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Mapping and classification of submerged aquatic vegetation using 3-dimensional side scan sonar
３次元サイドスキャンソーナーを用いた藻場の識別マッピングに関する研究

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1. Introduction

Seagrass beds have significant rolls in marine coastal ecosystems. For example, they purify water by its photosynthesis, provide dwellings to aquatic life including fishing resources and stabilize bottom sediment. Thus they support biological diversity in coastal area. However submerged aquatic vegetation (SAV) resources have been decreasing in Japanese coastal area because of human factor, such as industrial pollution, and environmental changes. Therefore preserving and recovering SAV resources have to be accomplished, and it is important to mapping and discriminating of SAV for adequate SAV resource management. In order to investigate SAV distribution and discrimination, researchers formerly have dived into the sea and estimated its amount by their own eyes, and these days remote sensing techniques have been applied to SAV investigations along to the acoustic and satellite equipment's innovations. Our research group has also made SAV investigations by acoustic methods using such as Dual-Frequency Identification Sonar (DIDSON).[1] In this study our research group, in associate with IIS, Shizuoka Prefectural Government and Windy Network Corp., aim to investigate broader coastal area than multi-beam sonar, by side scan images in shallow water. Moreover we also aim to implement bathymetry simultaneously with less effort than existing researches by using inrterferometric side scan sonar.

2. Method

2.1 Survey area

Our research area is placed at coast near Sotoura beach, Sizuoka Prefecture in Japan. Fig. 1 is the map of there which include investigated track lines and pictures of SAV flora there. In this area, sandy seafloor reaches gently shallower than 20 m depth. In a part of this area, rocks are strewed in order to develop fishing ground on account of a fishery policy taken by Shizuoka prefectural government. According to researches taken by

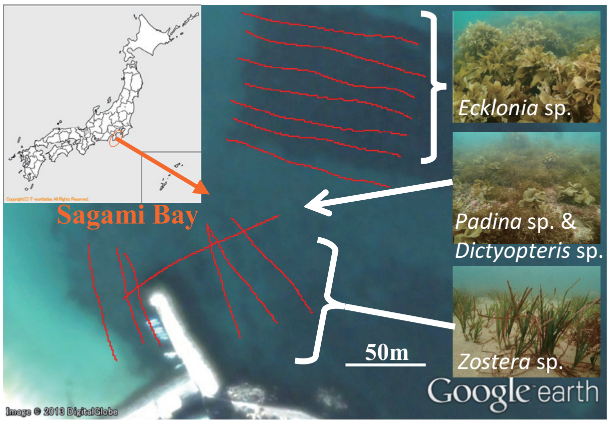

Fig. 1 Map of Sotoura beach taken from Google earth and http://www.sekaichizu.jp. Red lines are tracks of our investigation ship. Three SAV pictures are taken in second experiment, and white arrow and white parentheses indicate areas where each SAV are mainly growing.

them, it is already known that there are *Zostera* beds on sandy seafloor and *Ecklonia* on rocks.

2.2 Experiment settings

We have already made two experiments. In first experiment on July 1st 2013, we collected acoustic data of seafloor including SAV by an interferometric sonar GeoSwath plus compact (GeoAcoustics Ltd.) installed on port side of Investigation vessel Izu-Maru. Sonar frequency was 500 kHz. Positioning was provided by an RTK-GPS reciever (Trimble Inc.) installed right above GeoSwath transducer and the other receiver located on land. Attitude information in survey is collected by POS/MV (Applanix Inc.) motion correction equipment. For sound velocity corrections we made sound speed measurements faced at the transducer by Mini SVS (GeoAcoustics Ltd.) attached to GeoSwath. These equipment are connected to a PC and processed with Hypack (HYPACK, Inc.) ,which is the navigation software, and integrated into raw data format.

In second experiment on August 1st 2013, divers took photos of SAV as ground turth data for processing acoustic images and classifying SAV.

2.3 Method of bathymetric side scan

The GeoSwath uses phase comparison angle measurement commonly described as bathymetric side scan, and this system simultaneously acquires swath bathymetry and side scan data. Fig. 2 illustrated the method of bathymetry by GeoSwath. GeoSwath sonar includes a pair of transducers mounted on V bracket, and each side of V has one transmit stave and multiple receive staves. Amplitude and phase of returned sonar signal is measured on each stave and phase differences are used to determine return angle.

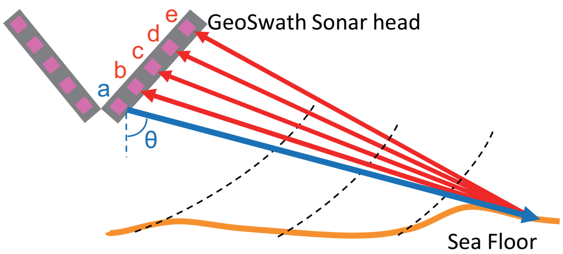

Fig. 2 Illustration of GeoSwath bathymetry theory. Letter "a" in blue correspond transmit stave and Letter "b" to "e" in red correspond receive staves. Blue arrow corresponds transmit plus and red ones sonar signals scattered from the seafloor. θ is return angle.

2.4 Image processing

As the tool for discriminating SAV species, spatial spectrum analysis was performed on the side scan image. This spectrum analysis of the image enables us to quantify the feature of SAV. In this study we extracted low spatial spectrum from the side scan image by applying two dimensional fast Fourier transform (FFT) to detect SAV, corresponding rough part of the image. As spatial spectrum became higher, we determined that color of pixel chaged red to blue.

3. Result and Discussion

After the first experiment we gat rage, angle and amplitude data set of seafloor in the investigation area, and using these data we made a side scan image as shown in Fig. 3. This image is 2,800 pixels in width and 2,700 pixels in height and brightness of a pixel corresponds seafloor which reflected strong backscatter. Brightness of one pixel was determined by amplitude in 10 cm square seafloor. Fig. 4 is the result of spectrum analysis applying to the side scan image. Red pixels corresponded to rough pattern seafloor, and in this area *Ecklonia* was comparatively rougher object than other objects such as rocks and other SAV. Actually this spectrum pattern showed *Ecklonia* flora investigated through the second experiment.

According to the second experiment, we

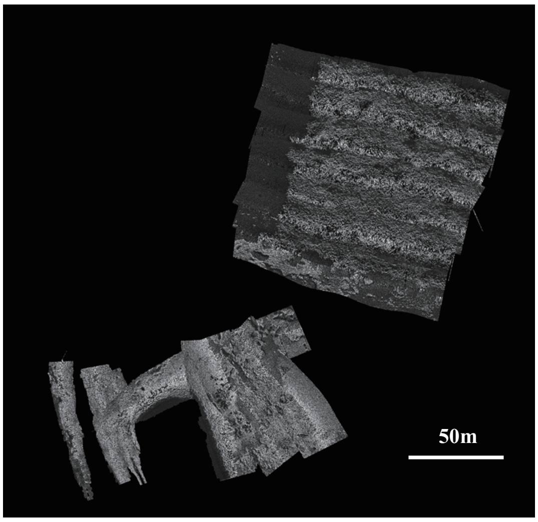

Fig. 3 Side scan image of the investigation area.

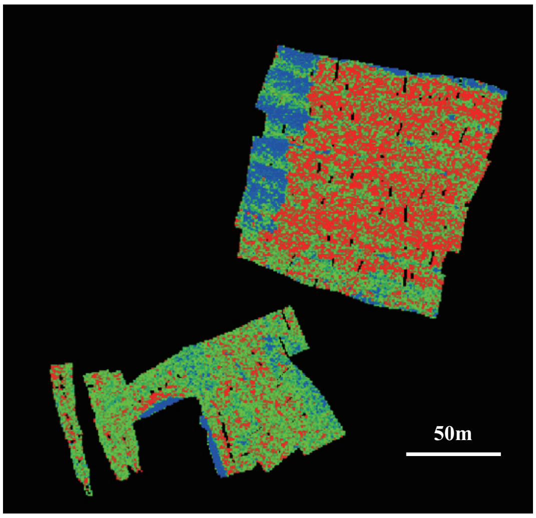

Fig. 4 Spatial Spectrum of side scan image.

classified four species of SAV, *Zostera*, *Ecklonia*, *Padina* and *Dictyopteris*. We also mapped the area where each SAV was growing. In bottom-left closed off area, where there were sandy seafloor, *Zostera* was mainly growing. *Padina* and *Dictyopteris* were growing in same area sparsely. On the other hand, in upper-right closed off area, where there were rocks on seafloor, *Ecklonia* was dominant species.

4. Conclusion

In our studies, bathymetric side scan sonar GeoSwath was applied to seafloor investigation in coastal area and found that this sonar is effective for investigating SAV. Moreover extracting specific spatial spectrum from the side scan image, we indicated *Ecklonia* flora on seafloor.

References

1. C. XU *et al.*: J. Marine Acoust. Soc. Jpn. **40** (2013) No.1.