## SUMMARY AND RECOMMENDATIONS

1. The Torres Strait Baseline Study (TSBS) was initiated by the Australian Government in response to the concerns of Torres Strait Islanders, scientists and fisherfolk about the possible effects on the Torres Strait marine environment from mining operations in the Fly River catchment of Papua New Guinea. The Study began in 1990. The scientific program commenced with a Pilot Study which undertook a preliminary assessment of the levels, and sources, of trace metals in Torres Strait, investigated several species of marine organisms for use as indicators of trace metal levels in the marine environment, and assessed levels of trace metals in seafoods commonly eaten by Torres Strait Islanders. The results of the Pilot Study were used to design a more comprehensive and broadscale Main Study, which was undertaken in the Torres Strait in 1992-93. It is the results of the Main Study which are reported here.

2. This report provides information on the trace metal content of sediments, indicator organisms, and some of the traditional seafoods of the Torres Strait.

3. The Study concluded that the influence of the Fly River on the trace metal levels and content of sediments and selected indicator organisms was limited to the northern Torres Strait. Other, smaller coastal rivers of Papua New Guinea influence the trace metal content of sediments in the north of the central Torres Strait. Levels of trace metals in locations influenced by the Fly River were less than levels reported from polluted regions, and comparable to levels found in unpolluted locations on the Great Barrier Reef. High levels of some trace metals, including cadmium, were found in some seafoods commonly eaten in the Torres Strait and warrant attention by health authorities. These high levels appear to be unrelated to human activities.

4. Marine sediments in the Torres Strait contain a suite of trace metals derived from different sources. Trace metals derived from mainland Papua New Guinea (from the Fly River and smaller coastal rivers) include aluminium, arsenic, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead and zinc. Levels of these metals are highest in fine-grained sediments in the northern Torres Strait near the mouth of the Fly River and close to the Papua New Guinea coastline. A number of these trace metals occur in higher concentrations in sediments coming from the Fly River, including aluminium, copper, mercury, nickel and zinc.

5. Cadmium in Torres Strait sediments is derived from marine sources: concentrations are highest in coarse-grained sediments with a high calcium carbonate content from the central and eastern Torres Strait. Selenium was not associated with either marine or land-based sources and concentrations were similar throughout the Torres Strait.

6. Sediments from the Fly River penetrate only a small distance into the Torres Strait, possibly to a line from just north of Bramble Cay (9°08.5’S, 143°50.1’E) to the northern end of the Great North-East Channel (9°13.5’S, 143°29.9’E).

7. Levels of cadmium, copper, lead and zinc in sediments reported in this study for the Torres Strait and mouth of the Fly River were similar to levels found in comparable, unpolluted locations in the tropics, and less than levels reported from similar areas regarded as contaminated.

8. The trace metal content of sediments in the northern and central parts of the Torres Strait west of the Warrior Reefs appears to be influenced by smaller rivers along the Papua New Guinea coastline, and not the Fly River. The influence of these smaller coastal rivers on the Torres Strait is limited, possibly extending only to the area west of Moon Passage (around 9°35.0’S, 142°47.0’E).

9. Levels of trace metals in sediments collected during the Main Study (1992-93) were similar to levels reported from the Pilot Study (1991-92). And, levels of trace metals reported in the present study were similar to levels reported in other earlier studies (1989-90) from similar locations in the Torres Strait and from near the mouth of the Fly River.

10. Two species of marine molluscs were collected as indicators of trace metals in the surrounding environment: the burrowing clam *Tridacna crocea* and the mangrove cockle *Polymesoda erosa*.

11. The levels of particular trace metals in burrowing clams was largely influenced by their location in the Torres Strait. Burrowing clams in the northern Torres Strait had higher levels of cadmium, copper, lead, manganese, mercury, silver and zinc. In the central and eastern Torres Strait burrowing clams had higher levels of arsenic, cobalt, iron, selenium, strontium and uranium. Chromium and nickel were highest in clams in the southern Torres Strait; aluminium was highest in clams from both the northern and southern Torres Strait.

12. Amongst reefs in the Torres Strait where burrowing clams were sampled, Bramble and Kokope Reefs were the most consistently influenced by water from the Fly River. Levels of copper in burrowing clams from these two locations were either less than, or equal to, copper levels in burrowing clams collected from similar locations on the Great Barrier Reef regarded as being unpolluted.

13. Levels of many trace metals in burrowing clams changed from the pre-monsoon to monsoon season: cobalt, copper, iron, nickel, selenium, strontium and uranium dropped from the pre-monsoon to monsoon at all stations; aluminium, manganese and lead also dropped from the pre-monsoon to monsoon season but not at all stations; zinc levels increased at all stations between the pre-monsoon and monsoon seasons; mercury also increased over the same time but not at all stations. Levels of arsenic, cadmium, chromium and silver did not change between seasons.

14. There was little correspondence in the relative levels of trace metals between burrowing clams and sediments which had been collected from similar locations in the Torres Strait. The only exceptions to this were copper, lead, manganese, mercury, selenium and zinc. Corresponding spatila trends in the levels of these metals were detected in both burrowing clams and sediments, in both seasons.

15. Seasonal changes in the levels of most trace metals in burrowing clams did not reflect the seasonal changes which were recorded in sediments collected from similar locations. Only four metals (cadmium, nickel, selenium and zinc) underwent similar changes between seasons in burrowing clams and sediments.

16. The complexity of the results for burrowing clams indicate that trace metal levels are a product of the environmental levels of metals, and some other environmental variable (e.g. salinity, water temperature, pH). This has implications for their use as indicators of environmental levels of trace metal levels in monitoring programs in locations where these variables undergo considerable changes.

17. Patterns in trace metal levels in mangrove cockles were variable and influenced to a greater extent by local variability in trace metal levels rather than their proximity to the major terrigenous sources of trace metals.

18. The trace metal content was assessed in a wide range of seafoods commonly eaten by Torres Strait Islanders, including fishes (fifteen species), molluscs (one species), crustaceans

(two species), green turtle and dugong. The majority of species had low levels of trace metals, when compared with established standards. The exceptions to this were:

- single specimens of parrotfish (high levels of cadmium and copper) and barramundi (high levels of mercury);
- boiled crayfish heads (high cadmium levels);
- dugong liver (high levels of cadmium, copper, selenium, zinc and possibly mercury); dugong kidney (high levels of cadmium and selenium); dugong intestine (high levels of cadmium); and
- turtle liver (high levels of cadmium, copper, mercury, selenium); turtle kidney (high levels of cadmium, selenium and possibly mercury); turtle intestine and muscle (high levels of mercury).

19. Established health standards for cadmium are exceeded by weekly consumption of relatively small quantities of crayfish hepatopancreas (between 79 and 222 g per week), dugong liver (17-47 g), dugong kidney (13-37 g), turtle intestine (29-82 g), turtle kidney (6-11 g), and turtle liver (10-28 g). Current consumption patterns of these foods in the Torres Strait are unknown.

20. Elevated levels of cadmium in turtle and dugong tissues are not unique to the Torres Strait. Similarly high levels occur in dugong from other parts of Queensland, and in green turtles from Hawaii.

21. Cadmium occurs naturally in Torres Strait marine sediments, with the highest levels occurring in coarse-grained sediments with a high calcium carbonate content.

**Recommendations**

The following actions are recommended, as a consequence of the results of this Main Study.

1. Undertake a long-term monitoring program for trace metal levels in the sediments and selected indicator organisms of the Torres Strait marine environment. The principal aim of this monitoring program will be to:

- gather long-term data on levels of trace metals in the sediments and selected indicator organisms of the Torres Strait, and the characteristics of sediments, in a way that will allow for the reliable detection of trends over time that could be associated with human activities.

1.1 Fulfil the principal aim of the monitoring program by following the sampling design used in the present study, with the following changes:

- examine alternative means of monitoring at Bramble and Warrior Reefs because of potential difficulties in obtaining sufficient numbers of burrowing clams (e.g. investigate the use of transplanted clams);
- collect mangrove cockles of a similar size/age range (e.g. 60-70 mm shell length) from the same localities;
- initiate community and scientific discussions on whether the extent of changes in trace metal content and sediment characteristics that are detectable through the current sampling program are acceptable, and amend the sampling program if necessary.

1.2 Continue monitoring at three yearly intervals. The monitoring program should therefore begin in the pre-monsoon season of 1995 (i.e. three years after sampling for the present study was undertaken).

1.3 The Great Barrier Reef Marine Park Authority to coordinate and undertake this monitoring program (because of the networks and expertise established during the course of the Baseline Study).

2. Survey the consumption rates of seafoods (especially dugong and turtle) and other foods by Torres Strait communities at different locations, and over an extended period of time. As a parallel initiative, this survey should be extended to include north Queensland coastal Aboriginal communities. Use these results, with the results on trace metal content, to assess the health implications of consuming large quantities of dugong and turtle.

3. Undertake a community education program at all island communities throughout the Torres Strait and coastal Papua New Guinea, to explain the results of this Study and the potential health implications. This program should be team-based and include a representative of the Great Barrier Reef Marine Park Authority familiar with the results of the Study, a Torres Strait Islander familiar with the Study and most island communities and a Torres Strait health worker.

4. Convey the results of this Study, and the potential health implications of the seafood study, to north Queensland coastal Aboriginal communities.

5. Analyse the remaining dugong and turtle samples, to reduce the variability in the estimates of levels of metals in these food items, as a means of improving public health advice and planning. Analyse additional samples of fish species where trace metal levels where high, but only a limited numbers of specimens were tested e.g. barramundi, parrotfish and Murray Island sardines.

6. Analyse whole, cooked hepatopancreas from crayfish, as it is known that this is now more regularly eaten in the Torres Strait.

7. Undertake additional statistical analysis of data on the trace metal content of sediments to incorporate the revised arsenic results, and also the effect of grain size variation on the spatial and temporal patterns of trace metals in sediments.