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MONITORING RIVER HEALTH INITIATIVE TECHNICAL REPORT
REPORT NUMBER 8b

Australia-Wide Assessment of River Health: Northern Territory Status Report and Commentary

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Monitoring River Health in the Northern Territory: status report and commentary (2003)

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When the National River Health Program Monitoring River Health Initiative (MRHI) was initiated in 1994, the Northern Territory agency primarily responsible for water resource management was the Power and Water Authority. Ecological assessment and monitoring by the Authority focused on reservoirs supplying potable water. Negligible effort was directed to monitoring the river health. The participation of the Power and Water Authority in the MRHI prompted the agency to extend biological monitoring to the Territory rivers, and more specifically, to develop predictive models to contribute to the assessment of the river health. Owing largely to logistic and practical constraints, only the seasonally, seaward flowing rivers in the Top End of the Territory were included in the MRHI (Fig. 1).

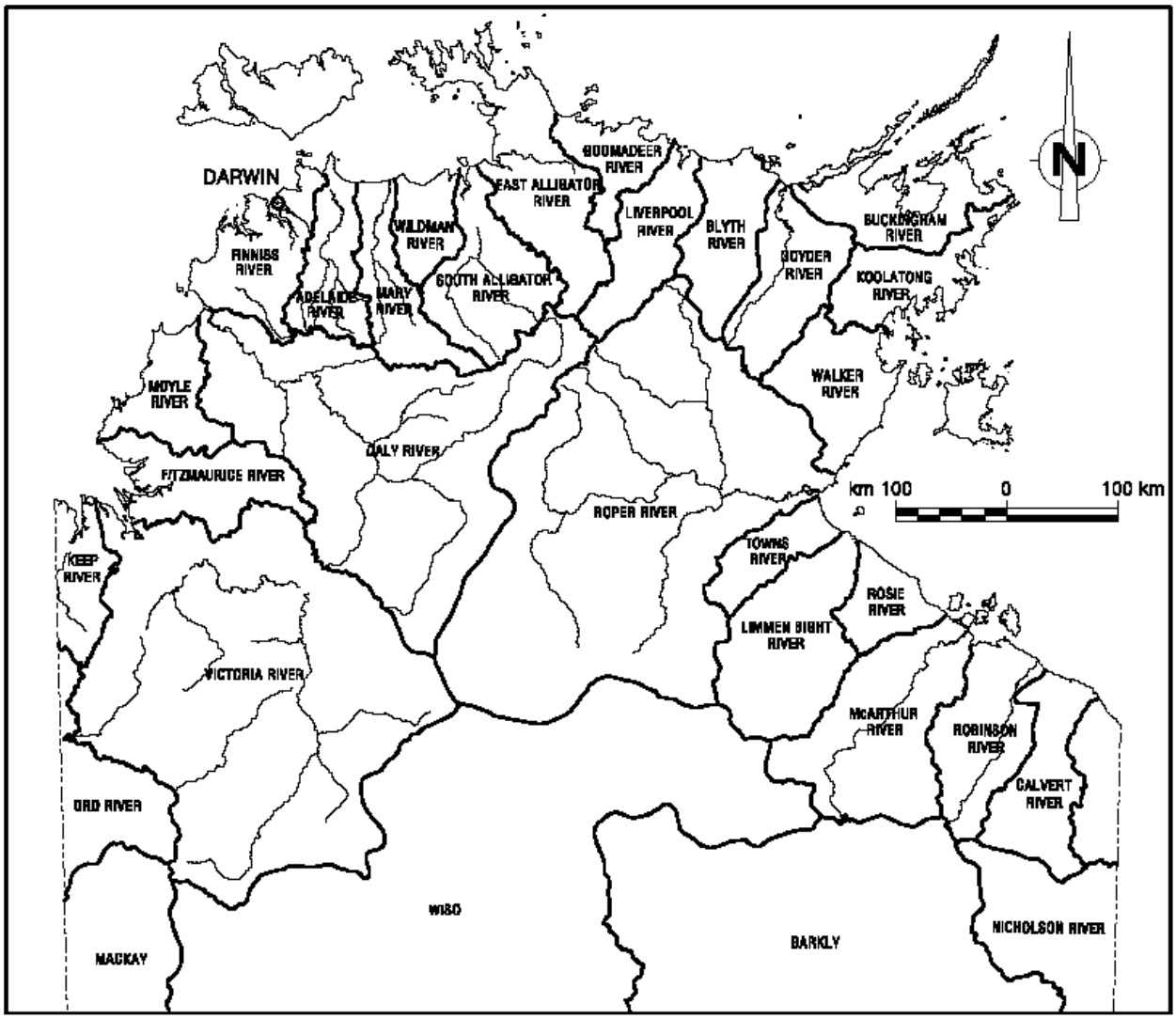

Fig. 1. Major rivers and their catchments in the Top End of the Northern Territory.

Flow regimes in the wet/dry tropics of the Top End are highly seasonal, with more than 95% of flow volume during the wet season. Most rivers and streams cease flowing during the dry season, though the timing is dependent on stream order, catchment hydrology, wet season rainfall and the depth of the groundwater table. In the dry season, seasonally flowing rivers reduce to either a series of permanent or temporary pools, or a dry riverbed. Some rivers, however, are perennial, being supplied by groundwater throughout the dry season; for example, the Daly, Katherine and Roper Rivers.

MRHI assessments during the wet season were both impracticable, for reasons of access and safety, and undesirable, owing to the frequency of storm runoff and flood events that modify the physical habitat and disturb the macroinvertebrate community. Consequently, samples were collected during the dry season. Early dry season sites were sampled between May and August, and late dry season sites between July and November. The overlap of the two sampling periods was due to differences between years in river access and river flow, and resource availability. At each site, edge and sand-bed habitats were sampled in accordance with the Territory's sampling protocol (Lloyd and Cook 1998).

The Northern Territory MRHI developed six predictive models. These models were derived from macroinvertebrate data and environmental variables at sites considered to be in reference condition. Macroinvertebrate samples were sorted in the laboratory. Models were produced for edge and sand bed habitats for the early and late dry season, and combined season data sets, for each habitat. The differences in the classification of the macroinvertebrate fauna groups for each model were small, with no clear geographic pattern between sites, or membership between years (Dostine 2001).

The predictive variables for each model differed considerably, ranging from four to eleven (Table 1), with alkalinity being the most common and appearing in four of the six models. The variables latitude, % total area pool/unknown, average velocity and catchment area appeared in three models. A marked alkalinity range exists for Northern Territory rivers, from very soft waters with little carbonate buffering capacity (e.g. 5 mg/L as $CaCO_3$), to rivers supplied during the dry season by dolomite and limestone aquifers with alkalinity as high as 500 mg/L (as $CaCO_3$). It should be noted, though, the *a priori* selection of alkalinity as a predictive variable assumes alkalinity is primarily a function of catchment geology, however it can be affected by acidic drainage from mine sites, the most commonly occurring point source of pollution in the Northern Territory.

The models were tested for rivers in the Daly, Finnis and Adelaide Rivers, and the small rivers and streams of the Darwin region. Urban drains and sites downstream of mines were classified into band C, being much poorer than reference condition. Other sites with no obvious cause of impact fell into band B, poorer than reference condition. This was particularly the case in the Daly River catchment (Table 2), and included some sites only accessible by helicopter.

Edge Habitat

Early Edge	Late Edge	Combined Edge
Latitude[1]	Latitude[1]	Altitude (m) [2]
Altitude (m) [2]	Longitude[1]	Stream Order [2]
Catchment area (km^2) [3]	Total alkalinity (mgL^{-1}) [4]	Total alkalinity (mgL^{-1}) [4]
Total alkalinity (mgL^{-1}) [4]	Total area macrophytes (%)	Minimum velocity (ms^{-1})
Habitat sampling depth (cm)		Pebbles (%)
Avg velocity (ms^{-1})		Avg river width (m)
Pebbles (%)		Total area macrophytes (%)
Total area riffle (%)		
Total area pool/unknown (%)		

Sand Habitat

Early Sand	Late Sand	Combined Sand
Latitude[1]	Longitude[1]	Catchment Area (km^2) [3]
Altitude (m) [2]	Stream Order [2]	Water Temperature (^oC)
Avg Habitat Depth (m)	Distance from Source (km) [3]	Total Alkalinity (mgL^{-1}) [4]
Avg Velocity (ms^{-1})	Catchment Area (km^2) [3]	Habitat Sampling Depth (cm)
Total Area Pool/Unknown (%)	Conductivity (□Scm^{-1})	Avg Velocity (ms^{-1})
	Water Temperature (^oC)	Minimum Velocity (ms^{-1})
	Habitat Sampling Depth (cm)	Cobbles (%)
	Maximum Velocity (ms^{-1})	Total Area Pool/Unknown (%)
	Cobbles (%)	
	Sand (%)	
	Total Area Snags (%)	

[1] decimal degrees
[2] obtained from 1:250 000 topographic maps
[3] used CAD mapping package
[4] as $CaCO_3$

Table 1. Predictor variables for six Northern Territory AusRivAS models (source: Dostine 2001).

	Model Band Category				
	C	B	A	X	No model
Model output	0%	60%	30%	5%	5%

Table 2. Daly River catchment test site results for the edge habitat, combined season model (n=20).

The SIGNAL index is an output of the AusRivAS models, and is based on the pollution sensitivity of taxa for temperate waters. When the O/E rating is compared to the SIGNAL index (Fig. 2), there seems to be little relationship between the two scores.

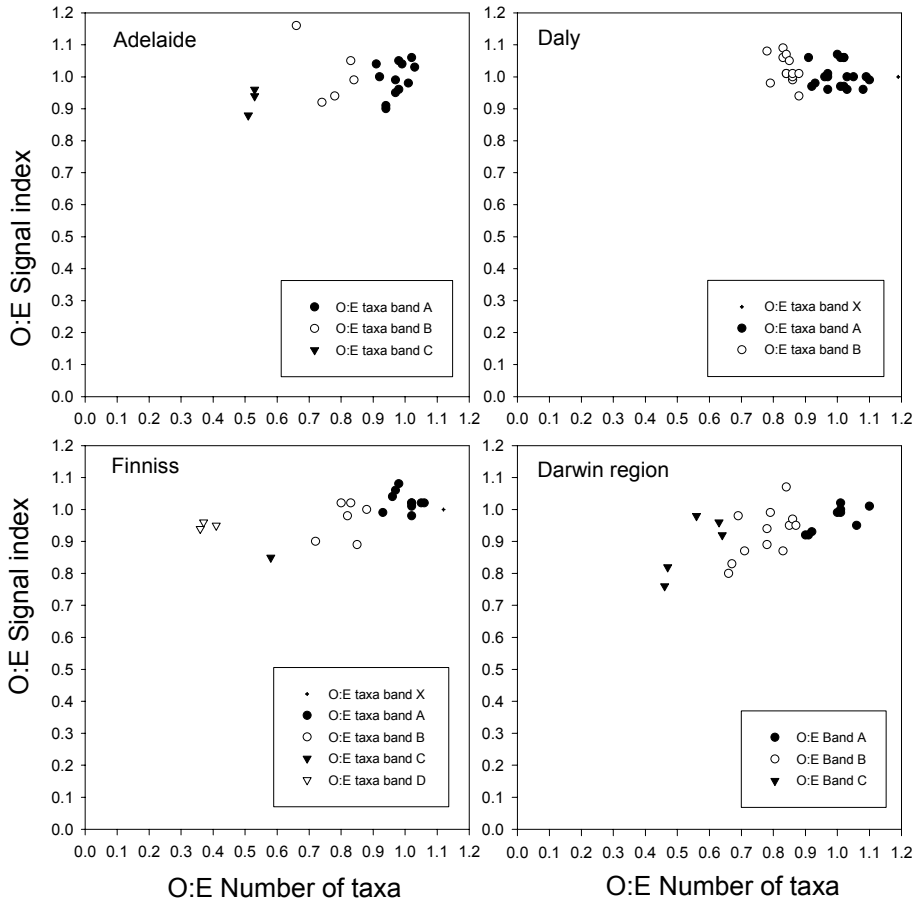

Fig. 2. Plots of the O/E number of taxa versus O/E SIGNAL index for four catchments in the Top End of the Northern Territory for Combined Edge model.

The greater than expected frequency of band B sites, with no discernible impact, and seemingly insensitivity of the SIGNAL index has prompted a recommendation that the use of the AusRivAS models be accompanied by sound design that includes several reference sites, and can be complemented by other assessment techniques. A second recommendation is that a regional model be developed for the north-western portion of the Top End, bounded by the Daly and Mary River catchments (Fig. 1). Such a model may better identify anthropogenic impacts, by removing any confounding geographic, and associated temporal, factors (see Dostine 2001).

Further model development.

The north-west Top End has been selected for the development of a regional model because it contains the most intensively used land in the Top End, and is a focus for Northern Territory natural resource management. The region contains the urban centres of Darwin and Katherine, fringing rural residences, as well as primarily industries, mainly horticulture and low intensity pastoralism, and mining. The Daly River Basin, a groundwater region within the Daly River catchment, will be developed for agriculture over the next 10 - 20 years. The north-west region of the Top End is, nevertheless, not

well developed relative to other intensively used parts of Australia. A large proportion, estimated at more than 95%, of the native vegetation in the region is retained.

The regional models will be developed for the early dry season, edge habitat, and use combinations of family and finer resolution taxonomic classifications. The development of the models will make use of additional reference site information collected from streams in the Darwin and Litchfield upland regions (see Dostine 2002), and from the Mary River catchment (see Schultz *et al.* 2002).

Additional taxonomic classification of the Daly River macroinvertebrate reference samples, mainly at genus level, has revealed a grouping of sites not identified at the family level (Dostine 2000). Three groups were identified, with one group comprising 2 sub-groups. These corresponded to (i) flowing lowland streams, (ii) upland flowing streams, (iii) non-flowing reaches of upland streams, and (iv) early drying small, seasonally flowing streams. Group 1 is characterised by distinctive fauna of molluscs and atyid shrimps. Group 2 featured fauna dependent on flowing water for respiration or feeding (e.g. Baetid genus, simulid larvae). The third group was characterised by taxa that occur in other groups. The forth group was fairly heterogenous.

Other river health assessment techniques

The Water Monitoring Branch of the Department of Infrastructure, Planning and Environment (Natural Resource Management Division) is investigating and considering the application of other river health assessment techniques to complement the use of AusRivAS models.

Benthic diatoms are being considered as a more direct biological integrator of water quality than macroinvertebrates. The addition of benthic diatom assessments to AusRivAS assessments could help distinguish between water quality and other (e.g. physical disturbances) impacts on macroinvertebrate communities. Diatoms have been shown to be responsive to ionic chemistry and nutrients in the Daly (Gell *et al.* 2002), Roper (Gell *et al.* 2002) and Mary (Schultz *et al.* 2002) River catchments. Benthic diatom assemblages have also shown to be responsive to elevated metal concentrations in the Mary River catchment, where there are a number of abandoned mines (Schultz *et al.* 2002). Diatom indices for management, however, have not been developed; instead the data has been analysed using multivariate techniques. Whilst there is a generally agreed national methodology for diatom sample collection, a nationally agreed assessment and reporting methodology is needed, assuming diatom data provides cost-effective additional information about river health.

The most frequent public compliant or query about river health in the Darwin region concerns the presence of macro-algae. There is a perception that macro-algae in rivers and streams are indicative of nutrient pollution, though investigations to date have not found this to be the case. Macro-algae are a common, and sometimes obvious, feature of rivers and streams in the Darwin region (Cowie 2003), and in the Daly River (Padovan and Townsend 2002). Extensive benthic beds of *Spirogyra* are present in nutrient deplete reaches of the Daly River. Currently, an inventory of macro-algae in Darwin Region streams is being undertaken to provide information about the distribution of macro-algae taxa, and evaluate which species are indicative of nutrient enrichment. The absence of

such information highlights the paucity of baseline knowledge about Northern Territory rivers in general.

Investigations to include fish in river health assessment in the north-west region of the Top End are about to commence. Fish provide information at larger spatial and longer temporal scales than macroinvertebrates or benthic diatoms. Moreover, they are fundamental biotic component of the river ecosystem. Also attractive is the ease fish monitoring results can be communicated to the public, and their known taxonomy and few taxa (Dostine 2003). The inclusion of fish amongst the suit of assessment techniques would be best advanced as part of a national effort to ensure collection techniques and analytical methods used in the Northern Territory are consistent with other parts of Australia. For this reason, the Territory will probably be influenced most by the Murray-Darling Basin Sustainable Rivers Audit protocols for fish monitoring. At best, and assuming no national effort or funding, fish are not likely to be included in any monitoring effort until after 2005, because methods need to be assessed, fish distributions evaluated, and possible purchase of expensive electro-fishing equipment budgeted. Unlike other states, the Territory Government agency responsible for monitoring of freshwater fish in the Northern Territory is focuses solely on fish of recreational or commercial significance, principally barramundi. Fish assessments, however, are undertaken by the Environmental Research Institute of the Supervising Scientist in the Top End.

Most riparian land, in fact the vast majority, in the Northern Territory is not cleared. In the Daly and Mary River catchments, the most widespread impact on the riparian land is the presence of herbaceous weeds (Faulks 1998, Schultz *et al.* 2002), rather than clearing. The significance of the riparian land is recognised by both aquatic and terrestrial ecologists in the Top End. Riparian land, as well as contributing significantly to river health, also provides corridors for the movement of vertebrate fauna, and has a high species richness compared to adjacent savanna woodlands. Any monitoring of riparian land adopted in the N.T. is likely to focus the extent of riparian clearing, by using remote sensing approaches, rather than site specific surveys.

Water quality monitoring in the Darwin region provides information about fluvial loads of sediment, nutrients and metals, and monitors the effect of land-use on these loads (Padovan 2003). Urbanisation has been found to double runoff coefficients (Haig and Townsend 2003) and increase sediment loads by at least a factor of five (Padovan 2003). Such water quality monitoring is informative about catchment and estuary condition. The fluvial load information is yet to be incorporated into river health assessment.

Two challenges face the Northern Territory for river health assessment. The first is the development of river health techniques applicable to rivers in the wet/dry tropics. Moreover, because the Northern Territory environment is, for the most part, in "good" condition, relative to the rest of Australia, such techniques need to be able to detect reasonably small degradations in river health to enable early management intervention to prevent further degradation. Such a requirement needs to be based on a better understanding of river ecology in the Top End than currently exists.

The second challenge recognises the vast land area of the Northern Territory, its small population, and the limited amount of resources available for river health assessments. Because not all rivers can be monitored, methodologies need to be developed to predict river health based on surrogate, mainly catchment, measures.

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