## SUMMARY

Shelf-scale budgets were developed for the nutrient elements nitrogen (N) and phosphorus (P) in the central Great Barrier Reef between Cape Tribulation (16°S) and Dunk Island (ca. 18°S). The intent was to quantify:

1) stocks of nutrients (nitrogen (N), phosphorus (P) and silicon (Si)) naturally occurring in central Great Barrier Reef waters;
2) natural gradients and variability in water column nutrient concentrations;
3) natural fluxes of nutrients into and out of shelf waters for comparison with anthropogenic or anthropogenically affected nutrient sources.

Based upon features of shelf geometry and differing patterns of development on the adjoining coastal plain, the shelf was divided into two boxes, a northern box between Cape Tribulation and Cape Grafton (the **Cairns box**: area = 5940 $km^2$, volume = 197 $km^3$) and a southern box between Cape Grafton and Farquharson Reef (the **Tully box**: area = 7830 $km^2$, volume = 312 $km^3$).

Stocks of dissolved and particulate nutrients in the two boxes were estimated from the results of extensive hydrographic sampling within and immediately adjacent to the boxes. The concentration data was partitioned by season (Summer: October-April, Winter: May - September) and cross-shelf (depth) location. Mean concentrations of a number of individual nutrient species varied significantly between seasons. Regardless of season, however, the highest concentrations of individual nutrient species generally occur near the coast (depth < 20 m), but these shallow waters contribute relatively little to total shelf nutrient stocks because of their relatively small volume (< 5 percent of shelf volume). Most water column nutrients reside on the outer shelf (> 30 m depth) because of the greater volume of water.

Dissolved organic nitrogen (DON = 50,100 metric tonnes) is, by far, the largest water column nitrogen pool (ca. 80 percent of total water column nitrogen), followed by particulate nitrogen (PN = 10,300 m.t.) and ammonium ($NH_4$ = 1,400 m.t.). Nitrate ($NO_3$) and nitrite ($NO_2$) stocks are very small (< 300 m.t.) in comparison. Phosphorus stocks are more evenly divided between phosphate ($PO_4$ = 2,200 m.t.), dissolved organic phosphorus (DOP = 5,000 m.t.) and particulate phosphorus (PP = 1,600 m.t.).

System-level inputs of nitrogen and phosphorus from rivers (7,000 and 700 metric tonnes. p.a., respectively), rainfall (2,700 and 160 m.t. p.a.) and shelfbreak upwelling (1,200-4,000 and 400-1,000 m.t. p.a.) were quantified from the results of field sampling programs. Sedimentation (= resuspension) fluxes of nitrogen and phosphorus (657,000 and 62,000 m.t. p.a.) were measured with sediment traps. Nitrogen and phosphorus inputs from sewage (400 and 110 m.t. p.a.), benthic mineralization (39,000 and 12,000 m.t. p.a.), atmospheric nitrogen fixation by coral reef cyanobacteria (1,400 m.t. p.a.) and *Trichodesmium* (4,600-213,000 m.t. p.a.), microzooplankton nitrogen and phosphorus excretion (21,000 and 2,700 m.t. p.a.) and mineralization of organic nitrogen by microbial communities (173,000 m.t. p.a.) were estimated using literature sources, locally collected data and appropriate regional studies. Phytoplankton nitrogen and phosphorus demand (277,000 and 38,000 m.t. p.a.) were estimated from regional measurements of primary production. Only indirect estimates could be made for removal of nitrogen and phosphorus through burial in sediments and sediment denitrification. No estimate could be made for cross-shelf mixing rates of water-borne nutrients. For a variety of reasons, there are very considerable uncertainties in estimates of the magnitude of atmospheric nitrogen fixation by *Trichodesmium* and shelf sediments.

Total external inputs of both nitrogen (17,000+ m.t. p.a.) and phosphorus (1400+ m.t. p.a.) are small relative to natural nitrogen and phosphorus recycling fluxes (>200,000 and >>15,000 m.t. p.a.) on the shelf. In particular, large vertical exchanges of detrital and/or inorganic carbon, nitrogen and phosphorus take place between the water column and benthos through resuspension and (re-)deposition of particulate materials. Microbially mediated recycling (water column and benthic) supplies 80-90 percent of phytoplankton demand for nitrogen, and likely a similar percentage of phosphorus, though at present no appropriate information is available for estimating local microbial phosphorus mineralization. Overall, external inputs of nitrogen likely contribute < 10 percent of natural phytoplankton nitrogen demand. For phosphorus, external inputs contribute on the order of 2 percent of estimated demand.

Direct human inputs of nitrogen and phosphorus through sewage discharge (< 30 and < 5 m.t. p.a., respectively) are currently very small relative to natural nutrient inputs. River inputs of nitrogen and phosphorus comprise a large proportion of external inputs, but are still small relative to internal recycling fluxes. Data on riverine inputs of nitrogen and phosphorus are currently inadequate to reliably partition river nutrient inputs into natural and anthropogenic (e.g. fertilizer and land-use related) components. A very large percentage of annual nutrient inputs from rivers are delivered by flood events within relatively short intervals (days - 2 weeks). Sediment and nutrient delivery during these events are still poorly sampled in most north Queensland rivers.

Variability in measured water-column nutrient, phytoplankton biomass and suspended solids concentrations are large relative to mean ambient concentrations. The detection of spatial and temporal trends will require a long-term commitment to the collection of data sets covering regional spatial scales.

Although nutrient levels are currently low in central Great Barrier Reef waters and external inputs are small relative to natural fluxes and stocks, our understanding of ecosystem behaviour is still not developed to the extent that the assimilative capacity of the central Great Barrier Reef for enhanced nutrient inputs can be predicted with any certainty. Caution is therefore advised in the management of nutrient inputs to Great Barrier Reef waters to ensure the conservation of the reef in perpetuity.