EXECUTIVE SUMMARY

1. The Torres Strait Baseline Study (TSBS) has involved an initial pilot sampling programme which consisted of the collection of sediments and biota. The objectives of the pilot study included: (a) the identification of animals and plants which would be suitable indicators of variation in environmental trace metal concentrations for the main study; (b) an assessment of the distribution and variance in trace metal concentrations in sediments and biota from the Torres Strait such that the sampling programme and strategies for the main study could be refined; and (c) a preliminary assessment of the impacts of present levels of trace metals in marine biota on the health of Torres Strait Islanders and coastal Papuans. This report presents results which relate to objectives (a), (b) and (c) above.

2. Results are presented for: (1) sediments; (2) a wide range of biota, including two species of seagrass (*Thalassia hemprichii* and *Thalassodendron ciliatum*), five species of bivalve mollusc (the boring clam *Tridacna crocea*, the rugose giant clam *Tridacna maxima*, the black-lip pearl oyster *Pinctata margaritifera*, the zig-zag oyster *Hyotissa hyotis*, the jewel-box oyster *Chama plinthota* and the mangrove cockle *Polymesoda erosa*), two species of gastropod mollusc (*Trochus niloticus* and the red-lipped stromb *Strombus luhuanus*), the sea cucumber *Stichopus chloronotus*, and the stripey reef fish *Lutjanus carponotatus*; and (3) a range of marine animals which comprise important food items for Torres Strait Islanders and coastal Papuans. Samples for (1) and (2) above were collected from a range of locations during two sampling periods: the pre-monsoon (September-October, 1991) and post-monsoon (April-May, 1992) seasons. Community fishery samples were collected over a period of nine months from June 1991.

3. Sediment samples identify the Fly River as a major source of fine-grained sediment containing a suite of major and trace metals (including aluminium, cobalt, chromium, copper, iron, manganese, nickel, lead, silica and zinc) to the northern Torres Strait. Arsenic, cadmium, magnesium, mercury and selenium are not primarily associated with terrigenous sediments and their concentrations in sediments are unlikely to have been significantly influenced by Fly River discharge. Cadmium is primarily associated with coarse-grained carbonates of marine origin.

4. Six species (*T. crocea*, *T. maxima*, *P. margaritifera*, *P. erosa*, *T. niloticus* and *L. carponotatus*) are identified as good indicators of trace metal bio-availability on

the basis that they do not appear to regulate the concentrations of most metals in their tissues. However, only two (*T. crocea* and *P. erosa*) are recommended for use as bio-monitors in the main study as the others were found to have low abundance and a patchy distribution.

5. Seasonal differences in metal concentrations were not consistent across all locations that were sampled for biota. Two patterns are apparent: (a) in the central Torres Strait most trace metals showed little seasonal variation or elevated concentrations during the pre-monsoon season; while (b) in the northern Torres Strait many trace metals displayed higher concentrations during the post-monsoon season. Spatial patterns in trace metal concentrations were still more complex. However, many metals displayed highest concentrations at the most northern locations closest to the Papua New Guinea coast and Fly River, particularly during the post-monsoon season. Increases in the concentrations of cadmium, copper, strontium and zinc in *T. crocea* over the monsoon period appear to be related to coastal runoff and to have resulted from: (1) increased concentrations of these metals derived from river discharge; and/or (2) physico-chemical changes in the watermass leading to increases in (a) the bio-available portion of the metals only and/or (b) metal kinetics within biota. Changes in the concentrations of aluminium, arsenic, cobalt, mercury, nickel, lead, selenium and uranium over the monsoon period are thought to be unrelated to coastal runoff.

6. Concentrations of cadmium, copper, mercury, nickel, lead and zinc from various tissues within *T. crocea*, *T. maxima*, *P. margaritifera*, *H. hyotis* and *L. carponotatus* are contrasted with results from other published studies of these species from the Torres Strait, Great Barrier Reef and Coral Sea. On this basis, copper, mercury, nickel, lead and zinc concentrations in the central Torres Strait do not appear to be elevated above concentrations found elsewhere within the Great Barrier Reef. Only cadmium in samples from throughout the Torres Strait is elevated above background concentrations in the Great Barrier Reef. Copper appears to be elevated during the post-monsoon season at the most northerly sampling location only, but only to a level slightly above that found at coastal locations in the Great Barrier Reef. On the basis of biological concentration factors for *T. crocea*, only dissolved cadmium concentration appears to be very high in the Torres Strait.

7. Samples of *P. erosa* collected from Boigu and Saibai Islands identify seasonal differences in the concentration of only two metals, copper and mercury, both of which were elevated following the monsoon period. The relatively high

concentrations of many metals from sampling locations on the Papua New Guinea mainland suggests that there may be a strong off-shore gradient which could potentially be confounded with any long-shore gradient. The marked differences in concentrations of many metals between the two mainland locations, which are separated by only a few kilometres, also suggest that inputs from rivers entering along the coast to the west of the Fly estuary may have a significant influence over local metal concentrations. This is consistent with Al-normalized trace metal concentrations in sediments which indicate that there is a major source of trace metals on the western side of the Torres Strait, possibly in Irian Jaya or along the west coast of Cape York peninsula.

8. The concentrations of arsenic, cadmium and selenium in the edible portion of foods consumed by Torres Strait Islanders repeatedly appear at levels close to or above the National Health and Medical Research Council's Maximum Permitted Concentrations for seafoods. These foods include the Murray Island sardine *Harengula ovalis* (Ari ari), the sardine/hardyhead (Koss), the green turtle *Chelonia mydas* (Waru) and the dugong *Dugong dugon* (Dhangal), all of which are reported to be important components of the diet of many Torres Strait Islanders. However, none of these trace metals (arsenic, cadmium and selenium) is believed to be associated with Fly River discharge to any appreciable degree. These results should not be taken to signify an immediate health threat to Torres Strait Islanders who consume these foods. However, they do indicate the need for a more detailed study of the diet of Torres Strait Islanders and coastal Papuans, and the metal concentrations associated with the foods that are consumed.

9. The following recommendations are made:

(1) The arrangement and number of sampling stations should be modified from that originally proposed and be as indicated in Figures 131 and 132 for sediments and biota respectively. The western leg of the sediment transect which parallels the PNG coast (Fig. 131) should be moved closer inshore so that variation in grain-size among locations is minimized. The station size for sediment sampling should be increased to 500m x 500m to avoid pseudo-replication of sites;

(2) Sampling of both sediments and biota as indicator organisms for the main study should be carried out during two periods: the pre-monsoon (October-November) and monsoon seasons (February-March);

(3) The boring clam *Tridacna crocea* and the mangrove cockle *Polymesoda erosa* should be selected as indicator species for the main study. The shell length of *T. crocea* should be restricted to a size range of 70 to 80 mm. An

alternative to shell length should be investigated as a measure of age (e.g. growth rings and shell weight);

(4) *T. crocea* should be collected along three transects from the following locations: Kokope Reef, Warrior Reef, Dungeness Reef, Poll Island, Campbell Island, Rennel Island, Aureed Island, Toms Son Bank, Bramble Cay, Underdown Reef, Little Mary Reef and Hibernia Passage reef. Five replicate samples should be collected from each of eight sites per location. Both replicates and sites should be randomly selected;

(5) *P. erosa* should be collected along three transects from the following locations: Boigu Island, Saibai Island, Bobo Island, Kussa Island, Warukuik, West Aberemuba, Zaigai Island and Sassie Island. Five replicate samples should be collected from each of three sites per location. Both replicates and sites should be randomly selected. Specimens should be flushed with double de-ionized water to remove any sediment adhering to the surface of the soft tissue or within the gut.

(6) The community fishery collection programme should continue. As a result of the paucity of samples from some locations, the small sample sizes and the relatively high concentrations of some metals in many species, collection should place an emphasis on:

(a) locations where few samples have been collected to date (e.g. Boigu and Saibai Islands); and

(b) those species which show relatively high concentrations of metals (e.g. *A. barracuda*, *C. schoenleinii*, *E. fasciatus*, *H. ovalis*, the sardine/hardyhead, *C. mydas* and *D. dugon*);

(7) Consideration should be given to establishing a 'market basket' survey (of the type referred to in NHMRC, 1991) of the trace metal levels in the foods which constitute a significant part of the normal Torres Strait Islander diet. Representative communities from the different regions of the Torres Strait should be selected; and

(8) Future chemical analysis of samples should include tin (Sn) and establish the levels of inorganic arsenic. The concentrations of both of these metals are unknown at present, yet they are important in assessing the health implications of metals in diets. Consideration should be given to reanalysing samples which show high levels of total arsenic from the present study for inorganic arsenic concentrations and tin, where sufficient material remains.