4. CONCEPTUAL MODELS OF NUTRIENT POOLS AND FLUXES

Table 4 defines the individual nutrient species which were directly measured and the acronyms for operationally defined nutrient categories used throughout this report.

Table 4. Acronyms and symbols for nutrient species used in this report.

Species		Units
NH_4	- Ammonium	µM, µmol/litre
NO_2	- Nitrite	µM, µmol/litre
NO_3	- Nitrate	µM, µmol/litre
DIN	- Dissolved Inorganic Nitrogen = NH_4+NO_2+NO_3	µmol/litre
DON	- Dissolved Organic Nitrogen	µmol/litre
TDN	- Total Dissolved Nitrogen = DIN + DON	µmol/litre
PN	- Particulate Nitrogen	µmol/litre
PON	Particulate Organic Nitrogen	µmol/litre
PO_4	- Phosphate, ortho-phosphate	µM, µmol/litre
DIP	- Dissolved Inorganic Phosphorus = PO_4	µM, µmol/litre
DOP	- Dissolved Organic Phosphorus	µmol/litre
TDP	- Total Dissolved Phosphorus = DIP + DOP	µmol/litre
PP	- Particulate Phosphorus	µmol/litre
POP	Particulate Organic Phosphorus	µmol/litre
$Si(OH)_4$	- Silicate, silicic acid	µM, µmol/litre
SiO	Silicate, silicic acid	µM, µmol/litre
Chl	- Chlorophyll	µg/litre
Phaeo	- Phaeophytin	µg/litre
S.S.	- Suspended Solids	mg/litre

1 megamole (Mmol) = 1,000 kilomoles (kmol) = 1,000,000 moles
1 kmol N = 14.01 kg N = 0.01401 metric tonnes N
1 kmol P = 30.98 kg P = 0.03098 metric tonnes P

The budgets being developed herein are based on the simplifying assumptions of spatial averaging over regional scales, that is, within the full area of the Cairns and Tully boxes and temporal averaging over seasonal or annual time periods. Within a year, two seasons are defined, a summer period (October-April, inclusive; 212 days) encompassing the normal 'wet season' and a winter season (May-September, 153 days) when SE trade winds predominate. Schematic depictions of the conceptual models for nitrogen (N) and phosphorus (P) pools and fluxes are shown in Figure 9 and Figure 10, respectively. These schematic models depict the major pools of soluble and particulate nitrogen and phosphorus, most of which are accessible to either direct measurement or indirect estimation by various approaches. Fluxes are identified by the arrows connecting pools, external sources and sinks. Again, most of these fluxes can either be measured directly or can be estimated by other means. Where possible, calculated annual fluxes have been weighted with reference to seasonal differences in the parameters measured and cross-shelf gradients in either concentrations or rates.

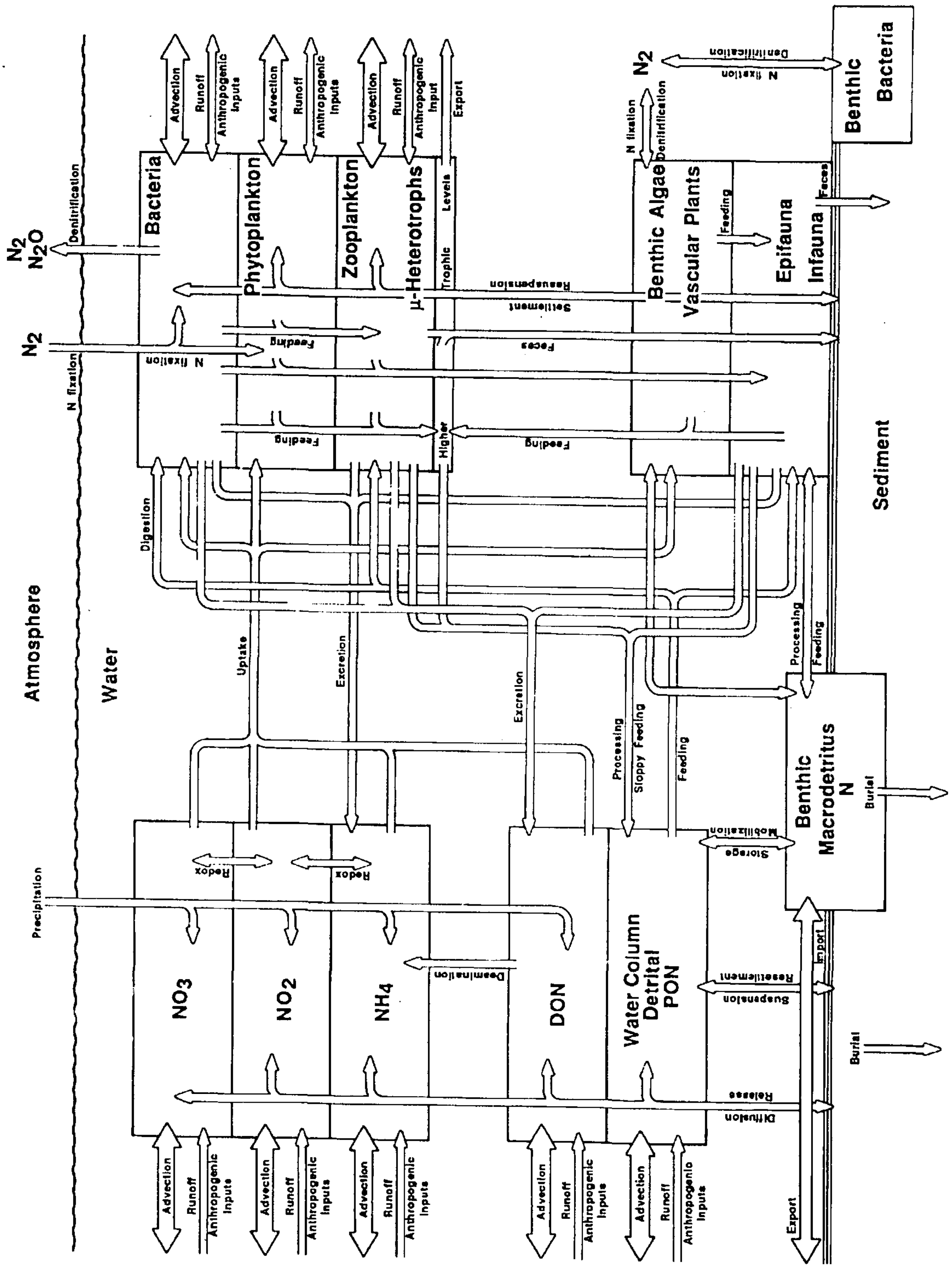

Figure 9. Schematic depiction of the water column nitrogen budget

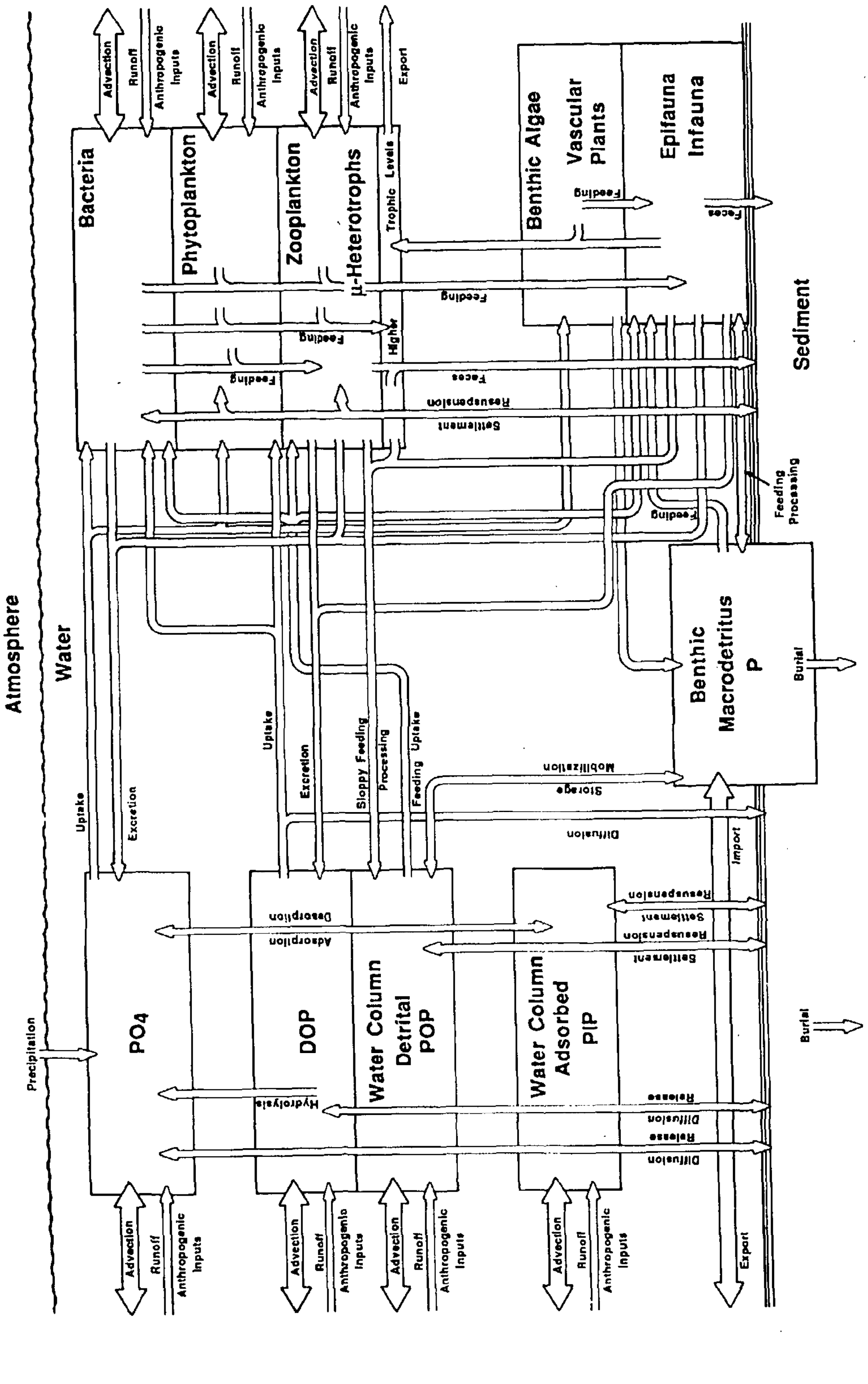

Figure 10. Schematic depiction of the water column phosphorus budget.

Nitrogen: Direct measurements were made of water column concentrations of inorganic nitrogen species (NH_4, NO_2 and NO_3), dissolved organic nitrogen (DON) and total particulate nitrogen (PN). Indirect estimates of the phytoplankton-nitrogen component of PN can be made from concurrent measurements of chlorophyll the N/chl *a* ratios of natural phytoplankton populations (e.g. Goldman, 1980). Zooplankton nitrogen stocks are calculated from direct measurements of zooplankton dry weight (> 73 μm size fraction) and the median nitrogen content of dry zooplankton weight (Figure 11). Zooplankton samples collected with a 73 μm net contained varying amounts of amorphous organic matter and large phytoplankton. This material dilutes the nitrogen content of the dried zooplankton. Its impact was reduced by basing calculations of zooplankton nitrogen on the median nitrogen content. In general, the nitrogen content of dried oceanic zooplankton ranges between 5 and 10 percent by weight (Parsons et al., 1977). It was not possible to calculate the amount of nitrogen present as either bacterial or microheterotroph (e.g. protozoan) biomass with any degree of confidence due to the lack of quantitative abundance data. Ikeda et al. (1982b) estimated that microzooplankton biomass (not including heterotrophic microflagellates) ranged between 7 and 15 percent of macrozooplankton biomass. The amount of nitrogen incorporated into water column detritus (dead organic matter) can be calculated in the first instance as the difference between total PN, as determined by direct chemical analysis and estimable stocks of phytoplankton and zooplankton nitrogen.

In the budgets presented herein, estimates can be made for nitrogen inputs from rivers (both dissolved and particulate forms), fixation of gaseous nitrogen by *Trichodesmium* and coral reef benthic communities, rainfall and shelfbreak upwelling, water column microbial remineralization and macro/microzooplankton excretion. Measured or estimable sinks include denitrification and net burial in sediments, particle sedimentation from the water column, and phytoplankton demand. No direct estimates could be made at this time for the magnitude of nitrogen fluxes associated with lateral mixing at the shelfbreak and longshore advection. Assuming the shelf system is at long-term steady state, net fluxes associated with longshore flows should be zero. Phytoplankton nutrient demand was estimated indirectly from measurements of primary production made in and adjacent to the study area. Benthic mineralization and water column mineralization fluxes are estimated from literature sources.

Phosphorus: Direct measurements were made of water column concentrations of dissolved inorganic and organic phosphorus (PO_4, DOP) and particulate phosphorus (PP). As with nitrogen, estimates of phytoplankton and zooplankton components of the particulate phase can be made from appropriate composition ratios. For oceanic and temperate estuarine zooplankton assemblages dominated by copepods, the phosphorus content usually falls between 0.5 and 1 percent of dry weight (Parsons et al., 1977). The limitations applying to estimates of bacterial and microheterotroph nitrogen stocks also apply to phosphorus. Non-living particulate phosphorus (detrital organic and acid persulfate extractable inorganic particle-associated phosphorus) can be estimated as the difference between total and biomass associated pools of particulate phosphorus. With the exception of fixation from an atmospheric source, the major system-level inputs or sinks of phosphorus can be measured or estimated in parallel with those of nitrogen.

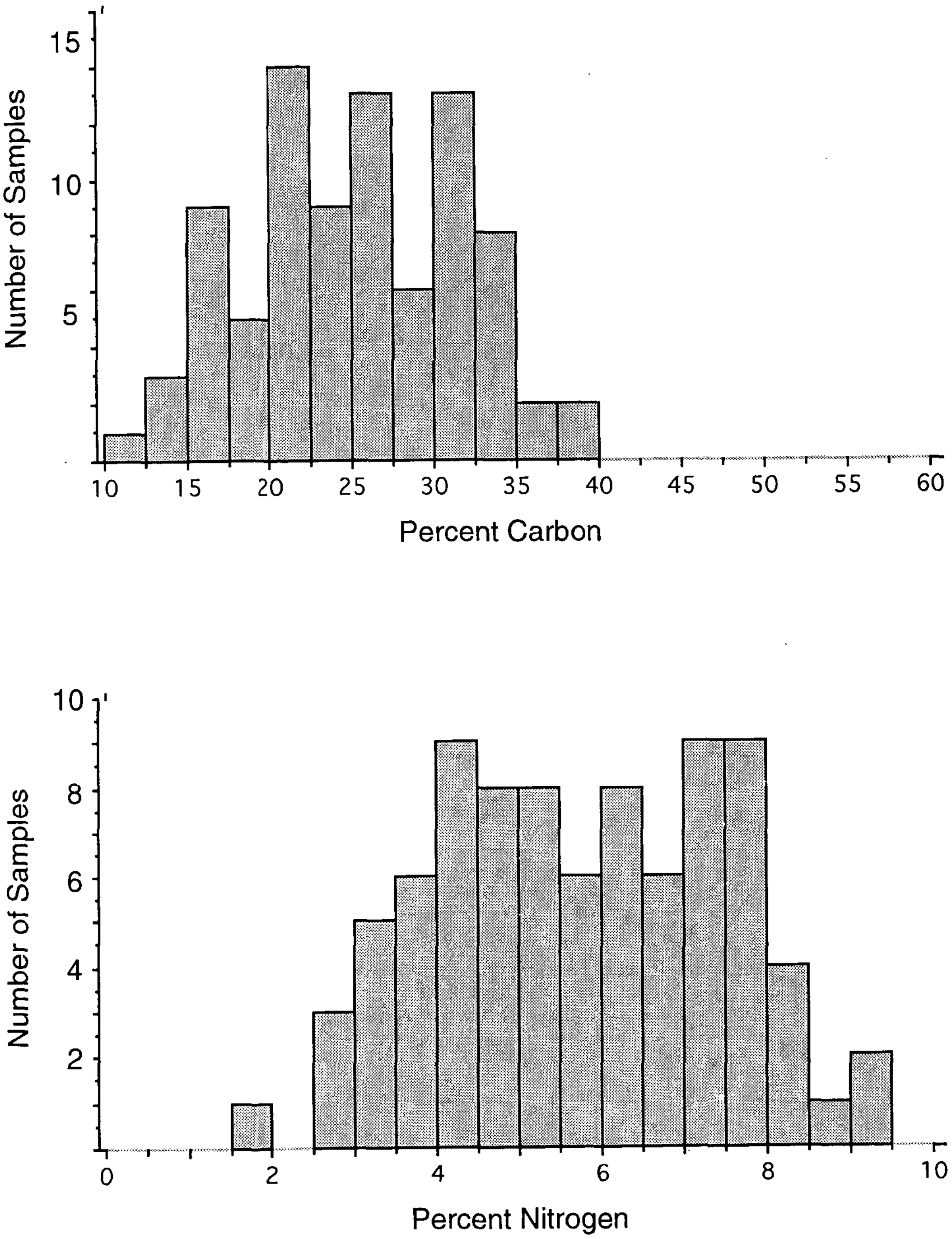

Figure 11. Carbon and nitrogen as a percentage of dry weight for zooplankton samples (73 μm) net collected in the Great Barrier Reef between 1983 and 1992.