Mapping seagrass in the Swan-Canning Estuary using sidescan sonar

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Seagrass distribution and other measures of seagrass condition have been used as broad scale biological indicators of marine and estuarine health. To date the distribution of seagrass in the Swan-Canning Estuary has been assessed based on aerial photographs, which is ineffective in deep, turbid waters. Sidescan sonar systems (SSS) provide acceptable results in a much wider range of environmental conditions, particularly as they are not affected by the turbidity or water depth of the river. A SSS was successfully used to collect backscatter data from 10 survey areas in the Swan-Canning Estuary ranging from 0.5 – 15m in depth. The SSS was able to distinguish areas of seagrass from bare sediment. A simple threshold classification method was used to produce geo-referenced habitat maps from each of the 10 areas showing the predicted distribution of low and high density seagrass, sand, mud and rock. The SSS is considered cost-effective and efficient for similar studies in other shallow water estuaries provided it is conducted in conjunction with ground-truthing at selected reference points.

Keywords: Swan River, seagrass, mapping sidescan sonar.

Introduction

Seagrass distribution and other measures of seagrass condition have been used as broad scale biological indicators of marine and estuarine health. To date the distribution of seagrass in the Swan-Canning Estuary has relied on aerial photographs (e.g. Hillman *et al.*, 1995) but with little or no ground-truthing to verify the images. Aerial images are prone to several errors due to various factors, which include sun glitter, turbidity (particularly in estuaries), variations in depth, and obscuring features such as floating macroalgae above the seagrass. Ground-truthing is labour intensive, expensive in terms of time and resources, difficult to repeat and also prone to error because of subjective interpretation and the necessity for large scale averaging between surveyed areas.

In order to use changes in seagrass distribution over time as an indicator of condition in the Swan-Canning Estuary and potentially in other estuaries along the West Australian coastline, a quantitative, reproducible method for determining seagrass distribution needs to be developed. Acoustic remote sensing using sidescan sonar (SSS) offers a cost-effective method and has been shown to be be effective in mapping seagrass distribution (Pasqualinia *et al.,* 1998; Mulhearn, 2001; Bickers, 2003). However, the shallow water limit of sidescan sonars for habitat mapping is not well understood. The scientific challenge is to minimise the depth at which SSS results are still valid.

The objectives of this work were to:

1. Determine the spatial extent of seagrass in selected regions of the Swan River using sidescan.
2. Assess the ability and relative merits of sidescan sonar for mapping seagrass in the Swan River.

This paper presents the sidescan sonar data acquisition, processing and classification methods and some example results.

Study Areas

Ten study areas for mapping seagrass in the Swan and Canning estuaries were identified based on previous data by Hillman *et al.* (1995). These sites were Rocky Bay, Point Walter, Freshwater Bay, Attadale Foreshore, Lucky Bay, Waylen Bay, Como Beach, Matilda Bay, Pelican Point and Armstrong Spit.

Methods

Data were collected during the period from 20/4/08 to 3/5/08, using high tides to cover the shallower areas. Wind speed varied from flat calm to 20kn, at which point measurement quality degraded unacceptably. Water visibility was generally less than 1m. For the majority of data collection there was negligible current.

An EdgeTech™ 4200 MP SSS was used to collect backscatter data (Figure 1). The tow-fish was fixed-mounted to the vessel to improve geo-referencing of data. Backscatter was collected at 250 kHz at the maximum range of 75 m either side of the tow-fish (i.e. a total swath of 150 m). The range was set to 75m because this was the furthest distance for which data could be obtained in the very shallow water areas in this study (typically < 2 m). Although a higher range was possible in deeper water, it was kept at 75m for consistency and for ease of comparison. OmniSTAR™ 8200HP DGPS was used to provide position information.

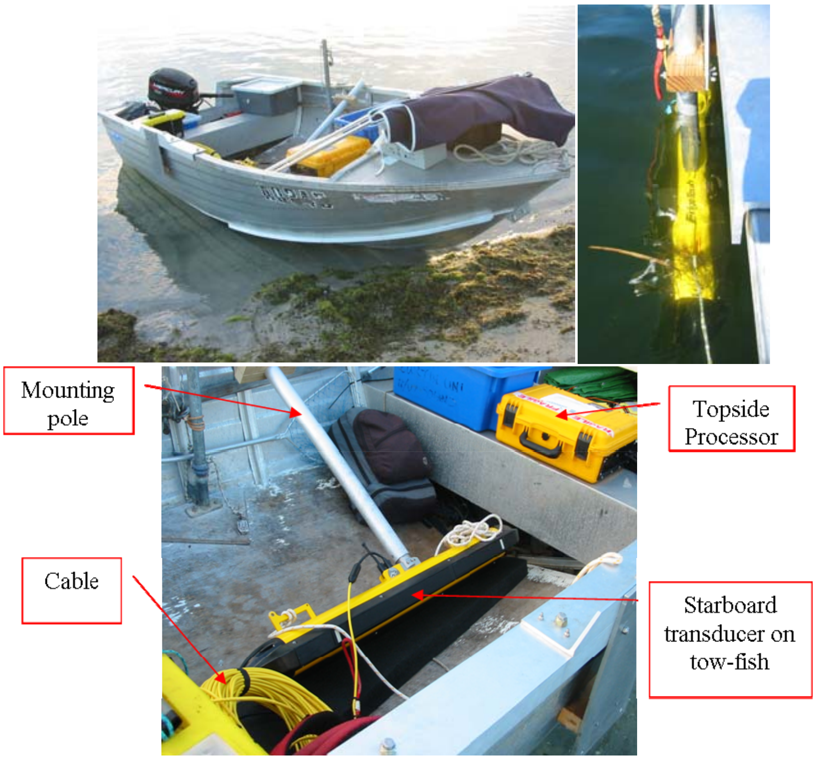

Figure 1: EdgeTech 4200 sidescan sonar system.

Processing sidescan data entailed applying two types of correction:

- geometric
- radiometric

Geometric corrections are the calculation of the X-Y position for each data point. As the EdgeTech 4200 measures motion and heading, the X-Y position was corrected for roll, pitch and yaw.

Radiometric corrections of backscatter data compensate for transmission loss, insonification area and incidence angle (Medwin and Clay, 1998). To aid in classification, a wavelet speckle filter (Yu and Acton, 2002) was applied before classification. Data were divided into five classes: mud, sand, low-medium density seagrass, medium-high density seagrass and rock and using ground-truth information, distributions of backscatter values for the different classes were calculated. Then all the backscatter data were assigned one of the five classes. The classified data were combined into a map gridded with a 2m cell size. Each cell contained several classified points, the most frequent class based on a 5 x 5 pixel Gaussian weighted moving window (to allow contextual information) was assigned to the cell.

Results

The SSS was successfully used to collect backscatter data over 4.4 km^2 in 8 survey days from 10 survey areas in the Swan River. An example of a single track of processed backscatter data is shown in Figure 2 (a). Ground-truth information (gathered from snorkellers) is shown to confirm the identification of seagrass and the sand and mud classes. The distributions of backscatter values for the different classes are shown in Figure 2 (b). Although the density of seagrass does correlate with the resulting backscatter intensity, it is not a linear relationship.

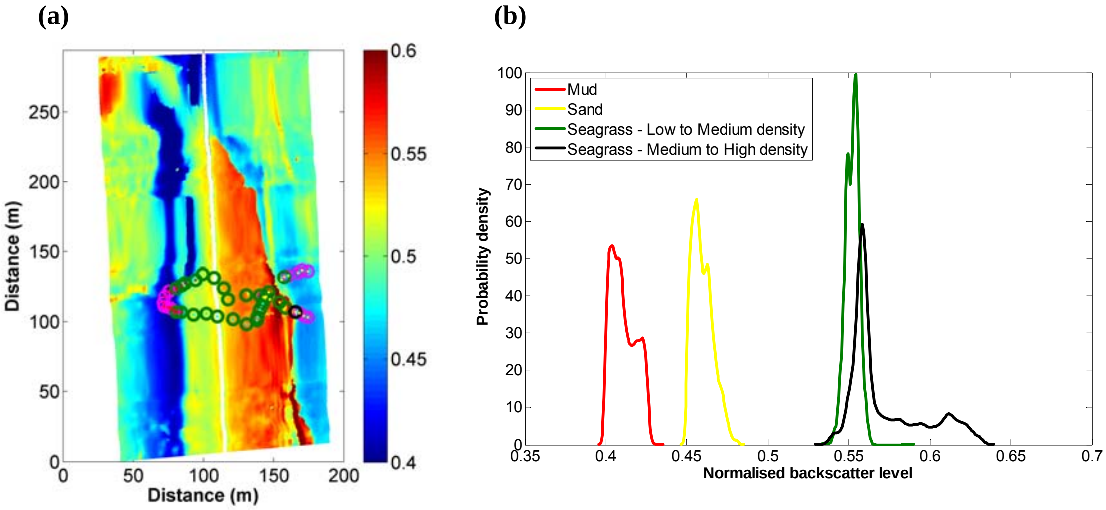

Figure 2: (a) Processed backscatter strength (as indicated by the colour bar) with ground-truth information indicated by the following symbols: seagrass cover: **o** <5%, **o** 5-50% and **o** >50%; sand (●), sandy mud (●) and mud (●); and (b), distributions of backscatter values for the different habitat classes.

Figure 3 shows the final habitat map for Armstrong Spit (a) along with the track plots over the chart from the survey area (b). Overall there is good agreement with the maps of seagrass distribution produced by Hillman *et al.* (1995). The depth range of the seagrass in some sites exceeds maximum depth of the detection in aerial photography studies. Although there was not enough information available to perform an accuracy assessment of the classification, comparison of the results with ground-truth data, such as in Figure 2, give good confidence in this mapping technique.

Conclusions

SSS was effective and efficient at mapping broad scale habitats of an estuary in depths 0.5-15 m. Even in depths of less than 1m of water a total swath width of 150 m was achieved. A simple threshold classification method was used to produce habitat maps from each of the sites showing the predicted distribution of seagrass, sand, mud and rock. Although SSS was successful at identifying seagrass, determining the relative density of seagrass from SSS data is still an area requiring further research. However, for mapping the presence of seagrass, SSS has shown to be effective in at greater depths than aerial photography. We conclude that SSS is a useful tool for habitat mapping in an estuarine environment.

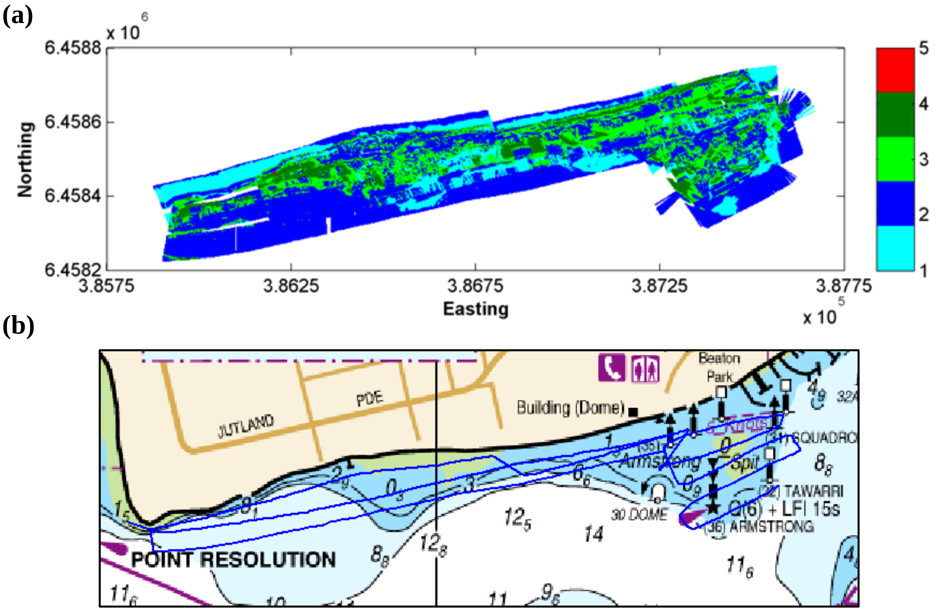

Figure 3: Results from Armstrong Spit: (a) Track plot over the chart, and (b) habitat map – 1 = Mud/Sandy mud, 2 = Sand, 3 = Seagrass (low to medium density), 4 = Seagrass (medium to high density) and 5 = Rock/Coastline.

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