PRELIMINARY RESEARCH REPORT

*S*outhern *Roe*buck *B*ay *I*nvertebrate and bird *M*apping 20*02*

SROEBIM-02

A Collaborative Project With Environs Kimberley, Broome

By

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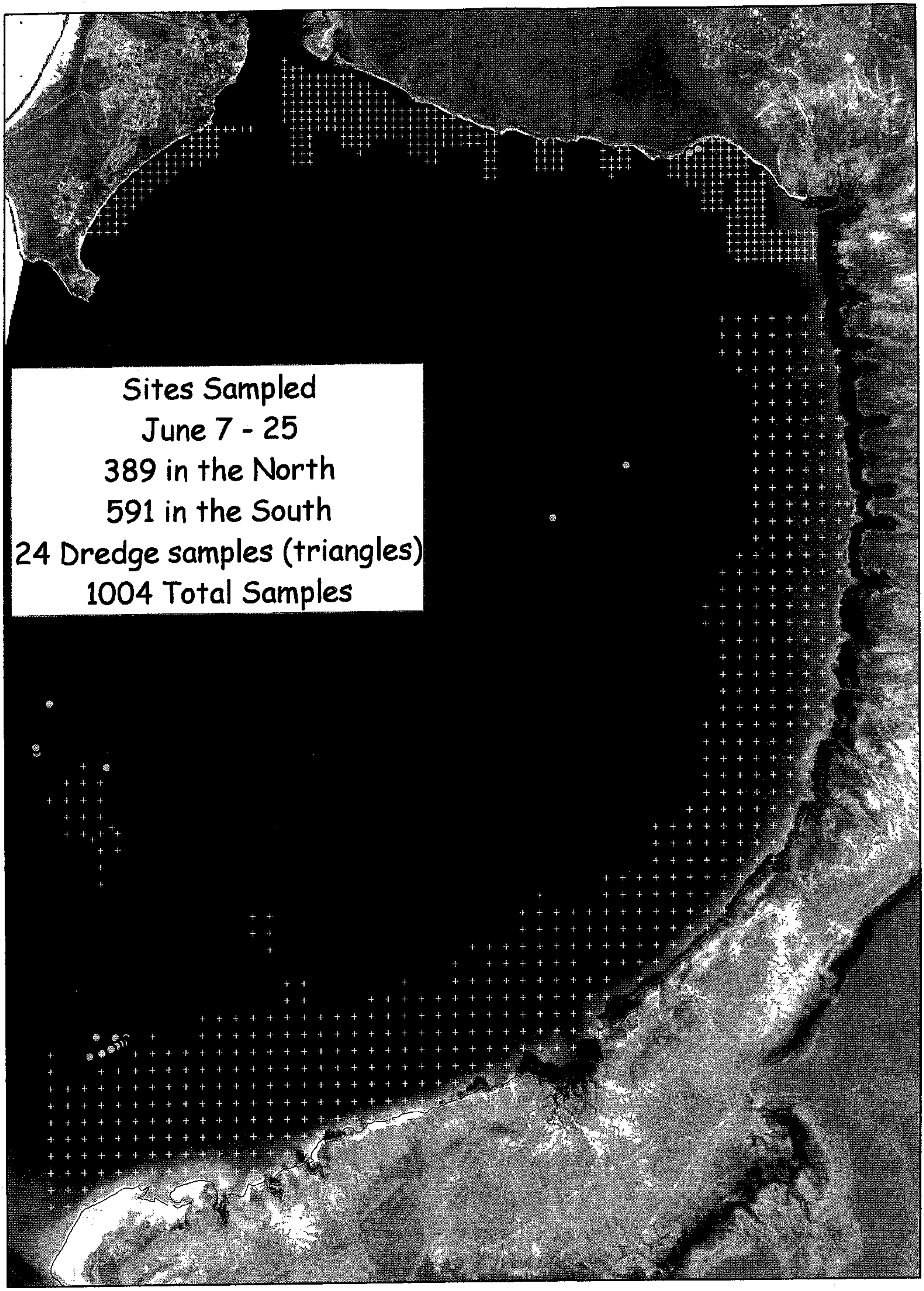

Sites Sampled
June 7 - 25
389 in the North
591 in the South
24 Dredge samples (triangles)
1004 Total Samples

Map 1.

1. Abstract

1. This is a preliminary report on an expeditionary and community outreach project focussed on the ecology of the intertidal mudflats of Roebuck Bay. The core expeditioners all took part in Environ Kimberley's one-day 'Celebrate the Bay' forum in the Broome Civic Centre which attracted over 150 delegates. Hosted by the Broome Bird Observatory, from 6 to 26 June 2002 the field project involved over 130 different people (excluding delegates at the forum).

2. The benthic sampling effort achieved almost complete coverage of the 160 km² of intertidal flats in Roebuck Bay. In the north of the Bay several areas were mapped out for the third time since 1997. Shorebirds were mapped at intertidal sample areas representing much of the foreshore. Over 1000 sampling stations were visited; more than 12,000 individual invertebrates were extracted from the sieved samples, identified to the nearest taxonomic level and their size measured.

3. In the quantitative samples a total of 205 different taxa were encountered. On the mudflats we noticed at least another 60 (mostly larger) species of invertebrate. About 50 taxa had not been encountered during previous benthic surveys the Kimberley region. Considerable changes in distribution and abundance were apparent with respect to many of the invertebrates and seagrass coverage in the northern parts of the intertidal area of Roebuck Bay, parts that were previously assessed in June 1997 and March-April 2000.

4. Quantitative shorebird surveys were made on some parts of the intertidal area. During the surveys in June most migrant shorebirds would have left for the breeding grounds in the far north, but sizeable populations of immatures still lived in the bay. Great Knots, Bar-tailed Godwits and Red Knots were now rather restricted to the eastern portions of the Bay (having vacated the northern shores used at other times of the year). In contrast, Terek Sandpipers showed the same type of distribution now as in previous surveys. Nevertheless, their common occurrence on the eastern mudflats had not been known.

5. The project involved a film crew from Artemis International that assembled footage for the Channel Nine 'Postcards WA' television programme. In addition the acclaimed Dutch nature photographer Jan van de Kam worked for the second time in Roebuck Bay, previous material from February-April 2000 now being in press with the National Geographic Magazine (Washington, DC).

2. Introduction

There are few places on earth where soft bottom intertidal mudflats support large numbers of migratory shorebirds. Roebuck Bay is 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 (and other sites like the Eighty Mile Beach foreshore).

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 (C.D.T. Minton *et al.* pers. comm.). 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 Kimberley Region 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 piersmai*) and Bar-tailed Godwits (*Limosa lapponica menzbieri*) of specific, reproductively isolated and morphologically and behaviourally distinct subspecies. The intertidal macrobenthic community of places like Roebuck Bay and Eighty Mile Beach 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 desk and laboratory work is required (based on the extensive collections of specimens made during this and previous expeditions) 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; Pepping et al. 1999), the benthic invertebrate mapping effort along the Eighty-mile Beach foreshore in October 1999 (ANNABIM-99; Pearson et al. 2002), 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 (Map 1) and the shorebirds that depend on this food resource. Our prime foci were the eastern and southern mudflats that 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 Broome Civic Centre. This one-day event was visited by about 150 people and was widely considered successful.

Our team comprised 140 participants of which 106 volunteers (including 9 Landscope expeditioners, 65 local volunteers, 11 logistical support crew, 11 science volunteers). There were 8 scientific co-ordinators (Petra de Goeij, Marc Lavaleye and Theunis Piersma from NIOZ, Pieter Honkoop from University of Sydney, 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 200 m intersections in the north (partly covered in 1997 and 2000) and 400 m intersections in the eastern and southern parts of the Bay, the latter representing areas now covered for the first time. In addition, a detailed study on the transition zone between beach and intertidal mudflat was carried out just off the Broome Bird Observatory and dredge samples were taken in various parts of the Bay (see Map 1). 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 this report we aim to summarise the methods and the results based on preliminary analyses carried out at Broome Bird Observatory during 7-26 June. It also enables us to thank the many individuals that put in their expertise, time and working power.

2. Methods

General and benthos

The study took place at Roebuck Bay between Bush Point in the southeast and Town Beach in the northwest (Map 1). With a spring tide on 13 June, sampling during the first week took place with tidal ranges that exposed the full extent of the intertidal flats. Later in the project, the range (or distance from the shore) of our sampling was severely constrained by the neap tides.

In the north of Roebuck Bay stations were placed on a 200 m grid. We tried to cover as much as possible of the areas sampled not only in June 1997 and then revisited in March-April 2000 (during the 'Tracking-2000' expedition, also based at the Broome Bird Observatory). In the much more extensive eastern and southern parts of the Bay sample stations were placed on a 400 m grid. Every sampling station received a unique station number composed of a row number (from south to north), a column number (from west to east) and an indicator of north (n) or south (s), and example being "r14c56n". Each station number combined with predetermined coordinates on a UTM-projection, using the Australian Map Grid 1966 as the horizontal datum. 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^2, removed. The samples with a total surface area of 1/40 m^2 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 (surface area = 1/650 m^2), stored in a labelled plastic bag and kept at outside temperature for transport to the laboratory. In the fullness of time these sediment samples will be analysed at NIOZ, Texel.

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°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°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 (see Table 1). 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.

Shorebirds

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. In addition, the distribution of birds on the northern beaches had been mapped five times over the past 5 years as part of the PhD studies by DR, so it was hoped that through comparison with these earlier datasets it would be possible to tell whether shorebird distribution in the bay has changed in recent times. A final motivation was simply to find out what birds occurred on the intertidal flats in the south and east of the bay. No birds surveys had been performed there in the past, although high tide counts at Bush Points had hinted that there may be riches to be found.

The mapping method used was developed specifically for northern Roebuck Bay and for the 200 m grid used to map benthos during the ROEBIM-97 expedition. Essentially the 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.

A full description of the mapping method used in the northern bay is provided in Chapter 9 of the ROEBIM report (Pepping *et al.* 1999). In southern and Eastern Roebuck Bay it was necessary to modify the methodology somewhat. A 400 m benthos grid was used in these remote areas, so bird numbers were counted in 400 m grid squares. 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 CALM hovercraft, mapping the birds at the shoreline during low tide.

Mapping

Once more, maps were to become the foundation upon which a benthic sampling expedition was based. Fortunately, the ROEBIM-97 and Tracking 2000 databases were available. The primary basemaps were 1994 (low tide) and 1995 (high tide) Landsat images, sample points from ROEBIM 97 and Tracking 2000, and two point grids for sampling in 2002. These two point grids included a 200m grid for the northern shore and a 400m grid for the eastern and southern shores. These were generated using a custom Visual Basic program and included AMG zone 51 (Ausgeoid 66 datum) coordinates and a unique identifier. Custom maps were generated for every field mapping team. They included a set of points (and coordinates) on a Landsat image base. 102 maps were generated during the 18 day expedition.

Sample points were located in the field using one of twelve handheld GPS receivers of five different models. They were invaluable for finding sample sites on the otherwise nearly featureless mudflats. For those that were keen, sample points were entered as waypoints into GPS receivers – thereby making the finding of those points even simpler. We also discovered that GPS use was far simpler now that Selective Availability has been turned off. Daily progress maps showing sites sampled to date were generated daily and used during evening (and very early morning.....) briefings.

Once the field sampling was complete, all field, bird, and species data were entered into the GIS database – often requiring considerable gyrations to get everything in the proper format. The results were the final maps shown in this report. These are preliminary maps – the data are only about 95% complete. We also did not map every species of invertebrate or bird. In the future, once the data have been completely entered/checked, a complete series of maps will be printed.

As a side note – a number of maps were made to support the activities of the BBO. These included a map of the bird viewing areas on the northern shore of Roebuck Bay (Lise Goss) and a couple of bush-bird banding site locations overlain on a Landsat TM image.

4. Preliminary results

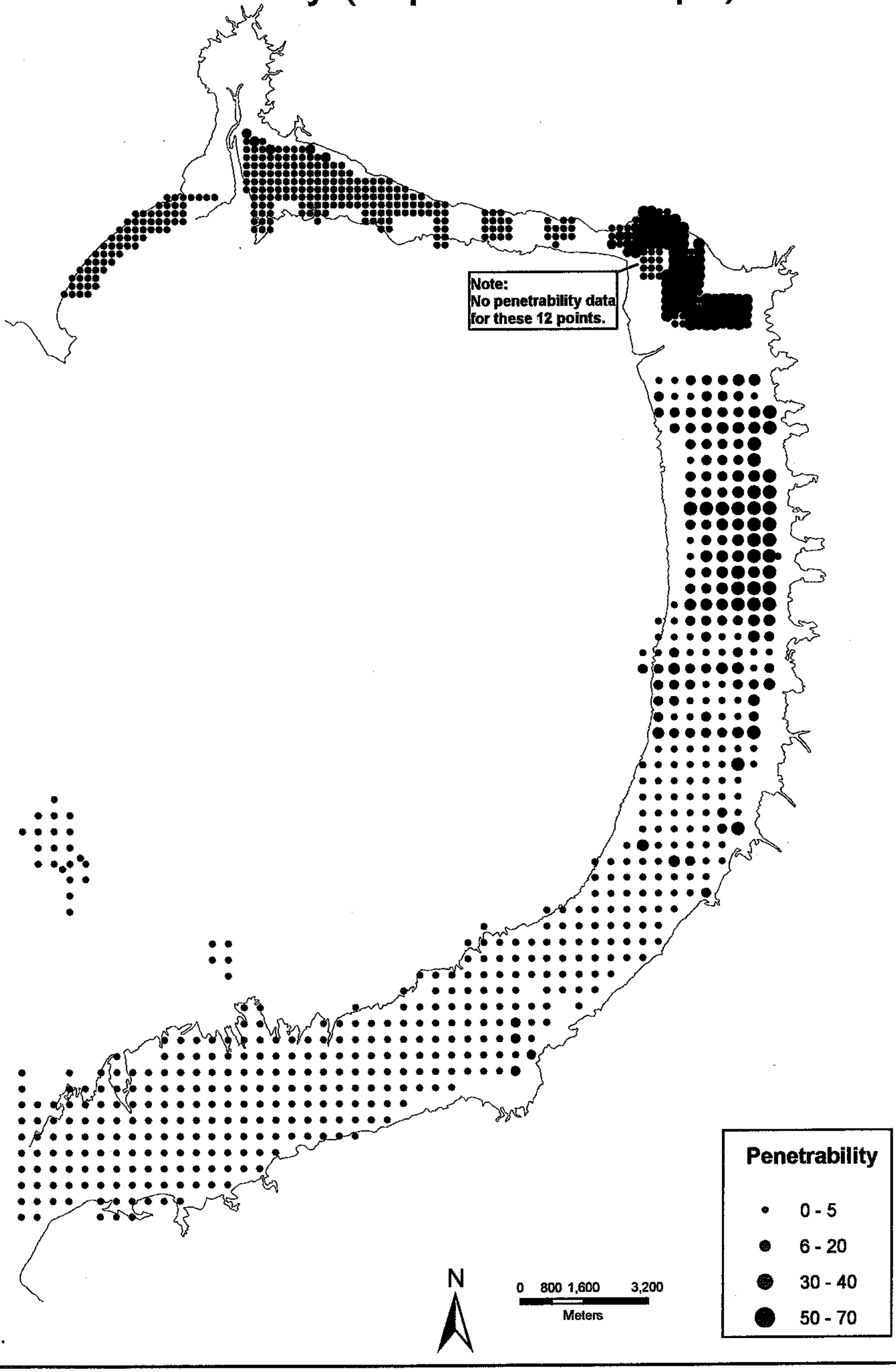
General observations

The Landsat image used in combination with the ground truthing carried out during SROEBIM indicated that the total area of intertidal flat exposed at spring low tides is 160,000 ha (equivalent to 160 km²). One of the most interesting measures taken in the field at each sampling location was the 'penetrability': the depth of the footsteps made by the observers. The measure is interesting because of the emotional content (moving even in 20 cm in deep mud is very exhausting) and because it is informative with respect to the kind of sediment at the location. Deep mud was mainly encountered in the Crab Creek corner of the Bay (Map 2). The deep mud extended only about 10 km further south, bordering the eastern fringe of mangroves. The intertidal flats of the southern part of Roebuck Bay were all sandy. This included the sandy 'island' exposed at low tide between the Port of Broome and Bush Point, a faunistically interesting area of sandflats named 'Atlantis'.

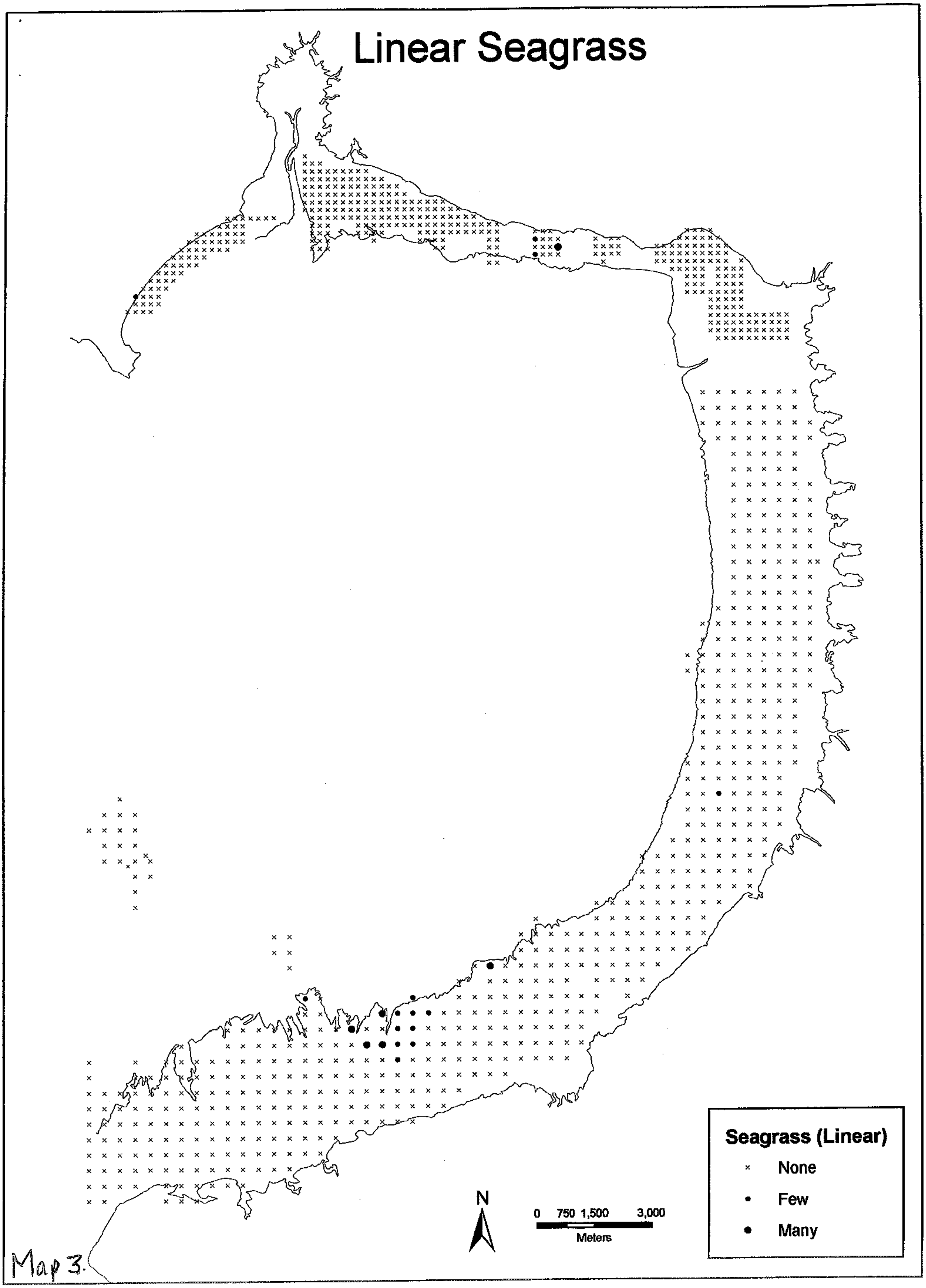
In June 1997 and in March and April 2002 two species of seagrasses (linear seagrass *Halodula* and oval seagrass *Halophila*) were commonly found in the northern part of the bay, commonly occurring in the quantitative grid samples. The present survey showed that by June 2002 they had disappeared almost completely. Only a few patches could still be found. Most likely the seagrass beds were wiped out by the cyclone Rosita in late April 2000. In the south, oval seagrass was abundant near the low waterline, especially in the mats of solitary tunicates described below. A few examples of another linear seagrass, *Thalassia*, not found before, were collected near Bush Point (Map 3).

Fish, of course, did not form an important part of the invertebrate quantitative sampling. Small mudskippers and gobiids were found in several samples of the grid. In the field, sightings of active mudskippers were relatively difficult to make, probably caused by the cold nights with temperatures below 10 °C. Large stingrays were sometimes and shovel-nosed sharks were often seen in very shallow water following the incoming tide as they came to feed on the mudflats. Loggerhead turtles were seen in the water and, on one occasion, on the flats.

Penetrability (depth of footsteps)



Map 2.


Linear Seagrass
Seagrass (Linear)
None
Few
Many
N
0 750 1,500 3,000
Meters
Map 3.

Distribution of the invertebrates

Porifera (sponges). — Many species of sponges were found on the flats. Some were washed ashore and others grew on the few hard substrates on the mud or sand. Only a few really had found a home in the soft intertidal sediments. Especially an erect blue colored sponge of 20 cm height was abundant at a few places at Quarry Beach and in the far south near Bush Point. Often one to three specimens of the colourful snail *Calliostoma monile* were attached to these sponges. The patch of the mudsponge discovered during ROEBIM-97 expedition was not found, but another species, with a similar elaborate root system, was now encountered in sandy areas near Bush Point.

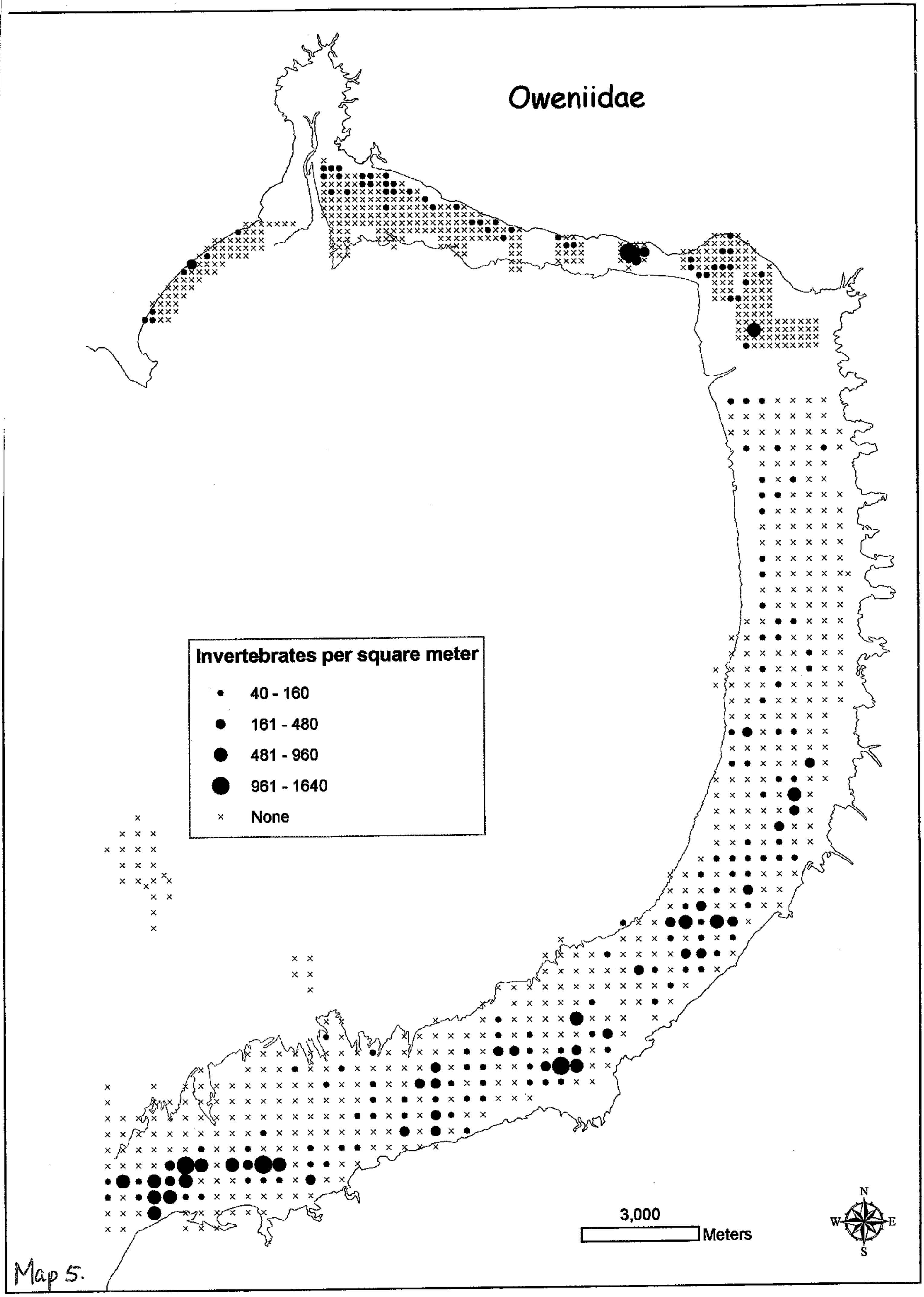
Cnidaria (anemones, polyps, seapens). — Large anemones, *Heteractis malu*, with a diameter of 10 cm, were abundant in sandy areas, especially at Town Beach, east of Dampier Creek and near Bush Point. They attract prey at night by being luminescent. The cylinder anemone (Cerianthidae) was seen at a few places and often had black phoronid "worms" living in their tubes. The soft Blue coral, *Heliopora coerulea*, was seen at the rocky patches near Quarry Beach. The small digging anemone, *Edwardsia*, was relatively rare in the quantitative samples (< 1%). Tufts of hydroid polyp colonies (10 cm long) grew on shells, polychaete tubes or other small hard substrates in sandy areas close to the low tide level near Bush Point and on 'Atlantis'. Often, very beautiful pink nudibranchs were living on these colonies. On the higher flats, hydroids were replaced by very similar tufts of brown algae. Particularly striking were the cylindrical seapens of which two species were found in the south of Roebuck Bay. The sea pen an internal skeleton sometimes occurred in high densities, standing only one meter apart, on parts of 'Atlantis' and at some places near Bush Point. The strange thing was that the white median naked skeletons could be protruded above the sediment for about 7 cm, while the living tissue had been retracted into the sediment. The length of whole animal itself was about 40 cm and the sea pens disappeared into the sediment when touched.

Polychaetes (bristle worms). — These small worms were abundant in the sediment and were not generally seen on the surface except for the tubes with attached empty shells (of the family Onuphidae, Map 4) and the green-coloured Phyllodocidae that can be crawling on the open surface. It is probably too slimy or perhaps toxic to be eaten by any predator. In the quantitative samples 31 families of bristle worms were found. The cat worms, Nephtyidae, showed up in more than half of the samples, the family Glyceridae in 31% of the samples, and the Oweniidae in 22%. The high abundances of the families Chaetopteridae and Oweniidae in June 1997 were not encountered, which shows that densities of some species can change dramatically over the years. Nevertheless, Oweniidae reached densities up to 1640 per m^2 (Map 5).

Mollusca (bivalves, snails, tuskshells). — Living specimens of the giant whelk *Syrinx aruanus* and the bailer shell *Melo amphora* were sporadically found. In the far south of the bay, the volute *Amoria damonii damonii* with a beautiful coloured shell and animal was found. It is endemic in NW Australia. In the same area also a few specimens of an olive shell, *Oliva* spec. were picked up. *Nassarius dorsatus* (Ingrid-eating snail) was quite abundant in the whole bay (Map 6). This predator/scavenger even showed up in 9% of the quantitative samples, and reached its highest densities in the muddy areas. Another very common snail was the moon snail, *Polinices conicus*, of which the long tracks in the sand are easily spotted. The sausage-shaped jelly egg cases were rather abundant, as were the collar like egg cases of two other species of *Natica*. The very variable coloured small trochid snail *Isanda coronata* was found at 31 stations in sandy areas, in a rather restricted region halfway the tidal zone (Map 7). The abundance was striking, sometimes reaching 2500 per m^2. Equal densities were reached by the small snail *Salinator*, which lives high up in the tidal zone near mangroves (Map 8). *Cerithidea cingulata*, the only Potamidae that lives on mudflats, also reached high densities near mangroves. In total 37 different species of snails were identified in the grid samples (Table 1).

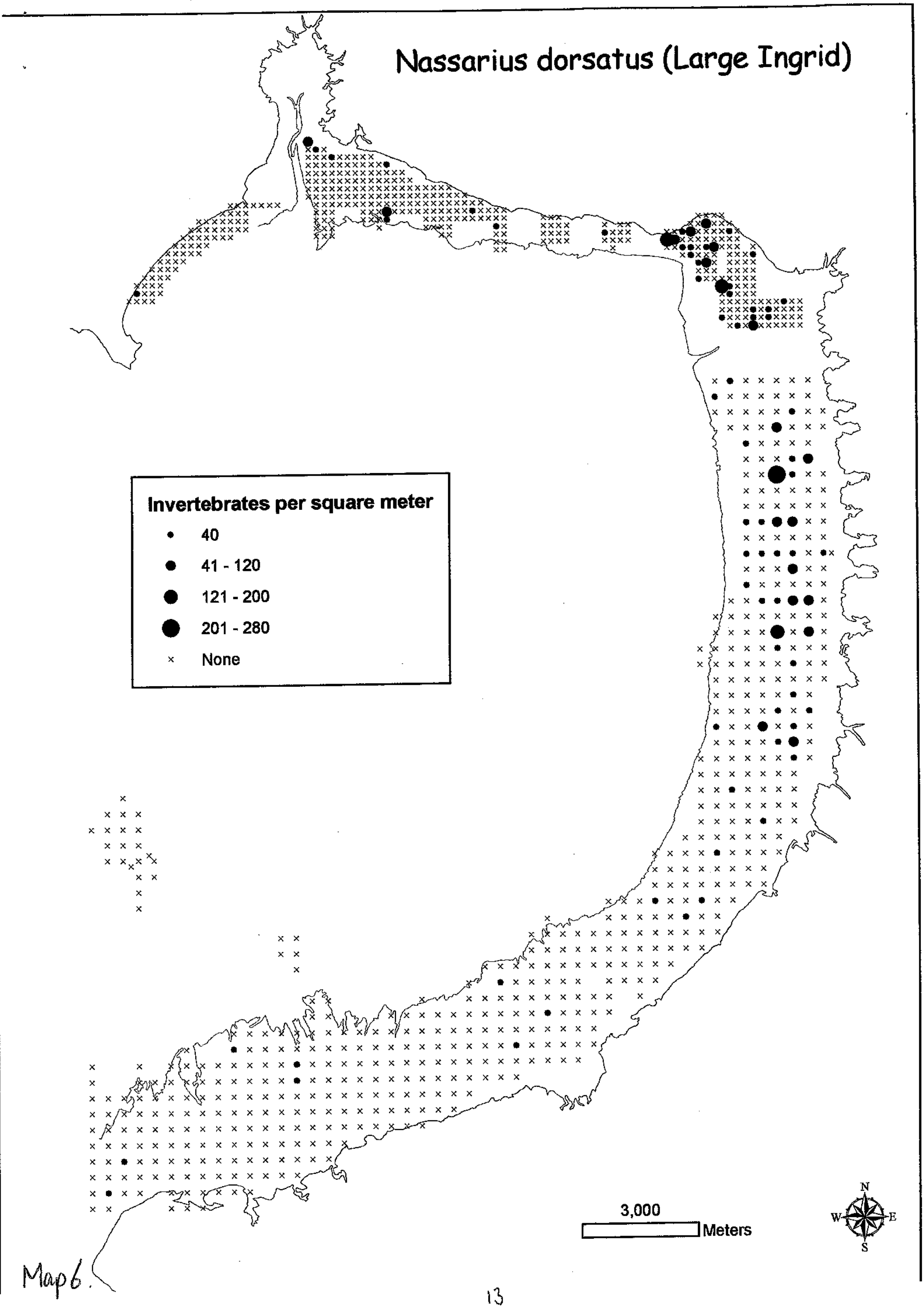
Tubes With Shells

Map 4.

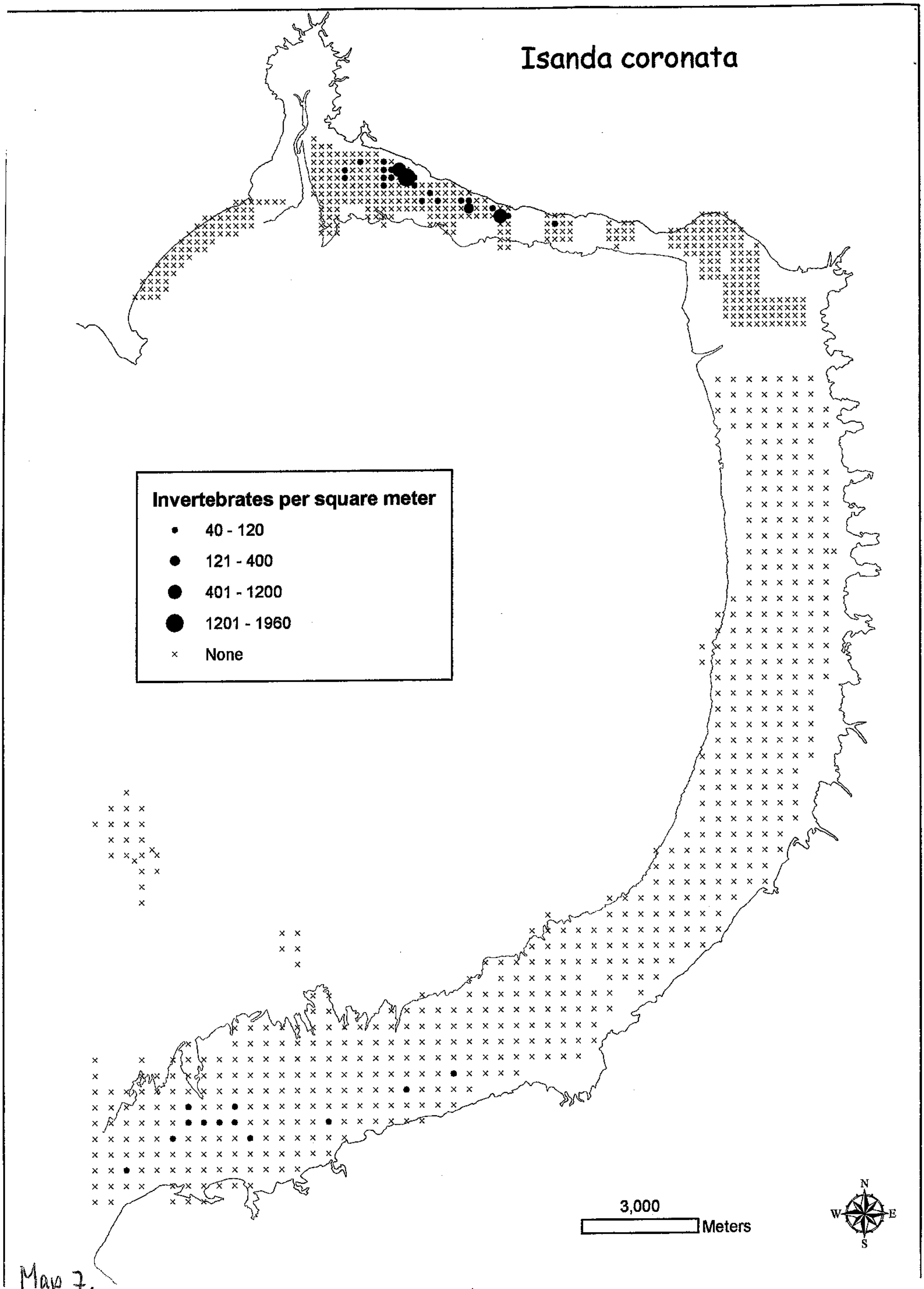


Oweniidae
Invertebrates per square meter
40 - 160
161 - 480
481 - 960
961 - 1640
None
3,000
Meters
N
W
E
S

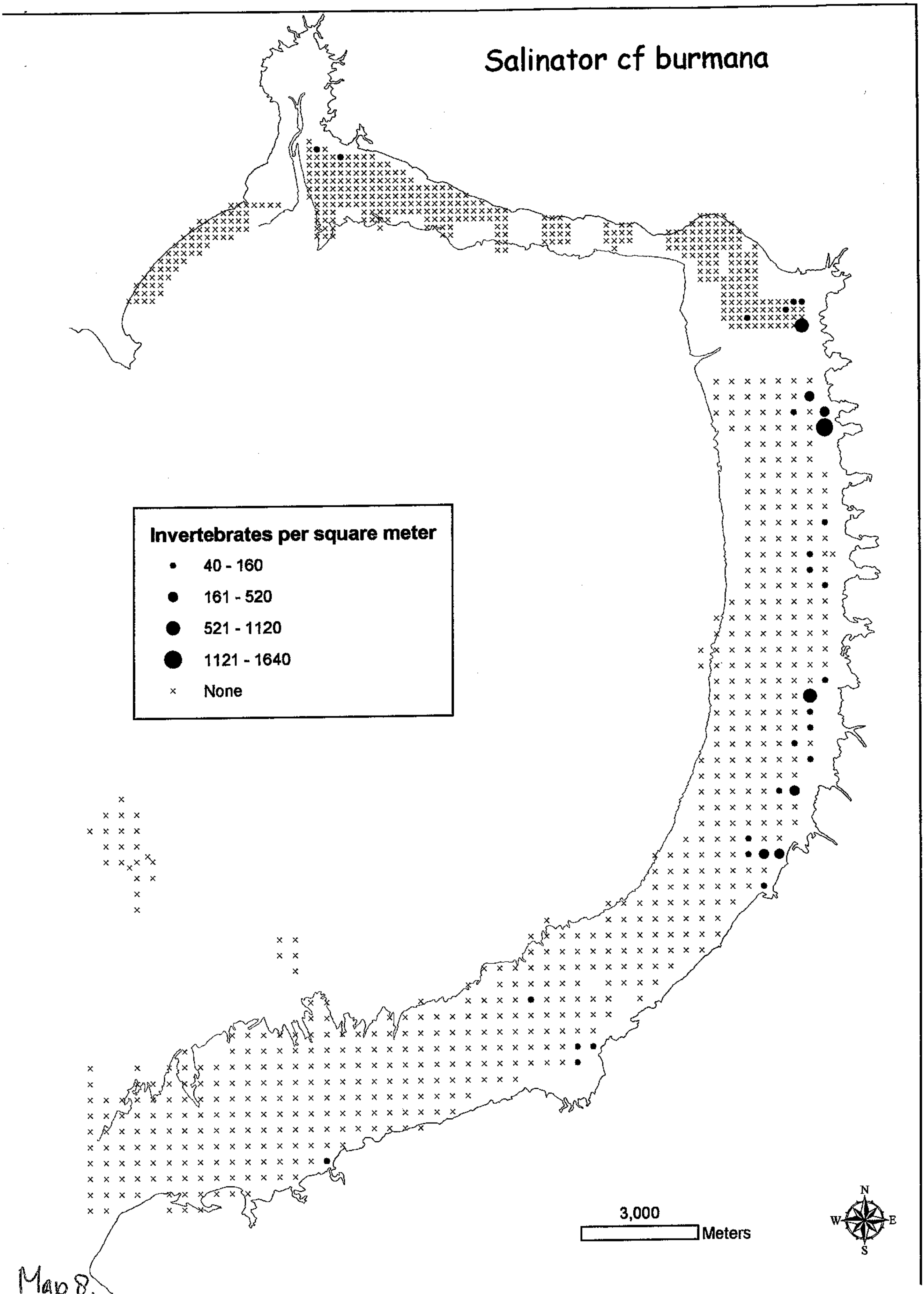
Map 5.


Nassarius dorsatus (Large Ingrid)
Invertebrates per square meter
40
41 - 120
121 - 200
201 - 280
None
3,000
Meters
N
W
E
S

Map 6.


Isanda coronata
Invertebrates per square meter
40 - 120
121 - 400
401 - 1200
1201 - 1960
None
3,000
Meters
N
S
E
W

Map 7.


Salinator cf burmana
Invertebrates per square meter
40 - 160
161 - 520
521 - 1120
1121 - 1640
None
3,000
Meters
N
W
E
S

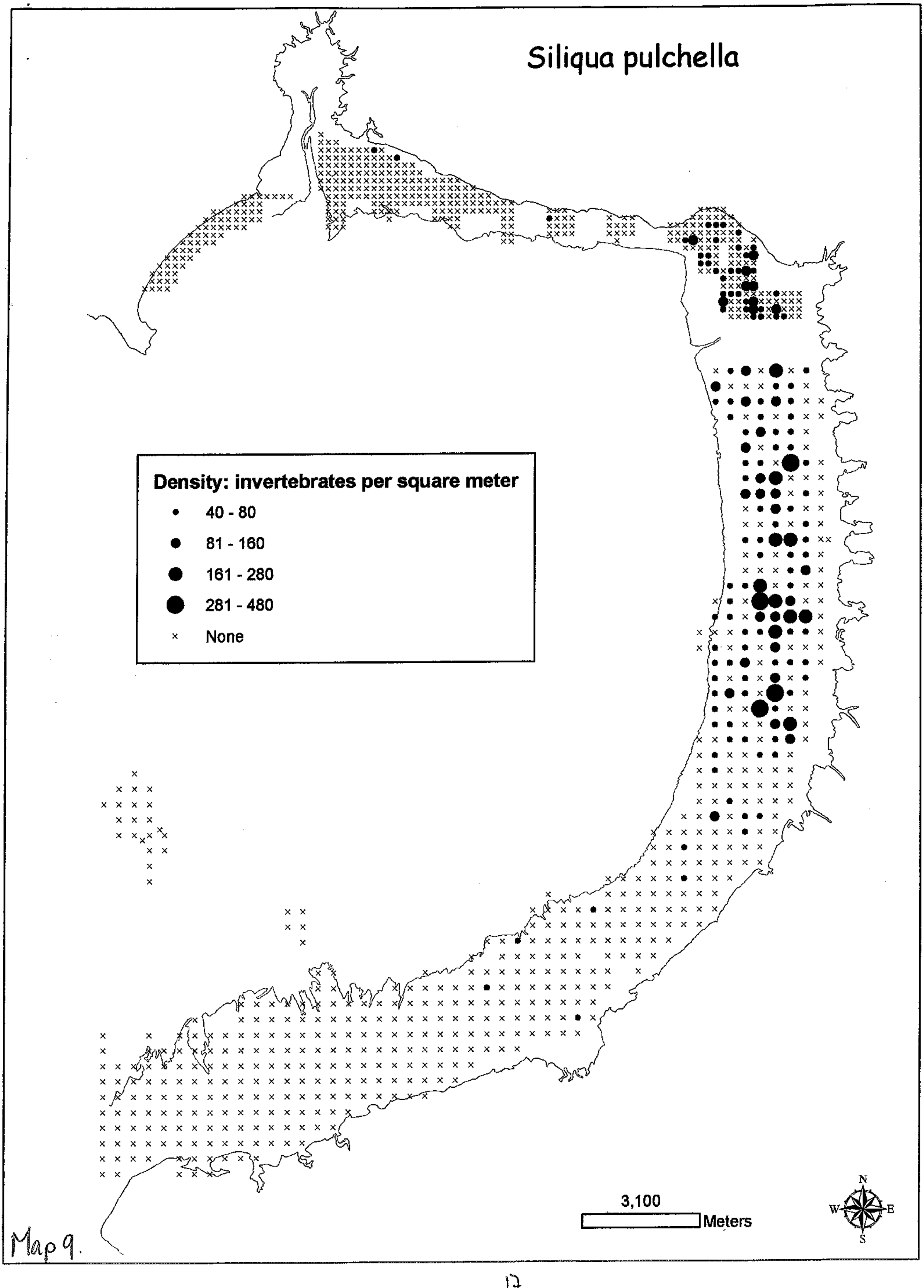
Map 8.

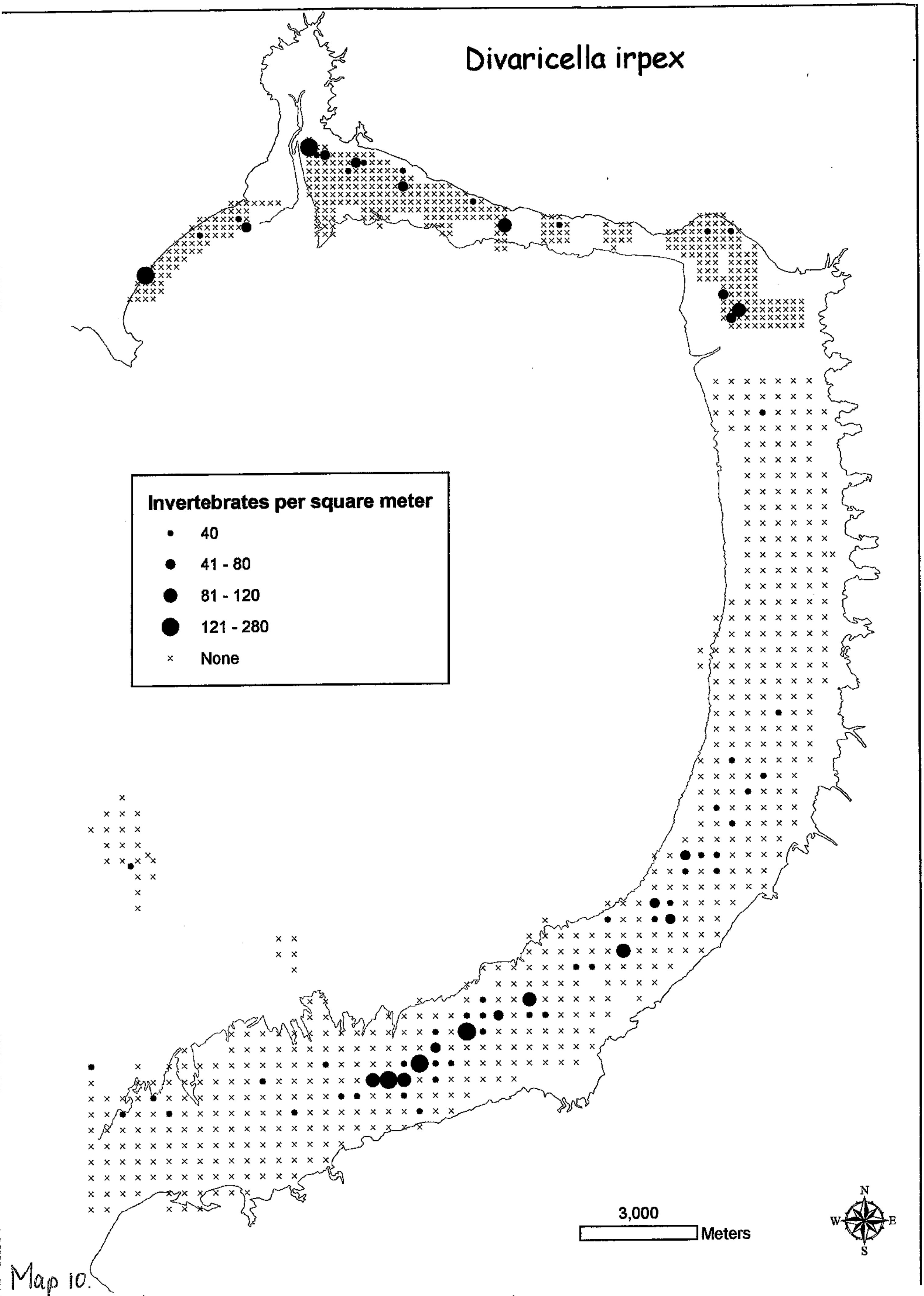
The largest bivalves in the bay are probably the several species of pearl oysters, of which hanging cultures are present in the deeper part of the bay. Our findings of large bivalves included two species of Pinnidae (razor clams), a hammer oyster (*Malleus alba*) and *Isognomon* oysters. One of the species of razor clams, *Atrina* spec. was very abundant at Town Beach. The edge of the shell is the only visible part of the 25 cm long shell, as it sticks a few mm above the sediment. Further the razor shell, *Solen* spec. was seen more often than in 1997 and 2000, and was found a few times at the surface attacked by black Nemertini (slimy worms). In the quantitative samples, *Siliqua pulchella* had the highest score of the bivalves with a presence of 16% of the stations (Map 9), especially in the muddy regions in the east. This abundant species (with a fragile shell that never makes it washed up 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. Next in abundance were *Divaricella irpex* (Map 10), *Anodontia omissa* (both Lucinidae), and *Tellina amboynensis* (Map 12)

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* (Map 11) In the family Tellinidae, however, 5 species are rather common. One of these common species, *Tellina* "exotica rose" was not found in our previous surveys of the bay in 1997 and 2000 (Map 13). Another species newly recorded in the bay was another *Tellina* species, which was discovered by accident on a sand bank near Bush Point when the Wallis hovercraft stranded there with temporary 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 at the University of Groningen and NIOZ in The Netherlands, during SROEBIM started her 4 year research to resolve part of this problem. The brown *Solemya* shells, that can swim and also easily float on the water surface, was present at 6% of the stations, and particularly abundant at Town Beach (Map 14). In total 48 species of bivalves were found in the quantitative samples.

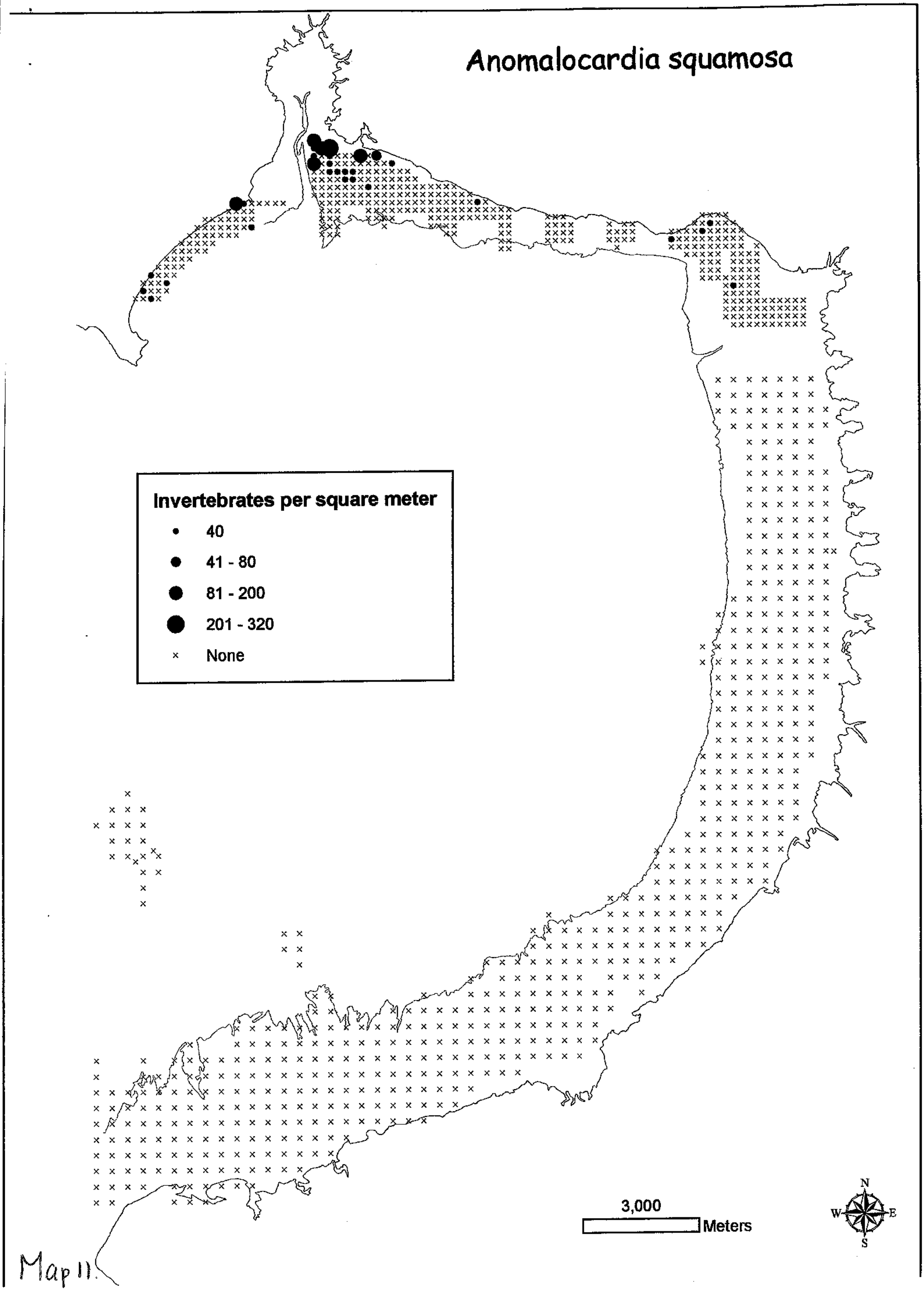
Three species of tusk shell (Scaphopoda) were encountered in the quantitative samples. The ribbed *Dentalium cf. bartonae* preferred the soft mud near the high water line (Map 15), while the smooth *Laevidentalium cf. lubricatum* lived lower on the shore in sandier areas (Map 16). At Fall Point on the northern shore close to the Broome Bird Observatory, however, they live next to each other.

Crustacea (crabs, shrimps, etc.). — The largest crustacean found on the mudflats was the mudcrab, *Scylla serrata*. However, the most abundant crab is without doubt the sentinel crab, *Macrophthalmus*. Although the crab itself is not always easily seen, its presence is indicated by its tracks that cover almost all tidal flats of the bay. More striking were the soldier crabs, *Mictyris*, that were seen at many sandy areas parading in large 'flocks'. During our earlier expedition in the bay these crabs were only encountered sporadically, and even now they showed up in only 4% of our quantitative samples. Less abundant than during the previous expedition were the Hymenosomatidae (small spider crabs) and the six legged crab *Hexapus*. Of the smaller crustaceans, Ostracoda (bivalved crustaceans) and Amphipoda (sand hoppers) were abundant with a presence at more than 15% of the stations. Small hermit crabs were especially abundant along the northern shore (Map 17). Especially the small ostracods attract attention as they emit green-blue light by disturbance. In total 15 species of crabs and 17 other species of crustaceans were found in the grid samples.


Siliqua pulchella
Density: invertebrates per square meter
40 - 80
81 - 160
161 - 280
281 - 480
None
3,100
Meters
N
S
E
W
Map 9.

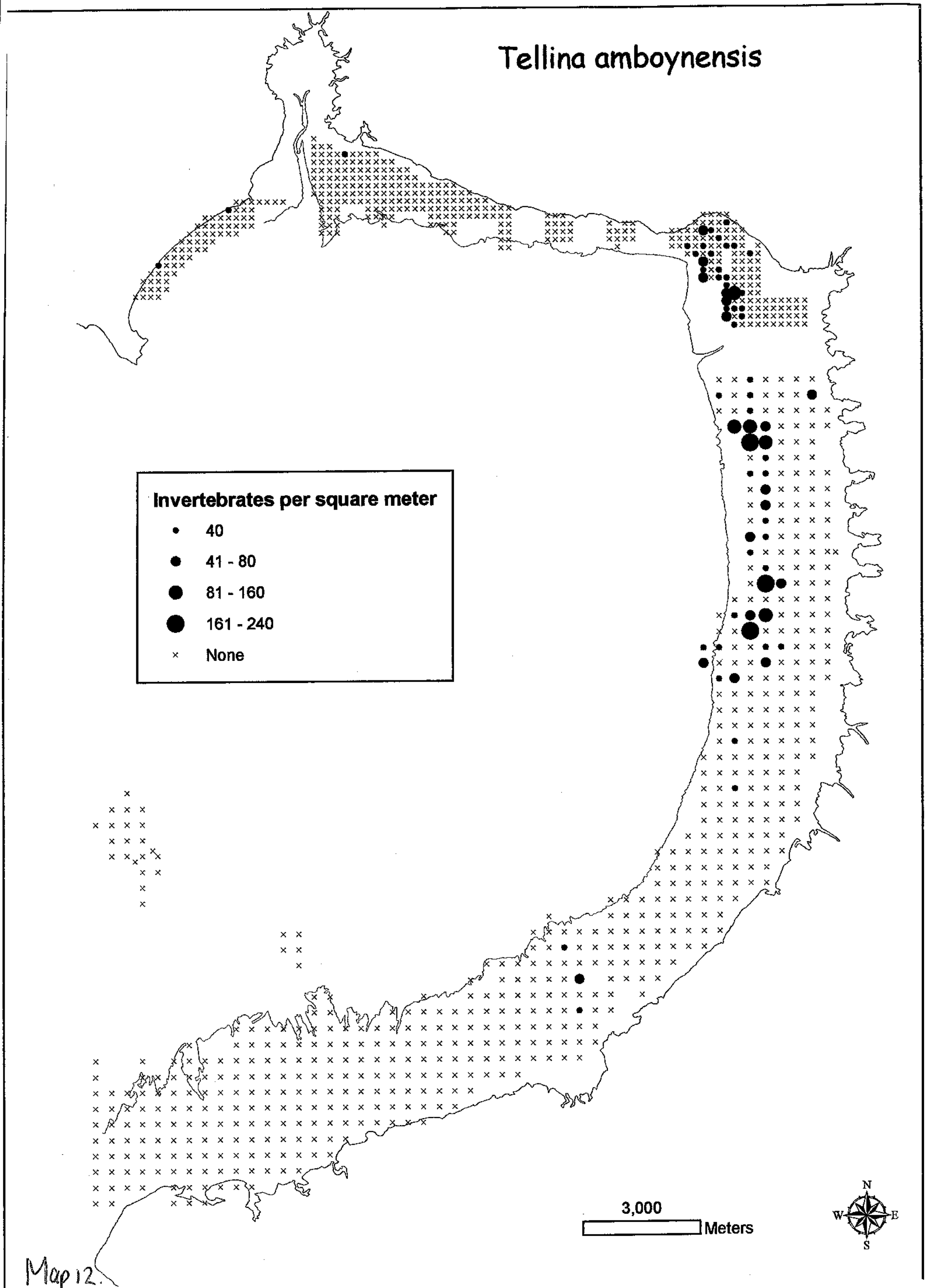

Divaricella irpex
Invertebrates per square meter
40
41 - 80
81 - 120
121 - 280
None
3,000
Meters
N
S
E
W

Map 10.

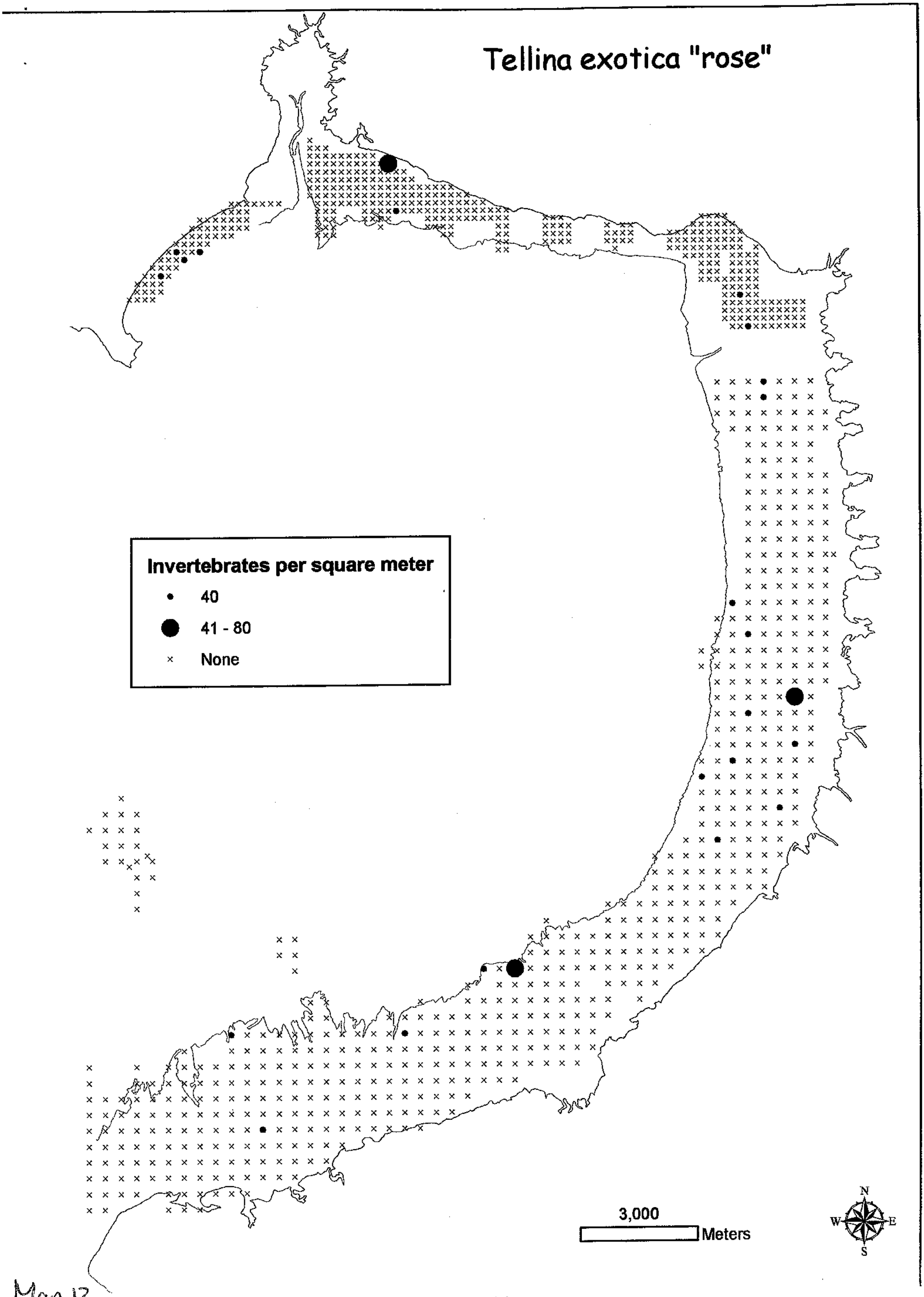


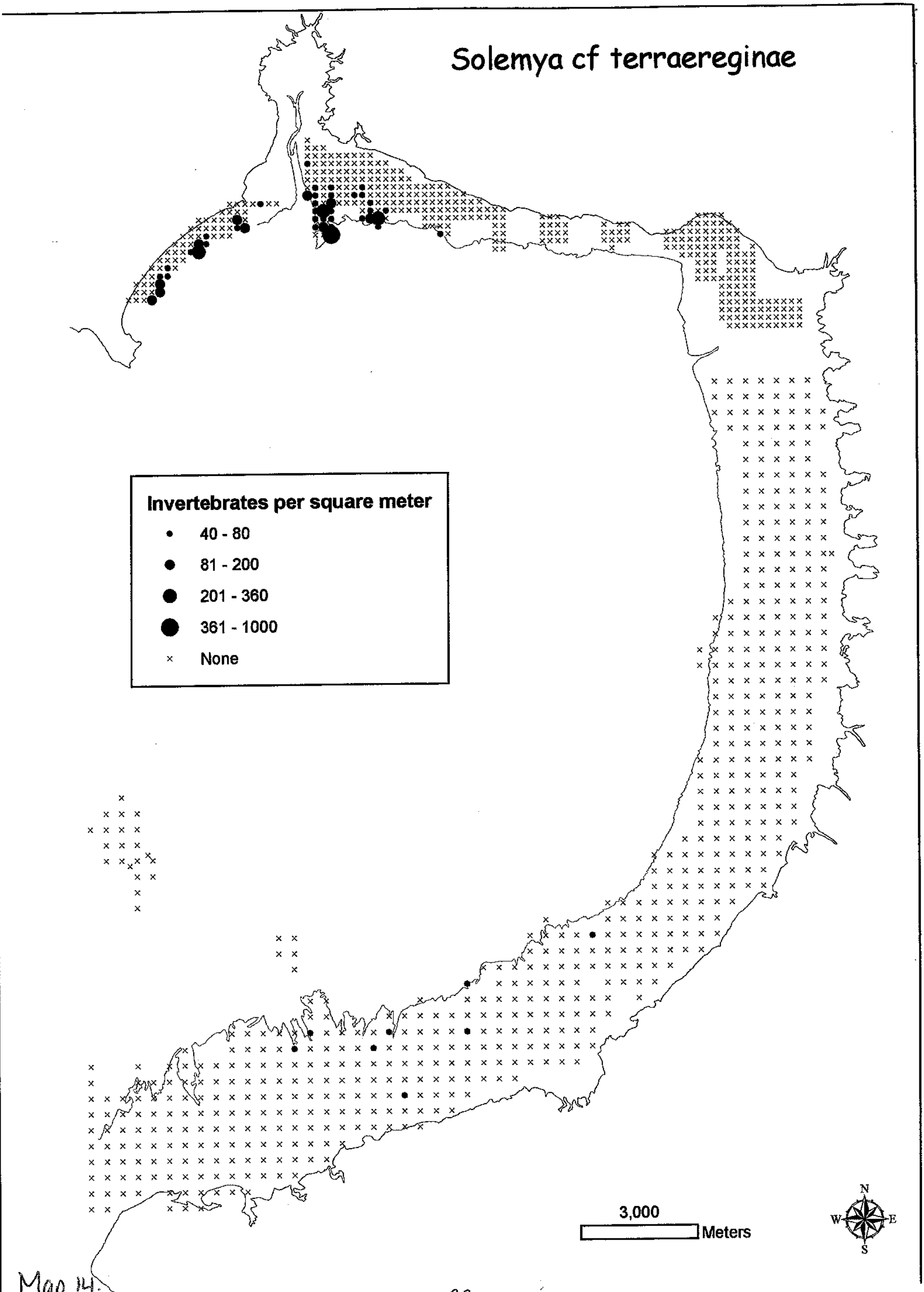
Anomalocardia squamosa
Invertebrates per square meter
40
41 - 80
81 - 200
201 - 320
None
3,000
Meters
N
W
E
S

Map 11.


Tellina amboynensis
Invertebrates per square meter
40
41 - 80
81 - 160
161 - 240
None
3,000
Meters
N
W
E
S

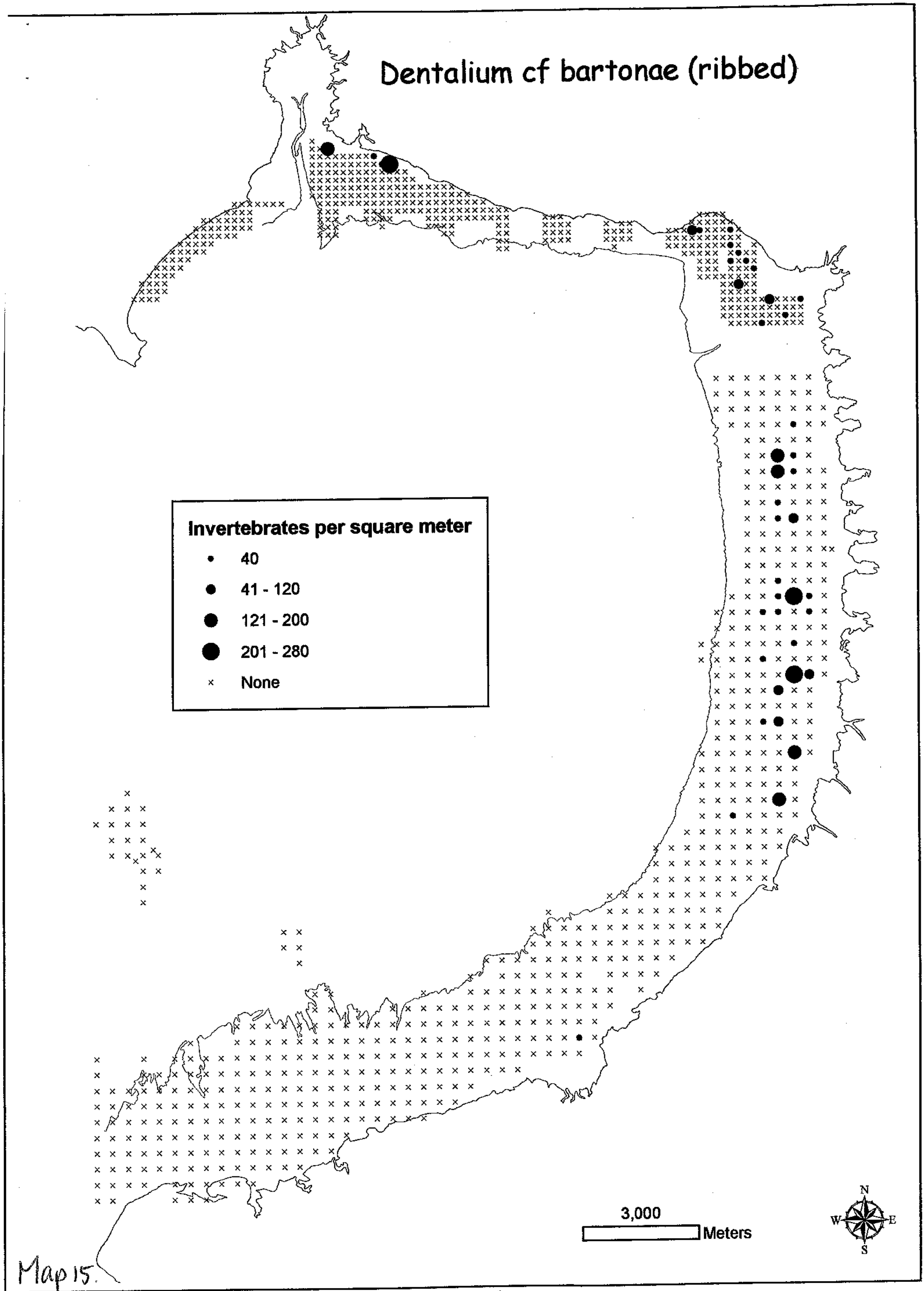
Map 12.


Tellina exotica "rose"
Invertebrates per square meter
40
41 - 80
None
3,000
Meters
N
W
E
S
Map 13.

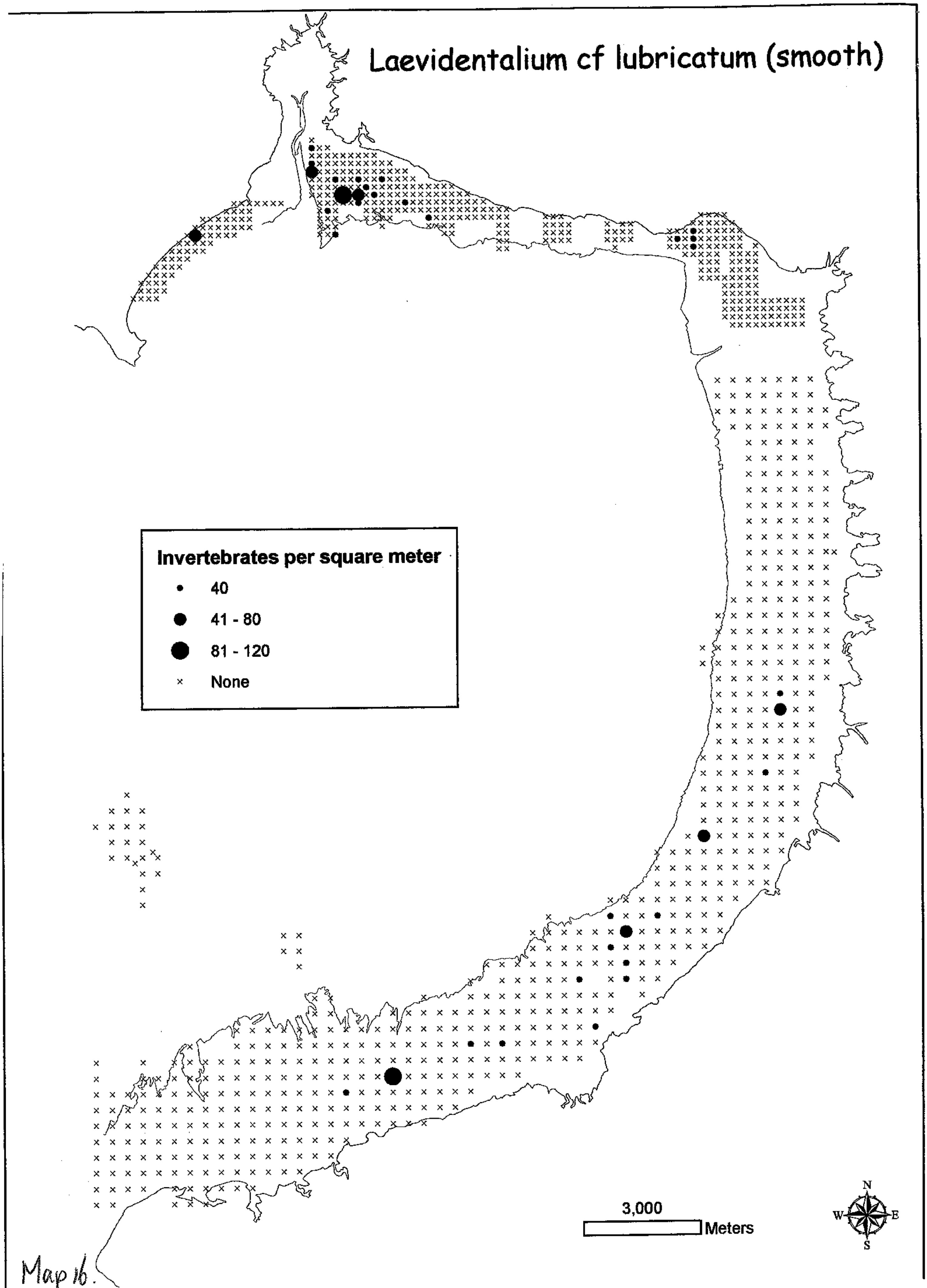

Solemya cf terraereginae
Invertebrates per square meter
40 - 80
81 - 200
201 - 360
361 - 1000
None
3,000
Meters
N
S
W
E

Map 14.

Dentalium cf bartonae (ribbed)

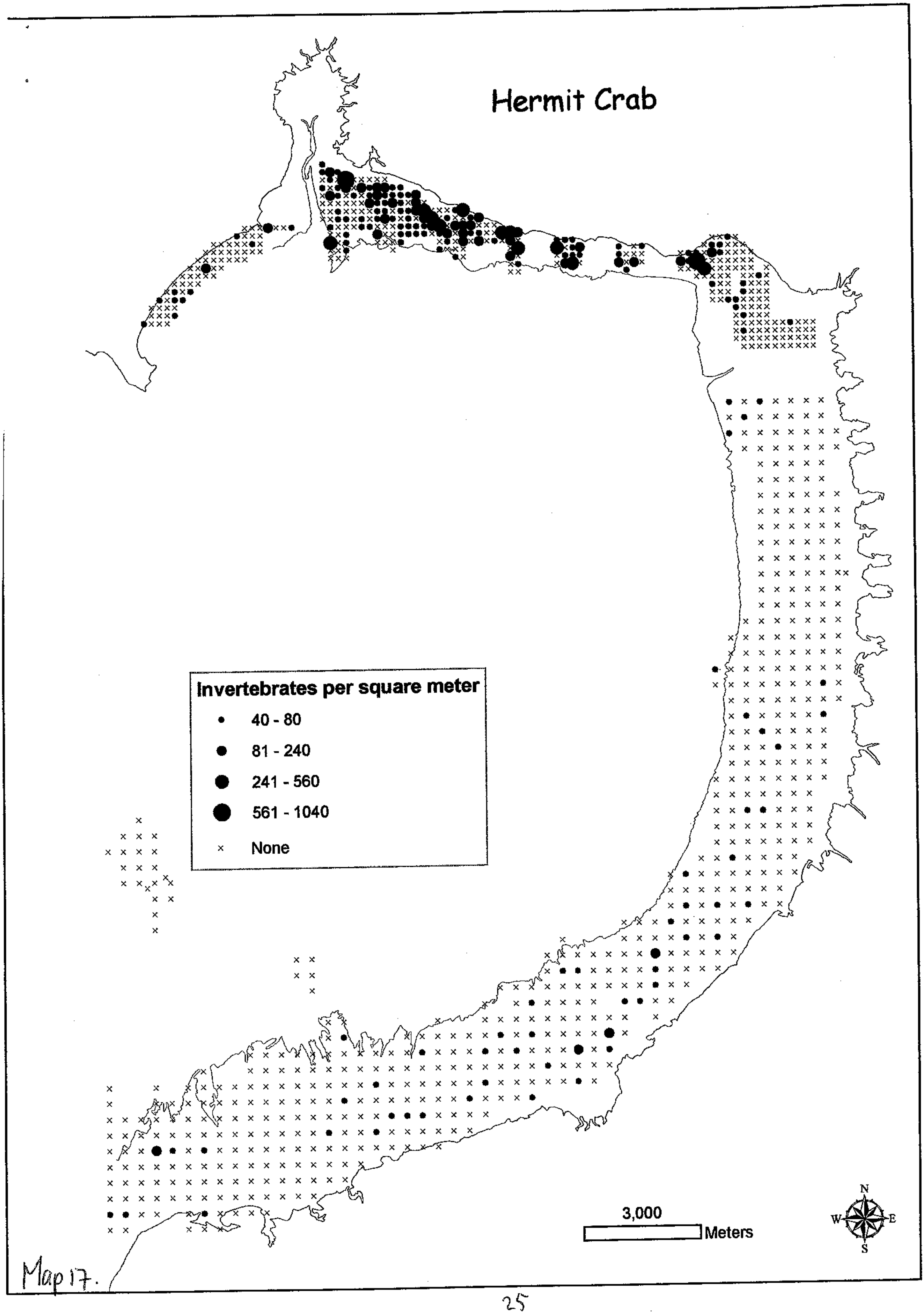


Map 15.



Laevidentalium cf lubricatum (smooth)
Invertebrates per square meter
40
41 - 80
81 - 120
None
3,000
Meters
N
S
E
W

Map 16.

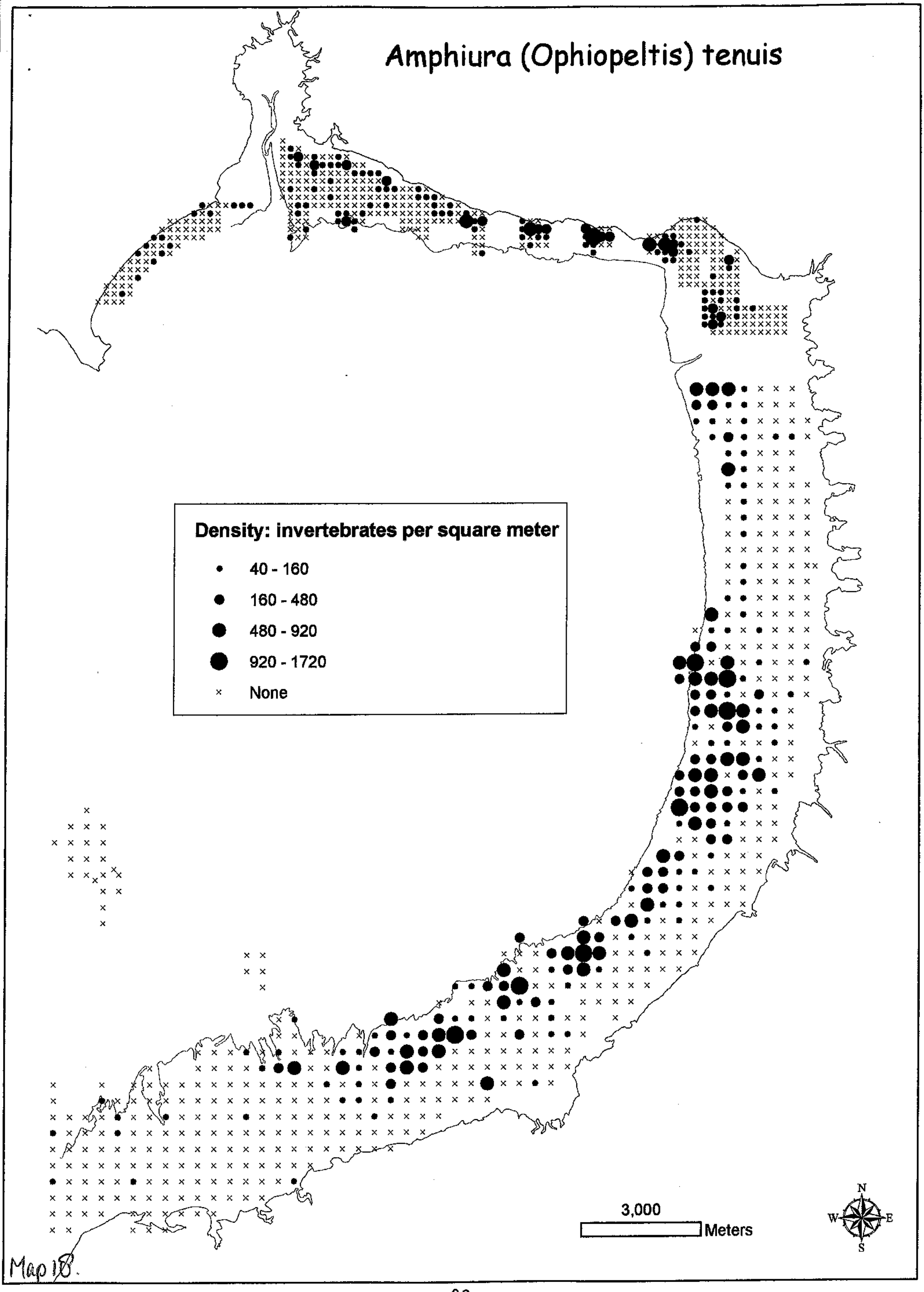


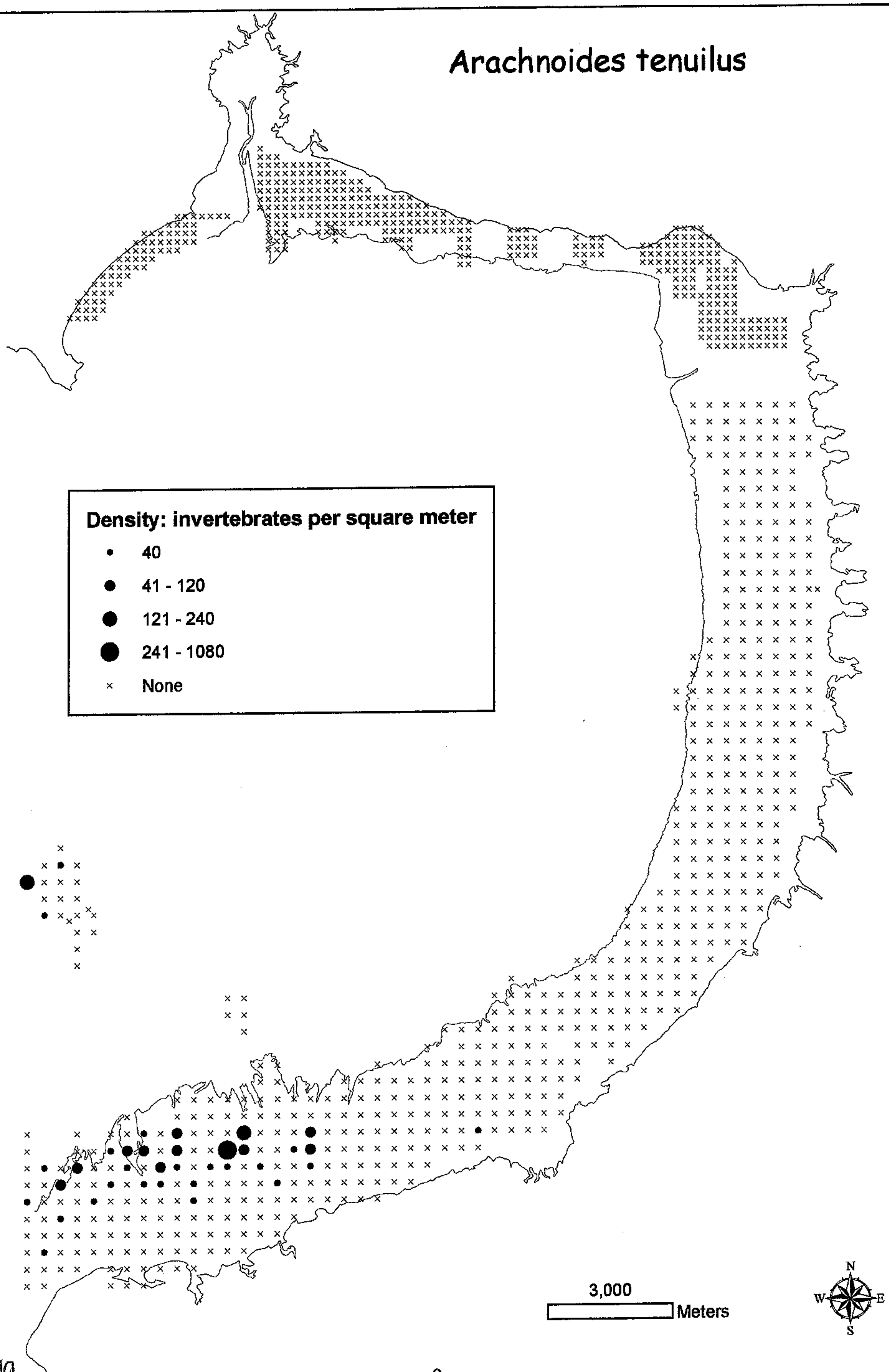
Hermit Crab
Invertebrates per square meter
40 - 80
81 - 240
241 - 560
561 - 1040
None
3,000
Meters
N
S
E
W
Map 17.

Echinodermata (starfish, sea urchin, feather stars, brittle stars). — Several species of feather stars (Crinoidea) were found in the bay. Most of these were fished with a small dredge at a depth of 6 meters. *Astropecten* (two species) were common, and despite their large size were even sometimes found in the quantitative samples. Very common (32%) was the long-armed brittle star *Amphiura tenuis* (Map 18). In terms of numerical occurrence it is only beaten by the polychaete worm *Nephtys*. The densities of this brittle star could be very high. As before, we often found a small red polynoid polychaete commensal with this brittle star. Five species of sea urchins were present on the mudflats. The two sanddollars were the most common. *Peronella tuberculata* was restricted to the northern part, while *Arachnoides tenuilus* was living in large numbers in the southern part of the bay (Map 19). Of the seacucumbers, 6 species were discovered. A brownish seacucumber with a length of about 5 cm length reached densities as high as 500 per m^2 at Town Beach.

Tunicates (seasquirts). — Many colourful species were found on the few hard substrates on the mudflats. In addition, a species of solitary tunicate lived in high densities as striking living 'carpets' near the low tide level near Bush Point. In such areas it was impossible to walk without squashing these animals and causing the squirts of water that gave them their name.

Smaller groups (Phoronida, Platyhelminthes, Brachiopoda, Nemertini, Enteropneusta). — Most of these animals are not particularly spectacular in size, shape or colour and neither were they found in great abundance. Ribbon worm (Nemertini) occurred in low densities throughout the bay (Map 20). Black and sometimes whitish individuals were encountered and the group is likely to be composed of several species. An orange flatworm was often seen crawling over the sandy surface east of Dampier Creek. Of the lampshells (Brachiopoda) two burrowing species of *Lingula* were found. One of these species is very large with a total length of more than 15 cm and a brown corrugated shell of 6 cm. It was not recorded previously.


Amphiura (Ophiopeltis) tenuis
Density: invertebrates per square meter
40 - 160
160 - 480
480 - 920
920 - 1720
None
3,000
Meters
N
W
E
S
Map 18.



Arachnoides tenuilus
Density: invertebrates per square meter
40
41 - 120
121 - 240
241 - 1080
None
3,000
Meters
N
W
E
S

Map 19.

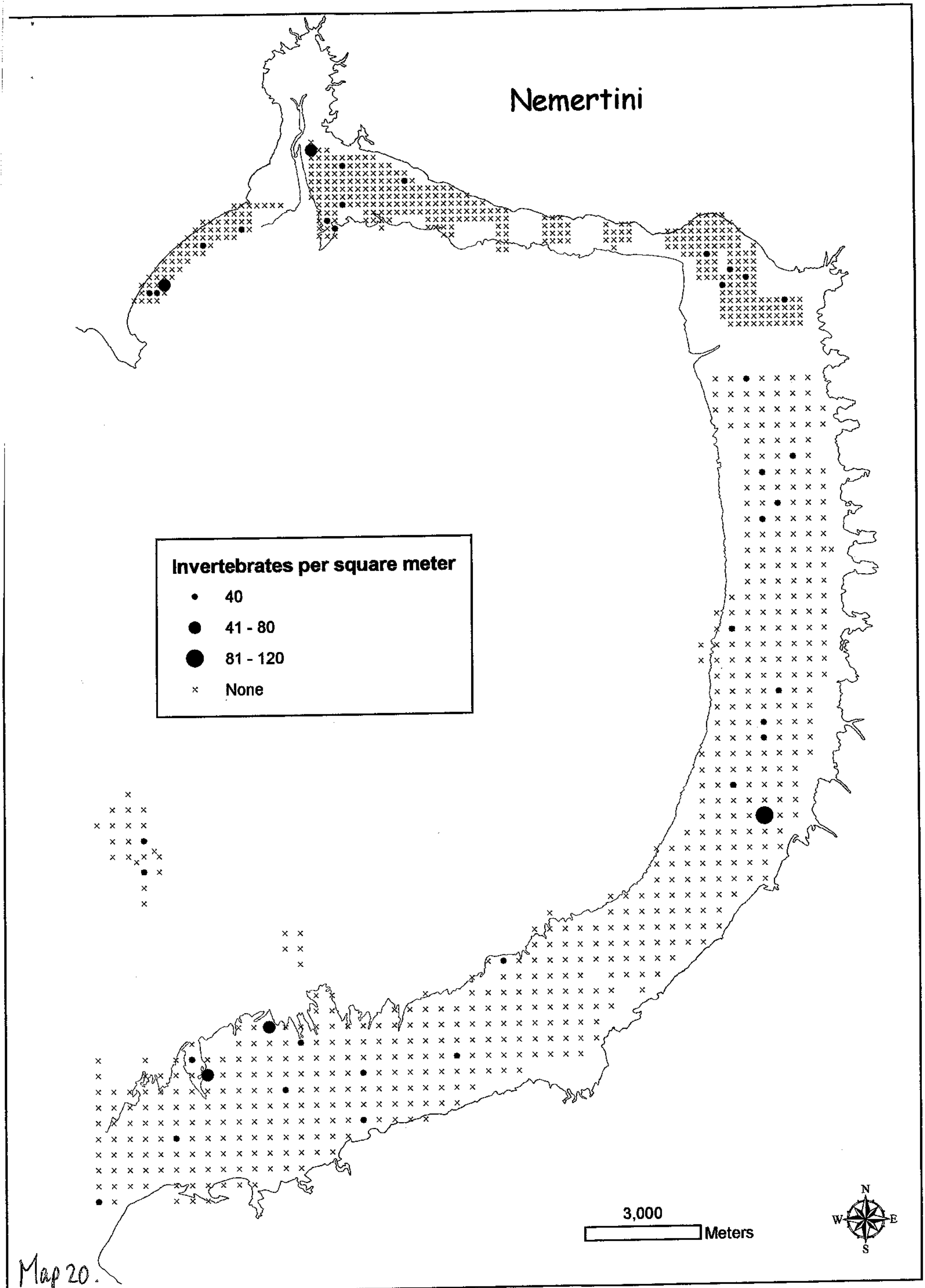

Nemertini
Invertebrates per square meter
40
41 - 80
81 - 120
None
3,000
Meters
N
S
E
W
Map 20.

Table 1. Species list of the 205 different taxa of intertidal macrobenthic invertebrates found in the quantitative samples during SROEBIM-02.

Species code	Species	Family/Group	Presence Number of stations
1101	Nucula cf astricta	Nuculidae	8
1102	Nucula cf. superba	Nuculidae	1
1151	Solemya cf terraereginae	Solemyidae	57
1201	Anadara granosa	Arcidae	8
1301	Modiolus micropterus	Mytilidae	2
1401	Anodontia omissa	Lucinidae	67
1411	Divaricella irpex=ornata	Lucinidae	74
1412	Divaricella bardwelli	Lucinidae	2
1421	Ctena/Bellucina	Lucinidae	25
1423	Ctena 'intermediate'	Lucinidae	1
1451	Montacuta spec.	Galeommatidae	1
1472	Galeomatid 'monroebi'	Galeommatidae	1
1471	Bivalvia "macrophthalmus"	?Lasaeidae	15
1501	Scintilla	Galeommatidae	1
1502	Galeomna	Galeommatidae	3
1601	Heterocardia gibbosula	Mactridae	9
1631	Mactra pura	Mactridae	3
1641	Mactra (brown)	Mactridae	1
1651	Corbula spec.	Corbulidae	6
1701	Cultellus cultellus	Cultellidae	1
1711	Siliqua pulchella	Cultellidae	162
1751	Semele spec.	Semelidae	1
1752	Psammotaea spec.	Semelidae	1
1800	Tellina sp. undetermined	Tellinidae	5
1801	Tellina capsoides	Tellinidae	21
1802	Tellina piratica	Tellinidae	54
1803	Tellina inflata	Tellinidae	5
1804	Tellina amboynensis	Tellinidae	73
1805	Tellina oval	Tellinidae	5
1811	Mud Tellina	Tellinidae	4
1818	Tellina "fabula"	Tellinidae	1
1819	Tellina cf serricostata	Tellinidae	1
1821	Tellina cf. exotica	Tellinidae	26
1823	Tellina exotica "rose"	Tellinidae	24
1824	Tellina 'shirley'	Tellinidae	7
1851	Mesodesmatidae	Mesodesmatidae	3
1871	Gari lessoni	Psammobiidae	8
1881	Solen spec.	Solenidae	8
1901	Anomalocardia squamosa	Veneridae	33
1922	Placamen gravescens	Veneridae	4
1923	Placamen calophyllum	Veneridae	1
1932	Tapes spec.	Veneridae	3
1934	Marcia hiantum	Veneridae	2
1935	Clementia papyracaea	Veneridae	2
1936	Callista planatella	Veneridae	1
1941	Gafrarium dispar	Veneridae	2
1942	Venus bushpoint	Veneridae	2
1946	Dosinia "inflated"	Veneridae	1
2001	Stenothyra spec.	Stenothyridae	22
2061	Calliostoma spec.	Trochidae	1
2062	Isanda coronata	Trochidae	35
2063	Isanda spec.(no sutural knobs)	Trochidae	1
2151	Nerita spec.	Neritidae	1
2301	Cerithidea cingulata	Potamidae	23

2351	Finella spec.	Scaliolidae	1
2401	Eulimidae	Eulimidae	10
2501	Polinices conicus	Naticidae	9
2502	Polinices "white blunt"	Naticidae	2
2511	Natica "dull colored"	Naticidae	1
2516	Sigaretus spec.	Sigaretidae	1
2551	Columbellidae	Columbellidae	7
2552	brown Columbellidae	Columbellidae	7
2553	Mitrella essingtonensis	Columbellidae	19
2554	Mitrella "wave"	Columbellidae	4
2601	Nassarius dorsatus (Ingrid-eating snail)	Nassariidae	90
2602	Nassarius "small Ingrid"	Nassariidae	8
2605	Nassarius 'ornate Ingrid'	Nassariidae	1
2701	Marginellidae	Marginellidae	17
2751	Vexillium radix	Mitridae	3
2801	Turridae (spinally ribbed)	Turridae	1
2802	Mangelia spec.	Turridae	3
2803	Turridae ax and rad	Turridae	1
2851	Terebridae	Terebridae	5
2900	Liloa	Haminoeidae	2
2901	Haminoae "green"	Haminoeidae	1
2911	orange-tipped nudibranch	Glaucidae	2
2941	Acteon	Acteonidae	6
2951	Tornatina	Cylichnidae	18
2981	Salinator cf burmana	Amphibolidae	34
2990	Rissoella	Rissoellidae	1
2992	Leucotina	Pyramidellidae	9
2993	Chrysallida	Pyramidellidae	2
2994	Turbonilla	Pyramidellidae	1
2995	Syrnola	Pyramidellidae	4
2997	Tiberia	Pyramidellidae	1
3101	Laevidentalium cf lubricatum (smooth)	Dentaliidae	37
3102	Dentalium cf bartonae (ribbed)	Dentaliidae	44
3201	Cadulus	Cadulidae	4
4001	orange flatworm	Platyhelminthes	1
4101	Nemertini	Nemertini	40
4201	Phoronida	Phoronida	18
4501	Sipuncula	Sipuncula	28
4511	Phascolion	Sipuncula	6
4521	ringed Sipuncula	Sipuncula	10
4601	Echiurus	Echiura	1
4901	Balanoglossus	Enteropneusta	5
5001	Polychaeta spec.	Polychaeta	21
5002	clubhead worm	Polychaeta	21
5051	Orbiniidae	Orbiniidae	160
5101	Polynoidae "grey"	Polynoidae	4
5121	Polynoidae "red symbiotic"	Polynoidae	153
5122	Polynoidae spec.	Polynoidae	3
5123	Polynoidae "green"	Polynoidae	1
5125	Harmothoe	Polynoidae	2
5151	Sigalionidae	Sigalionidae	61
5152	Sigalionidae (white)	Sigalionidae	2
5201	Amphinomidae (fireworm)	Amphinomidae	50
5301	Onuphidae	Onuphidae	57
5305	Eunicidae	Eunicidae	1
5351	Lumbrineridae	Lumbrineridae	38
5401	Pilargidae	Pilargidae	68
5411	Hesionidae	Hesionidae	2
5451	Nereidae	Nereidae	22

5471	Syllidae	Syllidae	5
5501	Phyllodocidae	Phyllodocidae	19
5511	green Phyllodocidae	Phyllodocidae	14
5601	Nephtyidae (catworm)	Nephtyidae	556
5701	Glyceridae (large)	Glyceridae	314
5751	Goniadidae	Goniadidae	6
5801	Spionidae	Spionidae	198
5802	Spionidae "red cirri"	Spionidae	2
5901	Chaetopteridae	Chaetopteridae	28
5905	Trochochaetidae	Trochochaetidae	3
5951	Magelonidae	Magelonidae	7
6001	Cirratulidae	Cirratulidae	12
6101	Paraonidae	Paraonidae	35
6201	Opheliidae	Opheliidae	131
6301	Capitellidae	Capitellidae	151
6401	Maldanidae (bambooworm)	Maldanidae	148
6402	tough-tubed 'maldanid' worm	Oweniidae	10
6501	Sternaspidae (mickey-mouse-worm)	Sternaspidae	4
6601	Oweniidae	Oweniidae	225
6801	Ampharetidae	Ampharetidae	13
6802	Terebellidae (branched tentacles)	Terebellidae	13
6811	Trichobranchidae	Trichobranchidae	1
6851	Sabellariidae	Sabellarriidae	1
6861	Pectinaridae	Pectinaridae	1
7101	Ostracoda "oval, smooth"	Ostracoda	146
7102	Ostracoda "square, sculptured"	Ostracoda	3
7103	Ostracoda "denticulated"	Ostracoda	15
7201	Gammarus	Amphipoda	103
7211	non-gammarid amphipod	Amphipoda	7
7221	Corophium	Amphipoda	38
7251	Caprellidae (skeleton shrimp)	Amphipoda	1
7301	Anthura spec.	Isopoda	34
7311	Eurydice spec.	Isopoda	10
7401	Tanaidacea	Tanaidacea	18
7501	Cumacea	Cumacea	25
7551	Mysidacea	Mysidacea	1
7601	mantis shrimp (Squillidae)	Stomatopoda	8
7701	Caridae (shrimp)	Caridea	46
7801	Gourretia coolibas	Caridea	1
7802	Callianassa	Caridea	12
7901	hermit crab	Anomura	214
8051	Dorippe cf australiensis	Dorippidae	7
8071	Raninidae	Raninidae	2
8101	Matuta planipes	Callapidae	7
8151	Porcellanidae (hairy crab)	Porcellanidae	4
8201	cf. Myrodes eudactylus	Leucosiidae	5
8211	Nursia abbreviata	Leucosiidae	2
8221	Ebalia spec.	Leucosiidae	15
8231	Leucosia D	Leucosiidae	7
8301	Halicarcinus cf. australis (spider crab)	Hymenosomatidae	17
8311	Mictyris longicarpus (soldier crab)	Mictyridae	42
8351	Pinnotheres cf cardii	Pinnotheridae	10
8401	Pilumnidae	Pilumnidae	6
8501	Hexapus	Goneplacidae	12
8601	Macrophthalmus (sentinel crab)	Macrophthalmidae	173
8611	Scopimera inflata	Ocypodidae	1
9050	sponge Porifera	Porifera	1
9100	Actiniaria spec.	Anthozoa	1
9101	Edwardsia	Anthozoa	5

9103	Edwardsia with white spotted tentacles	Anthozoa	3
9161	pin sea pen (with skeleton)	Pennatulacea	2
9162	short fat sea pen (without pin)	Pennatulacea	1
9201	Pycnogonida (sea spider)	Pycnogonida	1
9301	Lingula	Brachiopoda	9
9401	Amphiura (brittle star)	Ophiuroidea	43
9402	Amphiura (Ophiopeltis) tenuis	Ophiuroidea	321
9403	Amphiura cf catephes	Ophiuroidea	12
9404a	Ophiocentrus verticillatus	Ophiuroidea	1
9405	Amphioplus spec.	Ophiuroidea	1
9411	Ophiotrix (Placophiotrix) melanosticta	Ophiuroidea	1
9421	Dictenophiura stellata	Ophiuroidea	31
9501	Astropecten granulatus	Asteroidea	5
9502	Astropecten monachanthus	Asteroidea	5
9550	Temnapleuris alexandri	Asteroidea	1
9551	Peronella tuberculata	Echinoidea	3
9552	Arachnoides tenuilus	Echinoidea	40
9600	Holothuroidea spec.	Holothuroidea	12
9601	Leptopentacta grisea	Holothuroidea	1
9604	uncolored Synaptidae	Holothuroidea	1
9608	purple seacucumber	Holothuroidea	1
9631	Stolus buccalis	Holothuroidea	4
9675	tiny white holothurian	Holothuroidea	4
9701	Rooted Tunicate	Tunicata	2
9711	Colonial tunicate (rose)	Tunicata	1
9724	stalked tunicate	Tunicata	2
9725	solitary ascidian	Tunicata	3
9751	Amphioxis/lancelet fish	Agnatha	8
9771	branched foram	Foraminifera	2
9772	blue foram	Foraminifera	1
9801	Periophthalmidae (mudskipper)	Pisces	7
9810	Gobiid fish	Pisces	11
9815	whitefish	Pisces	3

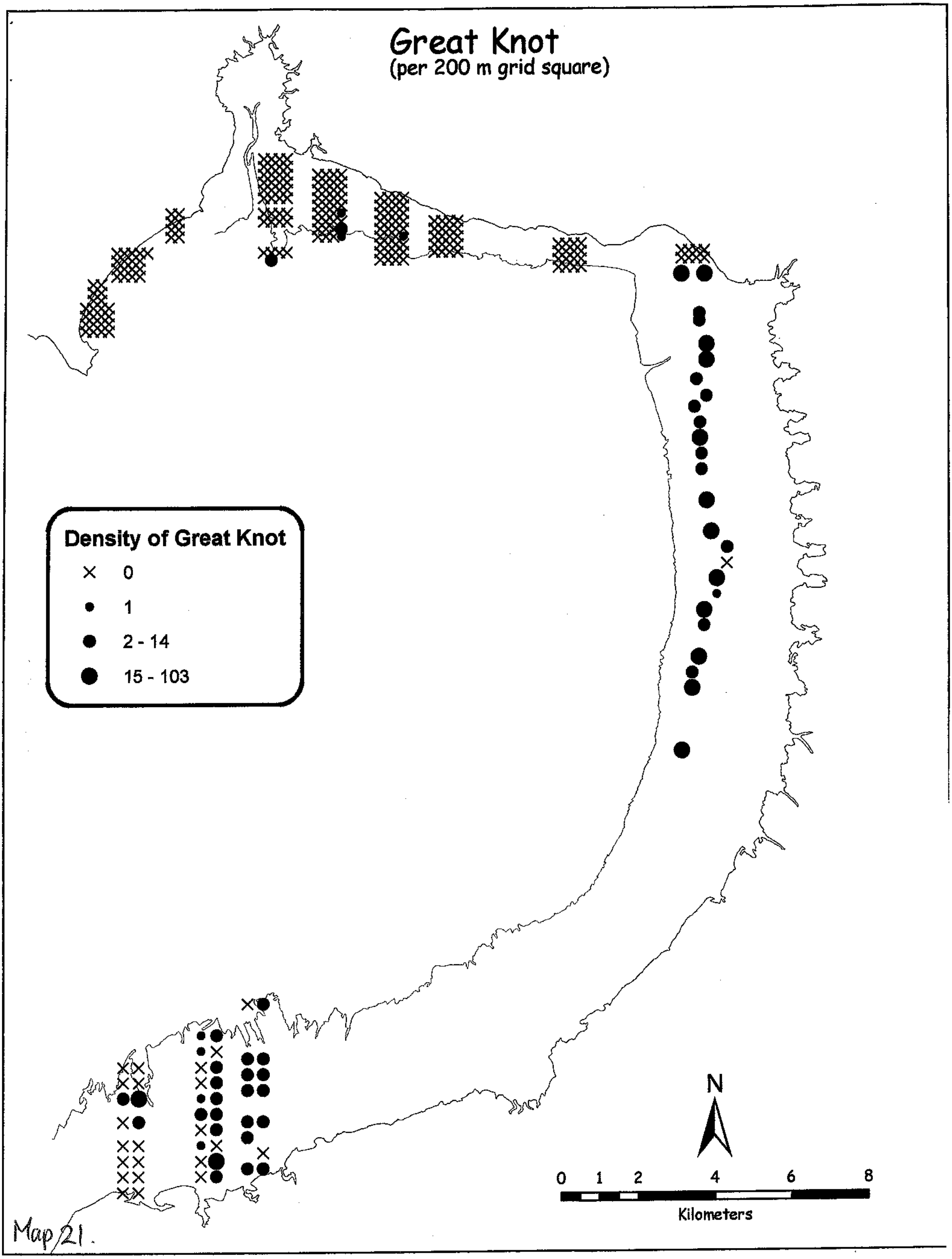
Shorebird distribution in the nonbreeding season

In all, over 13,000 birds were mapped on the mudflats of Roebuck Bay during the SROEBIM expedition. It is a reasonably impressive total given the time of year. This expedition was held during the North Australian dry season and the boreal summer, a time of year in which all adult migratory shorebirds should be breeding in the far northern hemisphere. There is indeed a vast exodus of adult shorebirds from Northern Australia between March and early May. However, in most shorebird species occurring in Roebuck Bay, immatures do not start to migrate north until they are at least two years old. This means that there always migratory shorebirds in Roebuck Bay, even though during much of the dry season (when adults are overseas and only immatures are present), numbers are only perhaps 20% of the huge numbers observed during the peak of the austral summer.

During SROEBIM we were therefore looking chiefly at immature migratory shorebirds. Much of our understanding of the delayed maturity of shorebirds comes from banding studies, and during SROEBIM an attempt was made to refine our knowledge of the age of first northwards migration by searching for colour-banded birds of known age. These did indeed confirm that Great Knots and Bar-tailed Godwits can delay their first northwards migration until they are at least three or four years old respectively. The colour-band searches also provided some nice demonstration of the globe-trotting abilities of shorebirds: leg-flagged birds resighted included a Curlew Sandpiper from south-eastern SA, a Red knot from Victoria, and a Great Knot, a Curlew Sandpiper and a Grey-tailed Tattler from Hokkaido in northern Japan.

Migratory shorebirds are not the only bird species using the intertidal flats, and during the dry season there are indeed slightly increased numbers of some birds more typically associated with inland wetlands in Australia, such as Pelicans and Darters. When these are taken into account the species list on the intertidal flats of Roebuck Bay begins to mount: 54 bird species were mapped (perched) on the intertidal flats during SROEBIM. Below, as case studies we provide maps of a few of the migratory shorebird species mapped on the intertidal flats. They demonstrate some of the most obvious distributional trends.

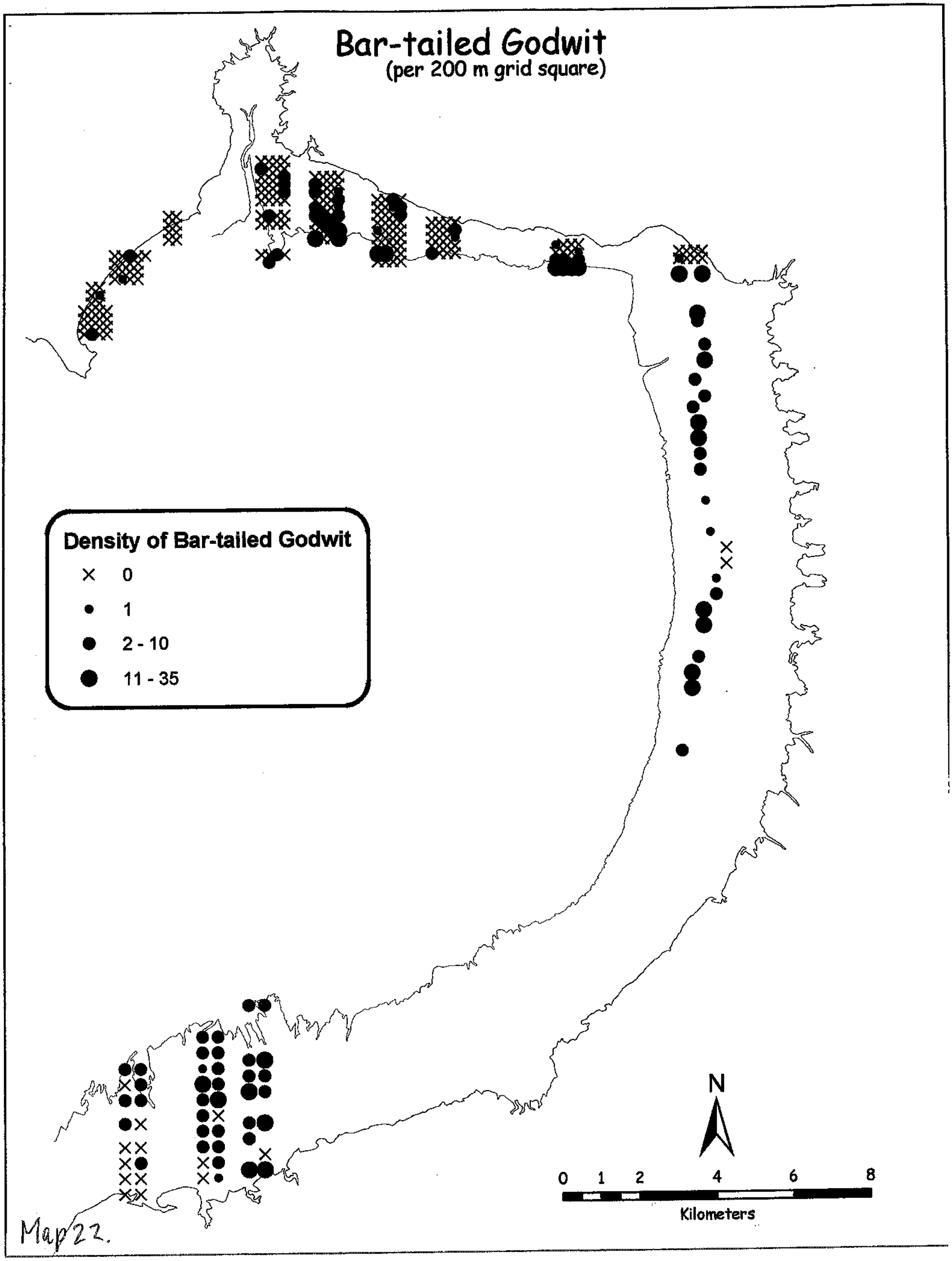
Great Knot. — The Great Knot distribution map illustrates perhaps the most startling trend shown in the distributional data. In previous surveys, large numbers of Great Knots had always been found feeding at the sea edge along the northern shores of Roebuck Bay. During June 2002 hardly any Great Knots 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? We do not yet know, but examination of the benthos data should allow us to test this possibility.


Great Knot
(per 200 m grid square)
Density of Great Knot
0
1
2 - 14
15 - 103
N
0 1 2 4 6 8
Kilometers
Map 21.

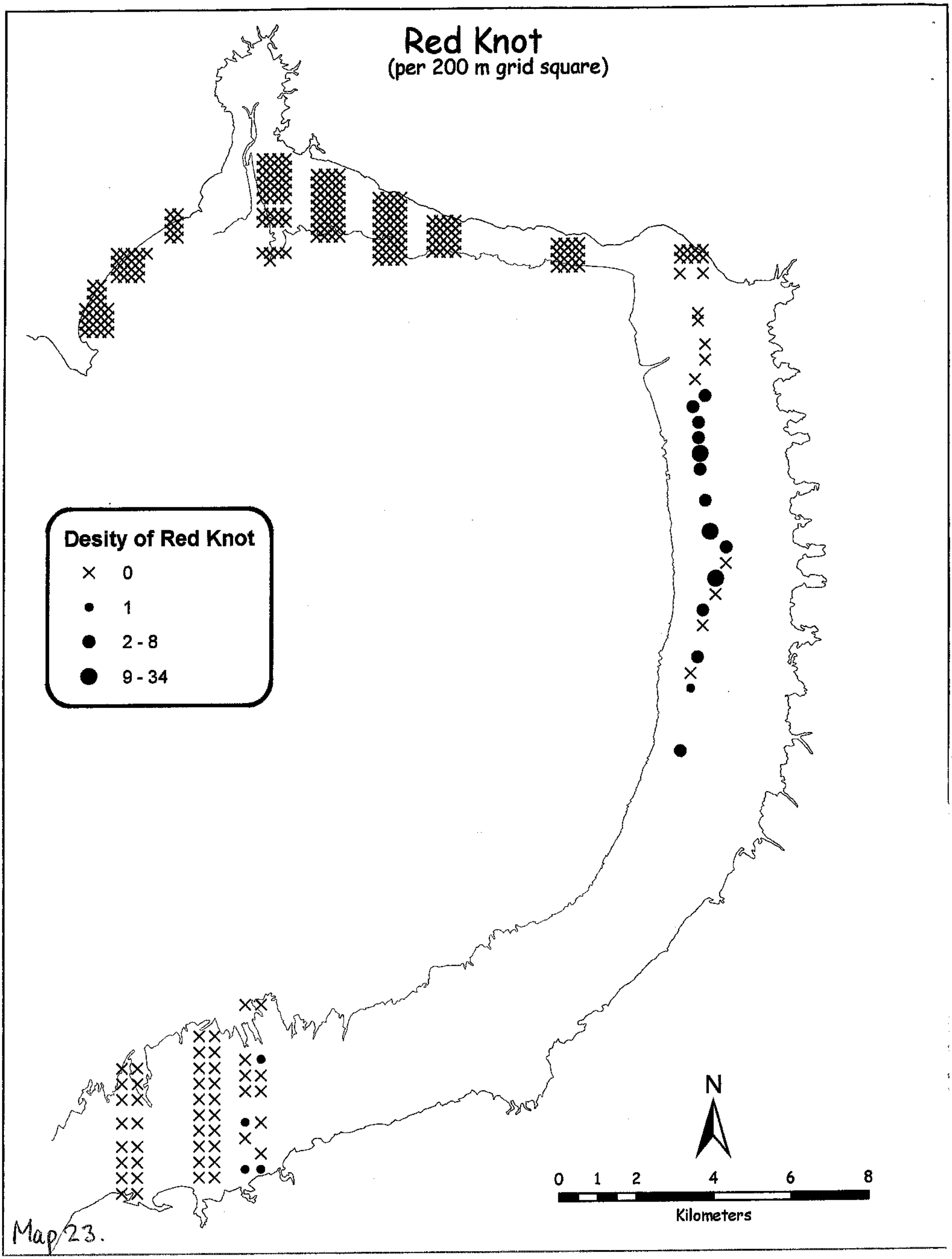
Bar-tailed Godwit, Red Knot and Curlew Sandpiper. — Two other species that showed a strong eastwards shift in their feeding distribution were the Bar-tailed Godwit (Map 22) and the Red Knot (Map 23). Previously, these species, like the Great Knot, had been widespread along the sea-edge of the northern shores. Now all were only abundant on the eastern sea-edge. It is perhaps relevant that the all of these species happen to be birds which feed at the sea-edge in dense flocks on buried prey which is located by touch, suggesting that a prey availability consideration might have played a part in the eastwards shift. A point of interest in the distribution maps of Bar-tailed Godwit and Red Knot is that within the east of the bay, the two species had differing distributions; Red Knots were most common where Bar-tailed Godwits were least common, and vice versa. Since the two species often co-occur in flocks this is unlikely to be a result of direct competition; it is more likely that differing prey choices led the species to different feeding areas. This would accord with observations made of Bar-tailed Godwits on the eastern flats feeding on *Anodontia*, a round white bivalve that can burrow to considerable depths. Such prey is within reach of the long-billed Bar-tailed Godwit, but quite inaccessible to the short-billed Red Knot. Curlew Sandpipers were restricted to the rather soft mudflats in the north-eastern corner of Roebuck Bay (Map 24).

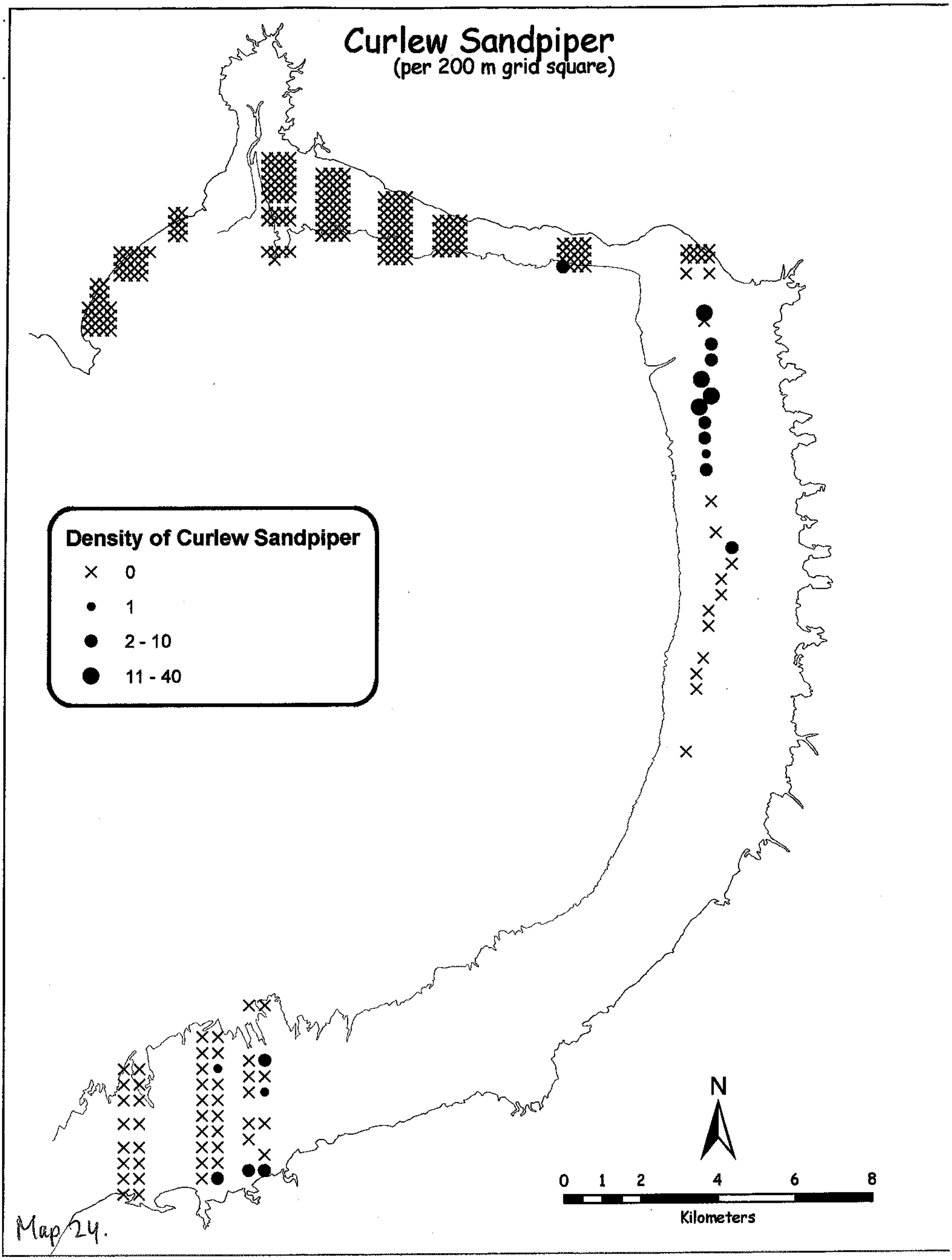
Terek Sandpiper. — In some contrast to the above case studies, the past and present distribution of Terek Sandpipers did not seem to have changed much compared to previous assessments. This species appears to have had a good breeding season in 2001, and accordingly the numbers seen in Roebuck Bay during June 2002 were fairly high. Along the northern shores they showed the same general trend in feeding distribution as on previous surveys: a concentration of birds on the Dampier Creek flats near Broome, and another, smaller feeding concentration near Fall Point (Map 25). What we were hitherto unaware of is that large numbers also occur on the eastern flats. Although we mapped these flats from the sea-edge during hovercraft surveys, the Terek Sandpipers were always seen here on the landward side of the grid squares, feeding on the open flats of the eastern coast where tasty crabs abound.

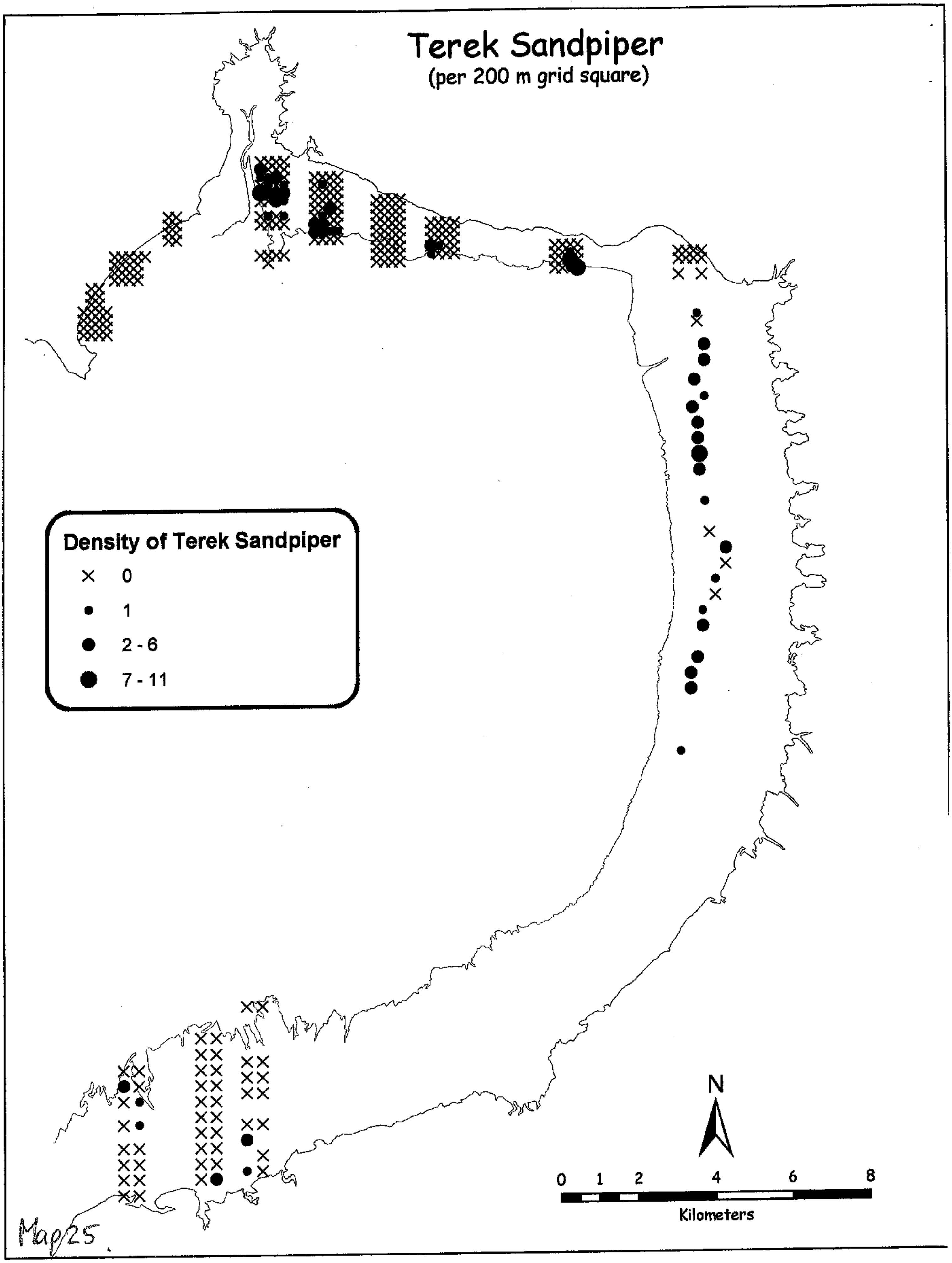
Most bird species mapped on the mudflats in June 2002 showed differing feeding distributions, and space prevents us from illustrating all of the patterns here. For example, there were species like Sanderling and Pied Oystercatcher for which the stronghold appeared to be the far south of the bay near Bush Point. A good deal of analysis will be needed to work out the exact habitat preferences of the birds of Roebuck Bay, but it is already clear that all of the bay is of importance to shorebirds.



Bar-tailed Godwit
(per 200 m grid square)
Density of Bar-tailed Godwit
0
1
2 - 10
11 - 35
N
0 1 2 4 6 8
Kilometers
Map 22.


Red Knot
(per 200 m grid square)
Desity of Red Knot
0
1
2 - 8
9 - 34
N
0 1 2 4 6 8
Kilometers
Map 23.


Curlew Sandpiper
(per 200 m grid square)
Density of Curlew Sandpiper
0
1
2 - 10
11 - 40
N
0 1 2 4 6 8
Kilometers
Map 24.


Terek Sandpiper
(per 200 m grid square)
Density of Terek Sandpiper
0
1
2 - 6
7 - 11
N
0 1 2 4 6 8
Kilometers
Map 25

5. Acknowledgements

The mapping exercise in 1997 (ROEBIM-97) covered most of the northern shores and about one quarter of the eastern mudflats. Time, lack of samplers and insufficient funds prevented the completion of the entire Bay. The equipment, machinery and personnel required to complete this project were the largest ever compiled for such a survey. It was made possible by considerable financial support from Coastcare (NHT), Department of Conservation and Land Management (through the Science Division, Landscope Expeditions, Wetland Conservation Projects and West Kimberley District) and the Royal Netherlands Institute for Sea Research (NIOZ).

Environs Kimberley provided immense support and effort with:

- Project funding
- Project co-ordination
- Ongoing support from the local community
- Strong advertising program
- Effective project promotion
- Publication of progress reports and results through the EK newsletter

Dan and Wendy Blunt, Chris and Jenny and the committee of the Broome Bird Observatory (BBO) provided a high level of logistical support. The usual comforts of the accommodation and meals areas of the Observatory were again available and enabled an economy of food preparation and provision to be attained. The BBO mud lab again provided researchers with a wonderful base in which to prepare samples, maps and co-ordinates. The identification of specimens could be carried out into the night to ensure there was never an overwhelming and ever-mounting number of specimens requiring identification or measurement.

Industry support was again evident through the valued contributions of a number of organisations:

- Wallis Drilling, through Jamie Wallis, again provided magnificent support (Table 2) with the provision of the Wallis 7 seat hovercraft, a 10 tonne truck with bulk fuel supply and the skilled hovercraft wrangler in Jamie himself. Many last light landings at Hovercraft Beach were necessary and many early morning departures tested the endurance of both hovercraft and driver. It was a great relief that neither mechanical nor human failure of any lasting nature was experienced throughout the expedition. Regular lubrication may have contributed to this extraordinary endurance.
- Broome Pearls provided an extremely functional and well prepared 8 metre alloy centre console vessel that ensured a high level of support and recovery ability in the remote parts of the Bay. The vessel was supplied with a full fuel tank (220 litres) and was capable of providing transport for up to 7 teams of samplers. Access to the more remote sites in Roebuck Bay would not have been possible without this vessel and the Wallis hovercraft. Special thanks to Chris Cleveland and Patrick Moase.
- CALM's Perth District provided a very useful smaller 3 person hovercraft for the duration of the expedition complete with an operator of exceptional skill and equal endurance (Glyn Hughes; Table 2). The use of this craft in concert with the Wallis hovercraft and the Broome Pearls vessel in the remote mudflats of the bay provided the teams with great confidence and a better ability to cover large areas efficiently. The hire rate for this vehicle reflected its good design and simplicity of operation.
- Kiss Refrigeration provided a mobile chiller at a reduced rate that ensured adequate storage space for fresh food (and drinks!)
- Cockburn Hire provided a generator at a competitive rate.

Table 1. Approximate use of the hovercrafts during SROEBIM-02. We distinguished between field time and estimated actual running time for the CALM Hovercraft (Glyn Hughes) and archived running time only in the case of the Wallis Hovercraft.

Date	CALM Hovercraft				Wallis Hovercraft
	Time start	Time finish	Field time (hr)	Run time (hr)	Run time (hr)
8 June	16:00	18:00	2.00	2.0	
9 June	06.00	11:30	5.50	3.0	2.7
10 June	14:00	17:30	3.50	3.0	2.5
11 June	13:00	17:30	4.50	3.0	5.7
12 June	13:15	17:30	6.25	3.0	5.2
13 June	06:00	13:00	7.00	4.0	1.6
	13:30	17:30	4.00	2.0	3.2
14 June	06:00	09:30	3.50	2.0	3.5
	13:30	17:30	4.00	3.0	
15 June	06:30	13:00	4.00	3.0	2.3
16 June	06:00	13:00	7.00	4.0	4.6
17 June					5.0
18 June	06:00	11:30	5.50	3.5	3.6
19 June	07:30	13:30	5.00	2.0	2.4
20 June	07:00	12:00	5.00	2.0	2.2
21 June	9:30	16:00	6.50	3.0	
22 June	12:30	15:00	2.50	1.5	4.1
	15:30	18:00	2.50	0.5	
Totals			77.25	44.5	48.7

The problem of finding sufficient personnel was resolved through the involvement of several volunteer organisations. These included some excellent young people from Conservation Volunteers Australia and Green Corps. Their youth and fitness was a definite advantage and their persistence with the sorting of samples proved extremely valuable. This project was developed around collaboration with community groups and it was pleasing to have the two volunteer organisations participating. Our thanks to the regional and local supervisors of these teams, Jenny Busniak, Ken Beasley, Megan Crossman and Elaine Campbell.

Landscope Expeditions again provided a very high level of support financially and physically. Several of the participants from Landscope Expeditions had returned for their second experience in the mud and provided important experience and high levels of practical and (in the case of Loisette Marsh) scientific expertise. New participants also contributed valuable skills that assisted project running and enhanced project outcomes.

Mike Lapwood and Kingsley Miller from the CALM West Kimberley District provided important boat handling skills and ensured safe passage for the passengers travelling to and from the remote sampling sites in the Bay. Thanks to the Allen Grosse and Kevin White for their support for the project and willingness to commit staff and resources. Broome volunteer sea rescue group provided important backup for our forays to remote parts of Roebuck Bay.

The organisers of this project also extend their thanks to the members of Rubibi who participated in the project – Elsie Edgar, Noreen Edgar, Micklo Corpus, Frans Hoogland, and

Ben Wurm. Special thanks to Micklo who sampled the remote Bush Point sites with one of the teams and helped sort the samples and later spent time with members of the SROEBIM group explaining the Minyirr Coastal Park concept.

Throughout this field project there has been a high level of logistical support from a number of very skilled people. Preparation of meals was carried out daily by Joanne Smith with assistance from Brent Johnson, Mavis Russell, Helen MacArthur and Pat and Bill Duxbury.

CALM Woodvale staff, Brent Johnson, Jim Cocking, Mike Scanlon and Alan Clarke assisted with the preparation for the expedition and are thanked for their high level of input. Mike Scanlon was severely injured just prior to the departure from Perth and was unable to participate in the field work. Substantial input and support from CALM was due to the continued support from Neil Burrows, Keith Morris, Jim Lane, Stuart Halse and Stephen White.

With every departure of sampling teams from the base camp there was a requirement to ensure their safe return. Mobile VHF radio transceivers were useful communication tools as were mobile cellular phones (CDMA provided better remote coverage than digital). However the most important factor in accounting for the safe return of samplers was the provision of a co-ordinating team at the base. This role was very capably handled by Brent Johnson, Bob Hickey and Dr Greg Murphy. Greg also provided medical care when needed and much enthusiastic motivation in the camp.

A film crew directed by Ian Pugsley documented the promotion of the use of volunteers in nature conservation programs run by The Department of Conservation and Land Management. It is expected that this will form part of the Channel Nine state-wide program "Postcards WA". Our thanks to Ian and his team for his input, to Brian Beaton for production advice and input to Ray Pedretti of Channel Nine and to CALM Corporate Relations Director Ron Kawalilak for supporting the concept.

Several individual members of the expedition provided exceptional support on the mudflats, in the sample sorting area and generally around the camp: Mathilde Breton, Jack Robinson, Grant Morton and Jeni Alford (in order of appearance).

Perhaps one of the most under-rated tasks in the operation is the preparation of sampling kits and collation of samples at the end of the day. Clever organisation of the respective components is essential to ensure parts of each sampling kit are not left behind. Special thanks to Yvonne Winchcombe for her excellent and continuous effort in this regard and to Suzanne Wade for her support for Yvonne.

We were much looking forward to the personal and scientific input from Sabine Dittmann, a well known benthic ecologist from Bremen, Germany. A sudden tropical illness prevented Sabine from taking part in the project and contributing her knowledge on animals smaller than the ones that we now studied (the meio- rather than macro-benthos) and her skills in the identification of polychaete worms.

There is a tendency for researchers to be so captivated by their results or objectives to become insulated from community needs and involvement. This project sought to redress this lack of community consultation by offering the local and wider community an opportunity to express their own aspirations or feelings for Roebuck Bay in a public arena. This could include management options as well as more personal issues relating to the use of the many facets of the Bay.

Environs Kimberley obtained funding through Coastcare for a one day forum that was titled – Celebrate the Bay. Various local interest groups and individuals were invited to comment. Other speakers provided information on numerous aspects of management of the

Bay. The organisers of the Forum wish to acknowledge the contribution to the success of this day to:

- Shire of Broome for the provision of the Civic Centre with all the associated sound systems and lighting and the lunches. In particular the Shire President Kevin Fong for his willingness to support the concept and for his enlightened and emotive comments on Roebuck Bay.
- Kimberley Development Commission for their financial support for the project.
- Paspaley Plaza Shopping Centre for access for displays.
- ABC Kimberley Radio, Goolarri Media and the Broome Advertiser for their support for the project.
- Nola Poon of the Mangrove Hotel for the provision of a function room for the post forum dinner.

Throughout the project a team of dedicated researchers have spent countless hours collating the data collected from the mudflats and assembling it in a logical format that can be easily understood. Our special thanks to Pieter Honkoop for his efforts throughout the project, Shirley Slack-Smith and Loisette Marsh for their fantastic effort with sample collections, identifications of specimens and curation of samples. The preliminary report received considerable input from the two Central Washington University undergraduates Ora Menees and Lise Goss.

From every expedition in the past has sprung ideas for the next event. One of the ideas in the minds of previous expeditioners has been to produce a useful handbook on the ecology of Roebuck Bay. This would require someone to secure a series of high quality photographs representing much of the wildlife of the intertidal zones of Roebuck Bay as well as the habitat types. Jan van de Kam is a professional photographer of some reputation with a publication record of books on wetlands and wildlife in Europe, Africa and the High Arctic. Throughout his career he tried to focus on shorebird related photographic projects. His presence during this expedition is acknowledged and his enthusiasm for the work appreciated. Geoff Hansen of Glengarry Photographics assisted with the cost effective supply of the film for Jan.

PRELIMINARY LIST OF PARTICIPANTS (with due apologies for any ommissions)

Campbell	Elaine		Conservation Volunteers Australia
	Vicky		Conservation Volunteers Australia
	Sylvie		Conservation Volunteers Australia
Summerbell	Tom		Conservation Volunteers Australia
Hamill	Jamie		Conservation Volunteers Australia
Phillips	Ruth		Conservation Volunteers Australia
Miller	Aly		Conservation Volunteers Australia
Eglese	David		Conservation Volunteers Australia
Beaton	Brian		Artemis International
Pugsley	Ian		Artemis International
	Greg		Artemis International
	Phil		Artemis International
Lewis	Janet	volunteer	BBO
MacArthur	Helen	volunteer	BBO
Lewis	Jenny	volunteer	BBO
	Chris	volunteer	BBO
Curran	John	volunteer	BBO
Curran	Michael	volunteer	
Joy	Phil	volunteer	BBO
Blunt	Dan	volunteer	BBO
Blunt	Wendy	volunteer	BBO
Moase	Patrick		Broome Pearls
Clarke	Alan		CALM
Cocking	Jim		CALM
Hughes	Glyn		CALM
Johnson	Brent		CALM
Lapwood	Mike		CALM
Miller	Kingsley		CALM
Pearson	Grant		CALM
Smith	Joanne		CALM
Kenneally	Kevin		CALM
Grosse	Allen		CALM
Willing	Tim		CALM
Halse	Stuart		CALM
White	Stephen		CALM
Black	Sally		CALM
Morris	Keith		CALM
Storey	Andrew		University of Western Australia
Tonts	Cheryl		CALM
Silver	John		Coastcare
Morris	Sean	volunteer	
Morris	Leslie	volunteer	
Dixon	Adele	volunteer	Environs Kimberley
Mann	Maria	volunteer	Environs Kimberley
Lowe	Pat		Environs Kimberley
Busniak	Jenny	volunteer	Greencorp
Bartlett	Laurie	volunteer	Landscope
Conforti	Fiorenzo	volunteer	Landscope
Marsh	Loisette	volunteer	Landscope
Eastwell	Lorraine	volunteer	Landscope
Heatherington	Barry	volunteer	Landscope
Heatherington	Jan	volunteer	Landscope
Rowe	David	volunteer	Landscope
Melzack	Karen	volunteer	Landscope

Verrier	Kathleen	volunteer	Landscope
Murphy	Greg	volunteer	
Birchenough	Andy	volunteer	Newcastle Uni. UK
Birchenough	Sylvana	volunteer	Newcastle Uni. UK
student A		volunteer	Newcastle Uni. UK
student B		volunteer	Newcastle Uni. UK
student C		volunteer	Newcastle Uni. UK
Compton	Tanya		NIOZ, Netherlands
De Goeij	Petra		NIOZ, Netherlands
Lavaleye	Marc		NIOZ, Netherlands
Piersma	Theunis		NIOZ, Netherlands
Richards	Jack	volunteer	Police Ranger
Hunter	Azu	volunteer	Police Ranger
Sherrell	Tom	volunteer	Police Ranger
Edwards	Kyle	volunteer	Police Ranger
Batt	Lenore	volunteer	Police Ranger
Tyson	Camisa	volunteer	Police Ranger
Thomas	Rowan	volunteer	Police Ranger
Hayward	Erin	volunteer	Police Ranger
Obern	Stuart	volunteer	Police Ranger
Jones	Nicole	volunteer	Police Ranger
Wood	Dawn	volunteer	Police Ranger
Abdullah	Chris	volunteer	Police Ranger
Bin Rasheed	Trevor	volunteer	Police Ranger
Kusabs	Antony	volunteer	Conservation Volunteers Australia
Ransom	Tanya	volunteer	Greencorps
Chapman	Andrew	volunteer	Police Ranger
Corpus	Micklo		Rubibi
Wurm	Ben		Rubibi
Hoogland	Frans		Rubibi
Edgar	Elsie		Rubibi
Edgar	Noreen		Rubibi
Edgar	Jayden		Rubibi
Kjellgren	Gemmaica		Rubibi
Rogers	Danny		Charles Sturt University, Albany
Breton	Mathilde	volunteer	Le Thor, France
Honkoop	Pieter		Uni. of Sydney
van de Kam	Jan		photographer Griendsveen, Netherlands
Marsh	Loisette	volunteer	Cottesloe
Russell	Mavis	volunteer	Waroona
Wallis	Jamie	volunteer	Wallis Drilling, Perth
Winchcombe	Yvonne	volunteer	Dunsborough
Strain	Hugh	volunteer	Broome
Alford	Jeni	volunteer	Hilton
Buckingham	Redyn	volunteer	Broome
Robinson	Jack	volunteer	Granville
Gillis	Matt	volunteer	Broome
Davis	Myles	volunteer	Broome
Greencorp A		volunteer	
Greencorp B		volunteer	
Greencorp C		volunteer	
Morton	Grant	volunteer	Broome
Grohman	Cornelia	volunteer	Broome
Slack-smith	Shirley		Western Australia Museum
Hickey	Bob		Central Wash University
Wade	Suzanne		Central Wash University
Menees	Ora	volunteer	Central Wash University

Goss	Liz	volunteer	Central Wash University
Dittmann	Sabine		Bremen, Germany
Price	Jimmy	volunteer	
Law	Kellie	volunteer	Broome
Palmer	Amy	volunteer	Broome
Rosenberg	Liz	volunteer	Broome
Duxbury	Pat	volunteer	
Duxbury	Bill	volunteer	
Nott	Sharon	volunteer	
Bourne	Cameron	volunteer	
Trudgeon	Wendy	volunteer	Broome
Dureau	Dave	volunteer	Broome
Vernes	Tanya	volunteer	WWF
Priest	Bianca	volunteer	WWF
Young	Sarah	volunteer	Environment Australia, Canberra
Ellis	Sonia	volunteer	
Fardell	Brian	volunteer	