4. FUTURE MONITORING

The initial impetus for establishing the Torres Strait Baseline Study was the concern about possible impacts on the Torres Strait marine environment from mining operations in the Fly River catchment of Papua New Guinea. Assessing the impacts of human activities in the marine environment is a complex process. The process is even more challenging in physically dynamic environments, such as estuarine-oceanic interfaces, where inputs can be unpredictable and variable (this is the situation in the northern Torres Strait). Ideally, assessing the potential impacts of Fly River mining operations on trace metal levels in the Torres Strait would involve comparisons over time (before, during and after the impact) between the Fly River-Torres Strait transect and several other physically similar river-reef transects at similar distances from rivers without mining operations. This situation is not available in the Torres Strait.

Detecting impacts in the Torres Strait from Fly River catchment mining operations will therefore require long-term monitoring at established locations. Long-term monitoring is essential so that the range of natural changes in trace metal levels can be documented, understood and evaluated against potential changes caused by human activities. Data presented in this report on trace metal levels in sediments and indicator organisms[4] will serve as a baseline against which future changes can be assessed. This data was, however, collected only over a single time period and provides little information about the full range of natural variations which are possible.

One of the most important sources of natural variation which needs to be understood is the effect of season. For example, for copper levels in burrowing clams, the amount of variation explained by seasonal effects, 10.24%, was only slightly less than the amount of variation explained by spatial effects, 16.43% (see appendix 10). Although the burrowing clam has been shown to be a reliable indicator of ambient trace metal levels (Burdon-Jones and Denton 1984a, Denton 1987), seasonally varying factors (such as water temperature, currents, salinity, food availability, gonad development) have the potential to affect the uptake of metals (Phillips 1980, Burdon-Jones and Denton 1984a). In addition, there are seasonal differences in the delivery of trace metals into the northern Torres Strait. Fly River water penetrates the northern Torres Strait during the monsoon season, and results of the present study suggests that the timing of this penetration is not predictable within the monsoon season. In summary, at different times of the year the levels of trace metals in an indicator organism such as the burrowing clam will reflect the ambient levels of these metals, and also the combined influence of ambient trace metal levels and other unrelated environmental variables, and biological features of the indicator itself.

These considerations have consequences for the development of a long-term monitoring program, and the interpretation of its results. Understanding the range of natural variations in trace metal levels will only be achieved by regular monitoring, in both seasons of the year, over a long period of time. This should be done, as a minimum, as frequently and at the same times of year as followed in the present study. This will undoubtably reveal considerable variation from year-to-year, especially in the results obtained during the monsoon season (for the reasons outlined above). However, if the monitoring is continued for a sufficiently long period of time, these natural variations will be documented and understood (an alternative, but more expensive option, would be to sample more frequently during the monsoon season as a way of pinpointing more closely the time of greatest influence of the Fly River).

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[4] It is not proposed to establish a regular monitoring program for trace metal levels in traditional seafoods. The metal of most concern in traditional seafoods, cadmium, is not attributed to Fly River runoff. Furthermore, levels of cadmium in the food items of greatest concern (green turtle and dugong) probably represent accumulation over many years, are highly variable, and detection of trends associated with human activities would be extremely difficult.

Several sampling issues need to be considered:

(1) *Frequency of monitoring*

It has been suggested (Burdon-Jones and Denton 1984a, p 153) that in 'remote areas' monitoring should be undertaken once every five years. The Torres Strait, however, is a dynamic and variable environment (Dight 1991) and so more frequent sampling is warranted, e.g. every three years.

(2) *Indicator species*

The Pilot Study (Dight and Gladstone 1993) suggested two species of molluscs that were suitable as indicators of dissolved and particulate trace metals respectively, the burrowing clam (*Tridacna crocea*) and the mangrove cockle (*Polymesoda erosa*). Both species should therefore reflect the total metal load available (Dight 1991), and should continue to be collected.

(3) *Sampling locations*

Given that one of the objectives of a long-term monitoring program of this sort in the Torres Strait will be to detect changes in trace metal levels associated with human activities, the sampling program should include stations which could be impacted as well as a number of control stations unlikely to be impacted (for the purposes of the monitoring program the potential changes at impact sites include an increase in the levels of some trace metals, and an increase in the amount of fine sediment). The sampling program followed in the present study (for sediments and indicator organisms) allows for such a comparison, as it includes a group of stations in the northern Torres Strait close to the mouth of the Fly River which are currently influenced by Fly River outflow (levels of trace metals at these stations appeared to be at background levels during this study), and groups of stations throughout the Torres Strait not influenced by the Fly River.

(4) *Detectable and acceptable changes*

The sampling program followed in the present study detected a change over time in the copper levels in burrowing clams of about 19.5%. This is the maximum change that was detected, smaller changes could be detected by the same sampling program. There needs to be discussions amongst scientists, environmental managers, and the Torres Strait community about the magnitude of change detectable that is desirable, and the implications of this for the cost of a long-term monitoring program. If appropriate, the sampling program should be amended to reflect this desired level of detection.