Australian Government
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Monitoring of the Ranger uramium mine, NT, using aquatic macroinvertebrates – 1988 to 2002

Presented at the Australian Society for Limnology and the New Zealand Society for Limnology Joint Congress, 1st to 5th December 2003, Warrnambool, Victoria

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January 2004

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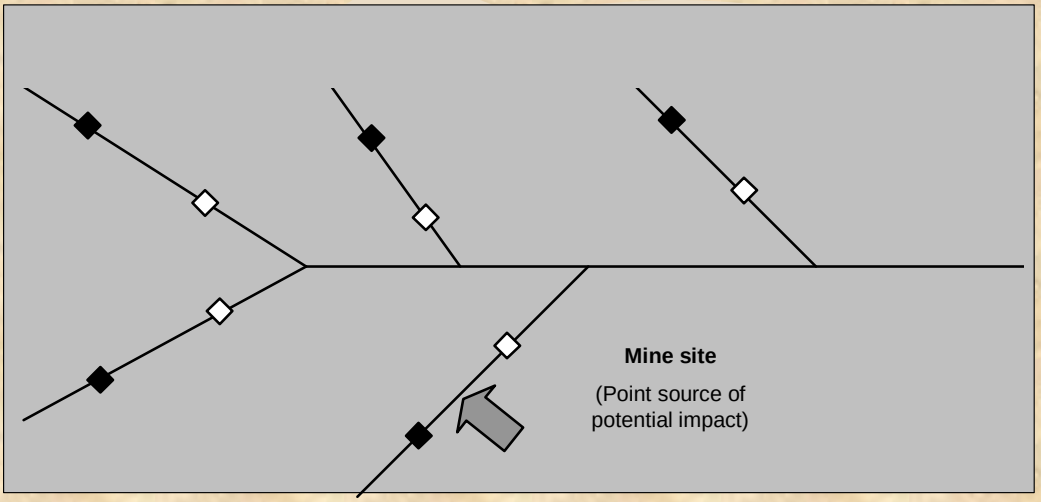
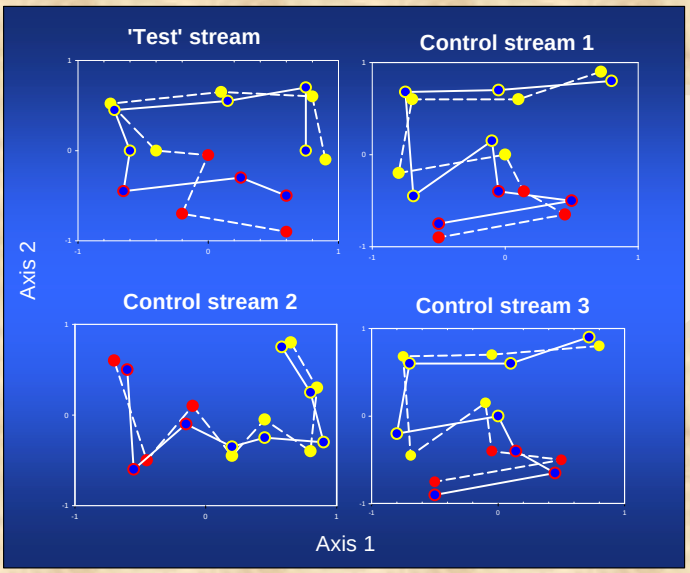
History of development of macroinvertebrate sampling program for Ranger Mine

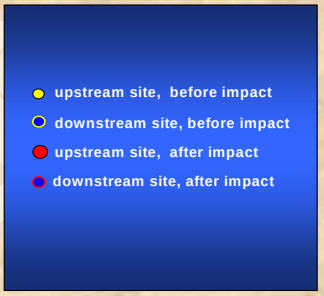
Years	Features	Defining events and/or research
1988-1993	• Many sites in same 'test' stream (up-/downstream)	• Development of **BACIP design** using multivariate dissimilarity measures
1994	• Paired sites (up-/downstream) in 'test' stream and in additional control streams (**MBACIP design**)	• 1993 Biomonitoring Workshop (peer review). Recommends: • Extend single-stream design (BACIP) to multiple-control-stream design (MBACIP) (sensu Underwood) • Consider rapid assessment approaches to sampling and sample processing
1995-1996	• MBACIP design (as for 1994) but "quantitative" live-sorting of samples	• Respond to recommendations of 1993 Workshop • MRHI and RBA influencing national approaches to river health assessments • Revision of Aust and NZ Water Quality Guidelines
1997-present	• MBACIP design but return to traditional quantitative sampling and sample processing • From 2001, ERISS takes on off-site monitoring role	• RBA methods not appropriate at this small point-source scale in World Heritage ecosystems

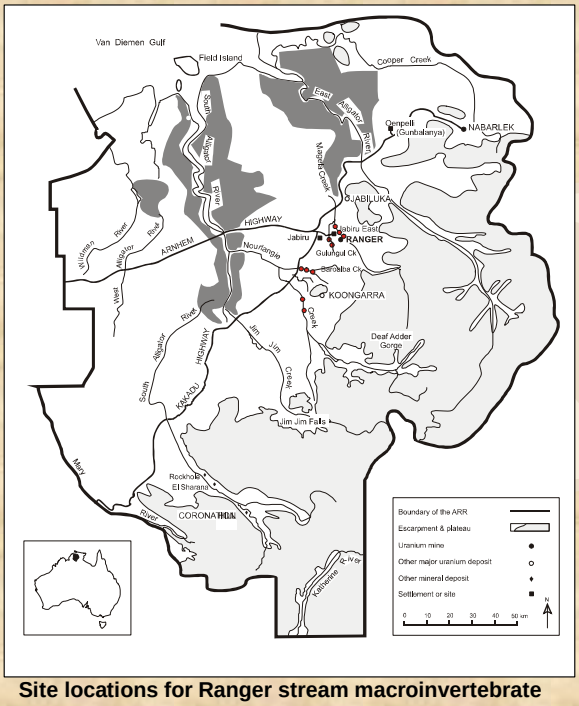
Design (MBACIP) suitable for detecting change in biological diversity in ARR streams



Principle of 'multivariate' MBACIP design, e.g. stream macroinvertebrate communities







Site locations for Ranger stream macroinvertebrate monitoring program

Study Area

Ranger uranium mine

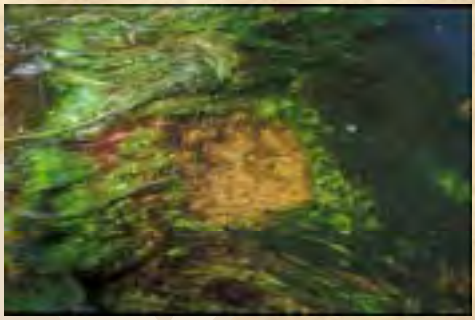
- No releases of tailings/mine process waters
- Regular discharge of mildly contaminated runoff waters (from waste rock) each wet season
- Ecotoxicity of major contaminants (U, $MgSO_4$) well understood

Study sites

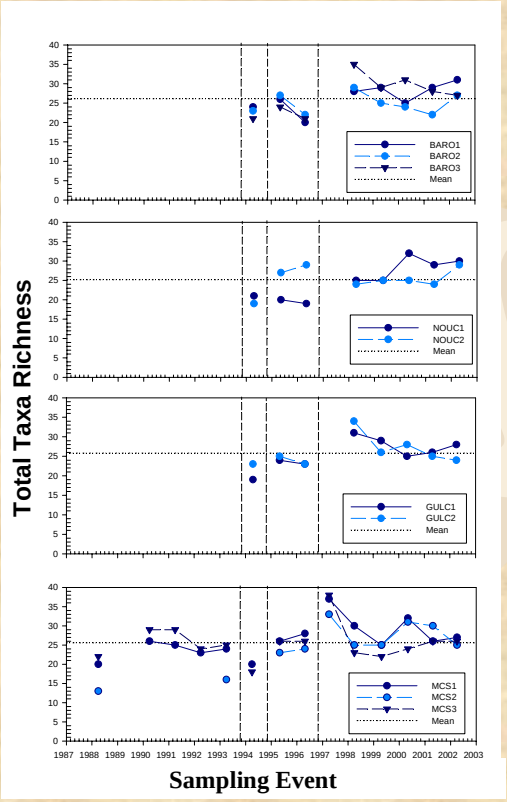
- Ephemeral streams
- Sandy substrate

Current Methodology

Macroinvertebrate sampling equipment

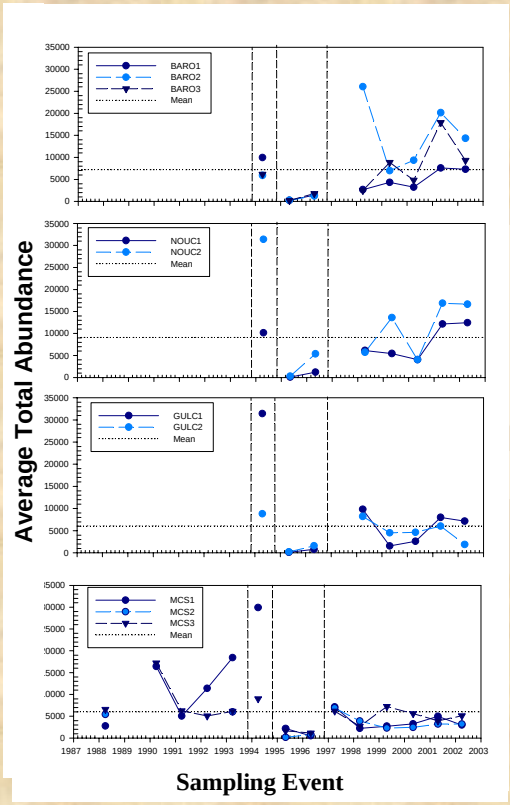


- Quantitative
- Multiple replicates and sites



Taxa Richness

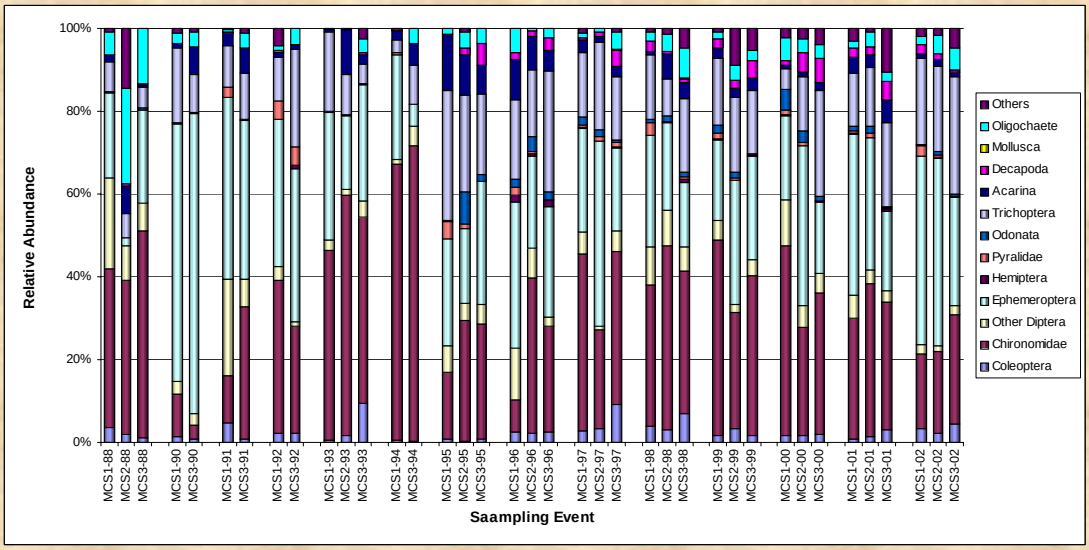
- Total richness per site, not average
- Family-level resolution except for Acarina and oligochaetes
- Similar overall averages amongst creeks
- No consistency within a creek as to the richer site (upstream vs downstream)
- Some differences amongst methods



Average Total Abundance

- All data standardised to per m^2
- High variability amongst methods
- High variability at all scales but similar overall averages amongst creeks

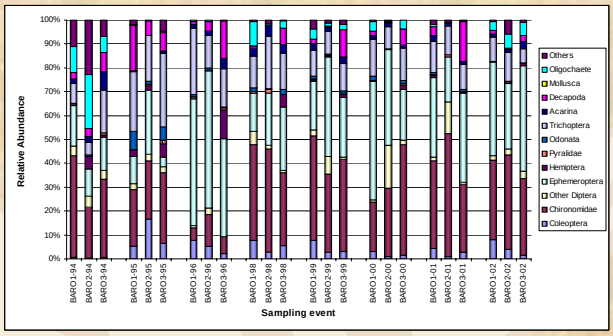
Relative Abundance of Taxa in Magela Creek

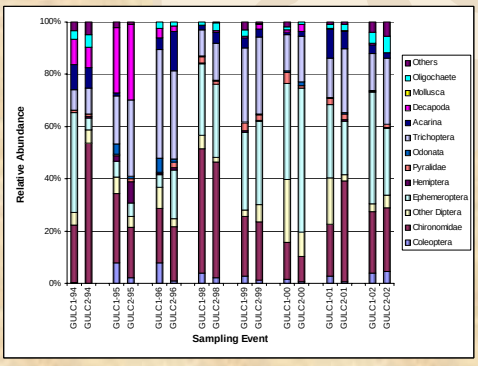


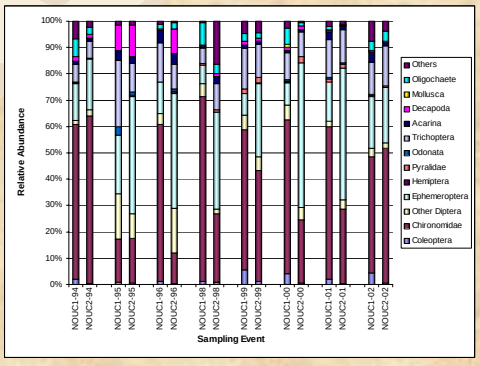
Notes to previous slide

- All sites dominated by midges (Chironomidae) and mayflies (Caenidae)
- Similar relative abundances between upstream and downstream sites per wet season
- Some differences between methods (e.g. Air lift sampled higher relative abundance of chironomids).

Relative Abundance of Taxa in Other Streams

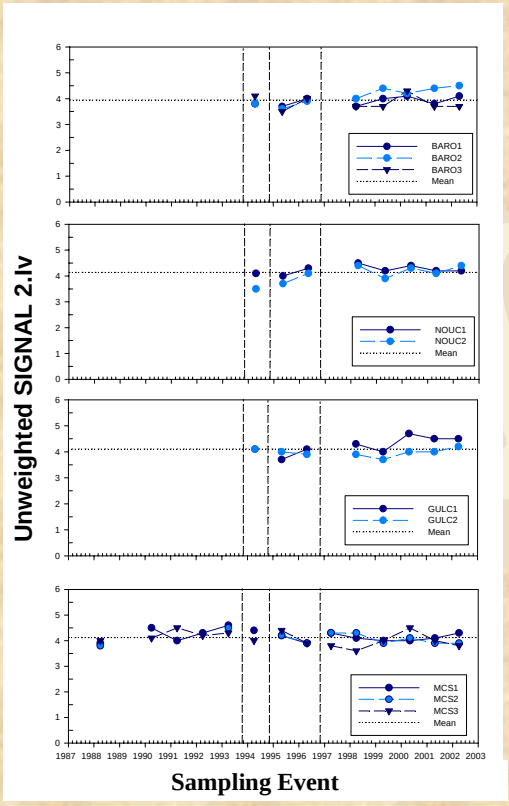






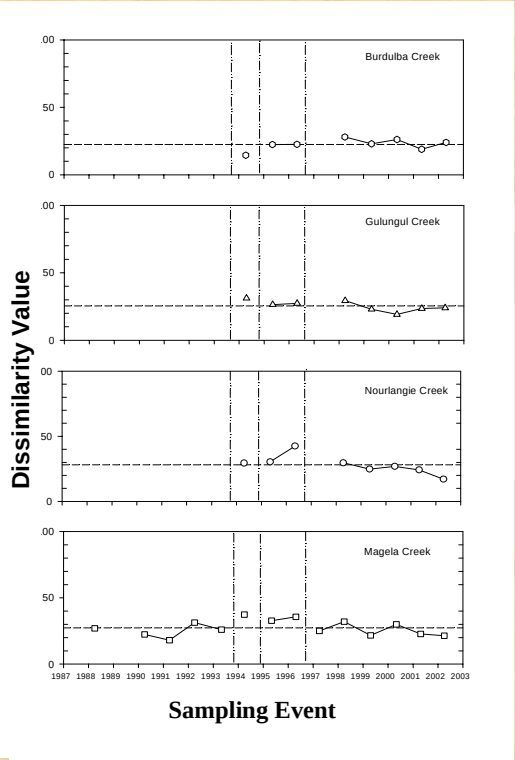
Notes to previous slide

- Similar relative abundance pattern within control streams as Magela Creek
- Dominated by Chironomids and mayflies
- Relative abundances similar between upstream and downstream sites per sampling event



Total SIGNAL score

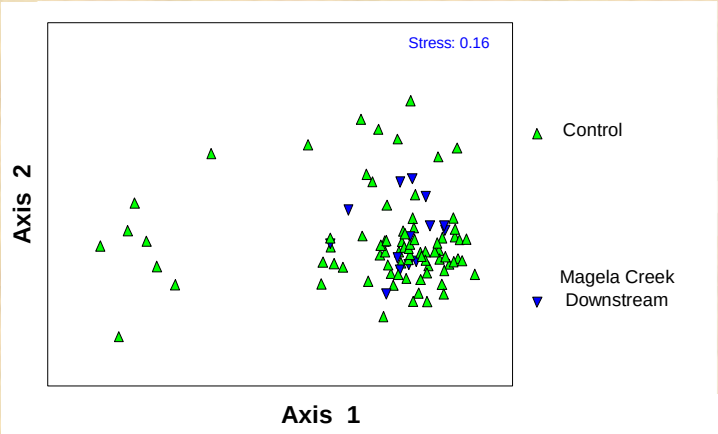
- Similar average SIGNAL scores amongst creeks
- Scores relatively constant over time amongst all streams
- Downstream Magela Creek sometimes “healthier” than upstream sites



Bray Curtis Dissimilarity

- Log (x+1) transformed data
- Dissimilarity measured between most upstream site and downstream site where 3 sites examined in a creek
- Average dissimilarity similar amongst creeks (single factor ANOVA, not significant)
- Scores relatively constant over time amongst all streams
- Highest dissimilarity at control - Nourlangie Creek - when "quantitative" live-sort method used

MDS Ordination



- All sites, all years (each site/year represented by single point)
- Magela Creek downstream site not separated from other sites implying 'no impact'
- Control sites in left of ordination space are "quantitative" live-sort samples

Conclusions

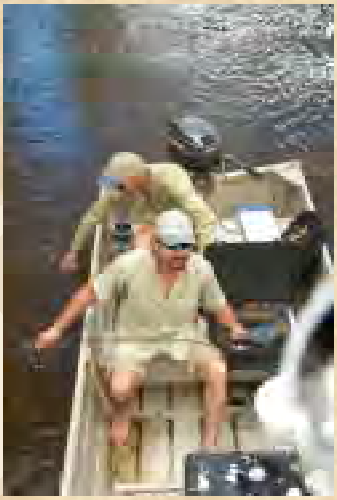
• Despite the lack of true baseline (pre-1980) macroinvertebrate data to enable application of true MBACIP approach, results from Magela and control streams in the ARR provide good evidence of "no impact" of RUM mine waste water discharges upon Kakadu National Park.

• This is strongly supported by the similar taxa richness, relative abundances of taxa, SIGNAL scores and dissimilarities between test site and control sites and streams.

• Dissimilarity measures better enable the temporal comparison of results amongst streams despite different sampling methods being used.

• Macroinvertebrate sampling is combined with other ***multiple lines of evidence*** that includes:

Water Quality Testing



Major metals, ions and standard *in situ* parameters

Direct Toxicity Assessment

determining safe dilutions for effluent discharge

Bioaccumulation in freshwater organisms

Radionuclide and metal concentrations in freshwater mussels and fish

Creekside monitoring

Egg production in freshwater snails and fish larval survival

Pop netting

Sampling fish communities in shallow lowland billabongs

Visual observations of fish

Sampling fish communities in deep channel billabongs

Conclusion cont'

- and which provides assurance that there are no environmental impacts upon Kakadu National Park from RUM mine waste water discharges.

The Future

Macroinvertebrate monitoring of 4 streams in the ARR and other programs of the Ecosystem Protection group will continue through the remaining life of RUM and its eventual rehabilitation.

The End –Thank you