SUMMARY

- The Torres Strait Baseline Study comprised four component programmes, each addressing a specific important aspect of the Torres Strait marine environment. This document reports results of the Commercial Fisheries component. Results of the other three components, Community Fisheries, Marine Sediments and Indicator Organisms, are reported separately in Dight and Gladstone (1993) and Gladstone (1996).

- This report provides information on the following heavy metals in commercial species of prawns and crayfish in the Torres Strait: silver, aluminium, arsenic, cadmium, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead, selenium, strontium, uranium and zinc.

PRAWNS

- Three species of prawns were studied: *Penaeus esculentus* (brown tiger prawn) and *Metapenaeus endeavouri* (Endeavour prawn), which together comprise around 90% of prawns landed in Torres Strait and *Penaeus longistylus* (red spot king prawn) which makes up the remainder.

- Prawns were collected from two main sites in June and October/November 1992.

- Generally, metal levels reported were either significantly less than those reported previously from polluted environments, or additionally, in agreement with or less than those from representative unpolluted areas, including previous studies in Torres Strait.

- This was not the case for cadmium. Cadmium levels in the present study were comparable to those reported from elsewhere in Australia and a polluted coastal site in the Arabian Sea and higher than those reported from some unpolluted sites.

- While this indicates a high cadmium bioavailability in Torres Strait, it is clearly not due to pollution. Cadmium is not a metal associated with Fly River runoff but rather a naturally occurring element in marine carbonate sediments. Such sediments are prevalent in Torres Strait.

Factors affecting metal levels in prawns

- Prawn heads contained highest levels of most metals measured. This was not surprising, as the head contains the hepatopancreas, an organ known to be an important metal storage site in decapod crustaceans.

- Tail flesh contained among the lowest concentrations of all metals except arsenic and mercury. Thus, except in the case of these two metals, tail flesh does not contain important metal storage sites and is not a good indicator tissue for metal monitoring.

- While not a good indicator tissue, tail flesh is the most important tissue with respect to trade and human health. This is because it is the tissue that most people eat and thus it is generally accepted as the tissue to which trade and health limits apply. This study examined the influence of various 'manageable' factors on the levels of metals in this tissue.

- Most results of this study support the expectation that prawns regulate essential elements and accumulate non-essential elements.

- Two exceptions were copper and zinc, which are essential metals associated with Fly River runoff and thus expected to occur in higher concentrations in sediments at the northern site. Prawns from the northern site contained elevated levels of these two metals in head tissues (the principal storage tissue), while levels of these metals in tail flesh remained constant.

- Seasonal variation (between pre-and post- monsoon) in metal content of prawn tail flesh was minimal. However, the monsoon season encountered during this study was abnormal, with lower than average rainfall.

- There was no difference in tail flesh metal levels between small and medium sized prawns. However, large prawn tails contain slightly higher levels of cadmium and mercury (both non-essential elements).

- There were no substantial differences in tail flesh metal levels between sexes or prawns from different moult stages.

- *M. endeavouri* tail flesh contained higher levels of cadmium, zinc, mercury and arsenic when compared with the other two species.

- Metal levels in tail flesh were measured for prawns which were handled according to treatments approximating various industry practices. Levels of copper, strontium, iron and cadmium were elevated in at least one of these 'industry' treatments.

- It is suggested that this elevation is due to leakage of high level tissues in the head (e.g. the hepatopancreas) into lower level tail flesh. The hepatopancreas readily breaks down and turns to 'mush' after prawn death and particularly after freezing and thawing. It is noted that head tissues of *M. endeavouri* are particularly fragile and that head 'leakage' may account for elevated levels of some metals in tail flesh of that species.

Metal levels in prawns with respect to trade and health

- Concentrations of most metals in prawns reported in the is study complied with trade and health limits. This i true regardless of whether whole prawn or tail flesh is considered (ie taken as the 'edible portion')

- One exception was cadmium. Average concentrations of cadmium in tail flesh were close to the Maximum Permissible Concentration (MPC) of 0.2 mg/kg, while some samples analysed exceeded it. Sustained consumption of prawn tails does not appear to present a health risk with respect to the World Health Organisation's Provisional Tolerable Weekly Intake (PTWI) for cadmium. However a recent medical review indicates that the current PTWI for cadmium may be too high.

- Given the close relationship between cadmium levels in tail flesh and the MPC and the ambiguity over safe consumption limits, any factor which influences cadmium levels in this tissue, even slightly, is important.

- Results of this study show that such minor elevation of cadmium in prawn tail flesh occurs with size, after some forms of industry processing and that *M. endeavouri* tails generally contain higher levels.

- If whole prawn is taken as the 'edible portion' for the context of legal limits, both cadmium and copper concentrations exceeded the MPC.

- With respect to health limits however, copper load in 10 whole prawns would contribute less than 5% towards the PTWI.

- This is not the case for cadmium. A single whole prawn may contribute 20-25% of the PTWI, and thus regular consumption of many whole prawns may constitute a health risk depending on how much cadmium consumed is bioavailable in the human gut.

Recommendations for further research

- It is recommended that further work be undertaken on the potential for handling methods to influence tail flesh levels of cadmium.

- It is also recommended that clarification of safe sustainable cadmium intake levels be sought from the medical community.

- It is further recommended that research be undertaken on the bioavailability to humans of cadmium in whole prawns.

CRAYFISH

- This study reports levels of metals in the Tropical Rock lobster *Panulirus ornatus* in Torres Strait. The commercial crayfish catch is almost exclusively made up of this species.

- Crayfish were collected from three reefs in June and October/November 1992.

- Levels of most metals reported here agree with those reported for the same species in the Community Fisheries component of the Torres Strait Baseline Study (Gladstone 1995). They also generally agree with levels found in comparable tissues in Torres Strait prawns, as reported in this study, with some exceptions.

- Arsenic occurred in higher concentrations in crayfish tail flesh when compared to prawn tail flesh.

- Copper also occurred in higher concentrations in crayfish tail flesh when compared to prawn tail flesh. This may be due to more residual haemocyanin in crayfish tails, as they have a larger volume:surface area ratio. Haemocyanin is a copper based blood pigment common to all crustaceans.

- Cadmium levels were much lower in crayfish tails when compared to prawn tails. This may be because crayfish heads are removed immediately after capture and prior to freezing, hence eliminating the potential for 'leakage' of high level head tissues.

- The scope of this study was restricted to metal levels in crayfish tails only, as commercial product consisted almost exclusively of frozen tails at the time. Since then a market in whole live animals has developed, and hence levels in crayfish heads have also become relevant with respect to commercial product. See Gladstone 1996 for a discussion on metal levels in crayfish heads.

Factors affecting metal levels in crayfish

- Crayfish tails from a site within Fly River influence (Kakope Reef) did not contain elevated levels of metals, when compared with other sites.

- Crayfish tails from Dungeness Reef contained higher levels of iron and cadmium, when compared with crayfish from the Cape York area. While iron is a metal associated with the Fly River, Dungeness Reef is outside its expected zone of influence. Cadmium is not a metal associated with the Fly River but is known to be associated with carbonate sediments of marine origin. This sediment type is probably more prevalent at Dungeness Reef than at reefs near Cape York.

- Samples collected from Dungeness Reef in June 1992 contained the highest copper levels recorded in this study. It is unlikely that this trend reflects environmental gradient in copper availability, because copper is an essential element which is regulated by decapod crustaceans, at least in tail flesh.

- There were no significant differences in levels of any metal between sexes.

- Levels of arsenic, cadmium, iron, manganese and nickel were higher in smaller crayfish tails, possibly due to the dilution effect of rapid growth. Zinc was higher in larger crayfish tails, possibly due to higher excretion rates in smaller crayfish.

- Crayfish tails collected from an industry source contained elevated levels of lead, probably due to contact with petrol and oil residues in the fishing boat and during processing. This elevation was not sufficient to cause concerns with respect to trade and health, as levels were still well below respective limits.

Metal levels in crayfish with respect to trade and health

- Tail flesh levels of all metals for which there is an MPC, with the exception of arsenic and copper, easily conformed to it. With respect to health limits, levels of all metals including arsenic and copper were such that crayfish tails could be safely sustainably consumed.

- When total arsenic was converted to inorganic arsenic only (which is the component to which the MPC applies), levels in some samples approached the MPC, while only three individuals exceeded it.

- This indicates there may be only a small margin of safety between the MPC and arsenic in crayfish tails. The conversion factor used was based on a 'worst case scenario', thus the result is pessimistically biased.

- Copper levels in some crayfish samples also approached the MPC and three individuals (independent of those that exceeded the arsenic MPC) exceeded it.

- This indicates there may be only a small margin of safety between the MPC and copper in crayfish tails. The source of this copper is likely to be residual haemocyanin and not environmental.

- Cadmium levels in crayfish tails were consistently well below the MPC.

Recommendations for further research

- Further work is recommended to clarify levels of inorganic arsenic in crayfish tails. Inorganic arsenic should be measured directly, rather than relying on conversion estimates based on total arsenic.

- Further work is also recommended to identify factors which influence residual copper levels in crayfish tails. Since it is likely that copper exists as residual haemocyanin, emphasis should be placed on handling methods which promote its removal (e.g. rinsing methods).

- Further work should examine the impact of including head tissues on total metal concentrations in crayfish with respect to trade and health limits. The potential for head tissues to contaminate tail flesh should be examined.