

# Research on Marine Environmental Noise Based on Acoustic Bait Domestication Technology

Shuai Chen<sup>1, 2</sup>, Hongliang Huang<sup>1, 2</sup>, Lingzhi Li<sup>1, 2, \*</sup>, Xin Rao<sup>1, 2</sup>, Yuqing Zhang<sup>1, 2</sup>

<sup>1</sup>Key Laboratory of Oceanic and Polar Fisheries, Ministry of Agriculture and Rural Affairs, Shanghai 200090, China;

<sup>2</sup>East China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Shanghai 200090, China.

\*Corresponding Author: Lingzhi Li

## ABSTRACT

Acoustic domestication type of marine pastures are generally established in shallow waters with water depth not exceeding 200 m. In order to study the effect of acoustic domestication, this paper aims to investigate the environmental noise in the shallow waters of the sea. Unlike the stable deep sea environment, the environmental noise in the shallow sea is extremely complex, which has a direct impact on the effect of acoustic domestication. In this paper, in order to study the marine environmental noise, a hydroacoustic signal processing system is established, which is divided into two parts: the hardware part and the software part; the hardware part is mainly for signal sampling, and the software part is for signal processing. The hardware part of the hydroacoustic signal processing system includes three parts: acoustic-electric conversion, intermediate processing and signal recording. The study of ship noise showed that the fishing boat is about 5m long, with a power of 60hp, and passes about 10m away from the hydrophone, and it is more than 10dB higher than that without a ship, when there is a ship passing, in which the 400Hz is 17.82dB higher. Measurements of ocean ambient noise at different depths show that the noise decreases with depth, but when close to the seabed, the noise decreases with depth due to the reflection effect of the seabed on the sound and the biological noise of the seabed.

## KEYWORDS

Acoustics, Fishery, Noise, Marine.

## 1. PREFACE

The natural noise spectrum in the deep sea is characterised by the presence of a number of different noise sources in different parts of the spectrum. There are tides, waves and earthquakes at low frequencies, distant vessels and rough sea surfaces at medium frequencies, and molecular thermal motion in seawater at high frequencies. In general, the natural noise level in the deep sea at any frequency can be estimated with some accuracy by measurement and calculation[1].

Acoustically domesticated marine meadows are generally established in shallow waters down to 200m depth. In contrast to the stable deep sea environment, the ambient noise in the shallow sea is extremely complex. There are many noise sources in bays, harbours and along the coastline, the noise data are discrete, there are many intermittent noise sources, and the ambient noise sources vary considerably from one sea area to another, with the noise at different times and in different places being very different. The noise level at a given time and location also varies considerably from time

to time, so that only a rough indication of the noise level in shallow sea areas can be given. The subject of this paper is the complex and variable environmental noise in the shallow sea[2-4].

## **2. MATERIALS AND METHODS**

The instruments used in the experiment are Seahawk SMH-20 Standard Spherical Hydrophone, OKI ST1030 Hydrophone, OKI SW1030 Sound Level Meter, NF-1930 Function Signal Generator, UETAX UA-210 Power Amplifier, UETAX UA -20 Underwater Transmitter Transducer, Tektronix TDS2024B Oscilloscope, Keyence NR-350 High-Speed Signal Acquisition Card, NF EZ 7510 Signal Recorder and Computer. The software used in the experiment was EZ 0751, Flexpro 7.0, etc.

The hydroacoustic signal processing system is divided into two parts: the hardware part and the software part, where the hardware part is mainly the signal sampling and the software part is the signal processing. The hardware part of the hydroacoustic signal processing system consists of three parts: acoustic-electric conversion, intermediate processing and signal recording.

The acoustic-electric conversion is realised by the hydrophone, and it was once tried to use the SMH-20 standard spherical hydrophone produced by the Seahawk Group of China Shipbuilding Industry Corporation, which operates at a frequency of 5 Hz to 100 kHz, with a free-field voltage sensitivity ( $0 \text{ dB} = 1 \text{ V}/1 \mu\text{Pa}$ ) of -202 dB, Although the NF-5307 differential amplifier was used to amplify the signal, it was found that only the 400 Hz signal had a better response in the low-frequency noise sampling below 500 Hz studied, while the other low-frequency signals failed to meet the requirements.

The final hydrophone used is the OKI ST 1030 hydrophone, its operating frequency is 20 Hz to 200 kHz, the key is its free-field voltage sensitivity ( $0\text{dB} = 1\text{V}/1\mu\text{Pa}$ ) is -178 dB, in the study of its low-frequency signal response can fully meet the requirements.

After the acoustic-electric conversion part was determined, the OKI SW1030 sound level meter had to be connected because the corresponding seven-pin converter head of the OKI ST 1030 hydrophone could not be found. However, after introducing the sound level meter into the system, the following problems have to be solved:

### **2.1. Sound level meter alarm**

Sound level meter in order to obtain a large signal can be a good response, set from 100dB to 180dB nine gears, the effective range of  $-\infty$  to +3dB, each file of its output electrical signals and the hydrophone to receive the acoustic signal of the conversion relationship is different, which requires that in the test process, once there is out of range, there is an alarm, it must be In the post-processing will be out of range part of the deletion.

### **2.2. Acoustic-electrical conversion relationship**

Due to the sound level meter for different signals with different amplification and attenuation, resulting in acoustic and electrical conversion off to become complex, and this relationship in the manual and other information is not described in this experiment is obtained through experimental determination. Determination of the amplifying system is the NF-1930 function signal generator - UETAX UA-210 power amplifier - UETAX UA-20 underwater transmitter, and the signal receiving system is OKI ST 1030 hydrophone - OKI SW 1030 sound level meter - Tektronix TDS2024B oscilloscope. It can be seen that the acoustic-electrical conversion relationship is secure for each gear by determining the correspondence between different sounds and output voltages. In addition, the voltage value of the sound level meter is attenuated by 10 dB, or about 3.1623 times, when the sound level meter is raised by one stop. According to this relationship, as long as the measurement of sound pressure and voltage correspondence on a gear can be, to avoid the influence of low-frequency signals, the higher the measured gear, the better, in conjunction with the actual situation, the UETAX UA-

210 power amplifier amplified to the maximum, the UETAX UA-20 underwater transmitter is placed in a  $4 \times 1 \times 1$  m water tank at one end. The UETAX UA-20 underwater transducer is placed at one end of a  $4 \times 1 \times 1$  m tank at half water depth, the OKI ST-1030 hydrophone is placed.

### 2.3. Selection of recording instruments

There are three instruments available for signal recording according to the existing conditions: Tektronix TDS2024B oscilloscope connected to the computer to record, Keyence NR-350 high-speed signal acquisition card connected to the computer to record, NF EZ 7510 signal recorder to record. Finally, combined with the continuous recording of signals and the convenience of DC power supply two aspects of the choice to use the NF EZ 7510 signal logger recording.

### 2.4. Format conversion \*.dat—\*.csv

The NF EZ 7510 signal logger records signals in \*.dat format. First I tried to import the data directly into Flexpro in \*.dat format, but I found that I could not understand the data structure. Because \*.dat files, according to the extension, mean DATA, i.e. data file, this type of file is not absolutely defined and many programmes have different ways of interpreting it. Finally, the NF EZ 7510 signal recorder comes with software EZ0751 will be converted to \*.dat \*.csv format to solve this problem, there is a problem, the conversion parameters must be real format rather than integer format.

### 2.5. Flexpro on the import of \*.csv file

Converted to \*.csv format can be imported into Flexpro, this is relatively simple, the \*.csv file at the beginning of the 11 lines is the basic information of the record file, choose not to import. In addition, the \*.csv file in this experiment is comma-separated, import the breakdown also select comma-separated.

### 2.6. Time series format

After the import can be seen in this experiment \*.csv file time series format 00:00.00035Flexpro can not be identified, collectively as 0, so it must be \*.csv file in the time series of changes, the use of Flexpro in the Fill column with values command to do a new time column, the command is:

Dim Start, Step

Start = '0.00000' // Change the start date here if necessary

Step = 0.00001 // change the step size in seconds if necessary

(number of lines(i), Start, Step)

This creates an isochronous time series that meets Flexpro's formatting requirements for octave analysis.

### 2.7. Correction of Acousto-Electric Conversion Relationships

After meeting Flexpro's formatting requirements, the data can be processed by octave analysis. However, since Flexpro is based on airborne acoustics with a reference sound pressure of  $20 \mu\text{Pa}$  and the experimental study is based on hydroacoustics with a reference sound pressure of  $1 \mu\text{Pa}$ , the results should be compensated by narrowing the acoustic-to-electrical conversion relationship, e.g. the acoustic-to-electrical conversion relationship of the 160 steps with a reference sound pressure of  $10.3 \text{ mv/pa}$  is corrected to  $0.3 \text{ mv/pa}$  in Flexpro. Flexpro is corrected to  $0.515 \text{ mv/pa}$ .

## 2.8. About drawing

The final 1/3 octave results must be plotted in Flexpro, usually using logarithmic axes for the x-axis.

## 3. RESULTS AND DISCUSSION

The finalised hydroacoustic signal processing system is OKI ST1030 hydrophone - OKI SW1030 sound level meter - NF EZ 7510 signal logger - EZ 0751 - Flexpro 7.0.

Drawing on the experimental experience of others, it has been found that a filter can be introduced into the system after broadly determining the frequency band in which the object of study is located, which can significantly improve the signal-to-noise ratio of signal sampling and processing. The filters in this experiment are realised by a sound level meter, whose high passes are 10 Hz, 100 Hz, 1k Hz, 10 k Hz, and whose low passes are 1 kHz, 10 kHz, 100 kHz. basically meet the needs of the experiment. In future experiments, if conditions permit, independent filters can be introduced, such as the NF-3600 filter, which can freely set the cut-off frequency in the range of 0.1-21.8 KHz.

Software processing is not only limited to Flexpro, MATLAB may also be a good choice, MATLAB is a kind of commercial mathematical software produced by the American Math Works Company, which is internationally recognised as one of the best scientific and technological application software, as early as in the 1990s, MATLAB has become the standard computational software of the international control community, which is a kind of numerical calculation environment and programming language. MATLAB is a numerical computation environment and programming language that makes important problems in engineering and science into a toolkit through the software in a way that is easier for engineers to understand and learn, and with the help of building blocks and problem solving. The two most basic parts are MATLAB and Simulink, but the most powerful part is its toolkit. Every generation of MATLAB adds some toolkits, and many scientists continue to improve them, and some enthusiasts publish their own toolkits in newsgroups. And in it there is a specialised digital signal processing toolbox that may be able to facilitate a fine-grained solution to the problems faced in this experiment.

### 3.1. Measurement of ship noise

There are three types of sound sources of ship noise: mechanical noise generated by the machinery on board; noise generated by the propeller movement; and hydrodynamic noise caused by irregular water flow through the hull and changes in hydrodynamic processes during the movement.

#### 3.1.1. Instruments and experimental sea area

OKI ST1030 hydrophone, OKI SW1030 sound level meter, NF EZ 7510 signal logger, DEM 6 type three-cup wind direction anemometer, FURUNO GP-7000T fish finder, FURUNO GPA-017 GPS, computer, etc. Heishi Reef Bay, Dalian, Liaoning Province, with latitude and longitude of N38°51.730'E121°32.807'. The FURUNO GP-7000T fish finder measured a water depth of about 6.2 m. The water depth was about 1.5 m, and the water depth was about 1.5 m.

#### 3.1.2. Methods

Ambient marine noise was sampled at times when there was no vessel in the field of view using an OKI ST1030 hydrophone - OKI SW1030 sound level meter - NF EZ 7510 signal logger at times when the wind speed was relatively stable.

Nearer the time when a fishing vessel passes near the test point, the ambient marine noise is sampled at this time and the condition of the fishing vessel and the wind speed at that time are recorded.

Finally, the data from the two samplings were processed to obtain comparative results.

### 3.1.3. Results and Discussion

The fishing vessel was about 5m in length, with a power of 60 hp, and sailed past at about 10m from the hydrophone. The DEM 6 three-cup wind anemometer measured 2.1—4.1m/s for the local wind speed at that time. The two samples were taken at similar times, the wind speeds did not change much, and the most significant cause of the change in noise conditions was ship noise. The 1/3-octave analysis results of the two samplings showed that in the 400H—800Hz band, a ship passing by was higher than no ship by more than 10dB, of which 400Hz was higher by 17.82dB. If this situation is raw sound in the acoustic tame type of marine pasture when baiting, it will have a great negative impact on the entrapment of fish populations[5].

## 3.2. Actual Measurement of Marine Environmental Noise in Heishi Reef Bay

### 3.2.1. Instruments and test sea area

OKI ST1030 hydrophone, OKI SW1030 sound level meter, NF EZ 7510 signal logger, DEM 6-type three-cup wind anemometer, FURUNO GP-7000T fish finder, FURUNO GPA-017 GPS, and computer

The test area was Heishi Reef Bay, Dalian City, Liaoning Province, with latitude and longitude of N38°51.730'E121°32.807'. The water depth was measured by FURUNO GP-7000T fish finder at about 5.0-6.8 m, and the wind speed was measured by DEM 6 three-cup wind anemometer at half-hour intervals throughout the day at about 4.4 -6.3 m/s. -6.3 m/s.

### 3.2.2. Methods

Noise conditions were measured every half hour from 8:30-14:30. The hydrophones were placed at different water depths for a short period of time when the wind speed was relatively stable and there was no vessel sailing in the field of view, to test the noise conditions at different water depths. The experimental data were recorded by NF EZ 7510 signal recorder in \*.dat format, and the experimental data were processed by NF EZ7510 and Flexpro 7.0.

### 3.2.3. Results and Discussion

Since the tests are tried to select the time when there is no ship sailing in the field of view or when the ship sailing is far away, the main factor affecting the noise of the marine environment at different times is the change of wind, that is to say, in the case of the relatively small influence of the ship travelling and the biological noise, the wind-generated noise contributes to the noise background predominantly, and the measured noise level is obviously related to the wind speed only, and when the wind speed is more than 2.6 m/s, the wind speed doubles, the spectral level increases at a rate of change of 6 dB increase. That is, the intensity grows with the wind speed squared.

Since the DEM 6 three-cup wind anemometer used in the experiment is a hand-held anemometer and can only record the wind speed manually, it does not meet the requirement of automatically recording the wind speed 10 m above the open sea surface. It failed to provide accurate real-time recording of wind speed. The results of sampling and processing throughout the day show that the noise situation in Black Rock Reef Bay at different times varies in a complex manner, with a 1/3 octave range of about 93-118 dB at 300 Hz, which is the frequency of our concern.

Measurements of ambient marine noise at different depths show that the noise decreases with depth, although near the seafloor, the noise increases due to the reflection of sound from the seafloor and biological noise on the seafloor, and the noise level near the 300 Hz frequency of our interest is about 87-122 dB. When using demersal fish as the domestication target species, the noise level near the seafloor is a necessary component of the domestication programme. ambient marine noise in the vicinity must be taken into account.

The ambient noise measured by James J. Finneran in San Diego Bay was 1/3-octave processed, and it should be noted that a filter with a fixed bandwidth of 12.2 Hz was used in the test from 100 Hz to 1000 Hz, giving a marine ambient noise level of approximately 100 dB in San Diego Bay. test site is closer to the shore and is more affected by shore wave noise.

## **ACKNOWLEDGE**

Supported by Fund of Key Laboratory for Sustainable Utilization of Open-sea Fishery , Ministry of Agriculture and Rural Affairs, P. R. China(LOF2024-01).

## **REFERENCES**

- [1] MCDONALD M A,HILDEBRAND J A,WIGGINS S M. Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island,California[J].The Journal of the Acoustical Society of America,2006,120(2):711-718.
- [2] LEE C H,SEO D O.The hearing ability of black rockfish *Sebastes inermis* to underwater audible sound-1.The auditory threshold[J].Korean Journal of Fisheries and Aquatic Sciences,2000,33(6):581-584.
- [3] ABBOTT R R.Induced aggregation of pond-reared rainbow trout(*Salmo gairdneri*)through acoustic conditioning[J].Transactions of the American Fisheries Society,1972,101(1):35-43.
- [4] ZION B,BARKI A,GRINSHPON J,et al.Retention of acoustic conditioning in St Peter's fish *Sarotherodon galilaeus*[J].Journal of Fish Biology,2011,78(3):838-847.
- [5] TLUSTY M F,ANDREW J,BALDWIN K,et al.Acoustic conditioning for recall/recapture of escaped Atlantic salmon and rainbow trout[J].Aquaculture,2008,274(1):57-64.