Acoustics Survey and Research on the Biological Resources of the Northern Sea of Antarctic Peninsula in January 2016

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Abstract. In order to ensure the fisheries development and conservation of biological resources in the northern sea of the Antarctic Peninsula, this study uses the scientific survey (EK60, Simrad; 38kHz,120 kHz) of R/V Xue Long in January 2016. The result shows: The total abundance of Euphausia superba Dana in the whole investigation area (51953.4 nmi²) was 3457.03 t (101129.74 ind/nmi², 55410.77 g / nmi²). The total abundance of the Thysanoessa macrura G.O. Sars was 81.43 t (35098.15 ind/nmi², 3215.01g/nmi²).

1. Introduction

While the overall situation of global fishery resources is not optimistic, the Southern Ocean fishery resources have attracted attention because they have a certain potential for development. Focusing on the Antarctic krill resources in the northern Antarctic Peninsula, countries under the jurisdiction of the Commission for the Conservation of Antarctic Marine Living Resources are actively engaged in fisheries fishing activities. However, it is worth noting that Antarctic krill, as a key species in the fragile Southern Ocean ecosystem, plays a crucial role in maintaining the stability of the ecosystem of the Southern Ocean. Therefore, at the same time as the development of marine stock enhancement, it is fully implemented. The investigation and research are an important part of protecting the ecological environment of the Southern Ocean.

In the past, many investigations [1] and studies of marine stock enhancement have also been conducted in the northern Antarctic Peninsula. For example, the United States conducted several surveys in the western sea of the Antarctic Peninsula and discovered various species of Antarctic krill (Euphausia superba, Euphausia crystallorophias, Euphausia triacantha, and Thysanoessa macrura) Different distribution patterns. Kate Richardson [2] analyzed the abundance changes of Antarctic krill from 1997 to 2011 and found that it was related to the El Niño-Southern Oscillation (ENSO). However, the most comprehensive investigation was the CCAMLR's biological resource survey [3] named “CCAMLR 2000 Survey” organized in January and February 2000. This survey covered the entire FAO48 fishing area and eventually obtained the 48th Antarctic krill fishing limit. 4 million tons provides a crucial scientific basis for the sustainable development of Antarctic krill resources in this sea area.

On the basis of past investigations, a more timely and comprehensive understanding of the situation of the marine stock enhancement in the Southern Ocean is necessary to ensure its healthy and sustainable development and to protect the ecosystem of the Southern Ocean. In this study, the fishery resources
acoustic survey data obtained from the investigation of the in the northern Antarctic Peninsula from December 30, 2015 to January 14, 2016, combined with biological sampling data, were used to target the biological resources were assessed.

2. Materials and Methods

2.1. Investigation

From December 30, 2015 to January 14, 2016, in the process of ferrying the Southern Ocean, scientific surveys (EK60, SIMRAD) were used to continuously perform acoustic surveys to obtain an acoustic image of the marine stock enhancement of the surveying ship. Acquired 224 G of acoustic survey data of marine stock enhancement, including 26.59 G of data from the operating site of the northern Antarctic Peninsula site. The data was automatically divided and saved by the system and was initially processed on site. Finally, it was brought back to the laboratory for final treatment in combination with biological sampling and environmental data. Through post-processing analysis of acoustic data, the resources and distribution of Antarctic marine stock enhancement can be obtained. The depth of investigation was set to 500 m, the 38 kHz transducer power was set to 2000 W, and the 120 kHz transducer power was set to 250 W. The pulse width is set to 1024 μs.

Figure 1 shows the display of the scientific sonar during the survey period. The blue and orange images at depths of about 20-30 m are generated by the marine stock enhancement in the beams. The vertical stripes of blue and red are the shipboard ADCPs. The interference generated by other acoustic devices, such as depth meters, where ADCP is the most significant.

In order to effectively study the biological significance of the acoustic image, this study used biological sampling of the key sea area using the “double balloon trawls for the evaluation of framed Antarctic krill resources” at the same time as the acoustic survey. The sampling network is a double-sac structure, with a mesh-type frame size of 4 m×2 m and a mesh size of 15 mm. During the investigation, according to the time schedule, biological sampling operations are selected after the station operation is completed. The towing speed is generally controlled at about 3-4 kn. The sampling depth is generally adjusted according to the influence of the scientific sonar and the sampling time is generally controlled at 20 min. the above. In the process of trawling, we used the results of the investigation of the tension of the winch on the ship, and we also studied the force of the sampling network.

In order to compensate for the limitations of the investigation time limit on trawl sampling stations, the surface Antarctic krill collection network (1 m in mesh diameter and 15 mm in mesh sac size) was specially constructed. It was fixed at the same time as geological and physical marine sampling. Near
the deck of the ship's side, successfully obtained biological samples such as Antarctic krill and Long arm cherry krill.

During the inspection period, 8 special trawl samples (8 stations \( \times 1 \)) were obtained. The station position is shown in Figure 2. About 15 kg of Antarctic krill samples, 200 g of jellyfish samples, 300 g of larvae, cope pods, and footholds were obtained. In field surveys, the near-shore and continental slopes of the krill densely distributed area are generally selected before or after leaving the station. The speed of the ship is maintained at 3-4 knots. The length of the cable is adjusted according to the image of the scientific sonar. The trawl is 0-20 minutes later, Low speed (speed about 0.2 m/s) put away.

![Figure 2. Antarctic krill frame double-sac sampling network operation site](image)

2.2.  Analysis and Test Methods

2.2.1. Acoustic investigation of marine stock enhancement. Acoustic assessment of marine stock enhancement is the use of scientific sonar to emit sound waves vertically to the ocean. Through the analysis of echo signals, the distribution of marine stock enhancement in the ocean and its biomass are known. It has the advantages of rapid investigation, wide range, and no damage to resources. The acoustic instrument used in this survey was the scientific sonar (EK60, SIMRAD, NORWAY). The operating frequency of the system was 38, 120 kHz. The knew system runs on WINDOWS 7 system. The data collection and storage are all automated. If the system fails to work during the investigation, the system will automatically give relevant prompts. Combined with the prompt investigation personnel can quickly the commissioning has effectively guaranteed the quality of survey data.

2.2.2. Biological Analysis of Samples. The Antarctic krill sample used in this analysis was used in the 32nd Antarctic scientific survey cross section survey in China, in the Weddell Sea North Sea area, and used an Antarctic krill dedicated double balloon frame trawl in January 2016 (frame main dimension 4 \( m \times 2 \) m, mesh capsule 10 mm) sampled. Each sample is dragged for 10-20 min. After the sample was sealed, it was preserved in a \(-80^\circ C\) cryogenic refrigerator and brought back to the Fisheries Eco-Environmental Laboratory of the East Sea Fisheries Research Institute. Make measurements.

3.  Results and discussion

Based on the above surveyed acoustic data and biological data, resource estimates can be made. The estimated formulas for the average target intensity, average body weight biomass, and resource of Antarctic krill in this survey are as follows:
This formula is a simplified SDWBA model formula given by CCAML R in 2009. When $kL$ is less than 200, the average error is less than 2.18 dB. $k$ is the wave number ($k = \frac{2\pi}{\lambda}$); $L$ is the length of the krill body in m. The relevant parameters are shown in Table 1:

**Table 1. SDWBA Model Formula Parameters.**

| Parameter | Formula Value |
|-----------|---------------|
| $A$       | $6.6455874521e+00-2.3282404324e+01i$ |
| $B$       | $1.2790907635e-01-3.7077142547e-02i$ |
| $C$       | $4.4631814583e-01-2.0095900992e-01i$ |
| $D$       | $-1.1920959143e-11$ |
| $E$       | $7.4232471162e-09$ |
| $F$       | $-1.7391623556e-06$ |
| $G$       | $1.8632719837e-04$ |
| $H$       | $-8.6746521481e-03$ |
| $I$       | $1.3214087326e-01$ |
| $J$       | $-8.1337937326e+01$ |
| $L_0$     | $38.35e-003$ |

\[
\rho_a = \frac{n_{asc}}{K \cdot 10^{0.1TS}}
\]

In the formula:
- $\rho_a$: how many organisms per unit area, unit: ind·m$^{-2}$;
- $n_{asc}$: acoustic data according to the water layer and track integration results, unit: m$^{-2}$·nmail$^{-2}$;
- TS: target intensity, unit: dB;
- K: constant, K=$4\pi \times 1852^2$. 

(2)
\[ \rho_{gi} = \rho_{ai} \times W_{mean} \] (3)

In the formula:
\( \rho_{gi} \): biological density, unit: g \cdot m^{-2};
\( W_{mean} \): average weight of krill group, unit: g;

The water acoustic survey near the Antarctic Peninsula mainly completed seven sections D1, D2, D3, D5, D6, DA and DB. According to the results of actual surveys, the waters around the western South Orkney Islands, and the southeast the sea areas and other marine stock enhancement are relatively abundant. Most of these sea areas lie on the edge of the Powell Basin and where the depth of the ocean on both sides of the Lopez Strait varies. In terms of ocean currents, the westward coast of the Weddell Sea has been changed by the Antarctic Peninsula to become an Antarctic circumpolar current that flows northwards to the east of the Drake Passage. The result is a clockwise circulation in the Weddell Sea, the Weddell vortex. In terms of sea ice, it is different from other sea areas of the Southern Ocean. West Wedder still maintains a large amount of sea ice in the summer and has a high percentage of ice for many years. The corresponding annual ice lakes exist. In terms of changes in sea ice, the sea ice area maintained by the West Weddell Sea in February was more northerly to the southwest, and most of them retreated to the coast in February.

The sea area with the most abundant marine stock enhancement in the entire investigation area is in the western part of the South Orkney Islands. The two max NASC unit sections are respectively 7802.14 and 4025.56 m²/nmi². In addition, the southeastern part of the island is the survey area. The more unusual phenomenon is that in the past survey, this area was far from the islands, and the water depth was deeper. The marine stock enhancement was not abundant. However, in this survey, the distribution of marine stock enhancement was second only to the west of the South Orkney Islands. NASC values the maximum is 5768.50 m²/nmi².

Using the square method in this assessment, the entire surveyed sea area was divided into five areas using acoustic data and biological sampling. The total area of the surveyed sea area was 51953.4 nmi². The total number of krill in the entire surveyed sea area was 630409345 ind, weighs 3,470.03 t; the total number of long arm cherry krill is 891,367,236 ind, and the total weight is 81.43 t. Among them, the number density of Antarctic krill is 101129.74 ind/nmi² and the weight density is 55410.77 g/nmi². The number density of S. japonica is 35098.15 ind/nmi² and the weight density is 3251.05 g/nmi².

Figure 3. Distribution of marine stock enhancement near the Antarctic Peninsula
Figure 4. Interpolation analysis of marine stock enhancement distribution near the Antarctic Peninsula

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