RIVER INPUTS OF NUTRIENTS

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INTRODUCTION

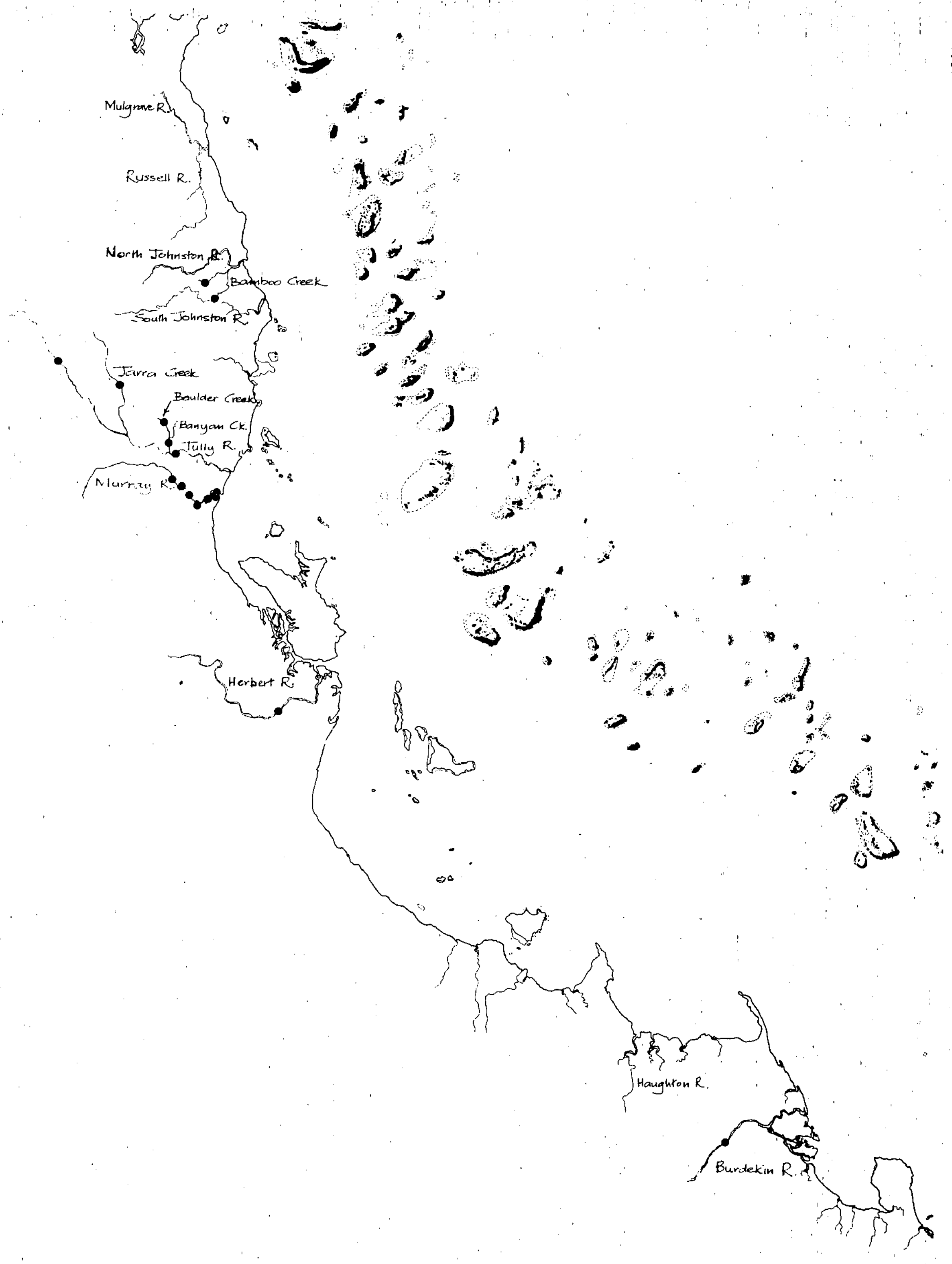
The interest of scientists at AIMS in river inputs of nutrients relate to their importance in determining the levels of phytoplankton primary production within the GBR ecosystem. General nutrient levels on the shelf and adjacent Coral Sea have been examined for some years and mechanisms for introducing nutrients onto the shelf investigated (Andrews and Gentien, 1982, Andrews, 1983, Andrews and Mitchell, 1986 and Wolanski, 1986). One such mechanism is upwelling along the shelf break which transports nutrients from the Coral Sea. Research into this process suggests it should be possible to budget these nutrient inputs using temperature and wind data (Andrews and Furnas, in prep). Shelf sediments hold a very large pool of nutrients from which remineralisation processes feed nutrients back into the pelagic zone (e.g. Ullman and Sandstrom, 1987). It is also known, from research following Cyclone Winifred last year, that cyclones can resuspend much sedimentary material from in and around reefs and thereby introduce large amounts of nutrients into the pelagic zone (Furnas et al, in prep). Data is lacking on a third likely source of additional nutrients, that from coastal rivers.

Nutrient sampling from rivers was commenced late last year and has continued this year as a relatively small research project. This effort comprises spot sampling at irregular intervals from 5 river systems (Figure 1) along the near-northern coast by ourselves and by individuals from local organisations. We have been sampling at the highway crossings of the Herbert, Murray, Tully and South Johnstone rivers. Brian Prove, (Department of Primary Industries, South Johnstone) has made collections in the South Johnstone and a major tributary, Bamboo Creek. John Reghenzani (Bureau of Sugar Experimental Station, Tully) has recently begun taking samples from the Tully River and a number of smaller creeks which feed it (Jarra, Boulder and Banyan Creeks). David Amos (Queensland Water Resources Commission, Ayr) is collecting samples from the Burdekin River.

Standard analyses done on these samples include major inorganic nutrients, NO , NO_2, NH_4 (constituting DIN - Dissolved Inorganic Nitrogen), PO,, $Si(OH)_4$, DON (Dissolved Organic Nitrogen) and DOP (Dissolved Organic Phosphorus) as well as filtration of suspended particulate matter for PON (Particulate Organic Nitrogen). DON and DOP have presented some early analytical problems and are not discussed here. The PON samples remain to be analysed. This paper discusses the set of inorganic nutrient data so far obtained. Data is also available from the Queensland Water Quality Council on some creeks and rivers in this region, but is not discussed here.

Water collections were made from bridges using a clean Kinsey sampling bottle or bucket, sampling the top metre of water. A comparison of triplicate surface and near-bottom samples from the Murray River confirm that flowing river water is well mixed horizontally and vertically, so the surface sampling strategy appears valid. Water for nutrient analyses is filtered through GF/F filters into acid-washed vials and frozen for later analysis (within 2-3 months). For PON, known volumes are filtered onto pre-combusted GF/F filter , which are then retained frozen until analysis. All samples are filtered in duplicate. Methods of nutrient analysis used are described in Ryle et al (1981).

Figure 1. River sampling sites.



River concentrations of inorganic nutrients are compared here with streamflow records from the QWRC for these river. As streamflow records for all sampling days are not yet available, monthly means from 1974 to 1984 have been used. A regional estimate of nutrient fluxes using these mean streamflows is calculated.

NUTRIENT RESULTS

For the present analysis, the nutrient data are divided into two sets, the first from the four northern rivers, the Herbert, Murray, Tully and South Johnstone and the second from the Burdekin River. Samples from smaller creeks are not included, as some of these show peculiarly high or low levels. Data from the four northern rivers have been combined and mean monthly concentration values plotted against the 11 -year monthly mean river flow for these rivers. The data for nitrate (NO,) is shown in Figure 2 on a monthly base. Each bar represents the mean of 2 to 12 monthly values. NO, generally accounts for about 75 % of DIN and a seasonal trend with significantly higher NO, concentrations during the summer period of peak river flow is apparent. The seasonal pattern of DIN, comprising NO, and NH, (Figure 3), is similar to this seasonal trend. PO, concentrations (Figure 4), are quite variable throughout the year and never very high. From this small data set, a seasonal trend cannot be discerned. Silicate (Figure 5) concentrations are highly variable, with some suggestion of higher levels in the periods of greatest river flow.

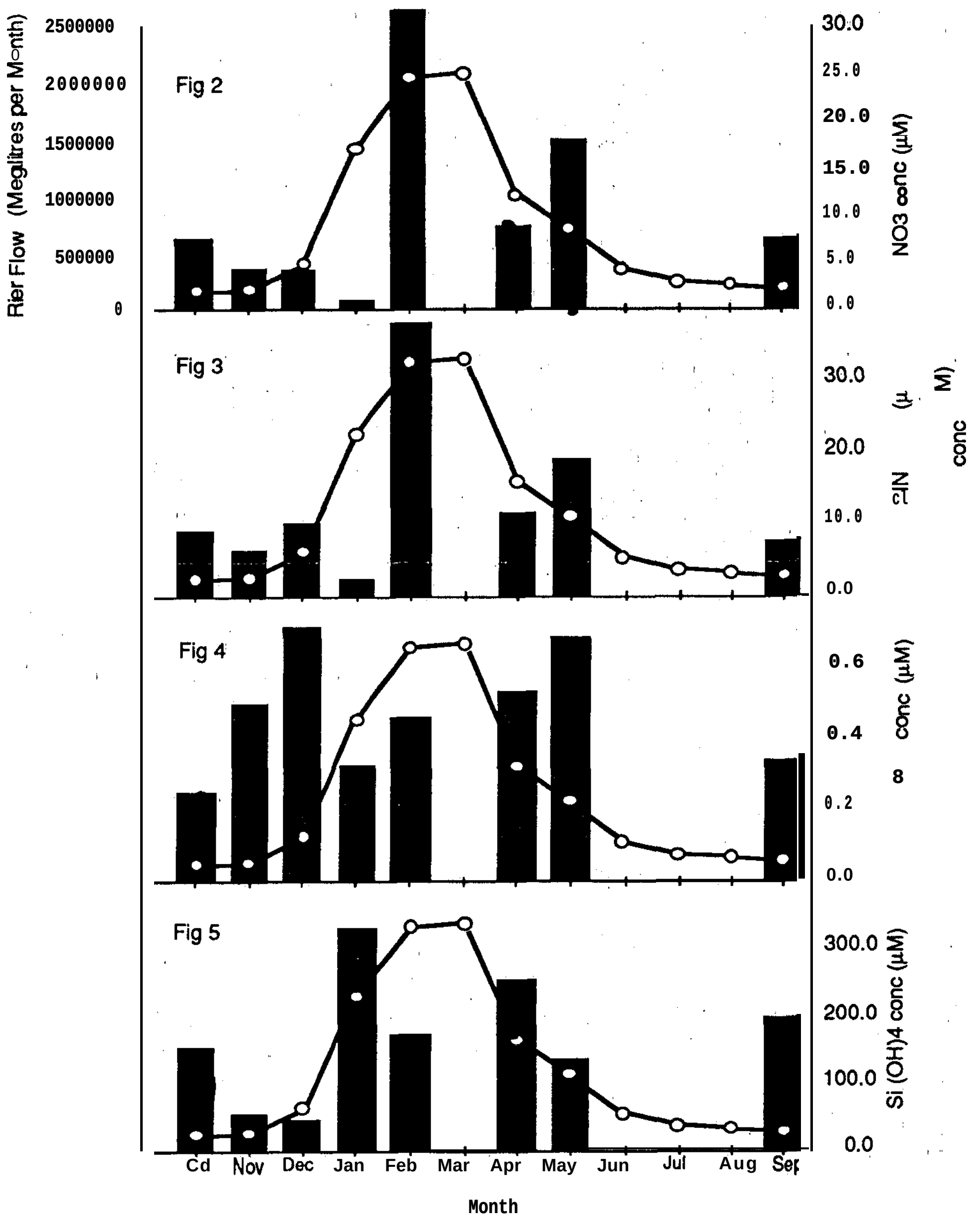
Data from the Burdekin River were collected at about fortnightly intervals. Discharge volume was measured concurrently. In Figure 6, discharge volume is plotted against NO_3 and DIN concentrations through the period sampled. There again appears to be a trend of higher NO, and DIN levels during periods of peak river flow. For PO,, shown in Figure 7, fairly steady, low levels are seen for most of the sampling period with only one elevated value. Studies in other regions have shown that very high levels of PO, may be flushed down at the beginning or peak of a river flood with much lower concentrations before and after. Silicate (Figure 8) shows some indication, from three values, of higher levels during flood periods.

CONCLUSIONS

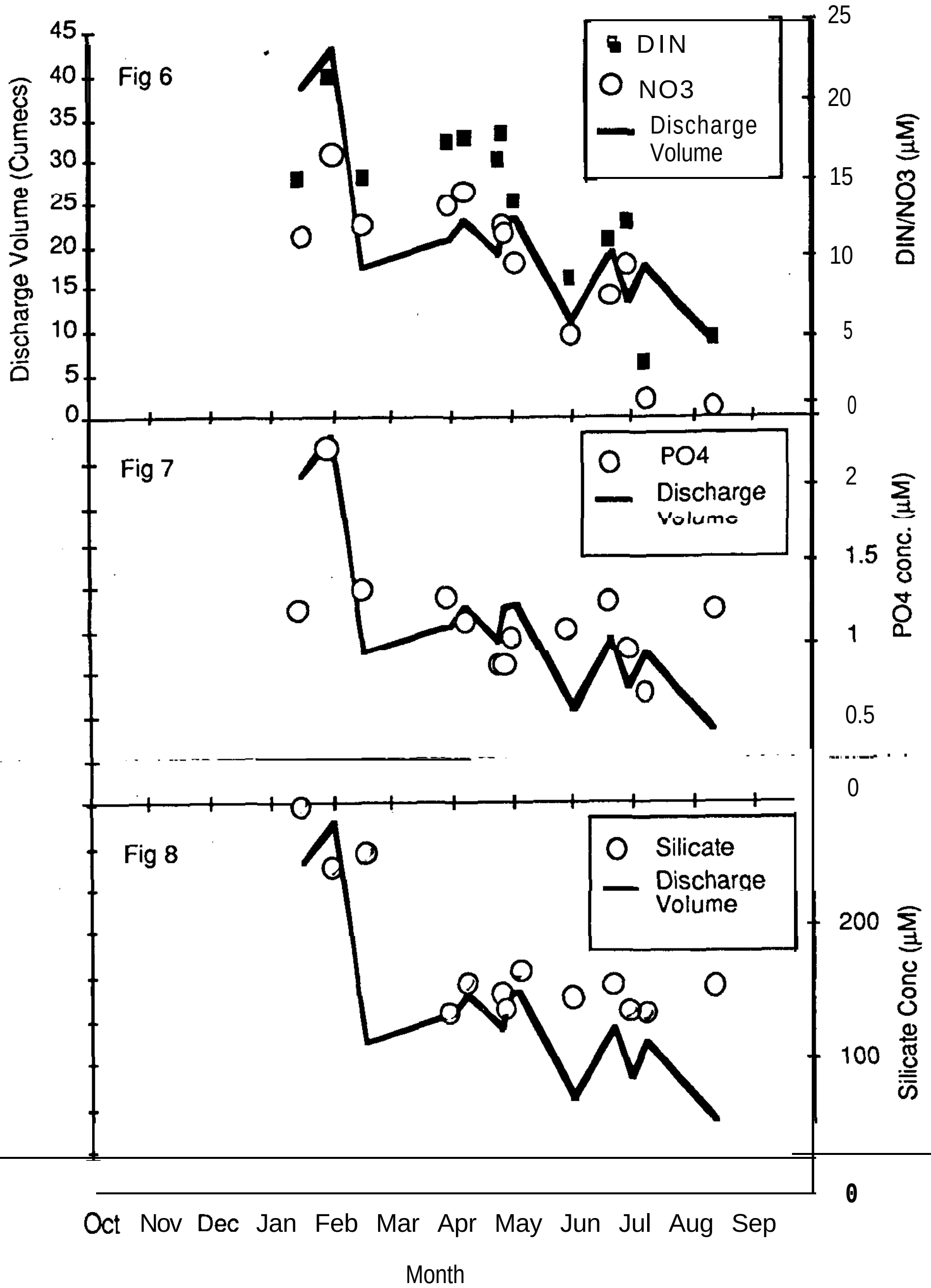
The objective of this study is to obtain reasonable estimates of nutrient inputs from coastal rivers to the shelf ecosystem, in particular N species, since N appears to be the nutrient limiting phytoplankton biomass in pelagic shelf waters. In attempting a first-order estimate, the total l l-year, monthly mean flows from all the major rivers from the Barron down to the Burdekin, a coastal distance of -300 km, have been summed. Using mean, monthly DIN values obtained to date and a simple concentration-flow relationship, it is estimated that -10,000 tonnes of NO,-N is output annually along this coastal area.

DON values are not reported here, but assuming a DON:DIN ratio of 2.3 obtained from other tropical rivers (Mkybeck, 1982), it is estimated that this would provide -2 µM-N per litre per year when averaged over the whole adjacent shelf. In terms of phytoplankton C fixed, this would account for ~3-4% of annual shelf production. However, since much of the river water is probably constrained within the near-shore region by long-shore currents (Wolanski and Van Senden, 1983; Wolanski and Thomson, 1984), a reduced shelf area of influence, approximately 20 km offshore in width may be assumed. The calculated N flux could then support as much as 50% of the total N requirements. It must be noted that these estimates are based a very small data set, with extrapolation over some missing months, the use of an averaged I l-year flow record and the above assumption of a DON:DIN ratio. Furthermore, while some of the summer samples were taken from rapidly running creeks and rivers soon after rain, none'were obtained from rivers at flood peaks.

Figures 2-5. Mean monthly **dissolved inorganic nutrient concentrations in the South J'onstone, Tully, Murray** and **Herber Rivers during** 1986-87 (solid bars) **in** relation **to 11-year mean of summed monthly'** discharge **rates** (open circles).



Figures 6-8. Discharge volumes and dissolved inorganic nutrient concentrations in the Burdekin River during 1987.



RIVER VARIABILITY

Finally, a comment should be made about the variability in flow of North Queensland rivers. While most flow occurs in the summer months, it can be extremely variable on day to day time scales. An example is the Herbert River before and after Cyclone Winifred (Figure 9). In the 5 days following this cyclone, 5 1% of the 1986 annual flow of the Herbert River was recorded. Considering such flow variation, it is important to monitor large flood events to see, whether higher nutrient levels occur during these periods. Though a sampling programme of this nature is difficult to organise, we plan to attempt event sampling.

Water flows also vary enormously from year to year. Figure 10 shows the annual flow in the Burdekin River in 1974, a wet year and in 1982, an "El nino" drought year. The 1974 flow, in which nearly 30 million megalitres was recorded in the month of January, was 28 times higher than the 1982 flow and 19 times higher than the 11-year mean used herein. Considering such year to year variability in river flow rates, large flood events could introduce large nutrient loads into relatively small areas of the shelf over a small time frame. . The results of such "event-scale" inputs of nutrients might range from effects on exposed benthic organisms to the promotion of phytoplankton blooms and subsequent enhanced survival of larval organisms.

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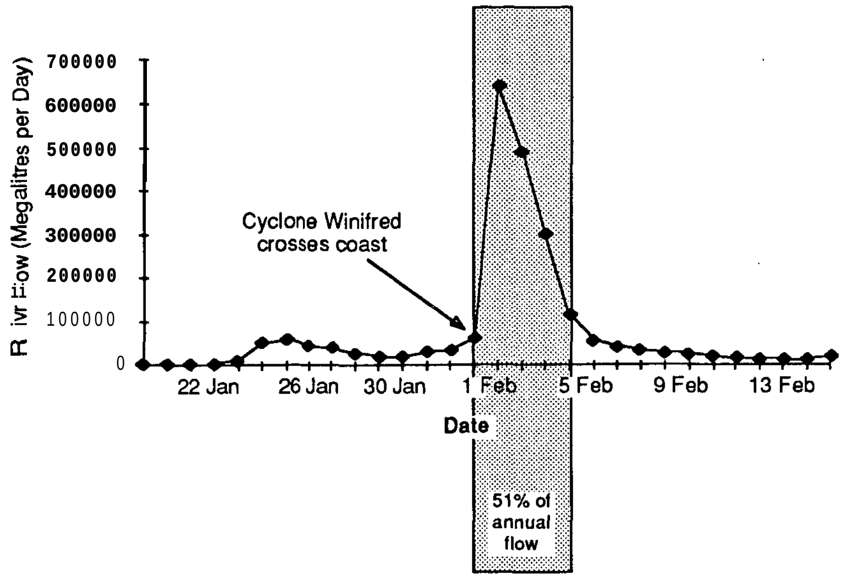
Figure 9. Discharge from the Herbert River resulting from cyclone Winifred.



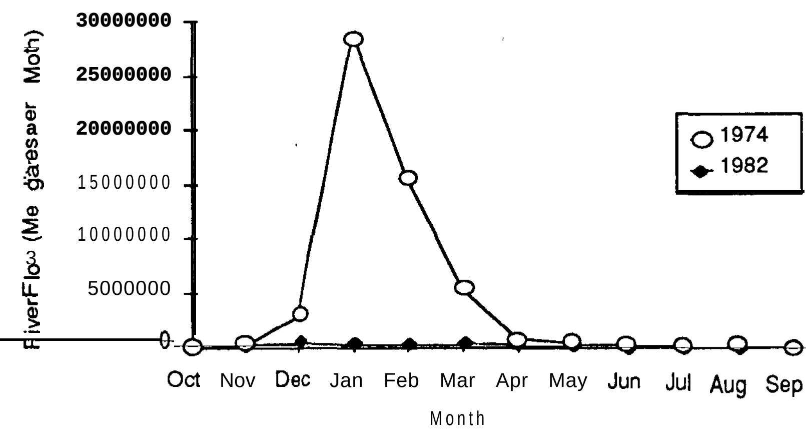


Figure 10. Discharge rates in the Burdekin River over two years, 1974 and 1982.