analysis of sound in controlled environment at the Lobster Breeding Center of the National Institute of Ocean Technology is conducted.

II. MEASUREMENT SETUP

The measurement set up with a hydrophone is shown in Fig.1. A vertical cable with a hydrophone is used for noise measurement. The noise data is sampled at a rate of 1MHz per second and the sampling is made for a period of 1sec. A hydrophone with a constant receiving sensitivity over a frequency range 0.1Hz to 120 kHz was used with a data acquisition system to collect the ambient noise. The portable data acquisition system is a DSP based system with 12-bit resolution with 8 channels. The measurements were made in the open ocean off Erwadi at Latitude 9° 11.4' N and Longitude 78° 42.8'E in February 2005 for a period of one day, where lobster culture is being carried out in the sea.

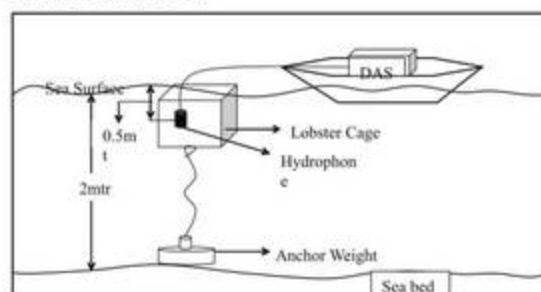


Fig.1. Measurement set up in the sea

For laboratory research in controlled environment lobsters have been collected from the sea and kept in a tank of required dimension. The frequency spectrum and the amplitude of the noise level of the lobster noise are studied under varying conditions.

III. ANALYSIS

The data acquired at the rate of 1MHz taken over a period of 1second is used for analysis. The power spectrum of the voltage data is computed by using the Welch periodogram. Broad band noise produced by lobster off Erwadi at a water depth of 2 m is analysed. Time series plots show intermittent transient peaks which is found to be the signature of lobsters (figure 2). The spectrum analysis ranges from 2kHz to 100kHz and the first three harmonic components of fundamental frequency 5.2 kHz have been observed (figure 3). Fig.4 gives the shallow water lobster harmonics in the controlled environment. Shallow water lobsters produce sound like musical instruments by generating harmonics of fundamental frequency 5.2 kHz. Time frequency spectrum of shallow water lobster harmonics is given in figure 5. The amplitude levels of the harmonic components have increased for open ocean measurements and Table 1 shows the sound levels at these frequencies

Table 1. Components for Open Sea and Laboratory Measurements

Frequency in kHz	Noise levels at open sea (dB)	Noise levels in the tank in laboratory (dB)
5.2	81.7	75
10.4	71	66
15.6	67.5	58
20.8	66	52

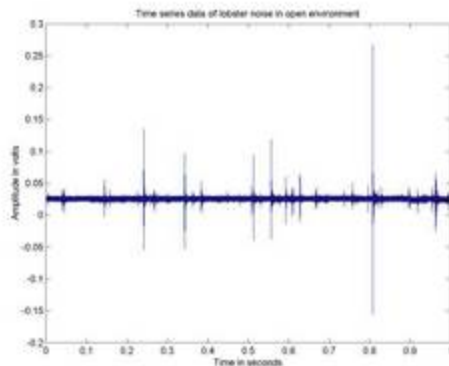


Fig. 2. Time series plot of lobster noise in open ocean

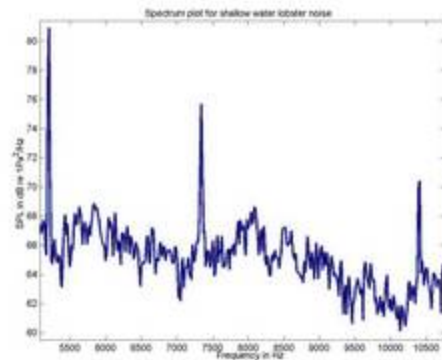


Fig. 3. Noise spectrum in open ocean

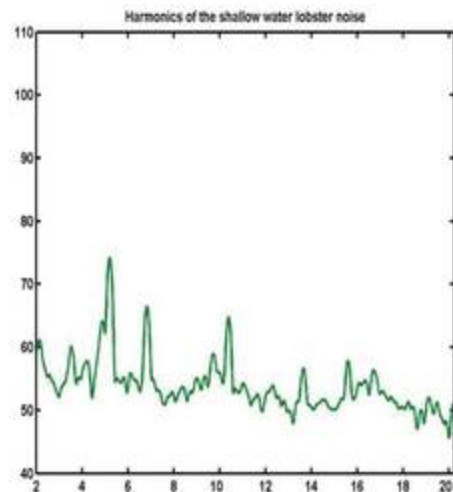


Fig. 4. Lobster spectrum in controlled environment

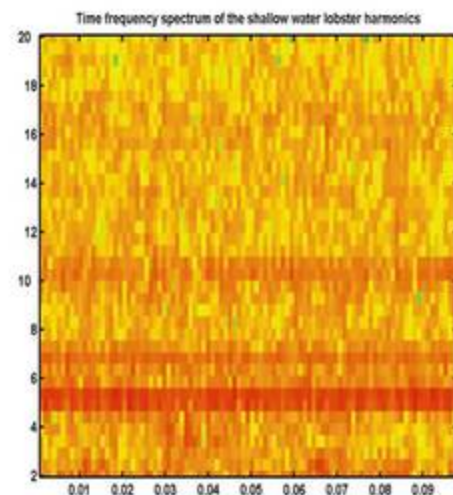


Fig. 5. Time frequency spectrum of shallow water lobster noise in the controlled environment

IV. CONCLUSION

The shallow water lobster sound analysis, based on their measurements in the open ocean, shows that they produce sound like musical instrument with same fundamental harmonic components as those present in the controlled environment. The increase in the amplitude in the open ocean could be attributed to the ocean ambient factors.

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