80 MILE BEACH 1999

Preliminary Research Report

Anna Plains *B*enthic *I*nvertebrate and bird *M*apping 1999

ANNABIM-99

by

Theunis Piersma

(Netherlands Institute for Sea Research - NIOZ and University of Groningen)

Marc Lavaleye

(Netherlands Institute for Sea Research - NIOZ)

&

Grant Pearson

(Western Australian Department of Conservation and Land Management - CALM)

Maps by

Michelle Crean

(Curtin University of Technology)

TABLE OF CONTENTS

1. Introduction

Among the wetland wonders of the northern part of Western Australia, the intertidal foreshore of Anna Plains Station, representing the northernmost 80 km of Eighty Mile Beach, stands out for its importance as a key nonbreeding area used by arctic-breeding shorebirds. Along Eighty Mile Beach, about half a million roosting shorebirds have been counted in recent years (414,000 in October 1998; C.D.T. Minton *et al.* pers. comm.). The great majority of these birds occur at the beach along Anna Plains Station, 25 to 75 km south of Cape Missiessy. Although it is widely agreed that most species (other than Little Curlew *Numenius minutus* and Oriental Plover *Charadrius veredus*) use the intertidal foreshore as their feeding area, nobody has hitherto studied either the feeding distribution and behaviour of shorebirds, nor has anybody studied the nature of their food resources along Eighty Mile Beach.

We really need such knowledge if we are to conserve the immense and internationally shared natural values of Eighty Mile Beach, and to find informed compromises between the increasing use of beach and foreshore by the soaring human population in the Kimberley Region and their use by the beasts and the birds. This is no trivial statement! 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*) and Bar-tailed Godwits (*Limosa lapponica*) of specific, reproductively isolated and morphologically and behaviourally distinct subspecies. The intertidal macrobenthic community of the Anna Plains foreshore is undescribed and is likely to contain unique species and species assemblages. Some of these species will be new to science.

This 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; it complements the comprehensive report edited by M. Pepping, T. Piersma, G. Pearson and M. Lavaleye now in press), 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 onwards. In the period 8-22 October 1999 we have made a concerted attempt to map both the invertebrate macrobenthic animals (those retained by a 1 mm sieve) along the Anna Plains foreshore and the shorebirds capitalising on this resource.

Our team comprised 72 volunteers (8 Landscope expeditioners, 8 Notre Dame University students, 33 local volunteers, 7 logistical support people, 16 science volunteers) and 8 scientific co-ordinators (Petra de Goeij, Marc Lavaleye and Theunis Piersma from NIOZ, Pieter Honkoop from University of Sydney, Grant Pearson from CALM, Danny Rogers from Charles Sturt University, and Bob Hickey and Michelle Crean from Curtin University). We visited about 900 sample stations laid out in a grid with 200 m intersections (the stations representing about 75 km² of intertidal mudflat) at 7 intertidal 'blocks' along about 80 km of beach (Map 1). The northernmost sector was found 10 km north of the Anna Plains entry to the beach, the southernmost 65 km to the south. In the course of digging up, sieving and sorting the mudsamples from the 900 stations, we identified and measured 18,600 individual invertebrates that represented about 112 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 as based on preliminary analyses carried out at Broome Bird Observatory during 22-28 October. It also allows us to pay tribute to the many individuals that made this work possible.

2. Study area and methods

The study took place along the section of Eighty Mile Beach bordering Anna Plains Station, stretching from 10 km north of the Anna Plains entry to the beach to about 65 km south of the Anna Plains beach entry. Along this stretch of beach 6 full and 1 partial 'blocks' of sampling points bordered by the high tide line on the landward side, and the then present low tide line on the seaward side were selected, the midpoints along the beach 15 km apart. The northern-most block was found 10 km north of the Anna Plains beach entry, the southernmost block 65 km to the south of that point. Other blocks were found 5 km, 20 km, 35 km and 50 km to the south of the beach entry, and all blocks were named accordingly (Map 1). With a spring tide on 11 October, sampling during the first week took place with spring tidal ranges, the full extent of intertidal flat being exposed. However, during the sampling of the blocks at 50 km and 65 km, the range of our sampling was severely constrained by the neap tides.

Each block consisted of 10 to 14 transects 200 m apart on a grid running east-west (the

'-10 km' to the '35 km' blocks) or south-north (the '50 km' and '65 km' blocks). Along each transect (numbered A to N from south to north) stations were placed every 200 m (assigned numbers going up from 1 to 20 in east-west or north-south directions), each of the blocks covering part of a predetermined 200 m grid covering the whole length of the Eighty Mile Beach foreshore. Every sampling station thus received a unique position-key (POSKEY) composed of the block-ID, the transect-ID and the down-the-shore-station-ID, an example being '35K3'. Each POSKEY combined with predetermined coordinates on a UTM-projection, using the Australian Map Grid 1966 as the horizontal datum. Navigating by GPS, teams of 2-5 people visited each of the stations based upon the geographical coordinates that were pre-assigned to them. It turned out to be helpful to use a handcompass to keep direction while moving about on the mudflats, and compensate for the inaccuracies of up to 50 m inherent in current GPS technology.

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. These sediment samples will be analysed by Dr Pieter Honkoop at the University of Sydney for grain size and organic content.

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 mudsurface, 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 camp, 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.

3. Preliminary results

Most observers, except the ones only walking the intertidal flats at the '65 km'-block, noticed the variable degree of difficulty walking over the intertidal flats. This large variability in 'penetrability' (probably to a great extent reflecting the degree of muddiness, or presence of small grain sizes) is nicely reflected in the map of penetrability (Map 2). There was a general decrease in penetrability (i.e. increased 'sandiness') the more one moved southwards along Eighty Mile Beach. There was also a great degree of patchiness in recorded penetrability at each of the blocks. Often, the areas of intertidal flat with soft mud (high penetrability) were eroding mudbanks. Even though there appeared to be a tendency for midshore areas to be the muddiest, we think that the geography of mudbanks, and the patterns of sediment-penetrability, will be continuously dynamic. Mudbanks would build up at particular sites in periods of relative calm wind and wave conditions, and erode away when the forces of nature change in character.

In the sorted samples collected at about 900 stations, we found, identified and measured a total number of 18,600 invertebrate animals. We recognised a total of 112 invertebrate taxa in these quantitative samples (Table 1). As several groups of animals were not identified to species level, for example the bristle worms (Polychaeta) that were sorted to the family level, the real number of species will be much higher, and the actual number of species found increases as we continue studying the collected animals. Furthermore, the many species of shells, sponges, and other remains of animals washed ashore are not included in the list. That a sizable proportion of the 112 identified taxa (34 or about a quarter) were only found at a single station suggests that many of the species were in fact quite uncommon. It is likely that they could only be collected due to intense and widespread sampling effort. Species richness was highest at ‘20 km’ (73 taxa compared with 41-60 in the other blocks; Table 1), and at this site the density and diversity of bivalves was certainly also highest.

Upon arrival at Eighty Mile Beach at Anna Plains Station, the many big shells along the spring high tide level are striking. Especially the Giant whelk (*Syrinx aruanus*), the Bailer shell (*Melo amphora*) and a large vase sponge are conspicuous and abundant. Living among this beached rubble is a land hermit crab (Coenobitidae) and Ghost crabs (Ocypodidae). These reddish ghost crabs were also seen walking in herds over the higher mudflats during the day. In the sandy area reached daily by the tides the presence of Sand bubbler crabs (*Scopimera inflata*) is evident from the peculiar little sandballs around their burrow. A bit lower in the sandy area, whole specimens of the thick-shelled colourful bivalve *Donax cuneatus* were found on and in the sediment. Some birds or crabs that dug them up could not get to the meat! In our quantitative samples a much smaller species of *Donax* shows up in densities as high as 3000 per m². This would be good food for shorebirds, and in fact Red Knots and Great Knots were observed feeding on wet patches of sandy beach on the ebbing tides, their droppings entirely comprised of *Donax* fragments.

For some species we have been able to produce maps of presence/absence. The common bivalves other than *Donax*, all of which are prime shorebird food, occurred predominantly low on the foreshore, quite close to the spring low water line (Maps 3-6). This is true for the Lucinid *Anodontia omissa* (Map 3) that was found most regularly at the 5 km block, but it was also true for the other Lucinid species belonging to the genus *Divaricella* (Map 4). *Divaricella irpex* was only found at the southernmost block at 65 km; a slightly different *Divaricella* (that may represent a separate species) was found at the 50 km and 35 km blocks. *Divaricella* was rare further north. *Tellina amboynensis* (Map 5) was not found in the southern blocks, but occurred low in the tidal zone. We found large individuals measuring over 2 cm in length, as well as many juveniles. We found abundant evidence of recent spatfall also in the light-shelled and highly active bivalve *Siliqua* cf. *winteriana* (Map 6) This species was

very abundant in places close to the low water line, the highest density being 8000 individuals per m². The sites of greatest density of *Siliqua* cf. *winteriana* were the 5 km and 20 km blocks. Spatfall of the less common *Tellina* cf. *exotica* was also encountered (no map). We discovered several species of bivalves not previously encountered during Roebuck Bay. Indeed, some of these may be new to science.

Tube-living worms belonging to the odd and rare phylum of the Phoronida (of which only about 15 species are known worldwide!) were found in the mid to low tidal range in the southern three blocks (Map 7). The bristle worms (Polychaeta) occurred at all sites, but with interesting differences between species and families. Of the two widely distributed families of active predators, the catworms Nephtyidae (Map 8) occurred slightly more upshore than the glycerid worms Glyceridae (Map 9). Whereas spionid worms Spionidae occurred mostly at mid- to low-shore levels in the central blocks (Map 10), the capitellid worms Capitellidae (Map 11) occurred at all levels of the shore but were widespread and abundant only at the southernmost 65 km block. The bamboo worms Maldanidae were much smaller in size than the ones found in Roebuck Bay and occurred at midtidal levels in the blocks between 20 km and 50 km south of the Anna Plains beach entry (Map 12). Owenid tubeworms occurred from the 20 km block southwards (Map 13). They were more abundant in the mid- and uppershore levels than near the spring low water edge.

Apart from the high parts of the foreshore, Ingrid-eating snails (*Nassarius dorsatus*; Map 14, which is based on the visual field recordings rather than the quantitative core samples) and sentinel crabs (*Macrophthalmus* spec.) were abundant at all blocks. A slender-shelled Columbellid snail was rather common too. Small Marginellidae were also seen crawling over the sediment surface. Surprisingly, here and there, orange sea pens (Pennatulacea) stick out of the sediment. Upon touching them they retracted rather quickly into the sediment. The soft mud patches could be recognised from a distance by the many mudskippers on the mudsurface. In the neighbourhood of human observers, these fishes were usually all hidden in their deep perpendicular burrows, the latter of which were quite different from the oblique holes of the sentinel crabs. In the quantitative samples, brittle stars (*Amphiura tenuis*) were sometimes very abundant (Map 15). Interestingly brittle stars occurred at the high shore at the -10 km block, the midshore at the 5 km and the lower shore at the 20 km and 35 km blocks (the sampling at 50 km and 65 km took place at rather neapy tides and the relationships there are therefore not clear). We found a strong association between a bright red species of Polynoidae (Map 16) and brittle stars (Map 15). It is evident that at stations with brittle stars no red polynoid worms were found. However, at virtually all stations where red polynoids were found, brittle stars were found as well, suggesting a dependence of red polynoid worms on brittle stars rather than the reverse. As is known from other polynoid species, red polynoid worms may live as symbionts on or near the brittle stars of Eighty Mile Beach. The hypothesis that these two animals indeed live together symbiotically or parasitically, found support when we carefully opened a core sample and found that the red polynoid lived in the burrows made by the arms of the brittle stars. The same exercise also revealed that the (central) body of the brittle star sits as deep as 13 cm in the sediment, and that the distal ends of the arms have dark spots.

Lots of a small orange transparent sea cucumber were found near the spring low water line at the 5 km and 20 km blocks (Map 17). Being small and almost transparent, the skin of these Synaptidae feels sticky because of the small sharp anchor-like calcareous deposits in the skin. The relatively large burrowing sea-anemones were especially interesting for the fact that all had 1-3 parasitic wentletrap-snails of the family Epitoniidae attached to their body, another striking interphyletic association at Eighty Mile Beach.

Some of the larger invertebrates were only encountered in the more southern blocks, for example some very flat sanddollars (*Arachnoides tenuilus*), several species of larger sea cucumbers and the bivalve *Solen* spec. Sometimes it was necessary to take samples at a station while there was still a lot of standing water. Although not dangerous, the encounters with shovel-nosed sharks or guitarfishes (Rhinobatidae) as they bumped against our legs were sometimes a bit unnerving. Three species of jellyfish were seen. The larger brown jellyfish *Cyanea* with dark spots was often found beached on the shore. A comb jellyfish was seen swimming in very shallow water, while the beautiful deep blue oceanic siphonophore *Porpita* found its grave at the beach.

Only one specimen belonging to the crustacean family of frog crabs (Raninidae) was found. The species in question was perfectly adapted to live rather deep in the mud. It had two long antennae with which it can form a breathing funnel to the sediment surface. Apart from mudskippers and some small Gobiidae, we caught several small Soleidae and noticed lots of small pelagic fish. This is an indication that the mudflats are important as a nursery for juvenile fish.

Ever since records began along the Anna Plains Station foreshore in 1981, the largest numbers of roosting birds were found just south of the station's beach access. During this expedition, on 13 and 17 October, we repeated the high tide counts of shorebirds between the -10 km and the 35 km blocks, and found the largest numbers of birds to occur along the usual stretch of beach from 5 km to 20 km south of the access. In addition, shorebirds were counted along the offshore transects, right in the middle of the six different blocks. Figure 1 shows a breakdown of densities of macrobenthic invertebrates per block in comparison with a breakdown of the numbers of shorebirds belonging to different 'foraging guilds' (i.e. groups of species with comparable feeding techniques). The guild of macrobenthos eaters comprised of the knots and the godwits achieved highest densities at the 20 km block. Their most likely prey category, the bivalves, reached highest densities at the adjacent 5 km block. Nevertheless, there was broad correspondence between abundance of birds and their benthic prey, both being depauperate at the northernmost block. We expect to find much clearer patterns of correspondence once we have analysed measurements of invertebrates to find which are most appropriate as shorebird prey.

4. Management Implications

The portion of Eighty Mile Beach that was sampled during this project could be described as in near pristine condition. We observed very little human impact along the intertidal zone from Cape Missiessy to Mandora although it is more apparent along the beach at focal points such as Wallal. We consider that this needs special management. The impact of major cyclonic activity such as the recent Cyclone Vance is significant, clearly visible and in some instances may be minimised through management strategies.

One of the objectives of this project was to produce an outline of conservation issues that need to be addressed for the proper management of Eighty Mile Beach. This is to be a collaborative effort between the main partners of the project and students from the Fremantle campus of Notre Dame University.

There are apparent, but possibly superficial, differences in the biota visible along the beach south of Mandora Station and the biota north of Mandora Station, that deserve further investigation. In particular is the lack, due possibly to tourists fossicking efforts, of relic shells on the various strandlines and a concomitant lack of hermit crabs. During a brief visit to Wallall Caravan Park there appeared to be a smaller crab fauna compared to the beaches further north. An assessment of the ghost crab population near the caravan park would be useful. It may be that they are fewer in number because of the higher vehicle traffic along that part of the beach.

Damage to dunes by vehicles being driven to sheltered sites at the rear of the dunes is clearly evident. Revegetation has been attempted but the growth of the plants is slow and often unsuccessful.

It is clear that one of the attractions of the Eighty Mile Beach, for tourists and local communities, is the ease of access to long stretches of remote and relatively uninhabited coastline. At present the effect of this activity on shorebird populations is reduced by the lack of accessability from the coastal highway to the shoreline north of Mandora Station. Shorebird densities are greater along this part of the Eighty Mile Beach. However it also clear that frequent disturbance by vehicles at high tide can be costly for migratory shorebirds, in terms of energy demands and should be minimised or eliminated.

A vehicle free zone should be considered for the area of coastline from Mandora to north of Anna Plains access road. This would in effect create a wilderness park and be managed by CALM.

The potential for a large horticultural industry on the coastal plain behind Eighty Mile beach is currently being examined by industry and government. Groundwater supplies may be linked to marine communities on the intertidal zone. Until this is clarified the use of groundwater should be closely managed.

Pollution of the intertidal and near shore habitats from chemicals associated with horticultural development is also a concern for managers of shorebird roosts and feeding grounds and pearl production nurseries. Further work on this is necessary and may be followed up through the on-going monitoring program of the benthos over the next two years. Curtin University will carry out a literature search for information on groundwater quality of this region.

Although there are no clear indications of commercially exploitable fisheries on the intertidal zone at present, it is conceivable that some level of netting may occur in the future. The populations of the reef forming Sabellariidae worms are especially vulnerable to disturbance by drag net fishing activities. Other species may also be at risk to other types of commercial exploitation and will benefit from protective measures instituted now.

5. Conclusions

Although many more stations were sampled at Eighty Mile Beach than at Roebuck Bay in 1997, fewer taxa were found at Eighty Mile Beach. The difference between the location (112 against 163 taxa) may be easily explained by the higher diversity of habitats in Roebuck Bay. Here there are mangroves, creeks and wave-protected areas with very soft mud, all of which are not present at Eighty Mile Beach. Nevertheless, it would be a great mistake to conclude that the fauna of Eighty Mile Beach is 'just' an impoverished Roebuck Bay fauna. More than 40 taxa were found at the Anna Plains foreshore only. Among these are several bivalve species mostly belonging to the family Tellinidae, the relatively large Columbellid snails, the tiny *Ringicula* snail, the tiny tuskshell *Cadulus* spec. Among the bristle worms, the 5 cm large *Pectinaria* or gold combs with their peculiar tubes of sand grains, were totally new, while clumps of the reef forming Sabellariidae were frequently found near the low water line. These sabellarids are peculiar to mechanically undisturbed sedimentary shores. New in the group of the Cnidaria (e.g. sea anemones) are the sea pens (Pennatulacea) and the burrowing sea anemone with its parasitic epitonid snails. The flat sanddollar (*Arachnoides tenuilus*) and several sea cucumbers are also new. The tiny amphipod *Corophium*, living like a hermit crab in all sorts of shells or parts of crab legs, was very abundant at some stations and is new record for our species list. The mussel *Modiolus micropterus*, that occurred in very low numbers in Roebuck Bay buried in the sediment, was found in abundance stranded on the beach and attached to old stems of the plant Spinifex.

There are several species that were peculiar, abundant or important to the Roebuck Bay intertidal benthic fauna that are missing in the Eighty Mile Beach samples. The strange cone shaped mud sponge, of which a restricted number of individuals was found at only one spot, was not found at all on the mudflats of Eighty Mile Beach. So it seems the distribution of this species is very restricted and needs special attention. Among the bivalves several common species of Roebuck Bay (*Solemya, Anadara granosa, Cultellus, Tellina capsoides, T. piratica, Gari lessoni, Anomalocardia squamosa* and *Laternula creccina*) were entirely absent at Eighty Miles Beach, suggesting a rather restricted distribution. In a regional context, these species may be restricted to Roebuck Bay. The many unknown tellinids may actually be endemic to either Roebuck Bay or Eighty Mile Beach!

Among the other Mollusca the total absence of the two species of Dentaliidae was striking. Not surprisingly the snails that were only seen in the neighbourhood of the mangroves, like the small Ingrid-

eating snail (Nassarius spec.), Salinator cf. burmana and the small Stenothyridae, were absent too. The plastic worms (Chaetopteridae) that occurred in high densities in Roebuck Bay and did give the sorters a hard time in 1997 were not found at Ostracoda, remarkable for leaving green or purple glowing tracks during the night, were not caught in our sieves. Another crustacean, the mantis shrimp (Squillidae), was only found a few times in the Eighty Mile Beach samples, while it was rather abundant in Roebuck Bay. Among the true crabs especially the absence of the Hymenosomatidae, a tiny spider crab abundant in the muddy parts of Roebuck Bay, was striking. Of the brittle stars we only found one species that buried in the sediment, while in Roebuck Bay there were several species. The diversity and differences between the sea cucumber fauna still has to be worked out, but it is already clear that there are important differences.

There are important management considerations for the intertidal and dune systems of Eighty Mile Beach. At present there are no provisions to control disturbances to roosting shorebirds by off road vehicles or increased human activity. These aspects of disturbance should be considered as part of an integrated management plan for Eighty Mile Beach.

6. Acknowledgements

Logistically the prospect of mapping benthic invertebrates of Eighty Mile Beach is daunting. The large expanse of intertidal zone requires a large number of participants (at least 80 were involved in this survey) to successfully complete such a survey. This is difficult to achieve without an adequate budget. In this context we acknowledge the personal financial contribution from the Landscope Expeditioners Richard and Susan Ahrens, Lawrence Bartlett, Fiorenzo Conforti, Fiona Joshua, Loisette Marsh, William Millar and David Seay. The contribution from this group added significantly to the success of the expedition and has helped lay a strong foundation for on-going community involvement in benthic studies at Eighty Mile Beach, Roebuck Bay and King Sound.

The Lotteries Commission provided a grant of $29,695 and established a base from which objectives could be refined and pursued. Without these funds the operations would have been severely curtailed. Community involvement could now be fostered and the success of this aspect has been considerable. On-going monitoring at the three sites in the Kimberley has been initiated by two local participants from this expedition and is due largely to the financial support from Lotteries Commission. There is great potential to bring to the local communities a fresh perspective of the value of intertidal habitats.

The Pearl Producers Association provided a grant of $4500 towards the costs of the expedition (including airfares for scientists from NIOZ) and is gratefully acknowledged. Our thanks to Mick Buckley and Richard McLean for their support. The CALM Landscope Visa Conservation Fund provided $2900 towards the cost of a vehicle to and from the site. This was the first solid offer of financial support for the expedition and provided the basis upon which optimistic planners could plan.

Environs Kimberley provided great support and enthusiasm for the project. Many thanks in particular to Maria Mann, Pat Lowe and Finn Pedersen for their effort, foresight and input into this important conservation program for intertidal mudflats.

The Western Australian Department of Main Roads very generously loaned the expedition a mobile facility caravan that was converted for the expedition into a laboratory. This excellent facility provided a clean air-conditioned environment for the laborious task of identifying the thousands of invertebrate specimens and the important tasks of map generation and data entry. These activities continued well into each night, without interruption from the usual hordes of insects that can be present in October. We are indeed indebted to Main Roads and in particular Andy Jameson and Bryan Bannon for their assistance and support.

The exhaustive nature of this work is demanding on individuals and the need to collect samples quickly during

spring tide periods can place additional strains on resources. Intelligent site selection is imperative to maximise gain per unit of effort in high tropical temperatures. The role of Bob Hickey in the generation of a quality GIS database from which location maps could be produced is acknowledged. The two primary foci in this survey involved the relationship of shorebird feeding sites to the nature and distribution of the benthic biomass and the further development of community interest in intertidal environments. The former consequently restricted the survey to the northern 100 km of Eighty Mile Beach and the latter benefited from this site selection because of the elevated biological (shorebird) components of that part of the study site.

Students from The University of Notre Dame, Fremantle Campus contributed a total of $800 towards the operating costs of the expedition and provided a very high quality of input into all aspects of the expedition operations. Their youthful exuberance and dedication to tasks were exceptional and contributed to the overall success of this project.

A total of 81 people provided some input into the expedition. During the survey 68 adults participated in field collections of samples and sorting, the primary science activities of the survey. It is pleasing that four children participated at various times and with a variety of activities. Their presence on site enabled parents to participate and thus contribute significantly. Another 9 people assisted by providing logistical support or advice and are listed as participants.

The result achieved after only 15 days of survey fieldwork is impressive and a credit to all those involved. We are indebted to every member of the expedition for their own important contribution. We are especially grateful for the following contributors to the *ANNABIM-99* survey. Jamie Wallis as a Director of Wallis Drilling provided an extraordinary high level of specific support with the provision of a 10 tonne truck and superb 7-seat hovercraft. Both of these items of equipment, provided free, ensured flexibility of operations and a quality of support previously only dreamed about. The generosity and professionalism of Jamie and his company is gratefully acknowledged.

Ted Costello and Warren Utting kept the machinery operating throughout the project, assisted with catering and offered their special skills and support around the camp and in the field. Their attention to detail, camp knowledge and ready offer of assistance at any time of the day or night (including a midnight run by Ted and Bob Hickey to Broome hospital) was invaluable. The vehicle provided by Ted was a significant asset for an expedition that struggled at times for adequate transport as a result of the overwhelming rate of participation by local Broome participants.

Brent Johnson, Chris Nicholson and Joanne Varley provided a superb cuisine and a quality of catering that defies description. Joanne continued the standard in the second week with able assistance from Jan and Kevin Dawson, Pat and Bill Duxbury, Helen McArthur, Marcel Ponti and Mavis Russell. The positive attitude and camp experience of these people contributed greatly to the high spirit of the camp and science activities.

We are also especially grateful for the generosity and tolerance shown by the Manager/ Director of Anna Plains Station John Stoate. By allowing the expedition to camp near the Station homestead ensured that participants would have access to abundant shade and potable water, be well looked after and able to concentrate on the field and lab work without wasting valuable time and energy on maintenance of camp activities in the hot sand. We are also grateful for the assistance from the Anna Plains mechanic Bob for his advice and understanding. The provision of the Anna Plains aircraft for a low level aerial photographic reconnaisance was of particular value for the possible identification of fresh water upwellings along the intertidal zone of the northern part of the beach. John also agreed to the concept of regular monitoring of Eighty Mile Beach benthos by a local community based group at several sites near the Anna Plains access track and the provision of a protected site adjacent to the main workshop for the mobile laboratory. This proactive and supportive action is very gratefully acknowledged.

Special thanks go to Jim Lane, Keith Morris and Neil Burrows of CALMScience and Allen Grosse, Tim Willing and Debbie Burke of West Kimberley District for their support for the project and for making

CALM staff and equipment available. We are especially grateful that Allen Grosse loaned us one of his vehicles.

Ron Watkins provided the Curtin Troopcarrier 4x4 which was of immense value for towing and a reliable transport of participants. Our thanks also for his input into the planning of the study and the offer to process the sediment samples. Leigh Davis and Graeme Behn of CALM Information Management Service assisted with the acquisition of Landsat and aerial photographs of the study site.

Coca Cola Bottling through John Triplett donated two 1000 litre potable water containers. Clive Minton is thanked for providing the results of his shorebird count of 1998 and for his ongoing valuable advice. Thanks to Nick Budge, Alan Clarke, Sandy Grose, Rod Mell and Sue Pegg, for assistance before, during and at the completion of the project. Special thanks to Ken Hartnett for his capable assistance as off-sider for Jamie Wallis and assistant in the camp.

The following people participated in one way or another in the fieldwork at Eighty Mile Beach: Persinne Ayensberg, Ruth Bowser, Venetia Brockman, Andrew Bussau, Jacinta Bussau, Cass Hutton, Jackie Cochrane, Liz Cochrane, Anne Marie Davies, Jan Dawson, Kevin Dawson, Bill Duxbury, Pat Duxbury, Maura Garry, Matt Gillis, Sharon Grey, Lucy Lawrence, Pat Lowe, Maria Mann, Charlotte Matheson, Helen Macarthur, Conor McGovern, Harley Pedersen, Kane Pedersen, Maria Pedersen, Marcel Ponti, Jamara Ryan, Michael Slattery, Roni Star, Jacinta Thomas, Michelle Wardley, Tim Watson, Danielle Whitfield, Michelle Crean, Bob Hickey, Richard Ahrens, Susan Ahrens, Lawrie Bartlett, Fiorenzo Conferti, Fiona Joshua, Loisette Marsh, William Millar, David Seay, Ted Costello, Ken Hartnett, Brent Johnson, Chris Nicholson, Grant Pearson, Warren Utting, Joanne Varley, Jamie Wallis, Shawn Debono, Megan Driscoll, Danielle Gabriel, Lindsay Goodwin, Benson Holland, Adam Kent, Marie Louise Thonell, Matt Valente, Anne Breckwoldt, Roland Breckwoldt, Michelle Costello, Petra de Goeij, Pieter Honkoop, Marc Lavaleye, Karen McKeogh, Caitlin McKeogh, Shapelle McNee, Jack Robinson, Danny Rogers, Mavis Russell, Finn Pedersen, Theunis Piersma, John Stoate, Debbie Burke, Allen Grosse, Chris Hassell, Tim Willing.

Table 1. Species list of intertidal macrobenthic invertebrates found in the quantitative samples, and their occurrence in the different 'blocks' along the foreshore of Anna Plains Station. Open dots indicate that the species has been found at a single station only; stars indicate occurrence at multiple stations.

Benthics and Birds ## ROEBIM '97 ## KING SOUND ## 80 MILE BEACH ## SROEBIM '02# # Bob's Homepage ## Geography Dept. ## CWU

Website design and maintenance by
Dr. Robert Hickey
last updated on 21 August, 2002