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There are few places on earth where soft bottom intertidal mudflats support large numbers of migratory shorebirds. Roebuck Bay is probably one of less than only twenty scattered around the globe. The features that characterise this Bay and make it so outstanding are varied and complex. They have also been the subject of considerable scientific and community investigation in recent years. This unusual collaboration between science and community has been the catalyst for some exceptional efforts to map the nature and distribution of the sediments of Roebuck Bay.

Roebuck Bay is indeed one of the wetland wonders of the northern part of Western Australia. The intertidal foreshore of the Bay stands out for its importance as a key nonbreeding area used by arctic-breeding shorebirds. About 150,000 roosting shorebirds have been counted in recent years. Although it is widely agreed that most species use the intertidal foreshore as their feeding area, only recently have studies been conducted on the feeding distribution and the behaviour of shorebirds, or the nature of their food resources at Roebuck Bay and Eighty Mile Beach.

This information is essential if we are to conserve the immense and internationally shared natural values of these important shorebird sites, and to find informed compromises between the increasing use of the foreshore by the ever increasing human population in the Broome area and their use by the beasts and the birds. A large proportion of the world's Great Knots (*Calidris tenuirostris*) depends on (very specific portions of) Eighty Mile Beach and Roebuck Bay for moult, survival and fuelling for migration. This is also true for perhaps all the Red Knots (*Calidris canutus piersmae*) and Bar-tailed Godwits (*Limosa lapponica menzbieri*) of specific, reproductively isolated and morphologically and behaviourally distinct subspecies. The intertidal macrobenthic community of Roebuck Bay is likely to contain unique species and species assemblages. Some of these species will be new to science. It is clear, however, that much more work on the extensive collections of specimens made during this and previous expeditions is required to establish this for a fact.

The present project builds on the logistical methods and the techniques developed and used so successfully during the co-operative intertidal benthic invertebrate mapping project in Roebuck Bay in June 1997 (ROEBIM-97), the benthic invertebrate mapping effort along the Eighty-mile Beach foreshore in October 1999 (ANNABIM-99), and the low tide shorebird counting methods developed by Danny Rogers (a PhD student of shorebird foraging at Charles Sturt University) in Roebuck Bay from October 1997 onward. In the period 7-26 June we mapped both the invertebrate macrobenthic animals (those retained by a 1 mm sieve) over the whole intertidal area of Roebuck Bay (Fig. 1) and the shorebirds that depend on this food resource. Our prime focus were the eastern and southern mudflats had not been visited and mapped before; it is this southern region of the Bay that gave the project the name SROEBIM-02, the Southern Roebuck Bay Invertebrate and bird Mapping project 2002. In addition to the mapping efforts, as a reach-out to the Broome community the project incorporated the 'Celebrate the Bay Forum' on 8 June in the Town Hall of Broome. This one-day event was visited by about 150 people and was widely considered successful.

Our team comprised 140 participants of which 106 volunteers (9 Landscape expeditioners, 65 local volunteers, 11 logistical support crew, 11 science volunteers). There were 8 scientific co-ordinators (in addition to the contributors there were Grant Pearson from CALM, Shirley Slack-Smith from the Western Australia Museum, Danny Rogers from Charles Sturt University, and Bob Hickey from Central Washington University). We visited almost 1000 sample stations laid out in a grid with 400 m intersections in the eastern and southern parts of the Bay and 200 m intersections in the north (partly covered in 1997 and 2000). In addition, dredge samples were taken in various parts of the Bay (Fig. 1).

Navigating by GPS, teams of 2-4 people visited each of the stations based upon the geographical coordinates that were pre-assigned to them. At each station 3 corers made of PVC-pipe were pushed down to a depth of 20 cm (less if the corer hit a hard shell layer below which we expect no benthic animals to live), and the core samples, each covering 1/120 m<sup>2</sup>, removed. The samples with a total surface area of 1/40 m<sup>2</sup> were sieved over a 1 mm mesh and the remains retained on the sieve placed into a plastic bag, to which a waterproof label indicating the station was added. At the same time a sediment sample was taken with a depth of 10 cm and a diameter of 4.4 cm (sur-

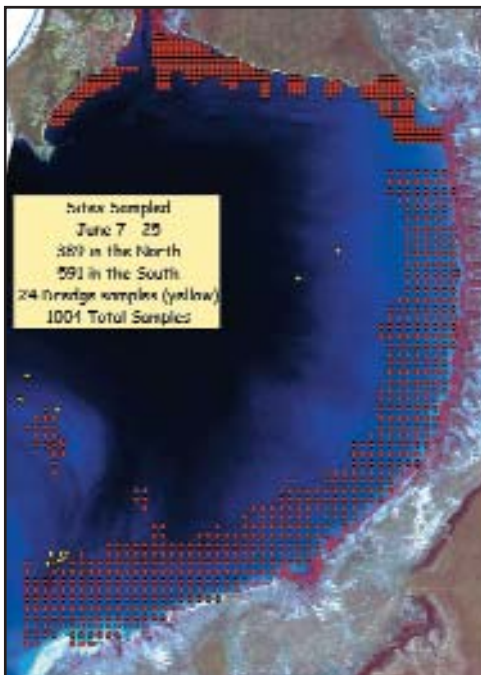


Fig. 1. Roebuck Bay near the town of Broome with sampling effort in dots.

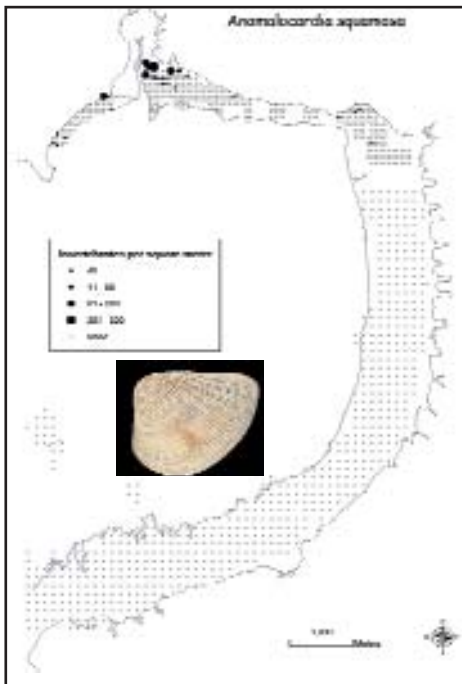


Fig. 2. Distribution of *Anomalocardia squamosa* in Roebuck Bay in June 2002.

face area =  $1/650 \text{ m}^2$ ), stored in a labelled plastic bag and kept at outside temperature for transport to the laboratory. In the field, records were made of the nature of the sediment (varying from mud to coarse sand), the presence or absence of shell layers and a visible oxygenated layer, the penetrability (depth of footsteps made by an average person, in cm), and the presence of visible large animals on the mud surface, the sort of animals (sand dollars, mudskippers) that are easily missed by our sampling technique. The sheets also allowed us to record which of the predetermined stations were actually visited, the names of the observers and the times of sampling.

The 'biological samples' were taken back to the Broome Bird Observatory, stored in a fridge at  $4^\circ\text{C}$  for a maximum of 1.5 days, and sorted in low plastic trays. All living animals were then kept in seawater, again at  $4^\circ\text{C}$  for a maximum of one day, upon which they were examined under a microscope and all invertebrates were assigned to a single taxonomic category. At the same time the maximum length (in case of molluscs and worm-like organisms), or the width of the core body (in brittle stars), was measured in mm. The latter information will be used to produce predictions of the benthic biomass values using existing predictive equations. Of all the different taxa, a reference collection was made for more detailed study of the species at a later stage.

In the course of digging up, sieving and sorting the mudsamples from all the stations, we identified and measured more than 12,000 individual invertebrates. These animals represented 205 taxa at taxonomic levels ranging from species (bivalves, gastropods, brachiopods and echinoderms), families (polychaete worms, crustaceans and sea anemones) to phyla (Phoronida, Sipuncula, Echiura, Nemertini, Hemichordata).

In total 48 species of bivalves were found in the quantitative samples.

In the quantitative samples, *Siliqua pulchella* had the highest score of the bivalves with a presence of 16% of the stations, especially in the muddy regions in the east. This abundant species (because of its fragile shell it is

never found on the beach) does not receive mentioning in the two recent Australian bivalve books, reflecting the fact that Australian mudflats were not very well studied up to now. The family Tellinidae and Veneridae contain the highest number of species, with respectively 11 and 10 species. Most of the Veneridae were rather rare, except for *Anomalocardia squamosa* (Fig. 2). In the family Tellinidae, however, 5 species are rather common, especially *Tellina amboynensis* (Fig. 3). Another rather common species, *Tellina 'exotica rose'* was not found in our previous surveys of the bay in 1997 and 2000 (Fig. 4). Still another *Tellina* species newly recorded in the bay was discovered by accident on a sand bank in the south when a hovercraft stranded with

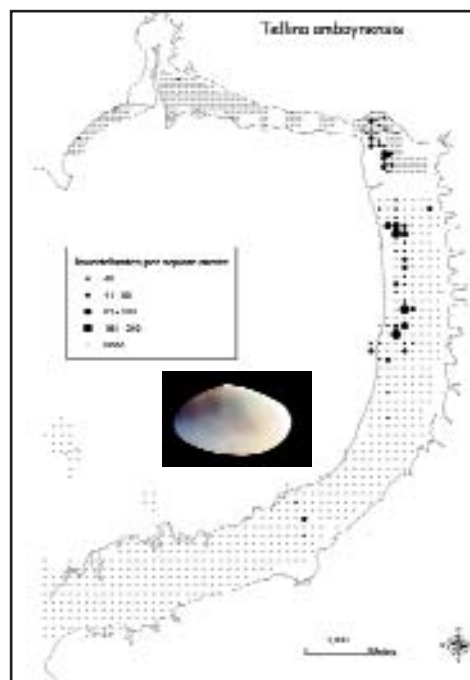


Fig. 3. (left) Distribution of *Tellina amboynensis* in Roebuck Bay in June 2002.

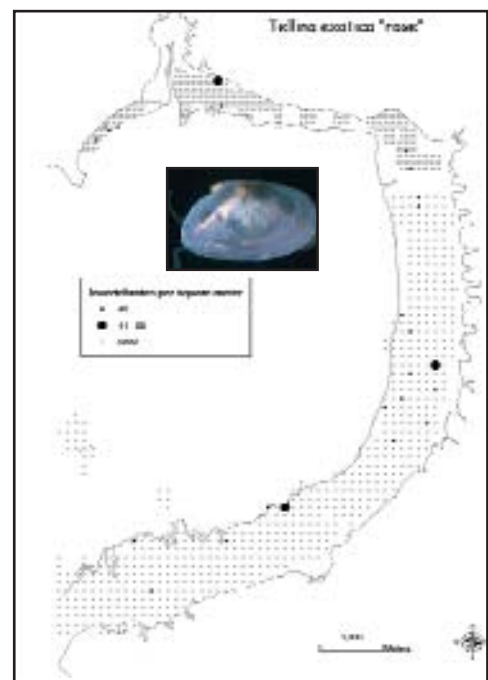


Fig. 4. (right) Distribution of *Tellina 'exotica rose'* in Roebuck Bay in June 2002.



photo's by Jan van de Kam

northern bay was divided into grid squares, each 200 m long; in the centre of each grid square was a benthos sampling site. Birds in each grid square were identified and counted, a combination of GPS and an optical method being used to judge where the boundaries of each grid square occurred. In southern and eastern Roebuck Bay a 400 m benthos grid was used. Ideally bird mapping should be done on receding tides by observers who time their transects so they reach the waterline at the slack water period of low tide. This approach reduces the scatter in the data caused by birds moving in response to tidal changes. In the southern bay there were logistical constraints that meant we had to map on rising tides. In the eastern bay, very muddy substrates prevented teams from performing traditional surveys on foot. However, we managed to get a reasonable idea of how many birds were feeding at the sea-edge in the eastern bay by spending two days in the hovercraft, mapping the birds at the shoreline during low tide.

The Great Knot distribution map (Fig. 5) illustrates perhaps the most startling trend shown in the distributional data. In previous surveys, large numbers of Great Knots had always been found feeding at the sea edge along the northern shores of Roebuck Bay. During June 2002 hardly any Great Knots were found in this area. This was not because of a lack of birds; Great Knots have long delayed maturity in Roebuck Bay, so dry season counts should be reasonably high, consisting as they do of not only one-year old immatures, but also two-year olds and some three-year olds. Indeed, large numbers of Great Knots were found roosting on the easternmost northern beaches. However, these birds probably came from the eastern coast of Roebuck Bay, where large numbers of Great Knots were seen feeding along the sea-edge during surveys performed from a hovercraft. The causes of this eastwards shift in the feeding distribution of Great Knots, which was mirrored in several other shorebird species, is not yet clear. There had certainly been some changes in the western flats of Roebuck Bay — most noticeably a loss of seagrass meadows on the Dampier Creek flats, perhaps as a result of cyclone Rosita in April 2000. Perhaps there were also changes in benthic composition that made these western flats a less attractive place to feed?

Fig. 5. Distribution of Great Knots *Calidris tenuirostris* in Roebuck Bay in June 2002.

skirt problems. These two new findings of *Tellina* species makes the question why there are that many species of these family in the bay even more intriguing. Tanya Compton, a PhD student with the University of Groningen and NIOZ, started her 4 year research during SROEBIM to resolve part of this biological problem.

Roebuck Bay is famed for its shorebirds. The importance of the area as a feeding ground for non-breeding shorebirds was the original stimulus for the research now in progress on the benthos of the intertidal flats. This being the case, it seemed like a good idea to map the shorebirds of the bay as we mapped the benthic fauna, to see how the distribution of birds and benthos are related. To map the birds, the

