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Research on Antarctic Krill Resources Survey and Assessment Methods

Shuai Chen¹, Hongliang Huang^{1,*}, Peng Zhang²

¹Key Laboratory of Oceanic and Polar Fisheries, Ministry of Agriculture; East China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Shanghai, China

²Key Laboratory of South China Sea Fishery Resources Exploitation & Utilization, Ministry of Agriculture; South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou, China

*Corresponding author e-mail: yangpu79@hotmail.com

Abstract. In order to protect the sustainable exploration of Antarctic krill resources and protect the ecology of Antarctica as much as possible, the investigation and assessment of Antarctic krill resources is very necessary. This article mainly describes the general principles, methods, instruments and equipment, technical requirements, observation and recording methods, calculation results and evaluation methods for Antarctic krill resources survey and evaluation, which is applicable to the Antarctic krill resources survey and assessment work. The survey is conducted by using a combination of acoustic surveys and biological sampling. The assessment of resources is performed by using the grid method.

1. Introduction

Antarctic krill resources are now an important development target in the development of offshore fishing. In order to protect the sustainable use of Antarctic krill resources and protect the Antarctic ecology from fishery development as much as possible, the investigation and assessment of Antarctic krill resources is very necessary[1-2]. The survey was conducted using a combination of acoustic surveys and test captures. At the beginning of the investigation and at the end of the voyage, the equipment should be acoustically calibrated to the specifications to ensure the accuracy of the original acoustic data. In-depth understanding of the ecological habits and acoustic imaging characteristics of the biological populations in the Antarctic waters; accurate determination and statistics of the composition of on-site trawl catches and the length and weight distribution of each species (including non-surveyed species) for image analysis And integral value allocation. Accurately identify the target intensity of Antarctic krill and other major catch species for quantitative acoustic assessment of the surveyed subjects. The investigation elements included hydro acoustic survey data and trawl sampling data such as the number distribution, population structure, and biological characteristics of Antarctic krill.



2. Survey Method

2.1. Take Route and Station Presets

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2.1.1. A sub subsection. In the survey, the drag site is set temporarily based on the condition of the acoustic image. The survey route design adopts the form of a rule parallel line. The direction of the design route should be as parallel as possible to the gradient direction of the factors (such as water depth, water temperature, etc.) that may affect the distribution of resources. The length of the design route should be designed in conjunction with the coverage factor. The coverage factor is determined according to formula (1).

$$\Lambda = \frac{D}{\sqrt{A}} \quad (1)$$

In the formula:

Λ —the coverage factor of the survey route is generally at least 4;

D —the length of the survey route, in nautical miles (nmi);

A —the area of the surveyed sea area, in square miles (nmi²).

2.2. Sampling

Surveys generally use biological resource survey ships equipped with scientific fish finder, trawl samples, and low noise. Sampling nets should use special survey nets with low selectivity, including bottom trawls and variable-layer trawls. The main equipments are as follows: Scientific fish finder; Instrument calibration kit, including standard ball, mono filament nylon line and small winch; Acoustic data download, storage and post-processing system; Computer, data CD burner or mobile hard disk; Global Positioning System; Dice, dissection needles, white trays, balances (or small scales), rulers, recording papers, label papers, sample storage containers, etc. required for biological data collection.

2.3. Acoustic data collection method

To start the host operation step, first confirm that the connectors on the rear panel of the host are well installed; turn on the power switch on the front panel of the host; turn on the monitor power switch; if the voyage requires paper information, turn on the printer power; use the joystick or the keyboard on the host panel to operate each Item setting; time echo detection-integration system and global positioning system time; according to the needs of the survey and the actual situation in detail set the system settings; the computer to record data and start recording data.

The procedure for shutting down the host is to first confirm that the voyage end data has been recorded; stop the transducer action; turn off the power to the host; turn off the screen and the computer power.

The initial water level of the integration should be at least twice the near-field distance of the transducer. The distance between the near-field and far-field interfaces of the transducer is calculated from equation (2).

$$R = a^2/\lambda \quad (2)$$

In the formula:

R —the distance between the near-field and far-field interfaces of the transducer in metres (m);

A—The diameter or length of the transducer in meters (m);

λ - Transducer operating wavelength in meters (m).

The integrated initial water layer of the commonly used scientific fish finder with 38 kHz and 120 kHz is 3 m ~ 5 m.

Integral termination of the water layer generally integrates to the bottom of the sea. When the water depth is deeper (greater than 500 m), it may be selected as appropriate. Integral water layer thickness is basically set at equal intervals, according to water depth optional 5m, 10m, 20m, 50m, 100m, 200m or 300m. The basic integral voyage unit selects 1 nmi when the scale of the survey is small, and 5 nmi when the survey scale is multiple of 5 nmi.

2.4. Collection of Biological Data

The trawl sampling aspect mainly includes the aspects of releasing, trawling, setting up nets, handling and recording of catch samples.

The location of the nets should be integrated with various factors such as towing speed, direction, flow direction, flow velocity, wind direction and wind speed. Trajectories should be used to collect the echo-image-generating creatures in the preset stations and image-intensive areas. According to the image density, it can be effectively towed for 10 min to 60 min, and appropriate samples are taken for biological analysis of species composition and species of each species. Before the release of the network, the ship's position shall be accurately measured, and the time for releasing the network shall be stopped for the trolling, and the trolling class shall be subject to the force.

In the trawl network, the trawling direction should be kept as far as possible toward the standard station, and the change of the water layer, longitude, latitude, and trawl speed in the krill image should be recorded. Attention should be paid to the dynamics of the surrounding vessels and whether the trawl is normal. If any abnormality occurs, it should be Change the drag to or immediately start the network.

In the event of major fishing accidents such as severe net-breaking that result in a large reduction in catches, they should be hauled back to the sampling.

Catch sample processing Weigh the total weight of the catch first, then randomly select no less than 200 krill per web as the analysis sample. Samples not analyzed at the scene should be bottled (bags) with a good label, well documented, checked for prompt quick freezing or infusion, or fixed with 5% formaldehyde or industrial alcohol.

The records must be recorded in detail for each trawl element (weather conditions; sea conditions; net release, network access; net gear type, specifications; total catch; sample weight; echo detection image, etc.) 1.

Table 1. Trawling Sampling Record Table.

Trawling No.		Ship name	
Trawl type		Trawl specifications	
Weather conditions		Sea conditions	
Net setting time		Lat. and Lon. of net setting	
Net hauling time		Lat. and Lon. of net hauling	
Echo detection image condition			
Catch situation			
Note:			

During the investigation, the guards should fill in observation records, and record in detail the start, end time, latitude and longitude of each voyage in the survey process, and other relevant information for image analysis reference such as stations, sea conditions, weather, and trawl information. Table 2.

Table 2. The data record of each voyage.

Voyage NO.		Ship name	
Equipment model		Equipment technical parameters	
Weather conditions		Sea conditions	
Start time		Lat. and Lon. Of Starting	
End Time		Lat. and Lon. Of End	
Echo condition			
Trawling situation			
Note:			

3. Data Processing Methods

3.1. Preprocessing of Acoustic Data

Exclude occasional non-biological source echo signals, such as bubbles, irregular seafloor and noise floor, and make necessary corrections to the original integrated value.

3.2. Pretreatment of biological data

Statistics, calculations of species, tail counts, body lengths, body weights, etc., of various net catches were provided for the distribution of integral values and biomass density calculations.

3.2.1. Gender and sex ratio. According to the Antarctic krill first abdominal foot discrimination male and female, record and count the proportion.

3.2.2. Body length and weight. Full length measurement: From the front of the eye to the end of the tail section, accurate to at least millimetres (mm). Body weight measurement: The total weight of the shrimp body was measured.

3.2.3. Ingestion Intensity. The ingestion intensity of krill was determined based on the color difference of the carapace and hepatopancreas.

3.2.4. Sexual development. The sexual development of krill was discriminated based on the male transmitter, spermatozoa, and the seminal vesicles and ovaries of the female.

3.3. Image Analysis and Integral Value Assignment

Image analysis and integral value interpretation are performed in units of basic integral flight units. According to biological sampling data and mapping data and the frequency response characteristics of Antarctic krill to identify the species of the target organism producing the echo map, and assigning the pre-processed total integral value to each biological species that contributes to the echo integration, the formula is shown in equation (3):

$$s_{Ai} = \frac{s_{A_i} \cdot \bar{\sigma}}{\sum_{i=1}^k n_i \cdot \bar{\sigma}_i} \quad (3)$$

In the formula:

s_{Ai} —— Integral value of biological distribution in units of square meters per square mile (m^2/nmi^2);

s_A ——total integral value in units of square meters per square mile (m^2/nmi^2);

n_i — the number of tails of creatures in the catch, in units of (ind);

$\bar{\sigma}_i$ — the average acoustic cross section of the organism, in square meters (m^2);

K — the number of species of organisms participating in the distribution of integral values in the catch.

4. Resource assessment

The entire survey area is divided into a number of grids, and the grid is used as a unit for calculation.

The formulas for formulating the mantissa and the biomass of the assessment type within the grid through which the survey route has passed are as shown in formula (4) and formula (5):

$$N = \frac{\bar{S}_A \cdot A}{\bar{\sigma}} \quad (4)$$

In the formula:

N — the number of resource mantissas within the grid to evaluate the category, in units of (ind);

\bar{S}_A — the average integral value of the assessed species within the grid, in units of square meters per square mile (m^2/nmi^2);

A — area of the grid, in square miles (nmi^2);

$\bar{\sigma}$ — the average acoustic section of the assessed species within the grid, in units of square meters (m^2).

$$B = N \cdot \bar{\omega} \quad (5)$$

In the formula:

B — Assess the biomass of the species within the grid in grams (g);

N — the number of resource mantissas within the grid to evaluate the category, in units of (ind);

$\bar{\omega}$ — the average weight of the assessed species within the grid in grams (g).

The resource mantissa and biomass of the assessed species within the grid that have not been surveyed are obtained using the interpolation method. The sum of the resources in each grid is the total amount of resources in the survey area.

Combining with the krill resources to inspect the navigation data and resource assessment results, the resources and regional distribution during the survey period were comprehensively analysed to map the distribution of krill resources.

Distribution, density and relative abundance of Antarctic krill estimated by maximum likelihood geostatistics on acoustic data collected during commercial fishing operations.

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