19. THE BALANCE BETWEEN UPTAKE DEMAND AND SOURCES OF NITROGEN AND PHOSPHORUS

Added together, estimated inputs of nitrogen to the water column from benthic mineralization, macro- plus microzooplankton excretion and water column microbial mineralization account for 87 and 82 percent of the nitrogen demand arising from calculated phytoplankton primary production in the Cairns and Tully boxes, respectively. External sources of nitrogen (taking the low end of the potential *Trichodesmium* fixation rates) account for 6-7 percent of phytoplankton nitrogen demand. For the sake of this calculation, it is assumed that reefs export little nitrogen to surrounding shelf waters. This may not be the case (Kinsey, 1991b). In any case, the contribution of reefs would be negligible. River and sewage inputs of nitrogen would account for 2-3 percent of the nitrogen demand. Collectively, recycling and external sources do not meet phytoplankton demand because of the potentially large losses of nitrogen from the shelf system through denitrification in sediments, burial in shelf sediments and lateral mixing/ advection to the EAC. Either inputs have been underestimated or in fact, the primary production measurements over-estimate phytoplankton nutrient demand. Quite clearly, an expansion of the contribution of nitrogen fixation by *Trichodesmium* could meet and exceed the shortfall in nitrogen, however, such an increase would also be readily apparent through an increase in primary production. This would have to be confirmed by extensive field sampling and experimental measurements of both carbon and nitrogen fixation by *Trichodesmium*. There is some scope for additional nitrogen inputs via sediment which were not fully accounted for in the extrapolation of So. Johnstone River nutrient fluxes, but this is also likely to be small.

In making these comparisons, it should be borne in mind that carbon and nutrient uptake are not always in balance, whether at the scale of individual cells (Goldman et al., 1981), ecosystem (Smith and Kinsey, 1989) or oceans. Over time scales of 24-hours, primary production rates appear to be a reasonable estimator of phytoplankton biomass production (Furnas, 1982). Within shorter time scales, however, it is readily possible that the primary production estimates may over-estimate nutrient demand. At present, there are no concurrent measurements of phytoplankton carbon and nitrogen [or phosphorus] uptake to calibrate nutrient demand to midday primary production rates. Obviously, there is a clear need to do so.

A similar comparison cannot be made for phosphorus at this time due to a lack of a reasonable estimate for water column phosphorus mineralization rates. As shown above, external sources are likely small relative to internal recycling fluxes which hold demand in check. Sewage and river inputs of phosphorus are on the order of 2 percent of the estimated phytoplankton phosphorus demand. The continual presence of PO_4 in shelf waters at virtually all times and the low DIN/DIP ratio of shelf waters (Furnas and Mitchell, 1986) suggests that biomass levels in the pelagic ecosystem of the central is nitrogen limited. This conclusion requires future examination (Smith, 1984) as better estimates of the magnitude of nitrogen fixation by *Trichodesmium* become available.