## Chapter 9 WATER QUALITY

This section summarises research conducted at Green Island into both nutrients and hydrocarbons - two major determinants of water quality.

Within the past decade there has been increasing awareness about the possible deleterious effects on the Great Barrier Reef of elevated nutrient levels. A Great Barrier Reef Marine Park Authority workshop was held in 1987 in response to 'higher than average' levels of phosphorus and nitrogen in some localised areas of the Great Barrier Reef Marine Park (Kelleher, 1988). Green Island provided a focus for one discussion group as the reef environment was generally considered to be severely degraded, with circumstantial evidence linking this degradation to changes in nutrient levels (Zann and Day, 1988). Kinsey (1988) considered it likely that the progressive degradation of Green Island reef could reflect in part the influence of coastal water degradation, with the influence of localised nutrient enhancement from the sewer outfall 'generally accepted as being pronounced'.

An earlier workshop, also arranged by the Great Barrier Reef Marine Park Authority, focused on heavy metals, PCB's and hydrocarbons in the waters of the Great Barrier Reef Marine Park. It was concluded that levels of these contaminants were so low as to be barely measurable (Dutton, 1985). However, it is not surprising that measurable levels of hydrocarbons have been detected at locations frequented by power craft, such as the mooring areas of Green, Heron and Lizard Islands (Smith *et al.*, 1987).

### NUTRIENTS

#### Rasmussen's studies

Water samples were collected from Green Island reef by the Queensland National Parks and Wildlife Service in April 1988 and March 1989 and analysed for phosphate, nitrate, nitrite, ammonia and dissolved silica (Rasmussen, 1988). In addition, sediment samples were collected in April 1988 and analysed for trace elements and nutrient desorption (Rasmussen, 1990). Phosphate levels in the water samples were found to be close to those regarded as capable of hampering calcification in hard corals, and it was suggested this may have been due to the agitation of the nutrient enriched sediments associated with the seagrass meadows (Rasmussen and Cuff, unpubl. ms).

To test the hypothesis that enhanced levels of nutrients in a marine environment may be recorded in coral skeletons as a change in skeletal chemical composition, coral cores were collected from Porites colonies at Green Island by Rasmussen (1990). These were analysed using Atomic Absorption Spectrometry for calcium, sodium, magnesium, potassium and iron content. Seasonal bands in the skeletons were studied using spectrofluorometric methods and X-radiography (Rasmussen and Cuff, unpubl. ms). It was noted that calcium carbonate precipitation had fluctuated considerably since the early 1940s,while magnesium precipitated into the skeletons had increased dramatically during the 1960s (Rasmussen and Cuff, unpubl. ms).

#### Allan and Johns' study

To gather information on nutrient levels and availability in the Green Island reef system, Allan and Johns (1989) performed protein and phosphorus analyses upon surface sediment samples collected from a number of sites [Fig.8.2] in August 1987 and July 1988. Details of the protein analysis technique employed are not given, while phosphorus analysis was conducted through the vanadium-molybdenum spectrometric method and the ascorbic acid method.

Protein levels were found to be very low, as were levels of free phosphorus, while virtually no acid hydrolyzable phosphorus was detected. A higher nutrient status of the seagrass meadow sediments was indicated by higher phosphate levels, although they did not consider the meadows to be acting as a sink for anthropogenic inputs through the trapping of particulates and sediment. The higher phosphate levels were attributed to the high primary production of macrophytes and possibly to the inlet/outlet pipes of the marineland. No reasons for the expansion of the seagrass meadows could be derived from the analytical data (Allan and Johns, 1989). Data from the study are unpublished at present.

Brady's study

Water samples were collected by Brady (1989) along a transect from the Barron River mouth to Green Island between September 1988 and December 1989. These were analysed for inorganic phosphate, total phosphorus, nitrate, nitrite, ammonia, dissolved oxygen, dissolved organic carbon and salinity. At the Green Island station, to the north-west of the cay [B: Fig.9.1], samples were collected at 10cm, 4m and 8m depths in September and November 1988, March 1989 and monthly between June and December 1989. For the samples collected between September 1988 and September 1989, mean phosphate and nitrate values were comparable to those reported by Steven *et al.* (1989). Mean total phosphorous was higher, and mean ammonia lower, than those values given by Steven *et al.* (1989). Data from Brady (1989) are unpublished at present.

Steven, Brodie and van Woesik's studies

In response to preliminary findings from the Green Island Multidisciplinary Study, which indicated a potential for sewerage effluent to be retained by eddies in proximity to areas of enhanced seagrass growth (van Woesik, 1989), Steven *et al.* (1989) conducted a pilot study of baseline levels of water quality around the reef. As a precursor to a comprehensive study of water quality at Green Island, the pilot study was undertaken to assess the spatial and temporal variation of a range of water quality parameters and to evaluate which parameters would be of most use in assessing water quality.

Field measurements were undertaken in June 1989 at a number of sites around the reef [Fig.9.1]. Nutrients (nitrate, nitrite, ammonium, orthophosphate (reactive phosphorus), total nitrogen, total phosphorus, particulate nitrogen), biological parameters (chlorophyll *a* , biological oxygen demand (5 days)) and physico-chemical parameters (suspended solids, clarity, dissolved oxygen, temperature) were measured (Steven *et al.*, 1989).

Higher concentrations of dissolved inorganic nitrogen (DIN) were recorded at the windward locations [S4, S6: Fig.9.1], with a significantly lower concentration on the north-eastern side of the reef in an area of patch reefs [S5: Fig.9.1]. Ammonium and DIN were found to vary significantly with respect to time of day and also between days. Particulate nitrogen and biological oxygen demand were considered unsuitable as parameters to be measured in the baseline study due to 'analytical problems and prohibitive costs' (Steven *et al.*, 1989).

While Steven *et al.* (1989) found no significant changes in ambient water quality which could be attributed to sewage discharge, phosphate levels were higher in the vicinity of the sewer outfall.

HYDROCARBONS

Hydrocarbons from petroleum products can be lethal to larval, juvenile and adult stages of some marine organisms, while sublethal levels may effect their behaviour and reproduction (Smith *et al.*, 1987).

Smith, Bagg and Sin's study

Smith *et al.* (1987) analysed samples of seawater, sediment and clams from Green Island reef for the presence of polycyclic aromatic hydrocarbons. The samples, taken during March 1983, showed only low levels of contamination which they attributed to fuel spillage and exhaust emission from power boats visiting the reef. Airborne and seaborne input of hydrocarbons from the adjacent mainland were considered to be insignificant.

Sediment samples were collected by divers from the top 2cm of the sediment layer at 21 sites [H1 - H21: Fig.9.1], while water samples were collected at seven of the sites [H1, H3, H4, H6, H7, H14, H16: Fig.9.1] and specimens of clams at six of the sites [H1, H5, H6, H11, H12, H14: Fig.9.1]. Significant hydrocarbon concentrations were detected, by high-performance liquid chromatography, in only four sediment samples [H15, H16, H17, H19: Fig.9.1], while only three water samples [H1, H6, H16: Fig.9.1] contained measurable concentrations. None of the clam samples contained detectable hydrocarbon concentrations. Concentration ranges of some of the hydrocarbons detected are given in Table 9.1.

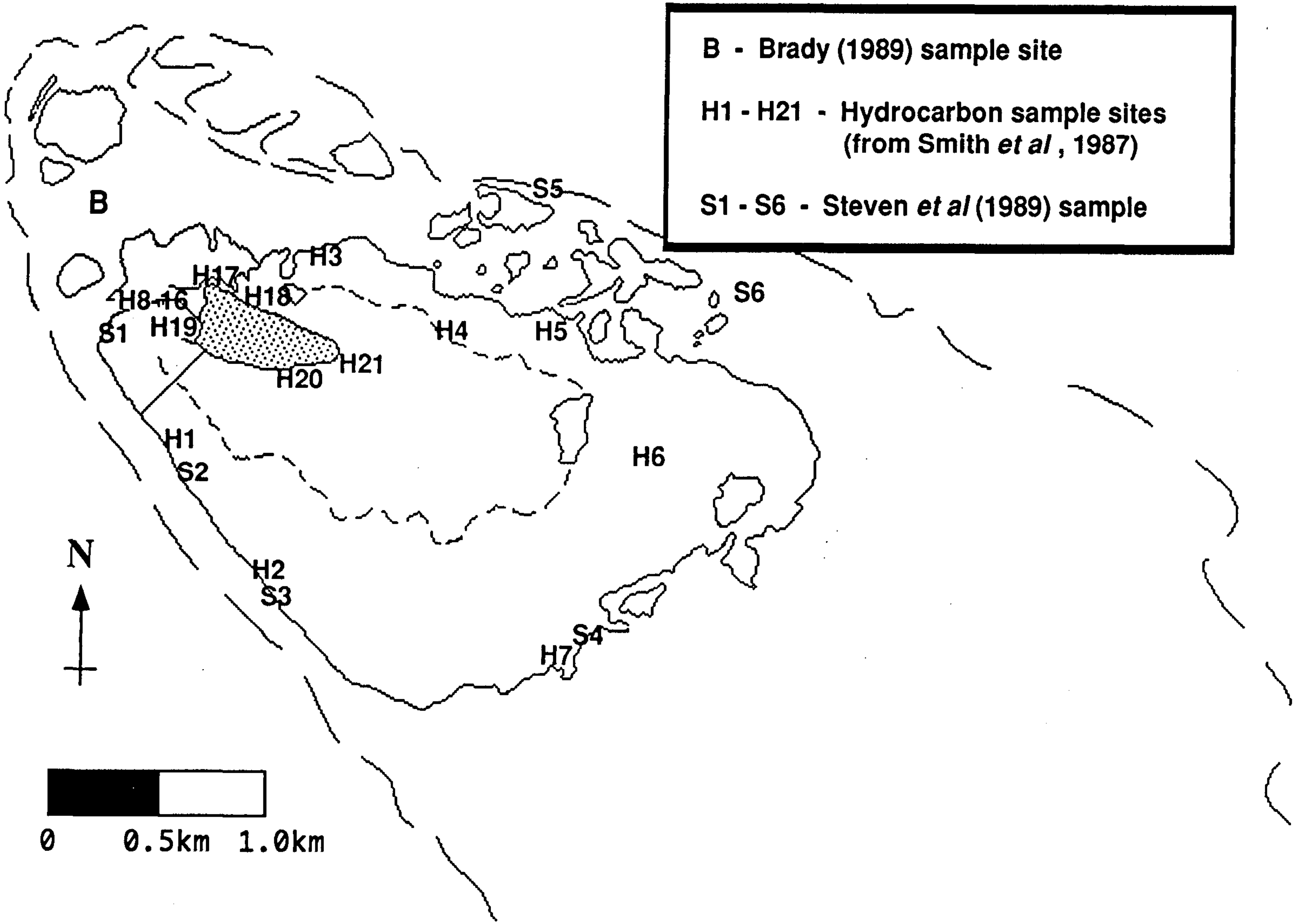


**Figure 9.1** Location of water quality sample sites

Table 9.1: Concentration ranges of some polycyclic aromatic hydrocarbons at Green Island (from Smith *et al.*, 1987).

| | WATER ($ng\ l^{-1}$) | SEDIMENTS ($ug\ kg^{-1}$ dry wt) | CLAMS ($ug\ kg^{-1}$ wet wt) |
|---|---|---|---|
| Pyrene | 53 - <1 | 15 - <1 | <0.03 |
| Anthracene | 25 - <1 | 1.0 - <0.06 | <0.05 |
| Benzo(a)pyrene | 6 - <0.2 | 4.3 - <0.004 | <0.004 |

All four of the sediment samples and one of the water samples came from the main boat mooring area to the west of the cay, and fluorescence spectroscopy of the water sample indicated refined oil products as the most likely source of the hydrocarbons. Another of the 'positive' seawater samples was not from the mooring area but only 350m southeast of the sewerage outfall (polycyclic aromatic hydrocarbons have been reported in sewage effluent), although hydrocarbon levels in the corresponding sediment samples were not significant. The third 'positive' seawater sample was from the eastern reef flat, but no explanation is offered for the detection of hydrocarbons there (Smith *et al.*, 1987).

Johns' study

A benthic sediment survey was conducted by Johns (1988) in June 1987 along a transect from Cairns Harbour to Arlington Reef. The closest sampling site to Green Island was about 7km to the west. Benthic grab samples were analysed using gas chromatography-mass spectrometry for biomarkers for terrigenous and anthropogenic materials.

While the bulk of fluvially discharged terrigenous organic matter was confined to sediments within 10km of the mainland, traces were detected in the lagoon sediments of Arlington Reef. This was taken to indicate the potential for the transport to nearshore reefs of terrigenous pollutants adsorbed onto suspended particles. There was evidence for anthropogenically derived hydrocarbons, 'probably of petroliferous origin', near Cairns Harbour, although these appeared to extend no more than 20km from shore (Johns, 1988).

Allan and Johns' study

Biomarkers indicative of petroliferous hydrocarbon input were detected by Allan and Johns (1989) in samples from horizontal particulate tows and sediments from the jetty area [site 12: Fig.8.2] and from the main seagrass meadow area [site 15: Fig.8.2]. These samples were collected in August 1987 and July 1988, and analysed using gas chromatography-mass spectrometry

They considered the distribution of the biomarkers to be suggestive of movement of exhaust hydrocarbons from the jetty area and accumulation in a 'westerly-northerly arc' around the cay. Mainland derived terrestrial and anthropogenic inputs to Green Island sediments were considered possible but unlikely. Data from the study are unpublished at present.