↳APPENDIX 1. DETAILS OF THE ACOUSTIC TECHNIQUE

Acoustic surveying

In these trials, acoustic survey transects were repeated (approx. 9 times) in each survey area to ensure adequate coverage of the survey areas and to allow for some redundancy of data. Seagrass and sediments were surveyed acoustically using two echo-sounding systems: a conical beam transducer and a fan beam transducer. Combinations of the character and amplitude of the recorded echoes and the geometry of the transducer output provided 3 interpretations of the acoustic data - broad habitat mapping (fan beam), seagrass density estimation (conical beam at grazing angle of approximately 10 degrees) and sediment type (conical beam).

Two transducer rigs can be used: 1) fixed transducer "mounted over the side" of the vessel, and 2) transducer attached to a towfish, towed a fixed distance behind the vessel. Minimum water depths acceptable for both rigs is approximately 0.7 m. The acoustic system emits high frequency (420 kHz) pulses of sound which, after reflecting or scattering from sediments or seagrass, return to a receiver to be recorded digitally. The geometry of the interaction between the acoustic beam and the environment was later used to calculate the mapping position and strength of each returned signal (see below: Processing of Digital Data). Echosound data was recorded on two systems: a) as a real-time hardcopy printout on an EPC 9800 Thermal Chart Recorder and b) stored to a computer hard disk.

All acoustic data was tagged with Universal Time data and linked to dGPS data which was collected simultaneously. Geographic position of the transducer and all acoustic data was calculated using the geometry of transducer and acoustic signals relative to the GPS antenna. Each acoustic technique used is described below.

Mapping seagrass habitat boundaries

The fan beam system was used for broad habitat mapping to obtain seagrass habitat boundaries. This technique uses a beam of sound that is very narrow in the horizontal plane (2°), and wide in the vertical plane (60° to 90°). This geometry has the effect of a sonar "sweep" of a seafloor area typically 1 metre wide by 70 metres long in a direction perpendicular to vessel track. The methods used here are described by Hundley et al (1994) and technical details of scanning sonars are discussed by Urick (1983).

Fan beam outputs provide an "acoustic map image" of the environment, which include seagrass and any other seafloor features. These acoustic map images are made up of colour contours representing decibel levels of the echo signal from the environment. Processed acoustic data in map form is only semi-quantitative and requires background knowledge and experience to interpret. Interpretation of the acoustic image requires monitoring the depth-sounder on board the survey vessel and interpreting unusual features in the raw data from the fan beam sonar. Processing and interpreting the fan beam data involve the following steps.

1) Examination of raw data and log notes taken during data collection

All features in the raw data are examined and log notes on depth, bottom topography and other visible seabed features are used to identify the location of features such as piers, seawalls, rock outcrops and even seagrass beds.

2) Processing of digital data

The digital data (recorded on hard disk) is (or pooled) into areas ("bins") of approximately 3 metres by 3 metres square. This data then has a "transmission loss" correction applied to it to remove effects of signal reduction with distance. This correction equalises the signal strength so that a given target, for example, at a distance of 40 metres (for example) will have an equal backscatter strength as that same target at 5 metres. These "bins" are then merged with navigation/positioning data to yield a X and Y coordinates for each bin. Each bin therefore has a X, Y and Z coordinate, with the X and Y coordinates as spatial and the Z coordinate as the "backscatter strength" of that bin.

3) Acoustic Image / Map generation

"SURFER" software is used to generate an acoustic contour image with the X, Y and Z coordinate data mentioned above. This geo-coded data can be presented in any image format, using contours, colours or surface plots to represent the decibel strength for each bin area.

4) Interpretation of Map Image

Interpretation of the map image requires examination of the raw data and any significant auxiliary information on bathymetry and other seabed features identified in Step 1. This process requires background technical knowledge and experience with acoustic/echosounding data and is similar to interpretation of aerial photographs. Seagrass biomass or seagrass density data, obtained from ground-truth sampling, is used to verify the interpretation of this acoustic (remote sensing) data. This interpretation yields seagrass bed (habitat) boundaries by identifying areas with seagrass against areas with no seagrass (bare substrate).

This method does not yield information on seagrass or algae species composition or other factors such as abundance of epiphytic algae. This information must be derived from ground-truth sampling.

Mapping Sediment type

Several acoustic techniques are available for mapping sediments (Higginbottom et al. 1994). Urick (1983) outlines basic technical aspects of acoustic-sediment interactions. The strength of the recorded acoustic signal is influenced by the grain sizes of the sediment within the sound beam footprint (ie., larger grain sizes, including coarse sands, reflect at a higher decibel frequency). Two techniques were attempted in these trials. The (downward-looking) vertical conical beam technique uses a narrow conical beam of sound (similar to a flashlight beam) projected at a fixed angle of 90°. Echo strength data is collected from the first and second bottom echoes. Comparison of these two echoes yields information on sediment type (Collins and Gregory 1996). Calibration of the acoustic data (with sediment data obtained from grab samples) is necessary for accurate description of the range of sediment types found during a given survey. Collection and processing of acoustic data for sediment mapping with the **vertical (90°) incidence technique** includes the following steps.

1) Data collection

Acoustic echo information from the seafloor is collected at intervals of approximately 1 metre along the survey transect, and is recorded to hard disk.

2) Data processing/display

Acoustic data is processed and merged with the positioning data. These values are averaged for each 5-10 m interval are then reduced to decibel levels. and the averaged data are tested against ground-truth data.

The 45° conical beam technique (with the conical beam sonar as described above projected at 45° downward) relies on the backscatter strength (at 45° incidence) to be an indicator of sediment type as described in Urick(1983). The technique involes:

1)Data Collection

The acoustic backscatter from the sediment is recorded to hard disk at approximately 1 metre intervals along the survey transect.

2)Data Processing / Display

The recorded echo strength from the 45° sediment acoustic backscatter is isolated and a moving average function may then be applied to the data which acts as a smoothing operator. This operation has the effect of averaging the backscatter on a scale of between 5 and 10 metres, and reduces any possible effects of transducer motion and seabed topography. This sediment indicator is then reduced to a decibel level. The acoustic sediment indicators are then merged with the positioning data and these data are calibrated to ground-truth data.