7. DISCUSSION

Concentrations of dissolved inorganic fixed nitrogen and phosphorus in waters of the far northern Great Barrier Reef during February 1990 were low and did not exhibit clear spatial gradients. Dissolved organic and particular nitrogen and phosphorus species dominated water column nutrient inventories. The resolution of dissolved silicate distributions is constrained by variability introduced from the freezing and thawing of samples. As the data set presented herein summarises the results from only a single cruise, it is not possible to say whether any of the apparent shelf-scale spatial patterns observed for any individual water column nutrient species are stable or ephemeral. The sampling was carried out within a period of low wind energy and high isolation. As a result, the vertical temperature differences observed at shelf stations are largely due to diel heating and low vertical mixing rates.

Under more energetic tradewind conditions, horizontal and vertical variability would be expected to be smaller.

Under the low-wind stress conditions which prevailed during the sampling period, inshore waters in Temple Bay, Lloyd Bay and Shelburne Bay were clear, with little evidence of sediment resuspension and no evidence of cross-shelf dispersal of fresh waters from the small local coastal rivers. The water clarity at inshore stations reflects the moderate productivity of these waters and their low-nutrient status under calm conditions. Water column nutrient and suspended sediment concentrations under high-energy, tradewind conditions are unknown.

Intrusive shelfbreak upwelling was observed at three stations, one (28) just inside of Raine Island entrance and two south of Wreck Bay, just inside of the outer barrier. Near bottom temperatures at station SHL28 were nearly 5°C lower than surface temperatures measured elsewhere and nitrate concentrations were sharply elevated (> 4 μM NO_3). Vertical temperature and nitrate gradients were much smaller at the other two stations. Thompson and Wolanski (1984) proposed that upwelling near Raine Island was, in part, driven by tidal fluctuations in the depth of the thermocline.

Statistically significant differences were observed between the present data set and nutrient data collected earlier in the Torres Strait and Lizard Island - Cooktown regions (Mitchell 1982; Furnas unpublished). Absolute differences between mean water column concentrations were relatively small, however. Restraint should be applied in examining these apparent between-study (geographical) differences because of systematic offsets between data sets related to sample collection, processing and analytical procedures.

Northern Great Barrier Reef shelf waters were reasonably productive. Video examination of the benthos showed substantial beds of macroalgae on the outer shelf, dominated in particular by *Halimeda* meadows described elsewhere in the northern Great Barrier Reef by Drew and Abel (1988). Water column areal primary production rates (0.13-0.38 gm C $m^{-2}hr^{-1}$) on the northern shelf were among the highest measured to date anywhere in the Great Barrier Reef (Furnas and Mitchell 1987, 1990). Shelf rates measured within the Great Barrier Reef lagoon between 14 and 15°S going to and from the study area were within the range normally seen for central Great Barrier Reef shelf productivity values (Furnas and Mitchell 1990). The highest areal production rates (0.61-0.67 g C $m^{-2}hr^{-1}$; approx. = 0.5-5.3 g C $m^{-2}d^{-1}$) were measured at two deep-water stations (27, 41) immediately outside of the barrier reef. These two high production rates were similar to production rates measured after Cyclone Winifred (3-4 g C $m^{-2}day^{-1}$). Mid-water chlorophyll concentrations (1.5-1.8 μg l^{-1}) at stations 27 and 41 were higher than normally observed at stations outside the reef in the central Great Barrier Reef (Furnas and Mitchell 1986) and were embedded within the top portion of relatively shallow themocline. Phytoplankton within these high-chlorophyll layers were therefore exposed to reasonably high

irradiance levels and elevated nutrient inputs from the nutricline immediately below. Both of the highly productive stations were located within embayments in the outer barrier (Raine Island Entrance, Wreck Bay).

Nutrient pumping mechanisms responsible for the apparent high reef-ocean boundary layer productivity are not fully resolved. Wolanski et al. (1988) invoked mixing from tidally forced jets of water through reef gaps or tidally pumped shelfbreak upwelling (Thompson and Wolanski 1984). Alternatively, Nof and Middleton (1989) suggested geostrophic mechanisms to raise subthermocline waters onto the shelf. Local, topographically controlled upwelling processes may therefore have contributed to the high productivity within the bays. Whatever the mechanism, there is evidence that high boundary layer productivity resulting may be localised or episodic in nature (Furnas and Mitchell 1990).

The cross-shelf changes in sediment characteristics reflect the relative contributions of terrestrial and 'reef-associated' processes to sediment composition. Inshore sediments contained higher percentages of non-carbonate muds while mid-shelf and offshore sediments were dominated by gravels formed from degraded *Halimeda* segments and carbonate muds derived from the *Halimeda* gravels or nearby reefs. It is likely that the bulk of the *Halimeda* gravels were formed in situ, whether or not the sediments were currently covered with living *Halimeda* at the time. The nitrogen content of the sediments was relatively low and in general, declined seaward across the shelf, while sediment phosphorus contents showed no clear cross-shelf gradient. The nitrogen and phosphorus contents measured were similar in magnitude to those measured by Alongi (1989) in the central Great Barrier Reef.

In summary, the area of shelf between 11 and 13°S appears to be pristine in character. Major external sources of nutrients to shelf waters include shelf-break upwelling and the small coastal rivers in the region. At the time of sampling, the shelfbreak upwelling was restricted to the immediate shelfbreak, while any riverine inputs were minimal. There was no clear evidence of freshwaters or other watermass parameter from the Gulf of Papua. The character of inshore waters, particularly within Temple Bay was excellent during the present study and likely varies in response to wind-driven resuspension, cyclonic disturbances and to a more limited extent, terrestrial runoff. Despite low dissolved nutrient concentrations, shelf and adjoining waters were moderately to highly productive. The composition and nutrient status of shelf sediments, however, reflect local sources of sediment materials and the lack of pronounced nutrient loading, suggesting that organic material reaching the bottom from the water column is rapidly recycled.

Dissolved nutrient concentrations within the study area were lower than in the Torres Strait and higher than in the Cooktown region. However, systematic differences between the three data sets compared cannot be ruled out as yet.

ACKNOWLEDGMENTS

We thank Captain Beard and the crew of the R. V. Lady Basten for their cheerful assistance throughout. Financial support was provided by the Great Barrier Reef Marine Park Authority.