internal report **341**

Australian Society for Limnology Congress, incorporating the Australian Wetland Forum, 7–10 July 2000, Darwin

Abstracts and presentations

eriss

September 2000

supervising scientist

AUSTRALIAN SOCIETY FOR LIMNOLOGY CONGRESS

7-10 JULY 2000, DARWIN

INCORPORATING THE AUSTRALIAN WETLAND FORUM

This report compiles the abstracts and powerpoint slides used in presentations made by ***eriss*** staff during this Congress. The talks are presented in order of presentation. A copy of the program is included for further information.

Sept 2000

Contents

DAY 1 – ASL2000 Congress Program – Sessions 1–4

Friday 7 July – 09.00-10.00 – Session 1 – Mal Nairn Auditorium, NTU Building 35	
Welcome and Opening – Chaired by Max Finlayson	
09.00-09.30	Gerry Wood – Litchfield Shire Council, NT – [Welcome and comments] – Be prepared!
09.30-10.00	Cathy Pringle – Institute of Ecology, University of Georgia – [Plenary talk] – Managing hydrologic connectivity to protect the biological integrity of reserves: A global perspective.
10.00-10.30	Coffee and Tea

Friday 7 July – 10.30-12.30 – Session 2A – Mal Nairn Auditorium, NTU Building 35	
Environmental flows – Chaired by Jenny Davis	
10.30-10.50	Chris Gippel – Fluvial Systems Pty Ltd – Environment Australia's Environmental Flow Initiative: Filling some major knowledge gaps.
10.50-11.10	Paul Wettin – NSW Department of Land and Water Conservation – Environmental flows for the Lachlan River; Or is it carp or salinity?
11.10-11.30	Satish Choy – QLD Department of Natural Resources – Challenges in assessing ecological condition in relation to environmental flows.
11.30-11.50	Peter Negus – QLD Department of Natural Resources – Using AUSRIVAS data to assess the impact caused by environmental flows.
11.50-12.10	Chris Burton & Greg Raisin – NSW Department of Land and Water Conservation – Assessment of the altered temperature regime of the Macquarie River, central west, New South Wales.
12.10-12.30	Mardi van der Wielen * – University of Adelaide – The impact of wetland drying on sediment suspension by carp.

Friday 7 July – 10.30-12.30 – Session 2B – Room 23.01, Building 23	
Water quality/algae – Chaired by Rick van Dam	
10.30-10.50	Lisa Thurtell – NSW Department of Land and Water Conservation – Lachlan Lower Lakes water quality investigation.
10.50-11.10	Sandra Grinter – QLD Department of Natural Resources – Development of local water quality objectives for the Condamine-Balonne Catchment: Preliminary results.
11.10-11.30	***Chris leGras – Environmental Research Institute of the Supervising Scientist – Patterns in heavy metal, uranium and general indicator concentrations in the streams of the Jabiluka lease area.***
11.30-11.50	Andrew Pinner * – University of Canberra – The identification of heavy metal hot spots: The Moruya River catchment.
11.50-12.10	Ian Webster – CSIRO Land & Water – Phosphorus dynamics in Australian lowland rivers.
12.10-12.30	Rod Oliver – Murray Darling Freshwater Research Centre – Environmental conditions influencing algal primary production in the River Murray.
12.30-13.30	Lunch

Friday 7 July – 13.30-14.50 – Session 3 –Mal Nairn Auditorium, NTU Building 35	
Snowy River I – Chaired by Dr Jane Growns	
13.30-13.50	Brett Miners – NSW Department of Land and Water Conservation – Snowy River issue: Overview and the role of science.
13.50-14.10	Wayne Erskine – State Forests of NSW – Channel contraction, sediment deposition, and vegetation and lichen invasion of the Snowy River due to flow regulation.
14.10-14.30	Chris Gippel – Fluvial Systems Pty Ltd – Environmental history of the Snowy River in Victoria: Implications for environmental water claims.
14.30-14.50	Sam Lake – Monash University – Rivulet to river? Ameliorating degradation of the Snowy River.
14.50-15.10	Coffee and Tea

Friday 7 July – 15.10-17.00 – Session 4 – Mal Nairn Auditorium, NTU Building 35	
Snowy River II – Chaired by Bill Williams	
15.10-15.30	Teresa Rose – NSW Department of Land and Water Conservation – The Snowy River: Science guiding the way forward.
15.30-15.50	Michael Stewardson – University of Melbourne – Environmental flow planning based on hydraulic events: Application to the Lower Snowy River.
15.50-16.10	***Jamie Pittock – World Wide Fund for Nature – What responsibilities do limnologists and other scientists have in setting environmental flow targets?***
16.10-16.30	Discussion
16.30-17.00	Discussion and summary

Day 2 – ASL2000 Congress Program – Australian Wetland Forum Sessions I–IV

Saturday 8 July – 09.00-10.00 – AWF Session I – Mal Nairn Auditorium, NTU Building 35	
Wetland stories	
09.00-09.05	Liz Brown – World Wide Fund for Nature – Welcome and introduction.
09.05-09.20	Charles Godjuwa & Wayne Campion – Djelk Rangers, Maningrida – A wetland story.
09.20-09.35	Max Finlayson – National Centre for Tropical Wetland Research – Another wetland story.
09.35-09.50	Michelle Handley & Pierre Horwitz – World Wide Fund for Nature & Edith Cowan University – The Australian Wetland Forum story.
09.50-10.00	Liz Brown – World Wide Fund for Nature – Outline of 'process' for the Forum.
10.00-10.30	Coffee and Tea

Saturday 8 July – 10.30-13.15 – AWF Session II – Mal Nairn Auditorium, NTU Building 35	
Evaluation of wetland/water initiatives and policies for stopping and reversing the loss and degradation of Australian wetlands	
10.30-10.35	Liz Brown – World Wide Fund for Nature – Introduction to session.
10.35-11.20	Jenny Davis, Andrew Boulton, Paul Boon & Naomi Rea – Murdoch University, University of New England, Victoria University & NT Department of Lands, Planning and Environment – Loss and degradation of Australian wetlands: Multiple causes, similar effects and flexible solutions.
11.20-11.40	Peter Cotsell – Environment Australia – Evaluation of national and state/territory wetland policies and initiatives.
11.40-12.00	Bill Williams – University of Adelaide – Evaluation and achievements of national wetland/water R&D programs.
12.00-12.20	Jamie Pittock – World Wide Fund for Nature – Evaluation of major international wetland/water treaties.
12.20-13.15	Sessional group discussions
13.15-14.00	Lunch

Saturday 8 July – 14.00-16.00 – AWF Session III – Mal Nairn Auditorium, NTU Building 35	
Mechanisms to involve all sectors of the community in stopping and reversing the loss and degradation of Australian wetlands	
14.00-14.05	Liz Brown – World Wide Fund for Nature – Introduction to session.
14.05-14.25	Christine Prietto – Shortlands Wetland Centre, on behalf of EA's National CEPA Task Force – Increasing awareness through outreach and education programs.
14.25-14.45	Tony Sharley – Banrock Station – Involving the private sector through incentives and consultation.
14.45-15.05	Liz Brown – Improving the delivery of research results and information – discussion.
15.05-16.00	Sessional group discussions
16.00-16.20	Coffee and Tea

Saturday 8 July – 16.20-17.00 – AWF Session IV – Mal Nairn Auditorium, NTU Building 35	
Summary and next steps	
16.20-16.50	Liz Brown – World Wide Fund for Nature – Summary of issues raised/decisions taken during the day.
16.50-17.00	ASL/WWF organisers – Next steps and thank you.

Day 3 – ASL2000 Congress Program – Sessions 5–9

Sunday 9 July – 08.40-10.40 – Session 5A – Mal Nairn Auditorium, NTU Building 35	
Tropical wetlands I – Chaired by George Begg	
08.40-09.00	Michael Storrs – Northern Land Council – Aboriginal owned wetlands of Australia's 'Top End': Management issues and actions.
09.00-09.20	Christine Bach – NT Department of Lands, Planning and Environment – Monitoring the Mary River wetlands in the Northern Territory of Australia.
09.20-09.40	Matthew Fegan – PhD student, Northern Territory University – Using GIS for texture assisted classification of wetlands imagery.
09.40-10.00	Caroline Camilleri – National Centre for Tropical Wetland Research – Prevention of aquatic aluminium toxicity by naturally occurring silica: Field and laboratory evidence.
10.00-10.20	Cathy Pringle – University of Georgia – Use of electric fences to evaluate top-down effects of omnivorous fishes in variable hydrologic regimes of a tropical stream.
10.20-10.40	Max Finlayson, Ian Eliot & Michael Saynor – National Centre for Tropical Wetland Research & University of Western Australia – The vulnerability of Kakadu's wetlands to climate change and sea level rise.

Sunday 9 July – 08.40-10.40 – Session 5B – Room 23.01, NTU Education Building 23	
Restoration – Chaired by Heather Shearer	
08.40-09.00	Paul DuBowy – University of Newcastle – The role of control and reference sites in wetland restoration.
09.00-09.20	Frank Burns – Frank L Burns Consulting Engineers – Water quality control in shallow storages by automatic aeration: Case studies from Albury Paper Mill, NSW, and Ballina Town Water Supply, NSW.
09.20-09.40	Jane Chambers – Murdoch University – Organic matter or nutrient addition: Which is best to kickstart a created wetland's foodweb?
09.40-10.00	Michaela Birrell * – University of South Australia – The viability of seed banks for the revegetation of temporary wetlands in the Watervalley Wetlands, S.A.
10.00-10.20	Anne Jensen – Wetland Care Australia – Practical wetland rehabilitation techniques.
10.20-10.40	Kimberley James – Deakin University – Rehabilitation of Kanyapella Basin: Identification of vegetation communities and possible threats to these communities.
10.40-11.00	Coffee and Tea

Sunday 9 July – 11.00-13.00 – Session 6A – Mal Nairn Auditorium, NTU Building 35	
Assessment of uranium mining – Chaired by Max Finlayson	
11.00-11.20	Michael Saynor – Environmental Research Institute of the Supervising Scientist – A field program to determine the geomorphic changes in the catchment containing the Jabiluka Uranium Mine.
11.20-11.40	Ken Evans – Environmental Research Institute of the Supervising Scientist – Assessment of impacts of erosion from waste rock dumps at Jabiluka on Swift Creek.
11.40-12.000	Paul Martin – Environmental Research Institute of the Supervising Scientist – Radiological impact assessment of uranium mining operations in the ARR.

12.00-12.20	Rick van Dam – Environmental Research Institute of the Supervising Scientist – Derivation of a site-specific water quality guideline for uranium based on local species toxicity data.
12.20-12.40	Chris Humphrey – Environmental Research Institute of the Supervising Scientist – An overview of requirements for environmental monitoring and assessment of the proposed Jabiluka uranium mine.
12.40-13.00	Frederick Bouckaert – Environmental Research Institute of the Supervising Scientist - Use of macroinvertebrate communities for monitoring and assessing potential impacts of the Jabiluka uranium mine on aquatic ecosystems.

Sunday 9 July – 11.00-13.00 – Session 6B – Room 23.01, NTU Education Building 23

Stream monitoring I – Chaired by Satish Choy

11.00-11.20	Michael Reid – Monash University – Palaeolimnological evidence of instream ecosystem changes in response to river regulation, Murray River, Australia.
11.20-11.40	Chris Burton & Greg Raisin – NSW Department of Land and Water Conservation – Assessment of salinity in the Macquarie River, central west, New South Wales.
11.40-12.00	Brad Sherman – CSIRO Land & Water – A review of methods for the mitigation of cold water pollution below dams.
12.00-12.20	Eren Turak – NSW EPA – AUSRIVAS in NSW: new models for old rivers.
12.20-12.40	Julie Coysh – CRC for Freshwater Ecology – 'Dirty water' models: Predicting biological change in streams using simulated impacts.
12.40-13.00	John Harris – Cooperative Research Centre for Freshwater Ecology – Do abandoned rock piles episodically poison streams? The Tooma River story so far.
13.00-14.00	Lunch

Sunday 9 July – 14.00-15.20 – Session 7A – Mal Nairn Auditorium, NTU Building 35

Remote sensing – Chaired by Paul Martin

14.00-14.20	Renee Bartolo – Northern Territory University – A remote sensing framework for the management of Australian tropical wetlands.
14.20-14.40	Jane Hosking – NT Department of Lands, Planning and Environment – Wetland monitoring using sequences of Landsat imagery in the Mary River catchment.
14.40-15.00	Dawn Williamson – University of New South Wales – Mapping inundation processes in the Alligator Rivers region of Kakadu National Park using remotely sensed data.
15.00-15.20	Darren Bell * – Northern Territory University – Vegetation correction of AirSAR data for mapping soil salinity.

Sunday 9 July – 14.00-15.20 – Session 7B – Room 23.01, NTU Education Building 23

Fish & Waterbirds – Chaired by Bob Pidgeon

14.00-14.20	Colton Perna – James Cook University – Fish habitat values of the Burdekin Delta distributary streams.
14.20-14.40	Michael Shirley – Sinclair Knight Merz – Fish communities of River Murray billabongs: The role of the introduced predator European Perch (*Perca fluviatilis*).

14.40-15.00	Eric Dorfman – University of Sydney – The importance of hydrological variability to tropical waterbirds in Australia.
15.00-15.20	Dorothy Bell * – University of New England – Dispersal of Eleocharis seeds by birds.
15.20-15.40	Coffee and Tea

Sunday 9 July – 15.40-17.40 – Session 8A – Mal Nairn Auditorium, NTU Building 35

Science and Communication – Chaired by Ben Gawne

15.40-16.00	Heather Shearer – Wetland Care Australia – Communicating wetland research to the community.
16.00-16.20	Ben Gawne – Murray Darling Freshwater Research Centre – Freshwater ecologists and the potential to enjoy cultural shock.
16.20-16.40	Paul Lloyd – MWWG – New and improved: Scientific understanding and management change.
16.40-17.00	Deb Nias – NSW Department of Land and Water Conservation – The Darling Anabranch: A case study in the interactions amongst science, landholders, government and politics.
17.00-17.20	Andrew Boulton – University of New England – What a tangled web: A field-class using net-spinning caddisfly larvae to reveal the complexity of environmental flow allocations.
17.20-17.40	Bruce Ryan & Abbie Spiers – Environmental Research Institute of the Supervising Scientist & National Centre for Tropical Wetland Research – How can we ensure that wetland ecology is relevant to wetland owners and managers?

Sunday 9 July – 15.40-17.40 – Session 8B – Room 23.01, NTU Education Building 23

Monitoring approaches I – Chaired by Chris Humphrey

15.40-16.00	Simon Linke – University of Canberra – E-ball: An alternative prediction method in comparative biomonitoring.
16.00-16.20	Bernie Cockayne – QLD Department of Natural Resources – Validation of the visual assessment method of pool and riffle habitats using the velocity/depth ratio, Froude number and macroinvertebrate classification.
16.20-16.40	Peter Gell – Adelaide University – Tareena Billabong: A potential LIMPACS site for Australia.
16.40-17.00	Glenn Johnstone * – University of Wollongong – Do rare taxa matter in multivariate hypothesis tests of community structure?
17.00-17.20	Grant Hose – NSW Environmental Protection Agency – Can AUSRIVAS detect pesticide effects?
17.20-17.40	Jacob John – Curtin University – Urban streams: Classification and biomonitoring.

Sunday 9 July – 17.50-18.50 – ASL Annual General Meeting – Room 23.01, NTU Education Bldg 23

17.50-18.50	AGM reporting and election of Executive for 2000–2002

Day 4 – ASL2000 Congress Program – Sessions 10–13

Monday 10 July – 08.40-10.20 – Session 9A – Mal Nairn Auditorium, NTU Building 35	
Stream monitoring II – Chaired by Peter Dostine	
08.40-09.00	Andrew Boulton – University of New England – Hyporheic 'health' of the Hunter River: Trends along subsurface flow paths.
09.00-09.20	Peter Hancock – University of New England – Hyporheic 'health' of the Hunter River: A proposed sampling methodology.
09.20-09.40	Karen Sutcliffe * – Murdoch University – How much can AUSRIVAS sampling tell us about the conservation status of aquatic insects in south-western Australia?
09.40-10.00	Monika Muschal – NSW Department of Land and Water Conservation – The ability of various biological techniques to assist with the making of natural resource management decisions.
10.00-10.20	Jonathan Marshall – QLD Department of Natural Resources – Indices of stream health based on the flow and substrate preferences of aquatic macroinvertebrates at the Family level.

Monday 10 July – 08.40-10.20 – Session 9B – Room 23.01, NTU Education Building 23	
Tropical wetlands II – Chaired by Michael Douglas	
08.40-09.00	George Begg – National Centre for Tropical Wetland Research – A preliminary assessment of the potential impacts of the introduced cane toad (*Bufo marinus*) in Kakadu National Park.
09.00-09.20	Michael Douglas – University of Northern Territory – Macroinvertebrate communities in native and exotic grasses on a tropical floodplain.
09.20-09.40	Kevin Boland – Tropical Water Solutions – The limnology of water-filled open-cut mine voids.
09.40-10.00	Simon Townsend – NT Department of Land, Planning and the Environment – Natural fish kills in the Top End: Three case studies.
10.00-10.20	Bob Pidgeon – National Centre for Tropical Wetland Research – Bioturbation effects in a natural fish kill in Kakadu National Park, NT.

Monday 10 July – 09.00-10.20 – Session 9C – Room 22.99, NTU Building 22	
Education and awareness – Chaired by Anne Jensen	
09.00-10.20	Communication, Education and Public Awareness (CEPA) for wetland conservation – Workshop & discussion – Getting wetland messages out effectively.
10.20-10.50	Coffee and Tea

Monday 10 July – 10.50-12.50 – Session 10A – Mal Nairn Auditorium, NTU Building 35	
Wetlands – Chaired by Bill Williams	
10.50-11.10	Bill Humphreys – WA Museum – Subterranean wetlands: A new frontier in arid Australia.
11.10-11.30	Jenny Davis (for Deb Thomas) – Murdoch University – How much water do wetlands need?
11.30-11.50	Alisa Krasnostein – Centre for Water Research, University of Western Australia – Conceptual models for predicting wetland water storage.
11.50-12.10	Emma Gale – Centre for Water Research, University of Western Australia – Analysis of meteorological data across WA: Inputs to wetland models.

12.10-12.30	Michael Healey – NSW Department of Land and Water Conservation – Can rapid wetland assessment techniques be useful across wetland types and different investigators?
12.30-12.50	Lien Sim – Sinclair Knight Merz – Chemical warfare in aquatic systems: Allelopathic interactions between submerged aquatic macrophytes and microalgae.

Monday 10 July – 10.50-12.50 – Session 10B – Room 23.01, NTU Education Building 23

Monitoring approaches II – Chaired by Frederick Bouckaert

10.50-11.10	Alex Leonard – UTS – Pesticides, passive samplers, macroinvertebrates and the Namoi River.
11.10-11.30	Richard Marchant – Museum of Victoria – Is it possible to extract all insect larvae from a benthic sample?
11.30-11.50	Craig McVeigh * – University of Adelaide – Monitoring mound springs with modern and fossil diatoms.
11.50-12.10	Joanne Ling * – University of Western Sydney – Development of a wetland assessment protocol using biological techniques.
12.10-12.30	Michael Stewardson – University of Melbourne – A new approach to describing the hydraulic environment of streams.
12.30-12.50	Alastair Buchan – NSW Department of Land and Water Conservation – The SCHMAPPS Model: Bridging gaps between limnology, community values and active management of NSW waterways.
12.50-14.00	Lunch

Monday 10 July – 14.00-15.20 – Session 11A – Mal Nairn Auditorium, NTU Building 35

River dynamics – Chaired by Andrew Boulton

14.00-14.20	Ben Gawne – Murray Darling Freshwater Research Centre – Coarse particulate organic matter in the Murray River.
14.20-14.40	Fiona Balcombe * – Griffith University – Temporal changes in the fine sediment texture of a gravel creek bed in south-east Queensland.
14.40-15.00	Peter Davies – University of Western Australia – Carbon metabolism in Cooper Creek, western Queensland: Wet and dry comparisons.
15.00-15.20	Chester Merrick – Murray Darling Freshwater Research Centre – Whole river metabolism and algal production in the regulated Lower Murray River, south-eastern Australia.

Monday 9 July – 14.00-15.20 – Session 11B – Room 23.01, NTU Education Building 23

Macro-invertebrates – Chaired by Jonathan Marshall

14.00-14.20	Helen Dunn – University of Tasmania – Identifying and protecting the conservation value of aquatic macroinvertebrates: A case study of the Tasmanian Plecoptera.
14.20-14.40	John Hawking – Murray Darling Freshwater Research Centre – The life history of an aquatic, leaf-roller caterpillar (Pyralidae: Nymphulinae) and its specific association with the floating pondweed (*Potamogeton tricarinatus*) in billabongs of south-eastern Australia.
14.40-15.00	Jane Growns – Monash University – Spatial and seasonal variations in snag macroinvertebrate communities in two regulated lowland rivers.

15.00-15.20	Melanie Pearson – La Trobe University – Preliminary investigation into the use of cellulose acetate gel electrophoresis for life history studies of Baetidae (Ephemeroptera) in a freshwater stream.
15.20-15.40	Coffee and Tea

Monday 10 July – 15.40-17.20 – Session 12A – Mal Nairn Auditorium, NTU Building 35

Algal/cyanobacteria blooms – Chaired by Bradford Sherman

15.40-16.00	Paul Wettin – NSW Department of Land and Water Conservation – Mitigating algal blooms with improved water quality: An example from the Lachlan River.
16.00-16.20	Jacob John – Curtin University – Toxic algal blooms and classification of urban wetlands of Perth, Western Australia.
16.20-16.40	Barbara Robson – University of Western Australia – Record summer rainfall induces a freshwater cyanobacterial bloom in the Swan River estuary.
16.40-17.00	Vlad Matveev – CSIRO Land & Water – Factors affecting variance in algal and cyanobacterial biomass in Australian reservoirs.
17.00-17.20	Carla Kinross – Fisher Stewart – Influence of bubble-plume aeration on seasonal stratification, internal nutrient loading and Cyanobacteria biomass in Lake Samsonvale (North Pine Dam), South east Queensland.

Monday 10 July – 15.40-17.20 – Session 12B – Room 23.01, NTU Education Building 23

Nutrient processes – Chaired by Jane Chambers

15.40-16.00	Paul Boon – Victoria University – Multiple metastable states in wetlands I: A background to experimental studies.
16.00-16.20	Kay Morris – Monash University – Multiple metastable states in wetlands II: Nutrient enrichment and the loss of submerged plants.
16.20-16.40	Paul Bailey – Monash University – Multiple metastable states in wetlands IV: Management implications of research findings.
16.40-17.00	Trish Bowen – University of Canberra – Magnitude and seasonality of Carbon inputs into the Murray River from riparian vegetation.
17.00-17.20	Stuart Bunn – Griffith University – The importance of benthic algae to aquatic food webs in Australian streams and rivers.

Monday 10 July – 17.25-17.35 – Session 13 – Mal Nairn Auditorium, NTU Building 35

Acknowledgements and Closing

17.25-17.30	Max Finlayson – Acknowledgments
17.30-17.35	ASL President – Closing comments

* Candidate for student prize

ASL 2000 Posters

Sophie Bickford	Student, Adelaide University	Holocene wetland dynamics in response to changes in climate and fire
Alastair Buchan	NSW Department of Land and Water Conservation	Monitoring environmental flows in New South Wales
Fiona Butson *	Student, Curtin University	Monitoring for salinity of inland waters in Western Australia using diatoms as tools for assessment
Samantha Capon	Centre for Catchment and Instream Research, Griffith University	Flow-related responses of floodplain vegetation in arid inland catchments
Sarah Cartwright *	University of Canberra	Invertebrate emergence from floodplain sediment: Linking hydrology, geomorphology and ecology
Joanne Clapcott	Griffith University	How are C4 plants contributing to the aquatic food webs of lowland Queensland streams?
Rhys Coleman & Jason Sonneman	Waterways & Environment, Melbourne Water & CRCFE, Water Studies Centre, Monash University	Towards a macroalgal index of water quality in Melbourne streams
Jenny Davis	Murdoch University	Predicting wetland response to changing water quantity and water quality
Maria Doherty	NSW EPA	Algal bloom management: Ben Chifley Reservoir
Patrick Driver, Peter Lloyd-Jones, Suzanne Unthank, Marcus Finn, Greg Raisin & Paul Wettin	NSW Department of Land and Water Conservation	Monitoring wetland responses to environmental flows in the Lachlan River, New South Wales
Keith Ferdinands	Northern Territory University	Something about Mary: Habitat conservation under multiple land use on the Mary River floodplains
John Foster *	University of Canberra	History books with floodplain sediment pages: A palaeolimnology study.
Sandra Grinter	Condamine Balonne Water Committee	The Condamine Balonne Water Committee — Improving Water Quality in the Catchment
Leesa Hughes	Monash University	Multiple metastable states in wetlands III: The importance of sediments as nutrient sources and sinks
Jacob John & Peter Mioduszewski	Curtin University	Limnology and biodiversity of Lake Jasper and adjacent wetlands — pristine freshwater systems in the south-west of Western Australia.
Erin Lowe	Curtin University	Biomonitoring acidic coal mine voids at Collie, Western Australia
Paul McKevoy & Andrew Pinder	SA Water	South Australia's oligochaete diversity revealed
Claire McKenny	Centre for Catchment and In-Stream Research, Griffith University	The effects of shade and nutrients on algae and grazers in SE Qld streams
Andrew Palmer	CSIRO	Assessment of Planktivorous fish stocks in the pelagic zone of a biomanipulated lake
Michael Reid	Monash University	Detecting effects of environmental water allocations in wetlands of the Murray-Darling Basin, Australia
Jim Thomson	Macquarie University	Testing the ecological relevance of a geomorphological river classification

* Candidate for student prize

ASL 39TH Annual General Meeting

Darwin, NT – Sunday 9 July 2000

Agenda

1. Adoption of agenda
2. Apologies
3. Acceptance of minutes of last AGM
4. Matters arising from minutes
5. President's report
6. Secretary's report
7. Treasurer's report
8. Honorarium for Treasurer
9. Auditor's report
10. Editor's report
11. Newsletter Editor's report
12. ASL Medal Award committee report
13. Student Award committee report
14. Student Travel Award committee report
15. Door Prize committee report
16. 40th Congress
17. Future congresses
18. Election of the executive
19. Election of the auditor
20. General business

Richard Marchant, ASL Secretary

Patterns in heavy metal, uranium and general indicator concentrations in the streams of the Jabiluka lease area

C leGras, D Moliere & D Norton

The temporary streams that occur on the Jabiluka lease site drain a highly leached sandstone catchment. Therefore, heavy metal concentrations in them should be very low. This expectation has been confirmed by three years of baseline and near-baseline chemical data acquired during the 1997–2000 Wet seasons.

A superficially surprising finding was that uranium concentrations were also very low, comparable with the lowest concentrations found elsewhere in the world. This is despite the existence of a large, near-surface uranium ore body. The very low ambient water concentration of uranium has important implications for effluent management, should the Jabiluka proposal proceed.

The streams acquire their general chemical character mostly from rainwater. However, each stream has its distinctive pattern of ionic composition and pH, which reflects the unique nature of its catchment. These too impose constraints on the design and implementation of a mining plan.

The data, although acquired over only three seasons, enable some preliminary benchmarks for effluent loads to be derived, based on a statistical analysis of the indicator values.

Patterns in heavy metal, uranium and general indicator concentrations in the streams of the Jabiluka lease area

<u>Christopher leGras</u>, Dene Moliere
& David Norton

Objectives of the Project

- to produce an independent database of relevant indicators

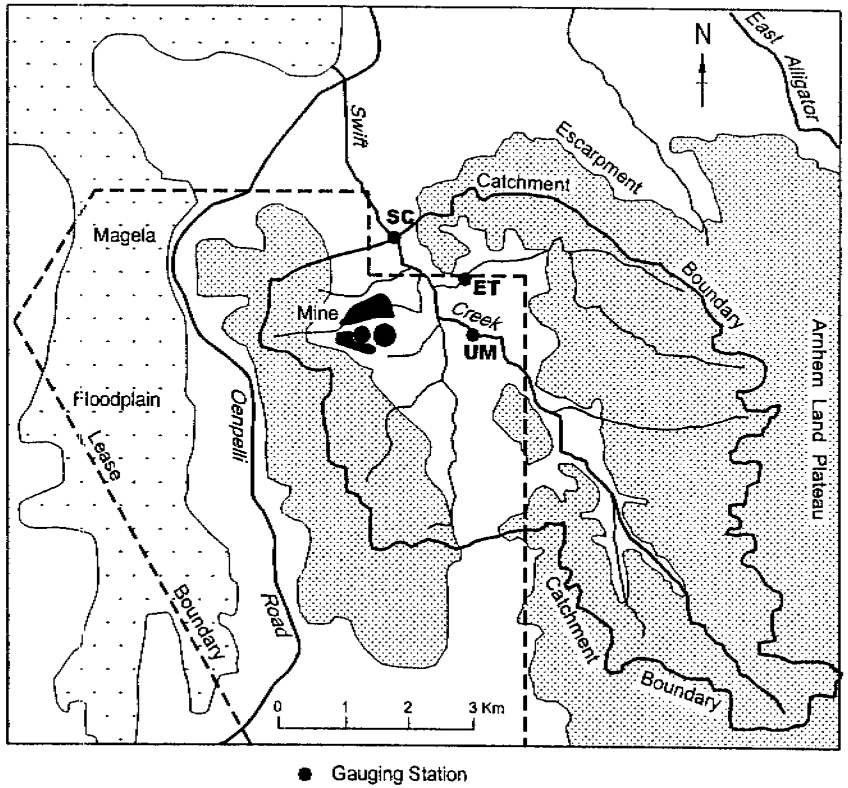
- to prepare a data set for comparison with that derived by ERA

- to understand intra-year and inter-year concentration patterns, and so derive a statistical basis to discern changes

Critical Indicators for Monitoring Program

Mg	Ore and waste-rock constituent
SO_4^{2-}	Ore and waste rock constituent
Mn	Potential mill reagent
U	Economic ore constituent

Line drawing of Jabiluka mine site



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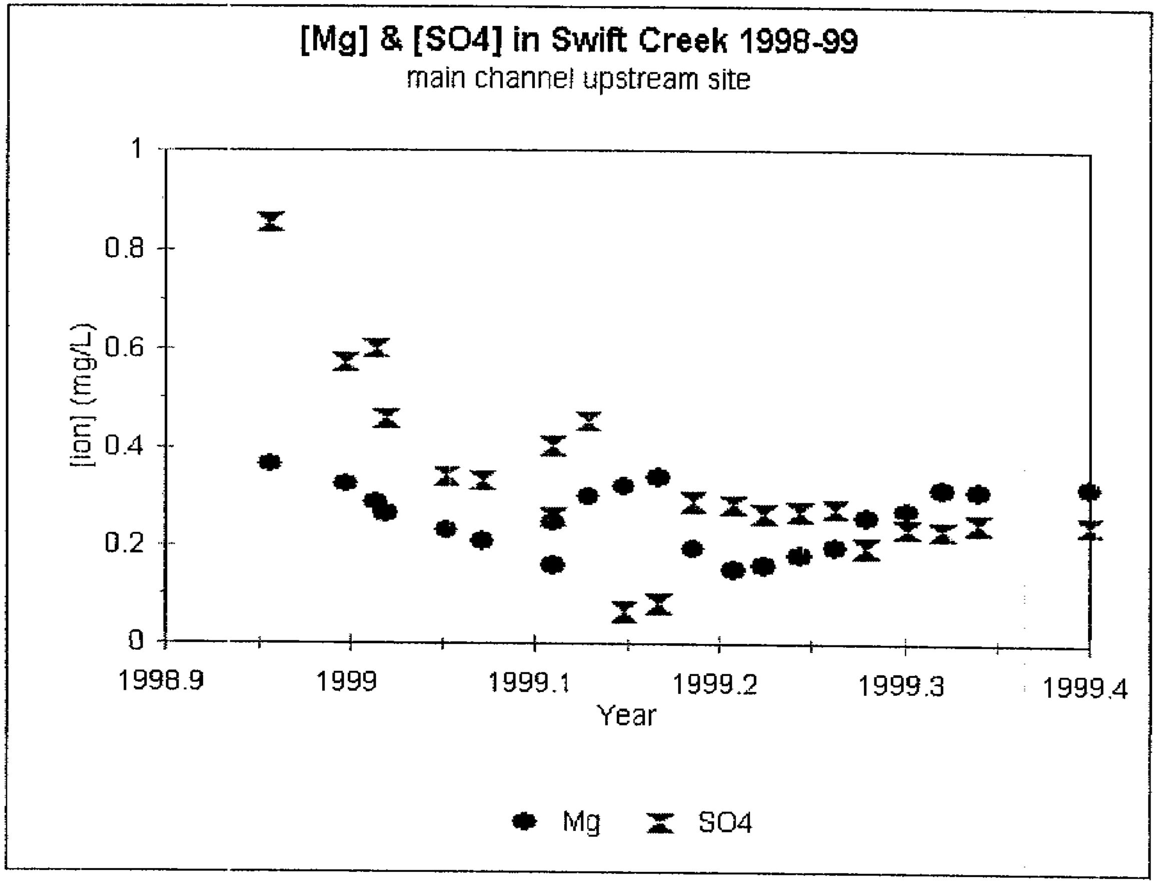
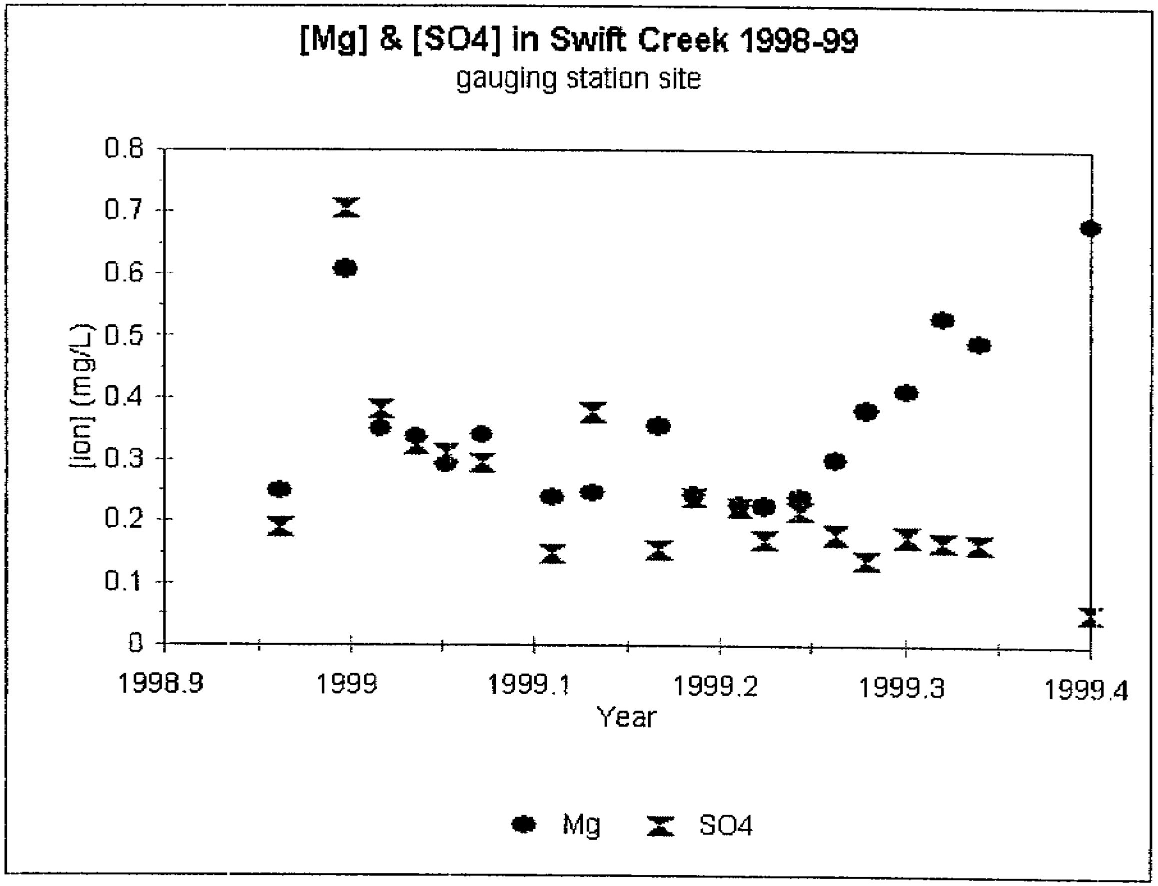
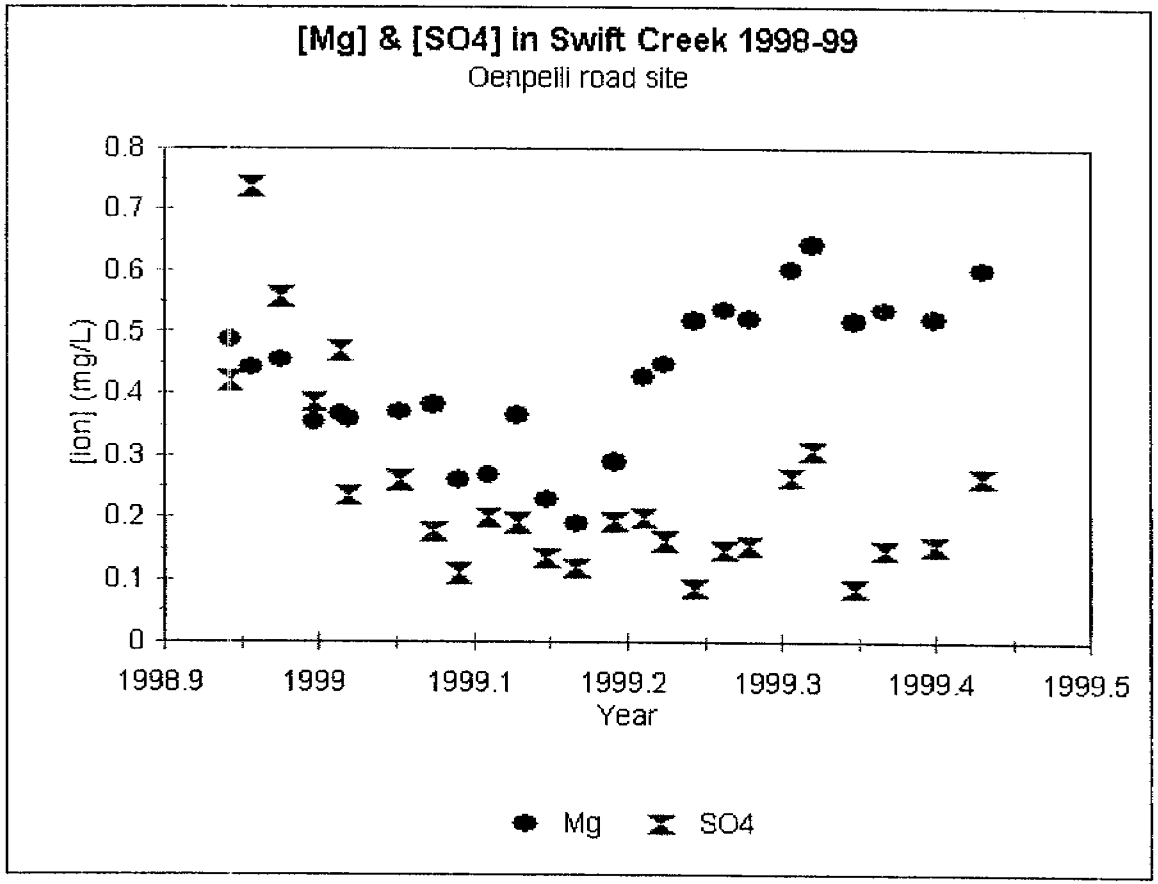


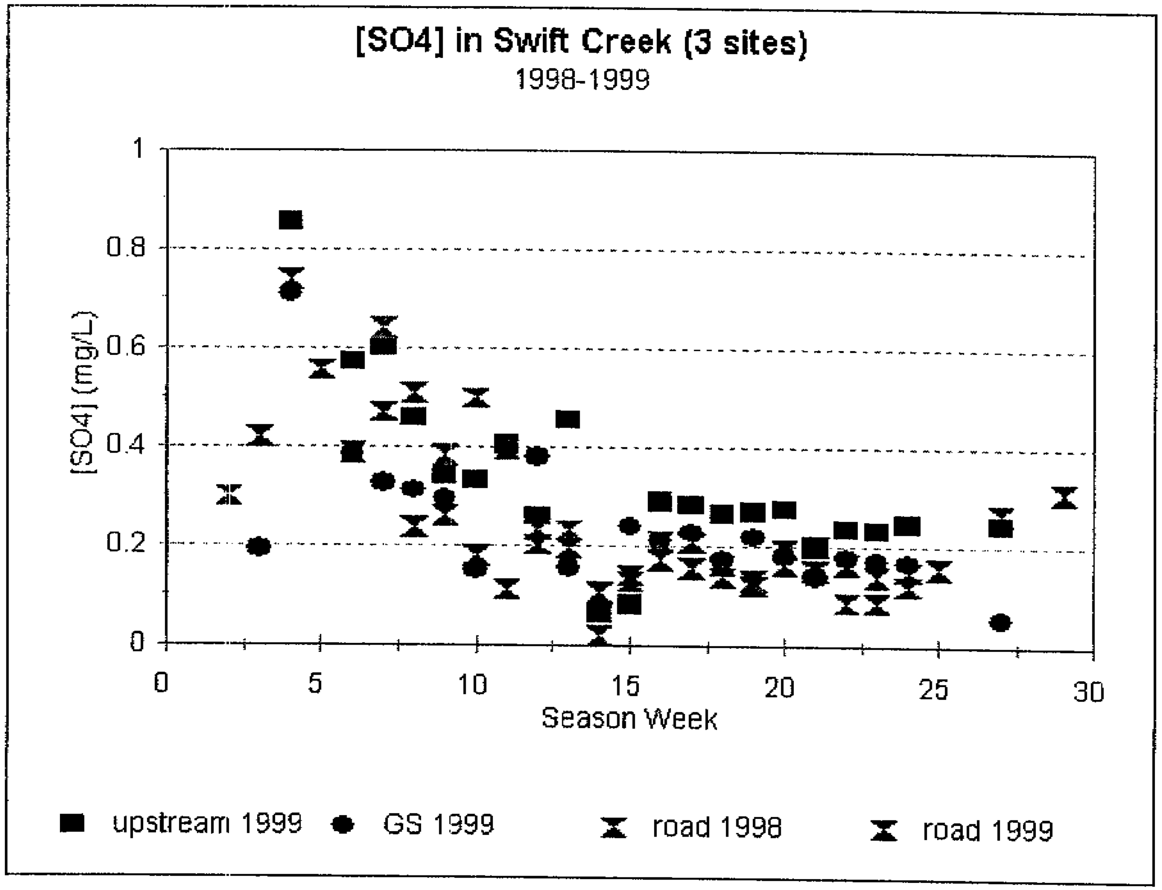
[Mg] & [SO4] in Swift Creek 1998-99
main channel upstream site
1
0.8
0.6
0.4
0.2
0
[ion] (mg/L)
1998.9
1999
1999.1
1999.2
1999.3
1999.4
Year
Mg
SO4

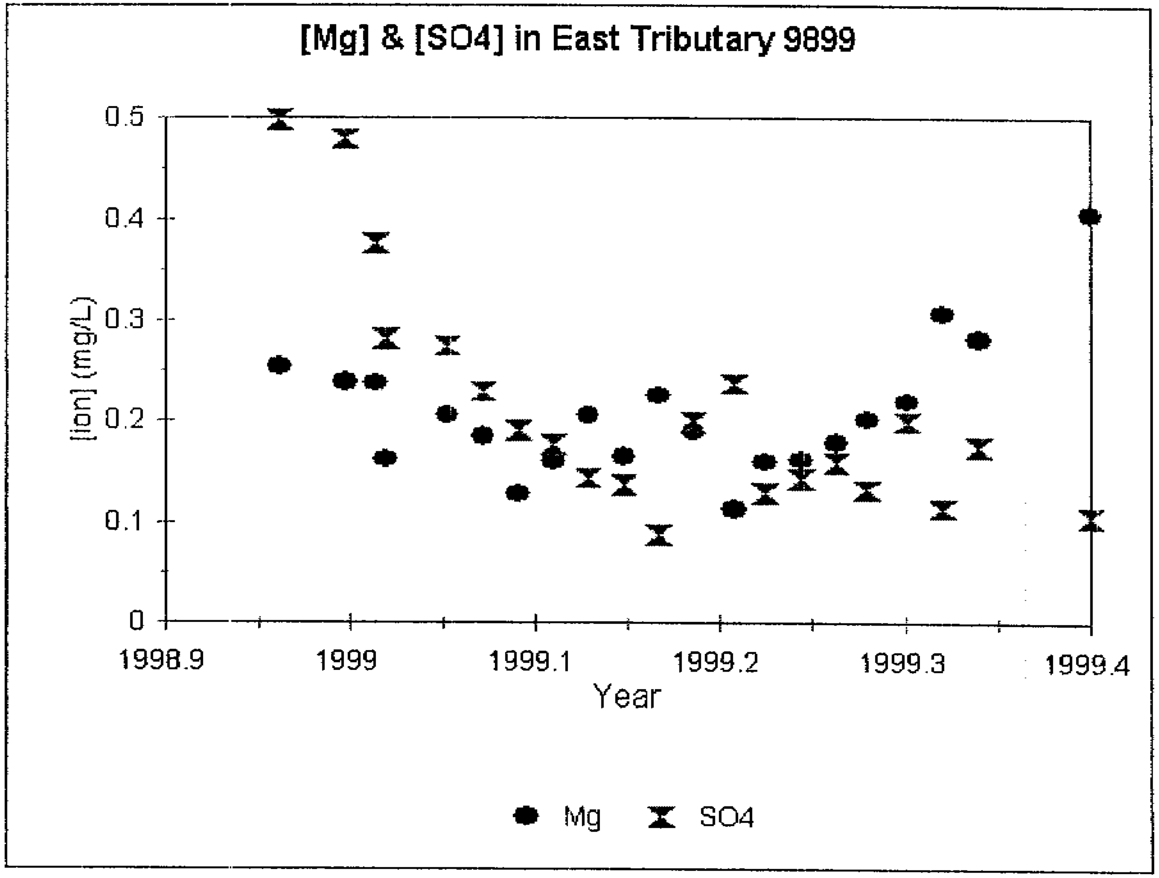


[Mg] & [SO4] in Swift Creek 1998-99
gauging station site
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
[ion] (mg/L)
1998.9
1999
1999.1
1999.2
1999.3
1999.4
Year
Mg
SO4

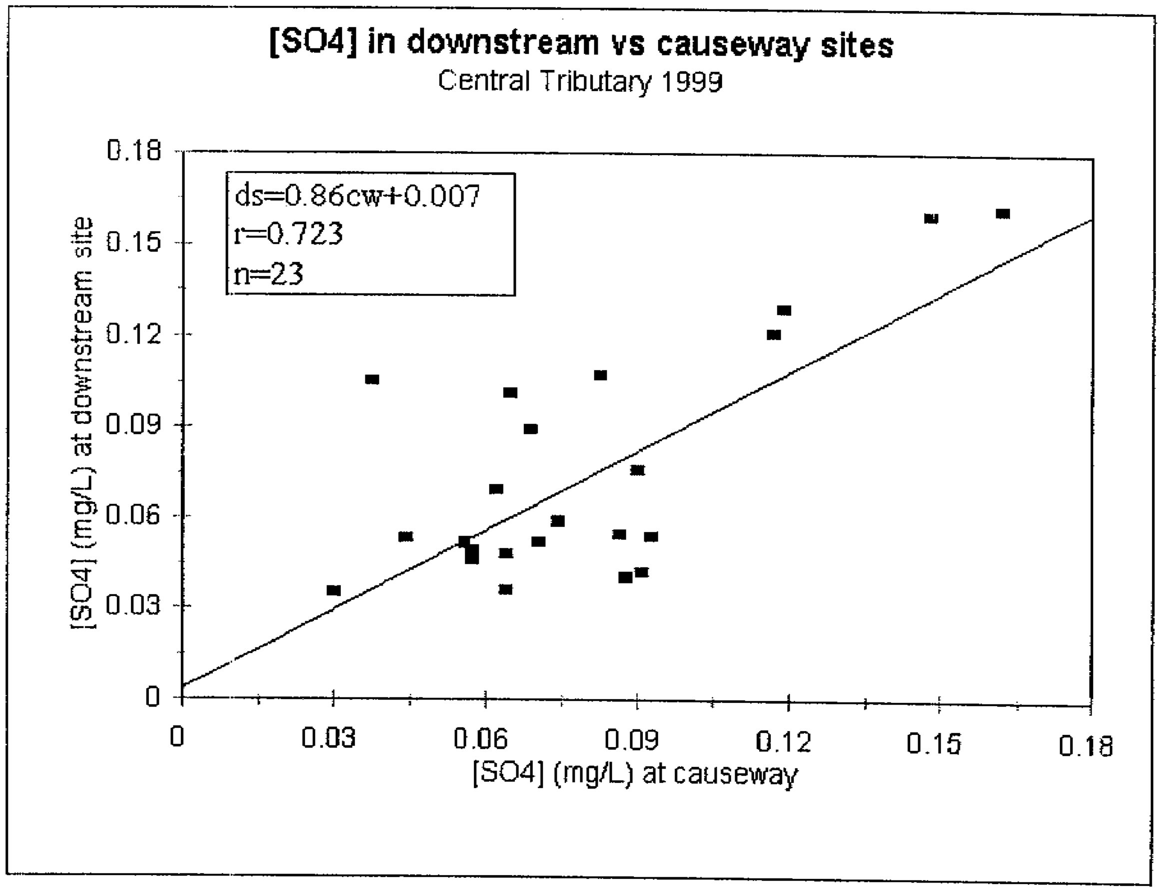


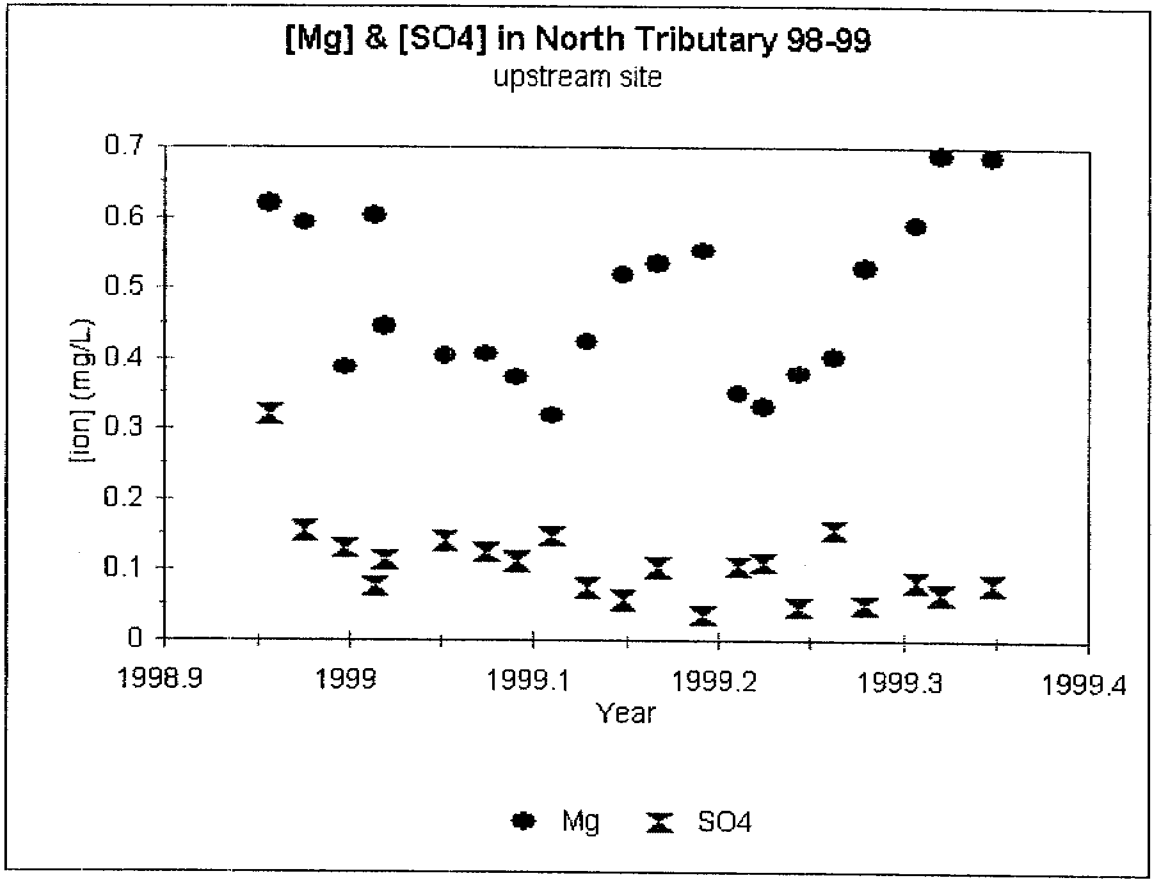
[Mg] & [SO4] in Swift Creek 1998-99
Oenpelli road site
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
[ion] (mg/L)
1998.9
1999
1999.1
1999.2
1999.3
1999.4
1999.5
Year
Mg
SO4


[SO4] in Swift Creek (3 sites)
1998-1999
[SO4] (mg/L)
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
Season Week
upstream 1999
GS 1999
road 1998
road 1999

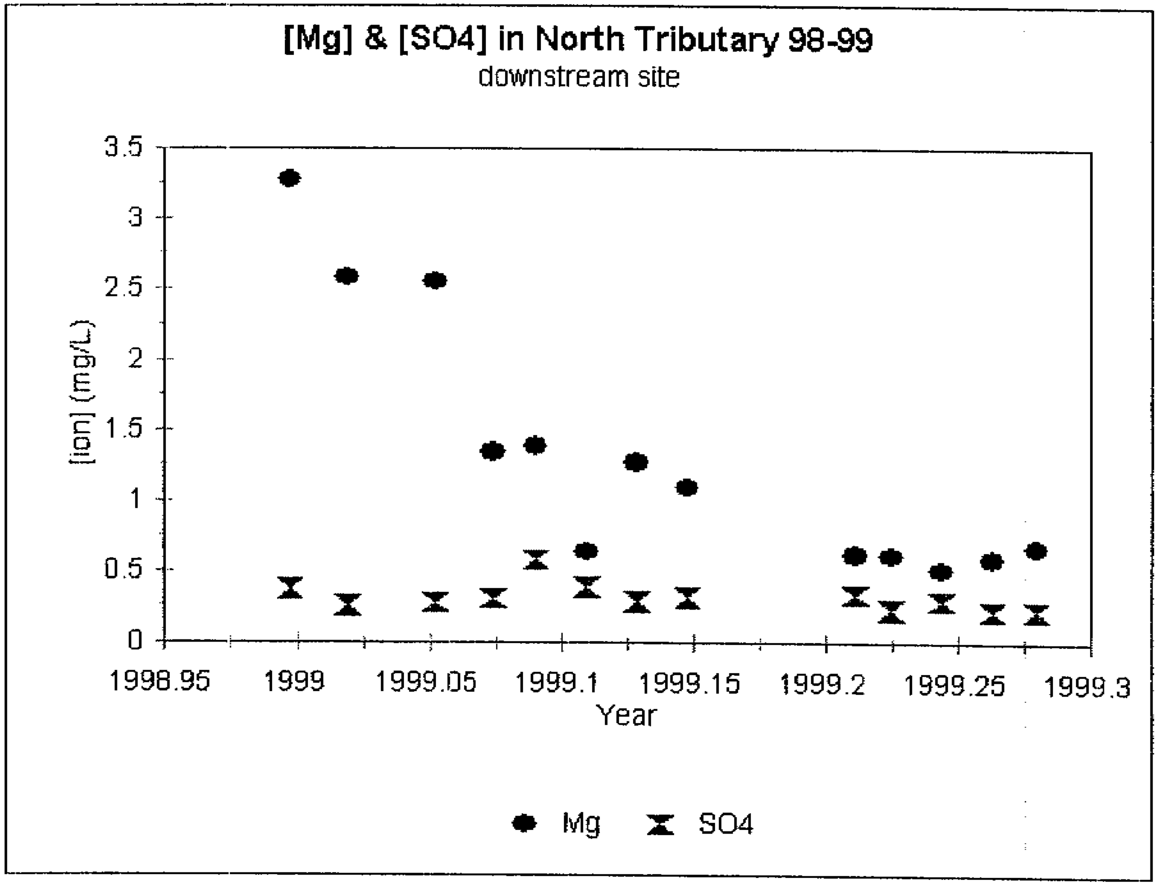


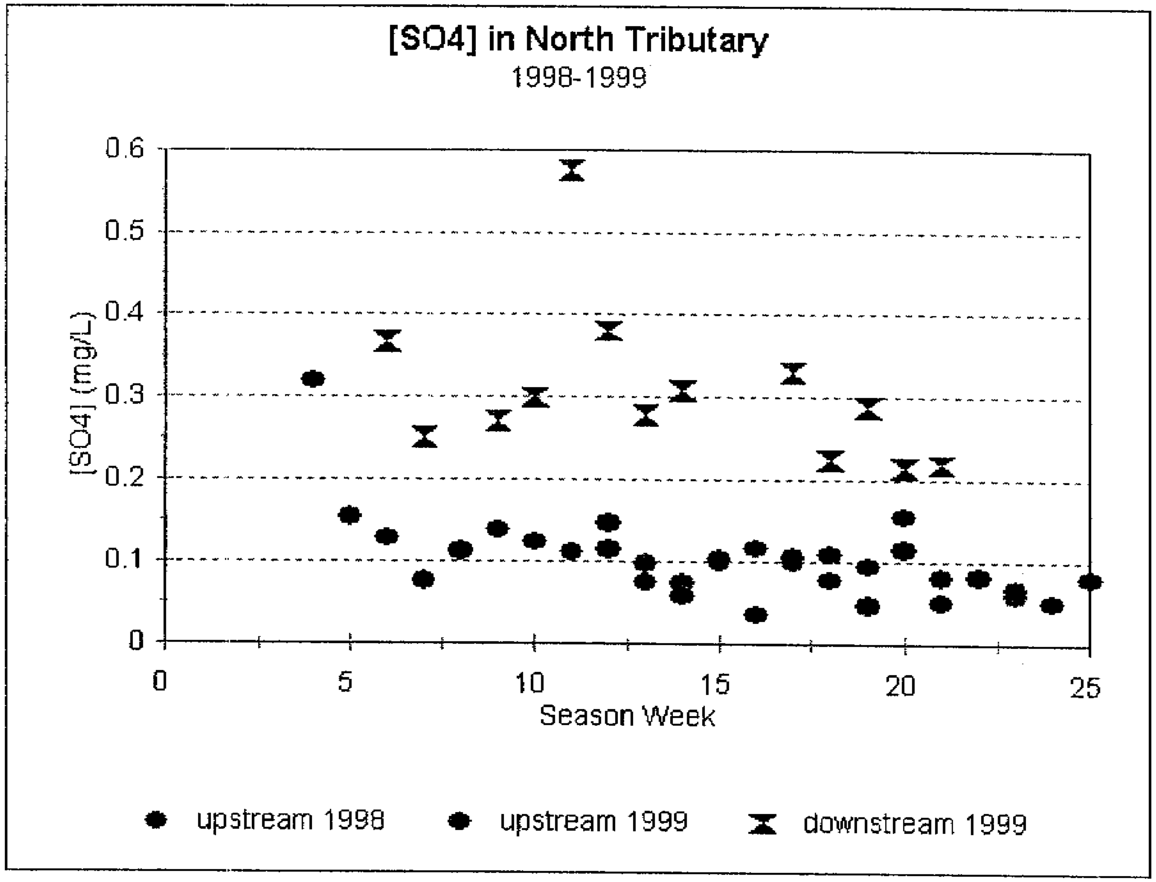
[Mg] & [SO4] in East Tributary 9899
[ion] (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1998.9
1999
1999.1
1999.2
1999.3
1999.4
Year
Mg
SO4


[SO4] in downstream vs causeway sites
Central Tributary 1999
ds=0.86cw+0.007
r=0.723
n=23
0.18
0.15
0.12
0.09
0.06
0.03
0
[SO4] (mg/L) at downstream site
0
0.03
0.06
0.09
0.12
0.15
0.18
[SO4] (mg/L) at causeway

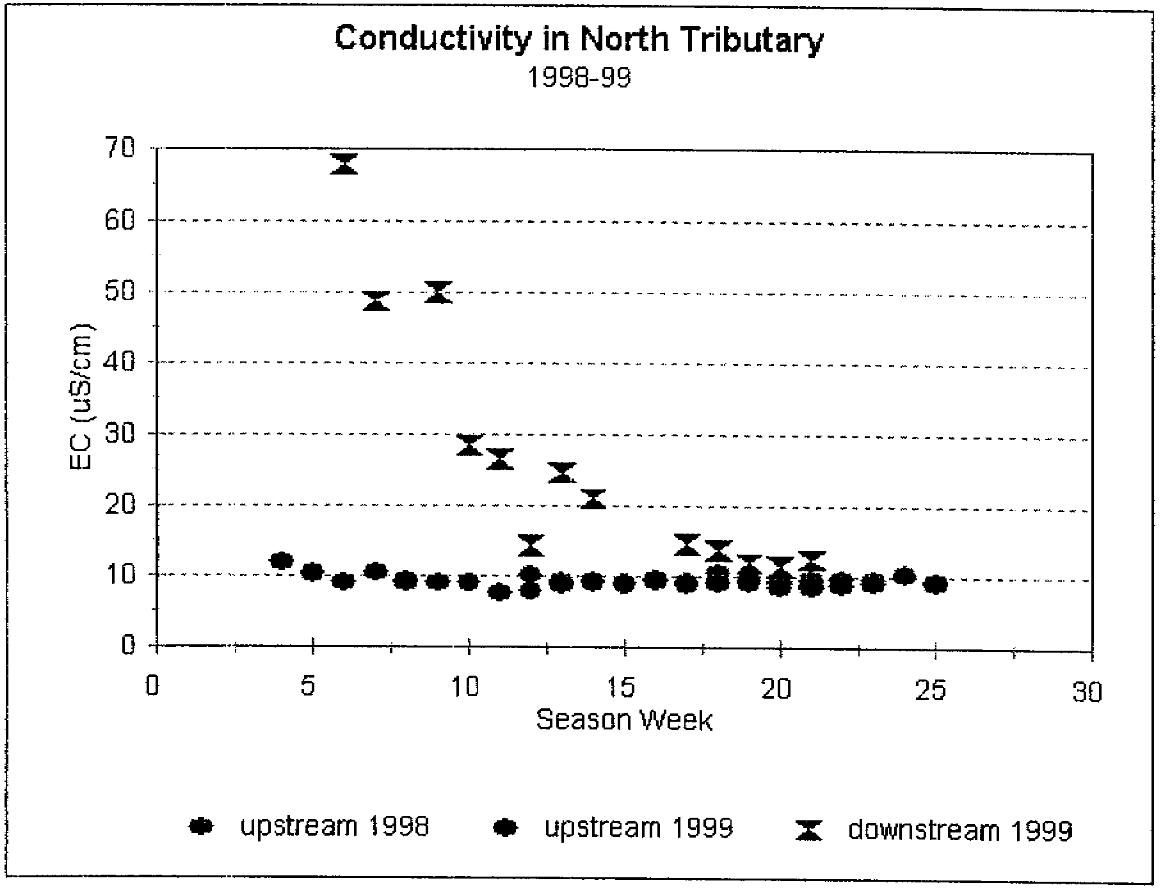


[Mg] & [SO4] in North Tributary 98-99
upstream site
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
[ion] (mg/L)
1998.9
1999
1999.1
1999.2
1999.3
1999.4
Year
Mg
SO4

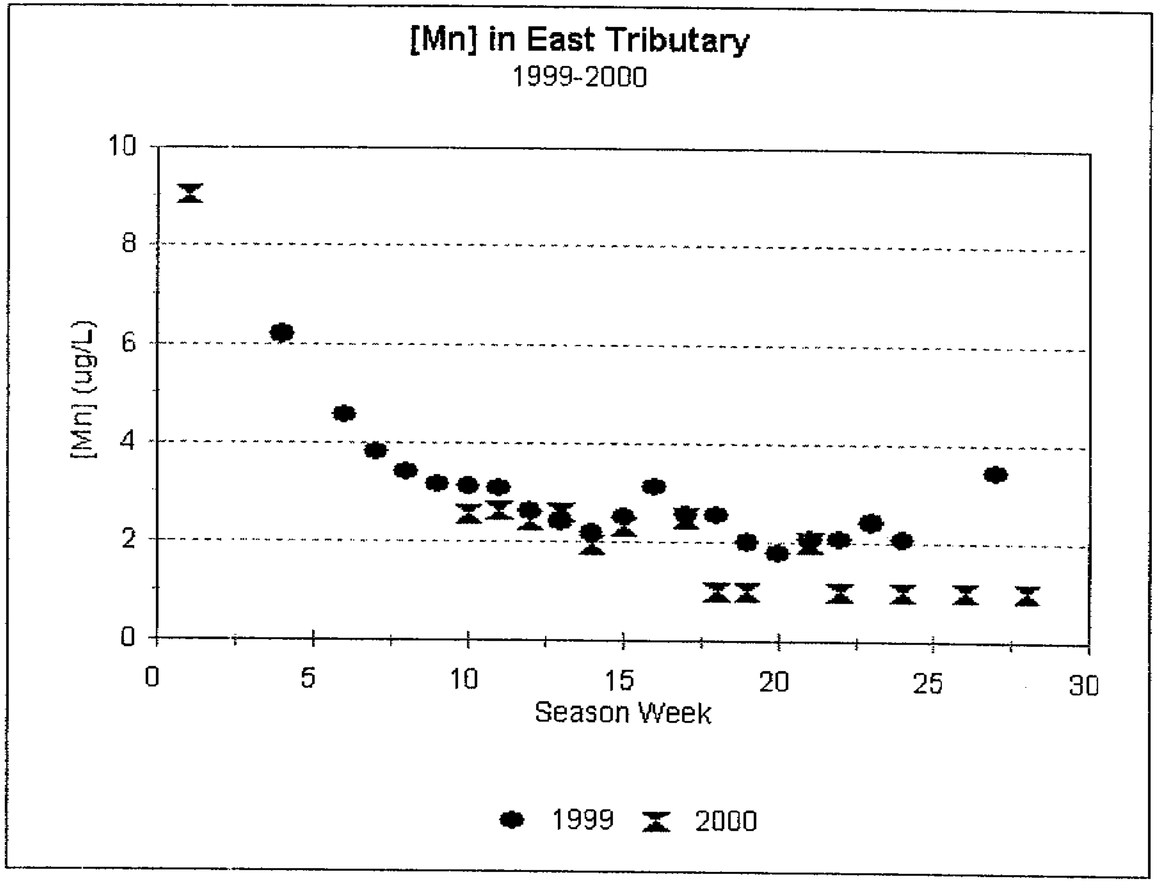

[Mg] & [SO4] in North Tributary 98-99
downstream site
3.5
3
2.5
2
1.5
1
0.5
0
[ion] (mg/L)
1998.95
1999
1999.05
1999.1
1999.15
1999.2
1999.25
1999.3
Year
Mg
SO4



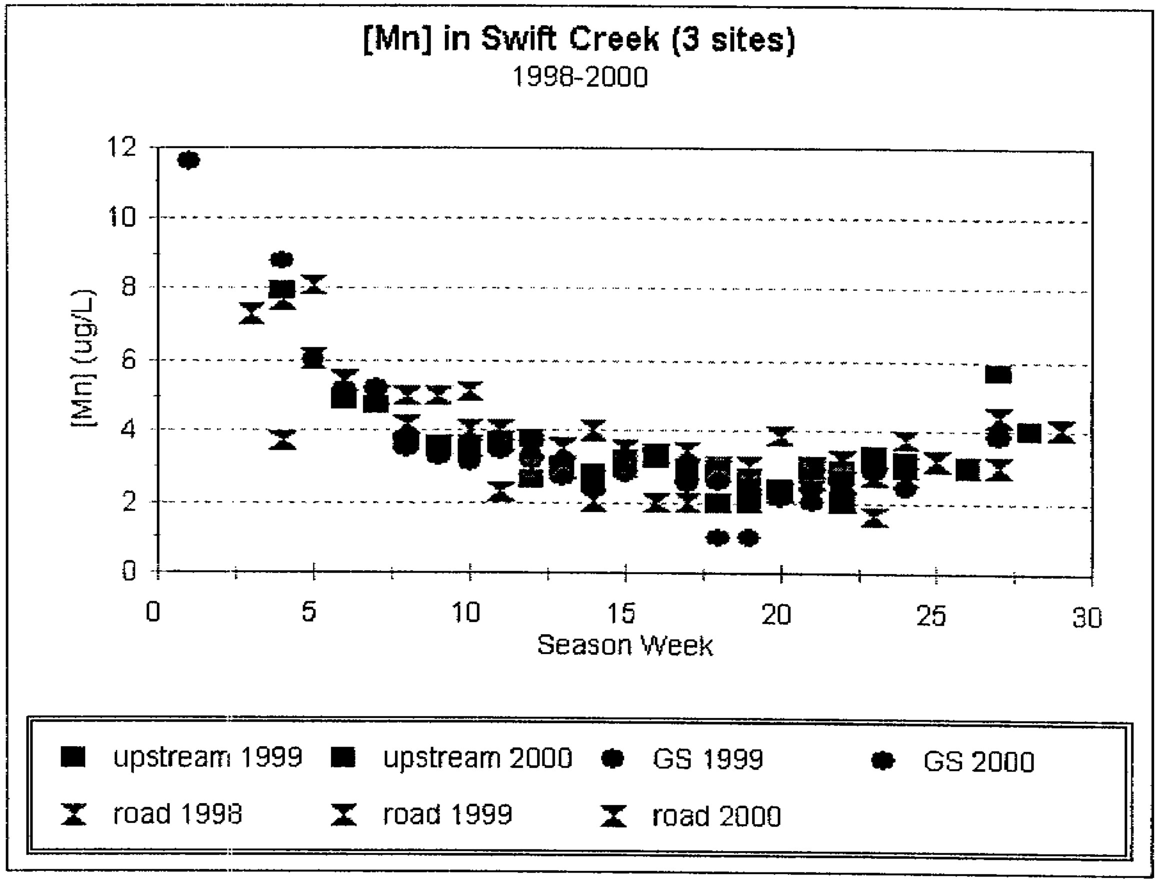
[SO4] in North Tributary
1998-1999
0.6
0.5
0.4
0.3
0.2
0.1
0
[SO4] (mg/L)
0
5
10
15
20
25
Season Week
upstream 1998
upstream 1999
downstream 1999



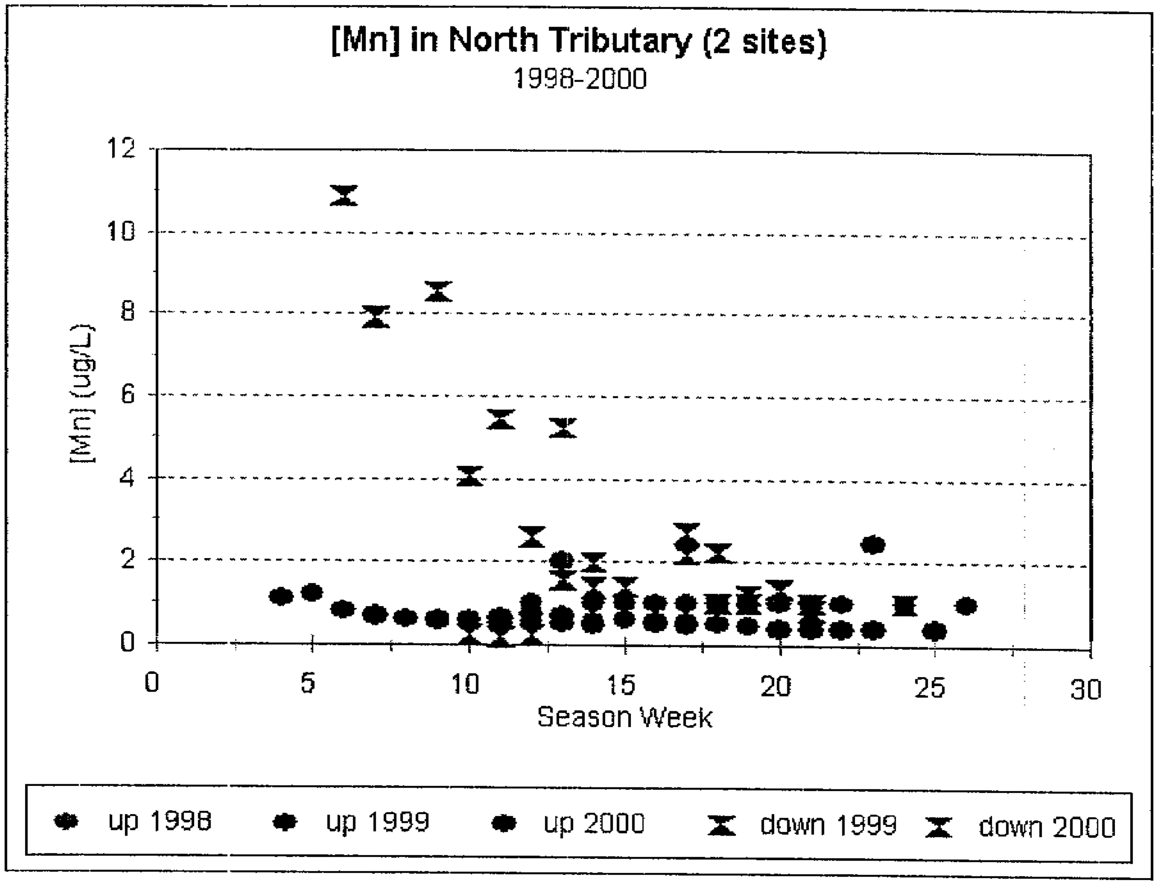
Conductivity in North Tributary
1998-99
EC (uS/cm)
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Season Week
upstream 1998
upstream 1999
downstream 1999



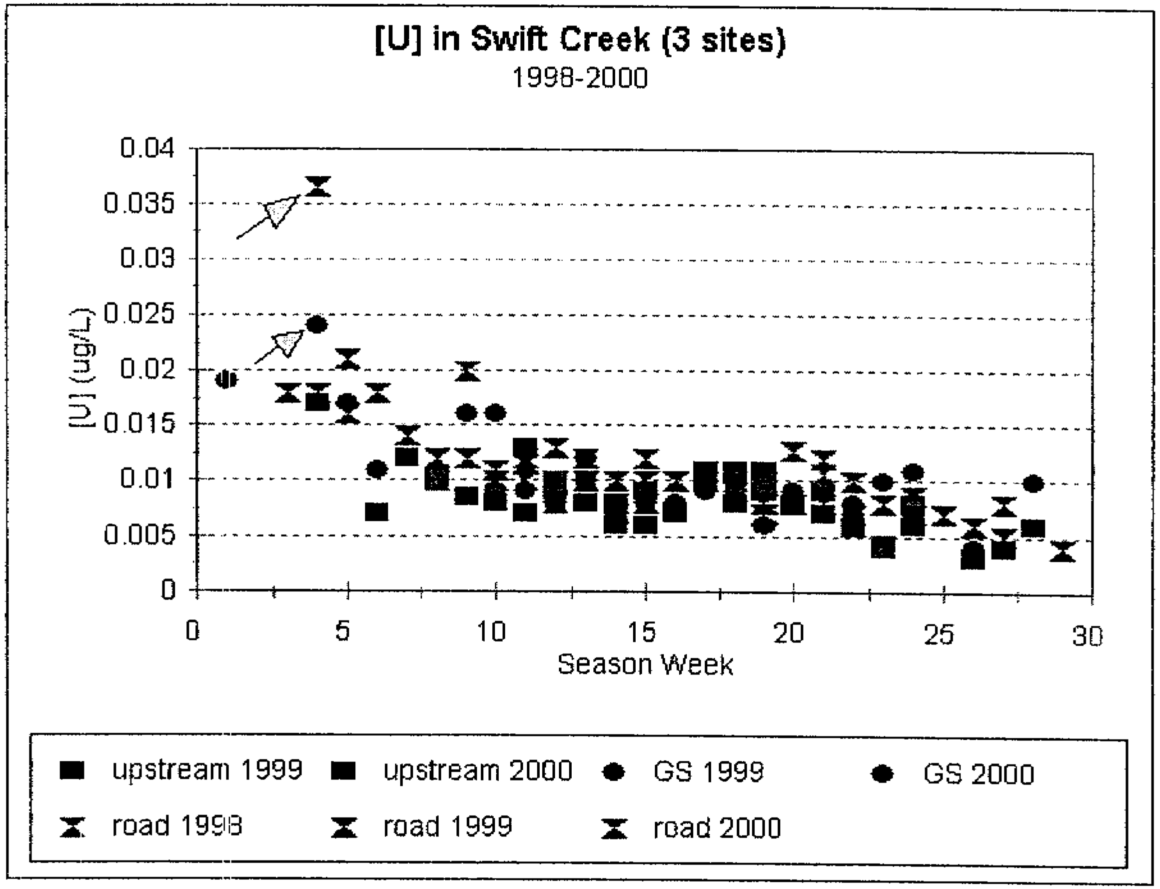
[Mn] in East Tributary
1999-2000
[Mn] (ug/L)
10
8
6
4
2
0
0
5
10
15
20
25
30
Season Week
1999
2000



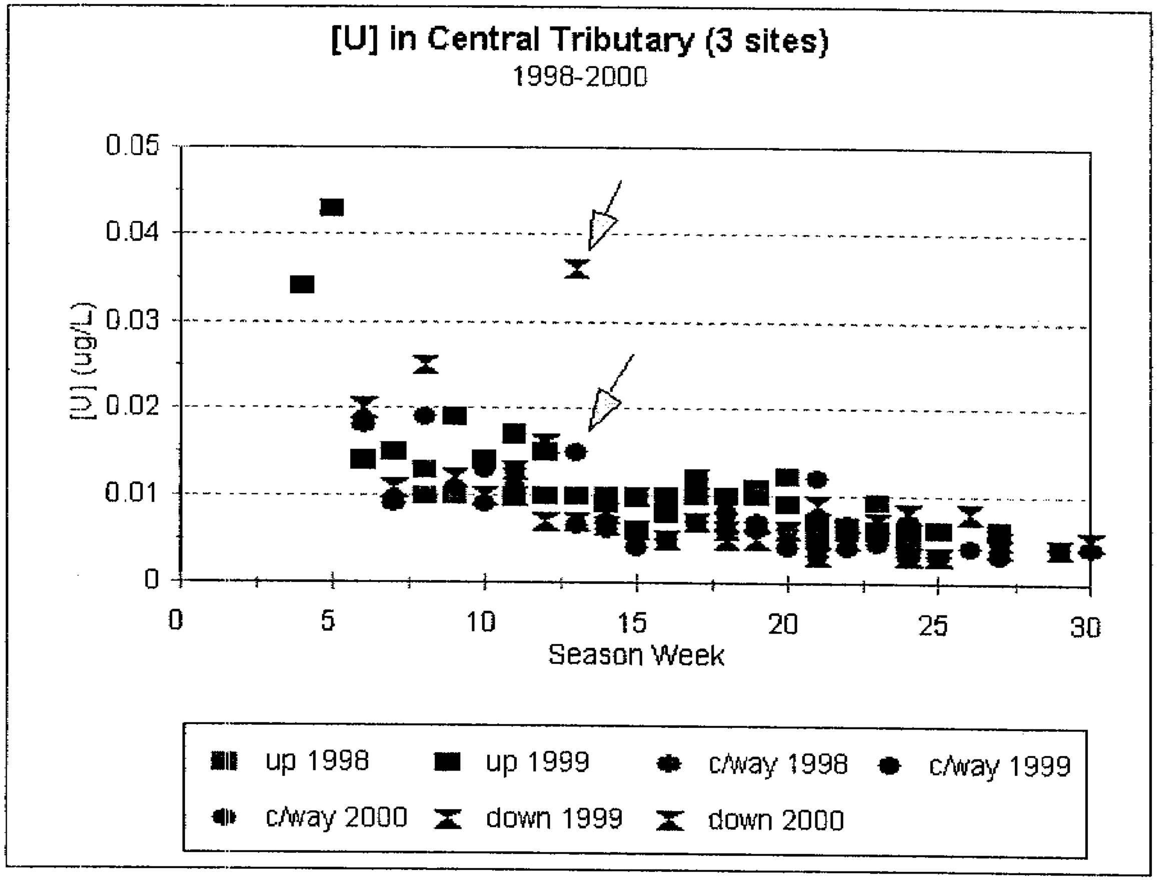
[Mn] in Swift Creek (3 sites)
1998-2000
[Mn] (ug/L)
Season Week
upstream 1999
upstream 2000
GS 1999
GS 2000
road 1998
road 1999
road 2000

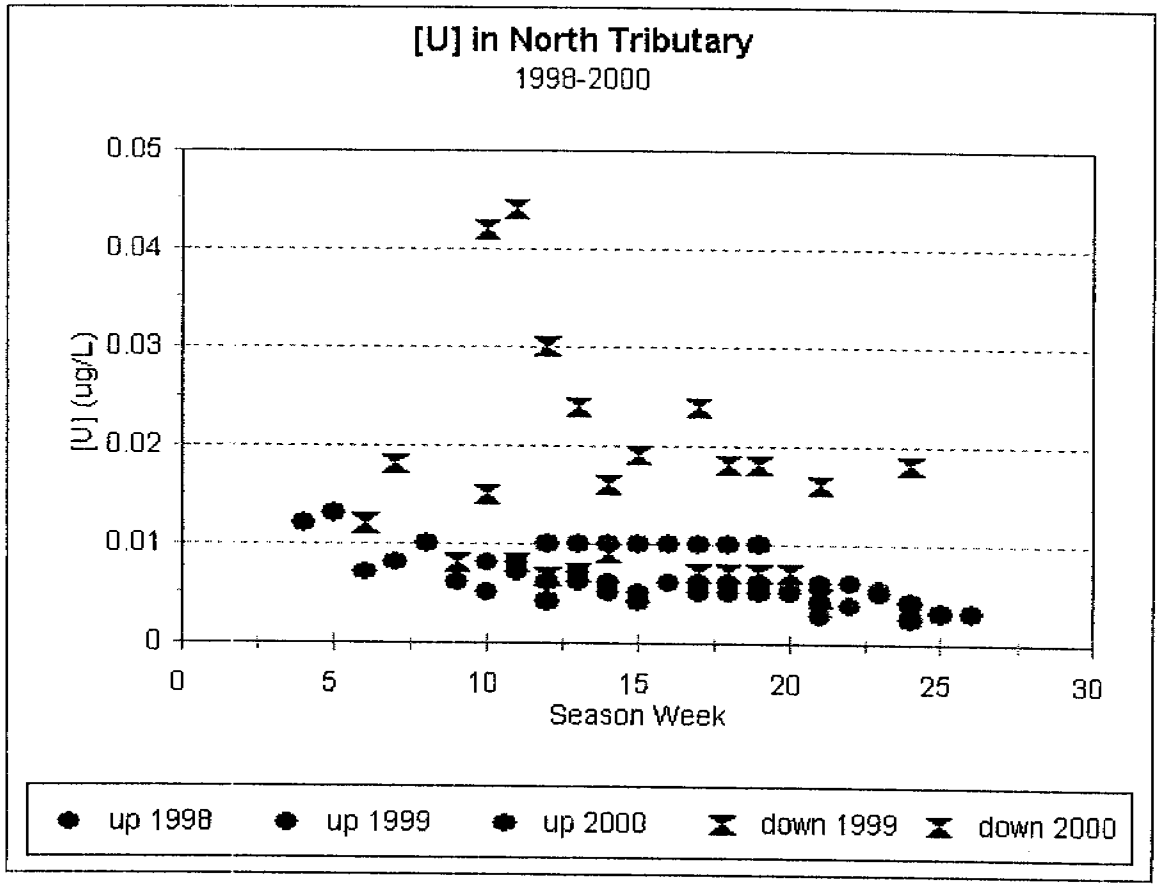


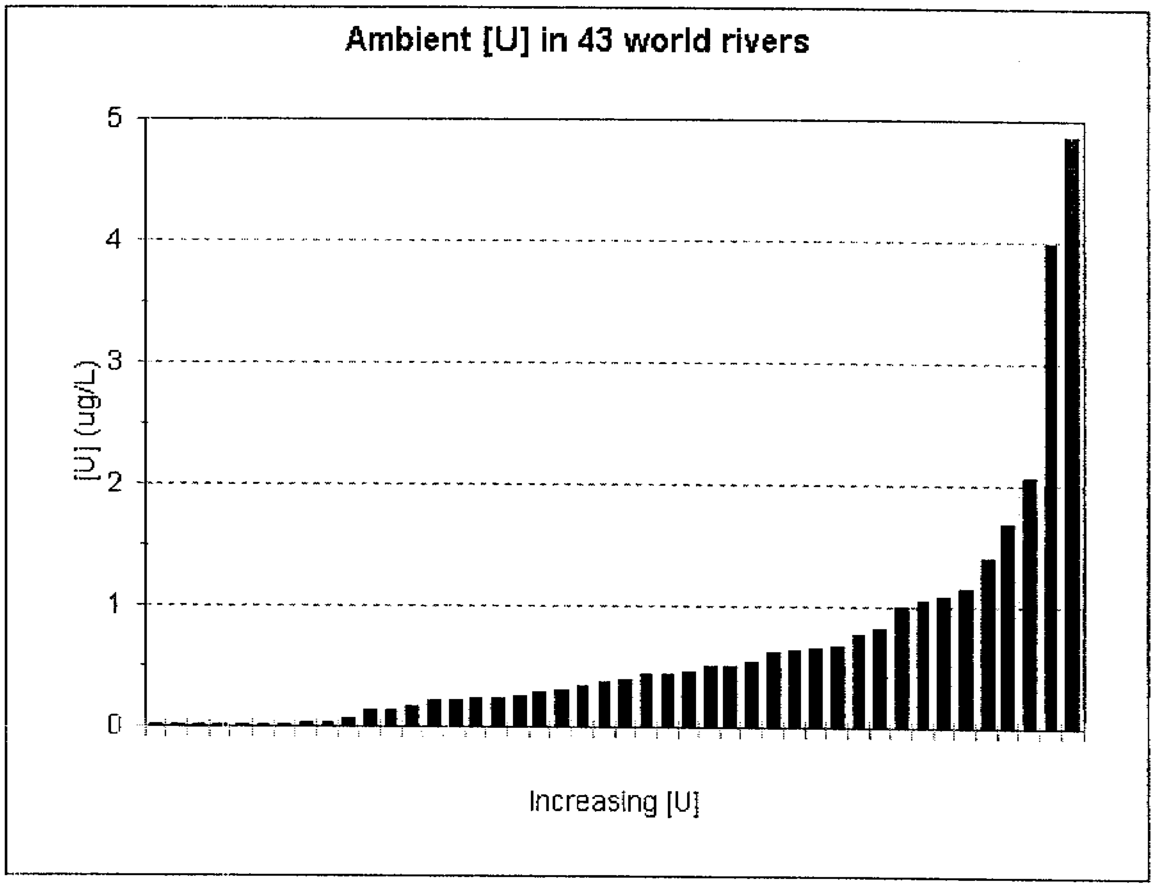
[Mn] in North Tributary (2 sites)
1998-2000
[Mn] (ug/L)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
Season Week
up 1998
up 1999
up 2000
down 1999
down 2000



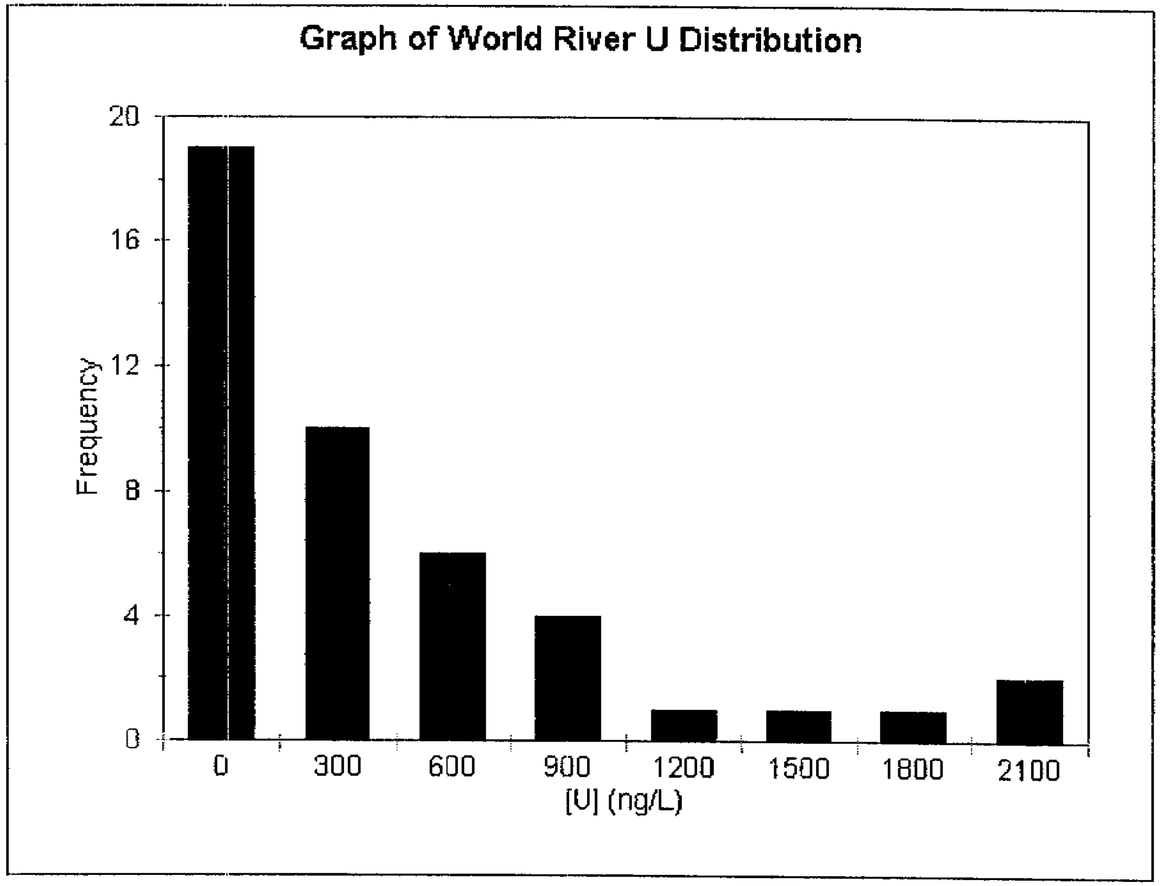
[U] in Swift Creek (3 sites)
1998-2000
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
[U] (ug/L)
0
5
10
15
20
25
30
Season Week
upstream 1999
upstream 2000
GS 1999
GS 2000
road 1998
road 1999
road 2000


[U] in Central Tributary (3 sites)
1998-2000
0.05
0.04
0.03
0.02
0.01
0
[U] (ug/L)
0
5
10
15
20
25
30
Season Week
up 1998
up 1999
c/way 1998
c/way 1999
c/way 2000
down 1999
down 2000

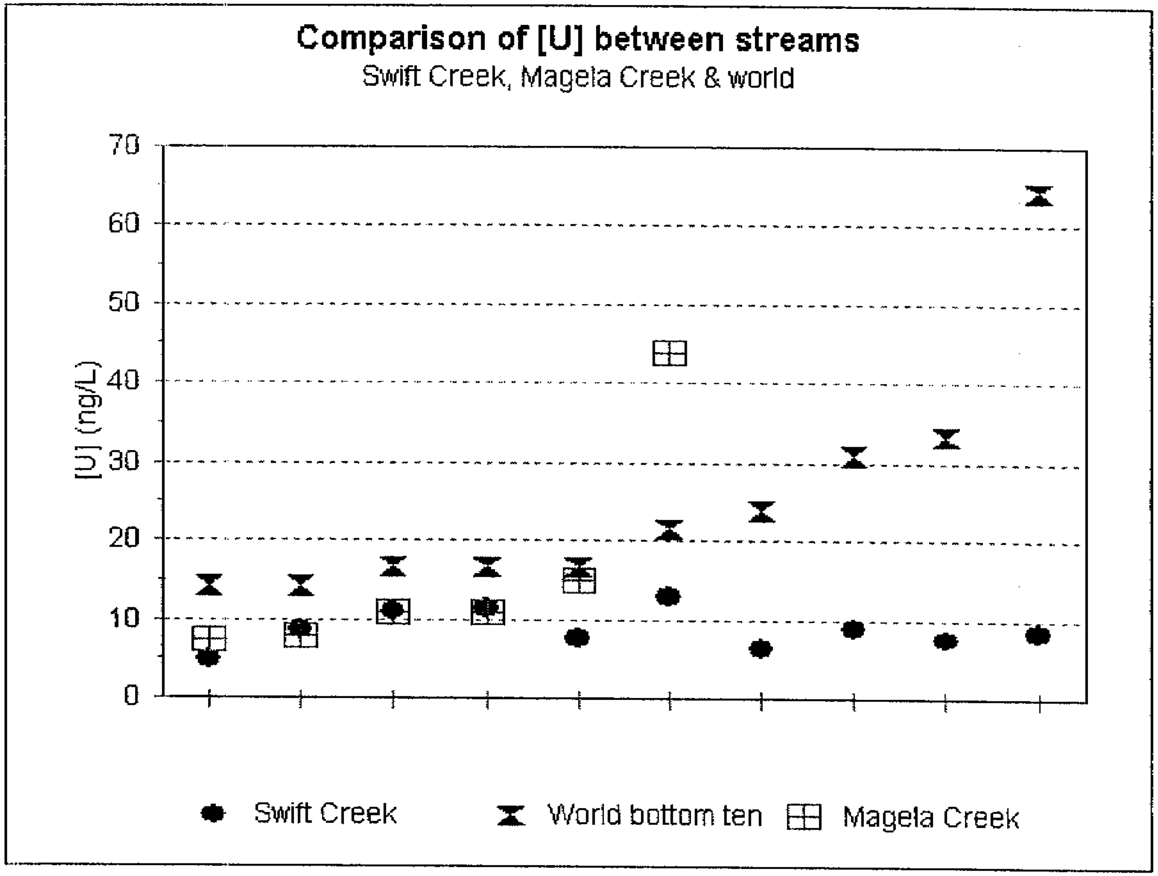

[U] in North Tributary
1998-2000
0.05
0.04
0.03
0.02
0.01
0
[U] (ug/L)
0
5
10
15
20
25
30
Season Week
up 1998
up 1999
up 2000
down 1999
down 2000



Ambient [U] in 43 world rivers
5
4
3
2
1
0
[U] (ug/L)
Increasing [U]



Graph of World River U Distribution
Frequency
20
16
12
8
4
0
0
300
600
900
1200
1500
1800
2100
[U] (ng/L)


Comparison of [U] between streams
Swift Creek, Magela Creek & world
[U] (ng/L)
70
60
50
40
30
20
10
0
Swift Creek
World bottom ten
Magela Creek

Preliminary findings

- Indicator concentrations are very low
- Concentration dispersion comparatively small between years
- Intra-year variability can be substantial, but relatively predicable
- Small perturbations can yield easily identifiable changes

Problems with the Protocol

Year 1: Unsure which sites were relevant

Year 2: Relevant sites identified, well resourced: a good year

Year 3: Resources curtailed: some relevant sites eliminated

Collaborators

Paul Buck

James Boyden

Elise Crisp

Peter Cusbert

David Klessa

Chris leGras

Dene Moliere

David Norton

Mika Peck

Andy Ralph

Karen Rusten

Michael Saynor

Another wetland story

M Finlayson

At the end of the 20th Century we claim that we have begun to appreciate wetlands and the many values that they provide. However, we have, in part, developed this appreciation in parallel with a realisation that much past land/water management has led to the loss and degradation of wetlands.

It is now widely accepted that wetland loss and degradation continued across Australia for much of the 20th Century. Tropical wetlands may not have fared as badly, but this statement, as with the former, is not based on a wealth of firm evidence. Despite an absence of quantitative evidence we have tended to accept the above statements as 'truisms' and have struggled to move onwards.

The realisation that wetlands were being lost and degraded led to considerable effort for the conservation and wise use of wetlands. At a federal and state/territory levels we have seen the development of policies and initiatives that support wetland conservation. NGOs have been actively involved in diverse wetland campaigns with the scientific base of the mid-1980s campaigns leading to greater advocacy and community-led initiatives. And we now have a 'band-wagon' of interest in wetlands — it is rolling but in which direction I am not sure.

Regardless, we need to become more aware of the reasons and processes that have caused, and continue to cause wetland loss and degradation as we develop the means to stop and reverse this situation. But, are our current efforts adequate? For example, can we really expect to manage and conserve or restore our wetlands if we still do not know how much exists, nor what condition it is in? We require a far superior information base for wetland inventory and assessment.

Whilst some wetlands have received more protection and even rehabilitation, the values and benefits that they provide are still poorly known. These are often unrecognised until they are degraded or lost. The latter occurs because we still do not fully understand the inter-relationships between the wise use of the land/water that has provided much of our economic wealth and our social and spiritual well being. The latter is the key point — the story of wetlands in Australia has been written separately from that about the social and spiritual well being of the broad community. The communal values of wetlands need to be recognised and placed at the forefront of socially acceptable and equitable land/water development plans.

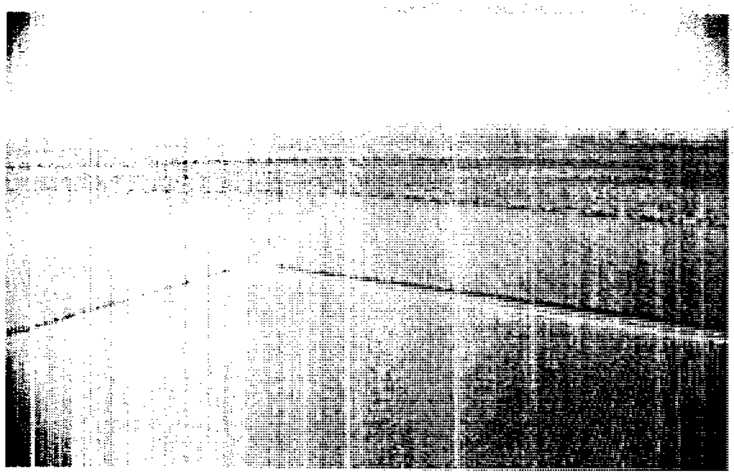
The ecological causes of wetland loss and degradation have been well espoused. These include - changes to water regimes, physical modification, eutrophication, pollution and salinisation, invasion by exotic species, non-sustainable harvesting and over-exploitation. Simply, these processes are known and need to be stopped.

The non-ecological causes of wetland loss and degradation are equally, if not more important. These include - population pressure, lack of public and political awareness of wetland values, lack of political will, over-centralised planning procedures, deficient financial policies, historical legacies of land use and tenure, poorly resourced conservation institutions, sectoral organisation of decision making, good legislation without subsequent enforcement, lack of trained personnel, and alliances which promote policies and studies rather than action.

Our success in 'writing' yet another wetland story will be shown by the level of maturity with which we address the above ecological and non-ecological causes of wetland loss and degradation and demonstrably stop and reverse the loss and degradation that has occurred. As scientists we need to accept that obtaining another prestigious grant or student program is not sufficient – we need to also ensure that our efforts provide results on the ground and that these involve and benefit the local community and general population.

ANOTHER WETLAND STORY

Max Finlayson
National Centre for Tropical Wetland Research
C/- eriss, Jabiru, NT, Australia



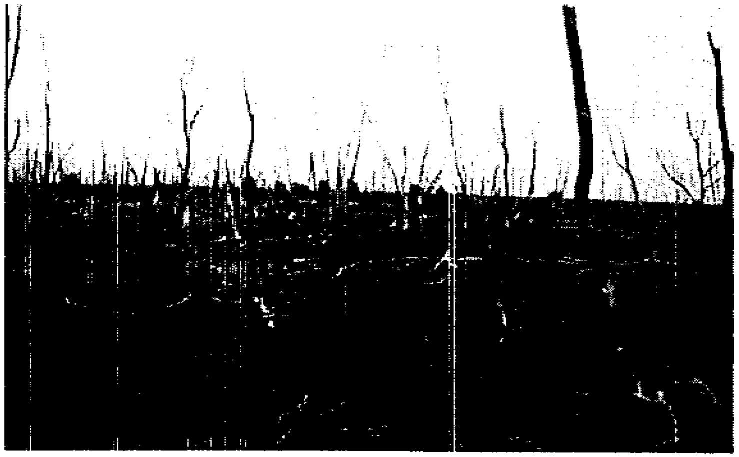
The story of wetlands in the 20th Century

- Much wetland has been lost or degraded, although less in the tropics
- We have not appreciated the community-wide values and benefits derived from wetlands
- Starting to appreciate these values and benefits now that have been lost
- Partial acceptance that these occur even though they are not supported by an adequate information base

Are we writing another wetland story?

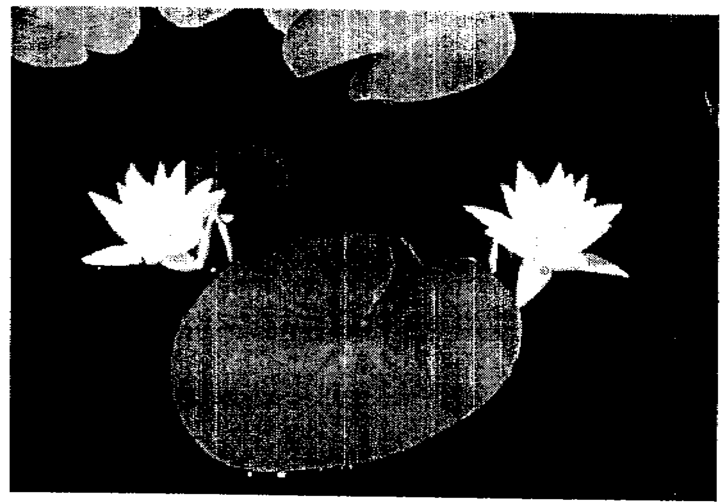
- Federal/state/territory land/water policies and initiatives have been developed
- Strong federal support for Ramsar and other conventions/treaties/principles
- Increased NGO wetland advocacy and awareness campaigns
- Funding for community-led wetland programs for management, restoration education

Are we writing another wetland story?



Is this the start of a new wetland story or just another funding trend or careerist/political 'band-wagon'?

Will this forum provide an answer? That is, outline the directions and set the base for the next wetland story?



• • • • • • • • • •

Can we write another wetland story?

- If we have community-wide acceptance of the values and benefits derived from wetlands
- If we accept that social equity underwrites the outcome of the wetland story
- If we rapidly stop wetland loss and degradation
- If we reverse past wetland loss and degradation
- If we do not accept poor trade-offs in exchange for wetland loss and degradation

If we address the causes of wetland loss and degradation

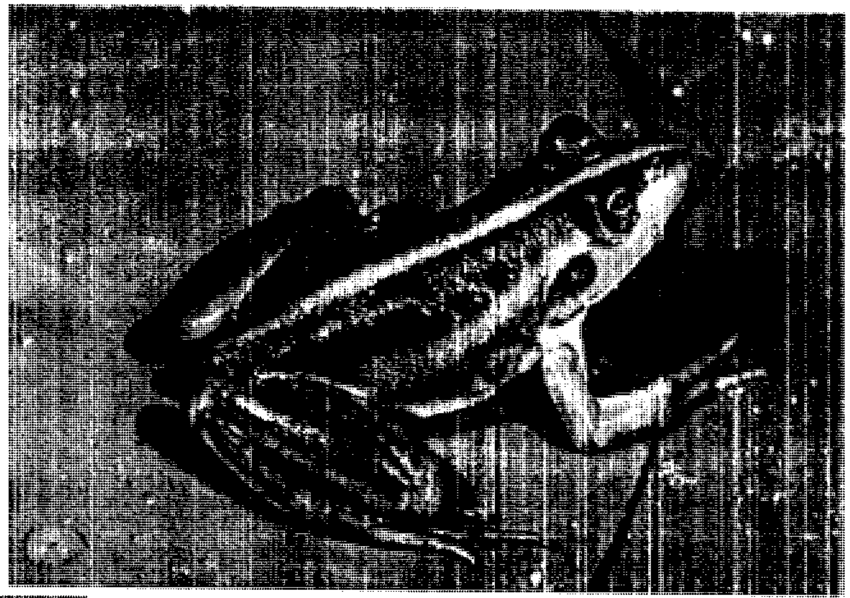
- Ecological and non-ecological causes need addressing by all sectors of society
- The underlying reasons for weed invasions, altered river flows, physical degradation of wetlands, pollution, and over-harvesting need addressing along with the consequences
- Action is required now, not after further study
- Monitoring and research are needed to support adaptive management

We can write another wetland story

- If we combine and address the socio-economic causes along with the technical causes of wetland loss and degradation
- If we accept it's primarily a socio-economic story, not just a story of adverse biophysical environmental change
- If wetland scientists are more involved with the general community and deliver more results on the ground

ANOTHER WETLAND STORY

Another wetland story needs a different balance to that we have experienced for so long



To achieve this we need to stop and reverse wetland loss and as scientists we play a relevant role

Prevention of aquatic aluminium toxicity by naturally occurring silica: Field and laboratory evidence

C Camilleri, SJ Markich*, C Turley, BN Noller, GK Parker*** & RA van Dam**
* Environment Division, ANSTO, Menai, NSW, Australia
** National Research Centre for Environmental Toxicology, Coopers Plains, Qld, Australia
*** Northern Territory Department of Mines and Energy, Darwin, NT, Australia.

Gadji Creek, in northern Australia, receives groundwater seepage contaminated by tailings water from the decommissioned Nabarlek uranium mine. The acidity of the groundwater has resulted in the release of aluminium (Al) from soil minerals. Thus, Al is often present in Gadji Creek at concentrations greater than those reported to be toxic to a range of aquatic organisms. However, silica, which is present naturally in groundwater and Gadji Creek water, has previously been hypothesised to bind with Al and ameliorate its toxicity to fish[1]. Laboratory toxicity tests on Gadji Creek water in August 1997 and September 1998 confirmed that the water was not toxic to one fish and two invertebrate species. Silica concentrations were over 50 times the molar concentration of total Al. Thus, it was hypothesised that silica in Gadji Creek could be reducing or preventing aquatic Al toxicity.

Laboratory experiments were carried out to assess the effects of silica on the aquatic toxicity of Al to the fish, *Mogurnda mogurnda*, in soft, low pH water. Results confirmed that elevated Si did in fact result in a reduction in Al toxicity. Subsequent speciation modelling indicated that bioavailable Al remained stable, regardless of the Si concentration, not supporting the hypothesis that Al-silicate complexation reduced Al toxicity. An alternate hypothesis, that Si actually inhibits Al uptake is proposed, and further research discussed.

[1] Birchall JD, Exley C, Chappell JS & Phillips MJ 1989. Acute toxicity of aluminium to fish eliminated in silicon-rich acid water. *Nature* 338, 146–148.

Prevention of aquatic aluminium toxicity by naturally occurring silica: Field and laboratory evidence

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C Camilleri ***eriss**/nctwr*

SJ Markich ANSTO

C Turley ***eriss** /nctwr*

BN Noller NRC Environmental Toxicity

RA van Dam ***eriss** /nctwr*

Background

- 1979 Nabarlek mined for U
- ore stockpiled and milled through to 1989
- 1995 site decommissioned and rehabilitated
  - rehab included spray irrigation of tailings water
  - NH^{-4} oxidised to NO_3^-, and entered groundwater. H^- ions formed, acidifying groundwater
  - Al released from soil minerals

Background (cont)

- Al found in elevated amounts in groundwater
- Groundwater seeps into Gadji Creek, increasing acidity

- Thus since spray irrigation Al has been present in Gadji Creek @ concentrations well in excess of ANZECC WQ Guideline values for the protection of aquatic ecosystems.

Background (cont)

- 1986-1995 fish surveys detected few differences in fish abundances and community structure compared with pre-spray irrigation
- Si is also present at high concentrations in Gadji Creek
- Si binds and ameliorates toxicity of Al to fish

Background (cont)

- Al acts as a gill toxicant
- Fish shown to be more sensitive to Al than other aquatic invertebrates
- ANZECC WQ guideline for the protection of freshwater aquatic organisms for Al is currently $40 \mu g L^{-1}$

General aquatic aluminium toxicity

- Aluminium speciation is complex
- Toxic Al species are: Al^{3+}, $AL(OH)^{+}$, $Al_{13}O_4(OH)_{24}^{7+}$
- Maximum toxicity at pH 5-6 (hardness & DOM also influence Al toxicity)
- At pH <6.5 Al toxicity reported at :
  - 0.01 - 0.2 mgL^{-1} (fish early life stages)
  - 0.5 - 1.0 mgL^{-1} (cladocerans)

Standard toxicity tests

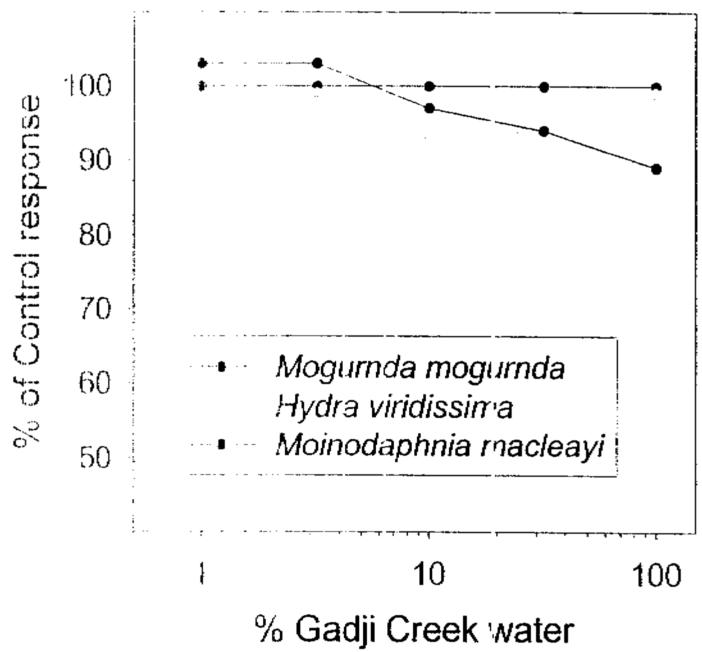
- Three standard bioassays
- Standard conditions (light, temp, etc)
- 3 species used from 3 trophic levels
- These species developed and used regularly at ***eriss*** ecotox laboratory

Summary of toxicity test methods

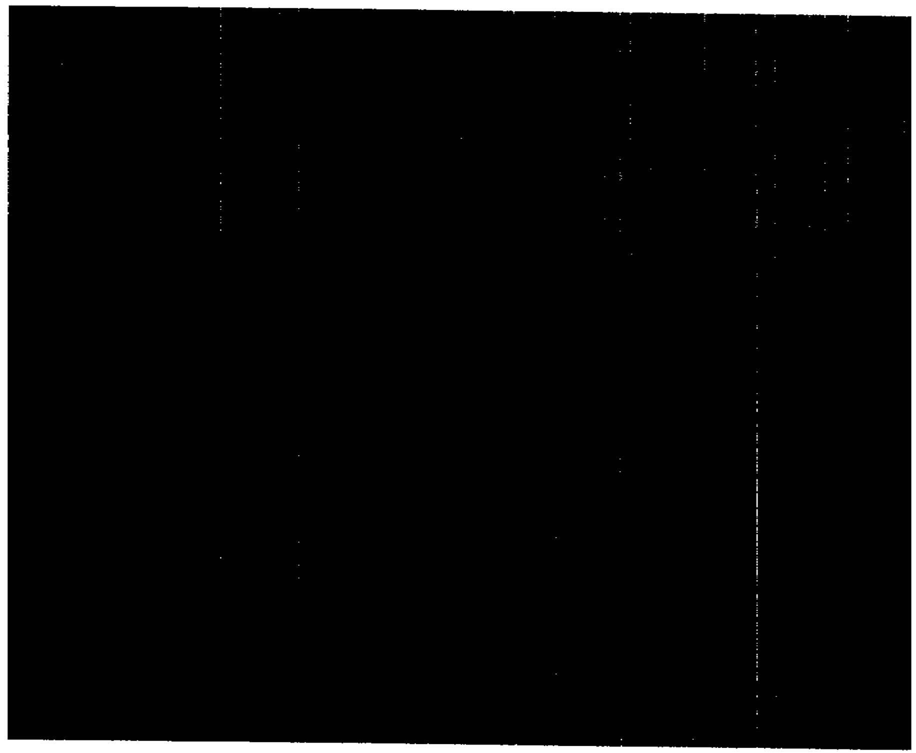
Species	Duration	Endpoint
Mogurnda mogurnda	96 h	survival
Moinodaphnia macleayi	3 brood	reproduction
Hydra viridissima	96 h	population growth

Toxicity of Gadji Creek water

1997



1998



Water chemistry of Gadji Creek

Parameter	1997 (mg/L)	1998 (mg/L)
pH	5.6	4.9
Conductivity (µS/cm)	287	125
Ca	13	3.4
Mg	20	7.8
Al (filterable)	0.038	0.14
Si (as SiO_2)	17	13
SO_4	103	38
DOC	3.3	3.9
Bioavail. Al	2.2%	12%

- Australian draft WQG for Al = 0.040 mg/L

Field results

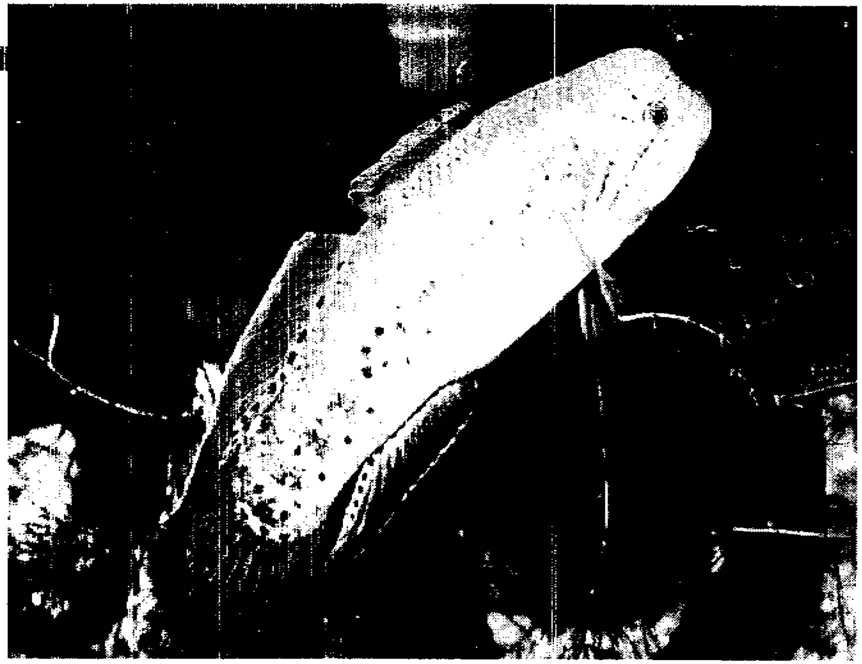
- Field results from Gadji Creek indicated no toxicity to hydra or fish, and only slight toxicity to cladocera (12% reduction in reproduction)
- Si was present in Gadji water at molar concentrations in excess of Al concentrations

Aim

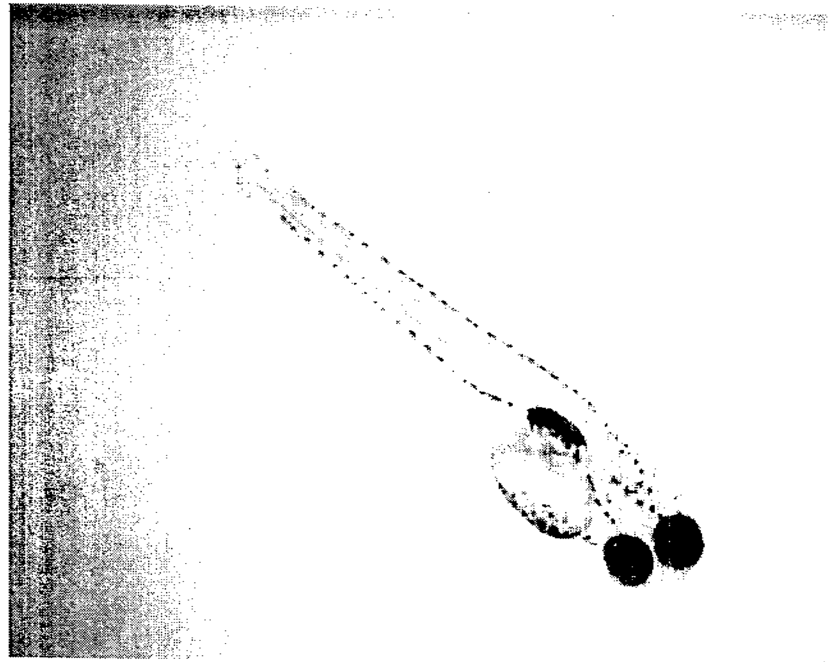
- Al is present in Gadji Creek water at concentrations greater than those known to cause toxicity to aquatic organisms.....
- To test the hypothesis that Al-silicate complexation reduces Al bioavailability to *M. mogurnda*.

Toxicity test method for fish

- **Species**: *Mogurnda mogurnda*
- **Test**: Acute sac fry survival
- **Test Duration**: 96 hr
- **Toxicant**: Al
- **Diluent**: soft ASTM synthetic water buffered with MES to maintain pH at 5

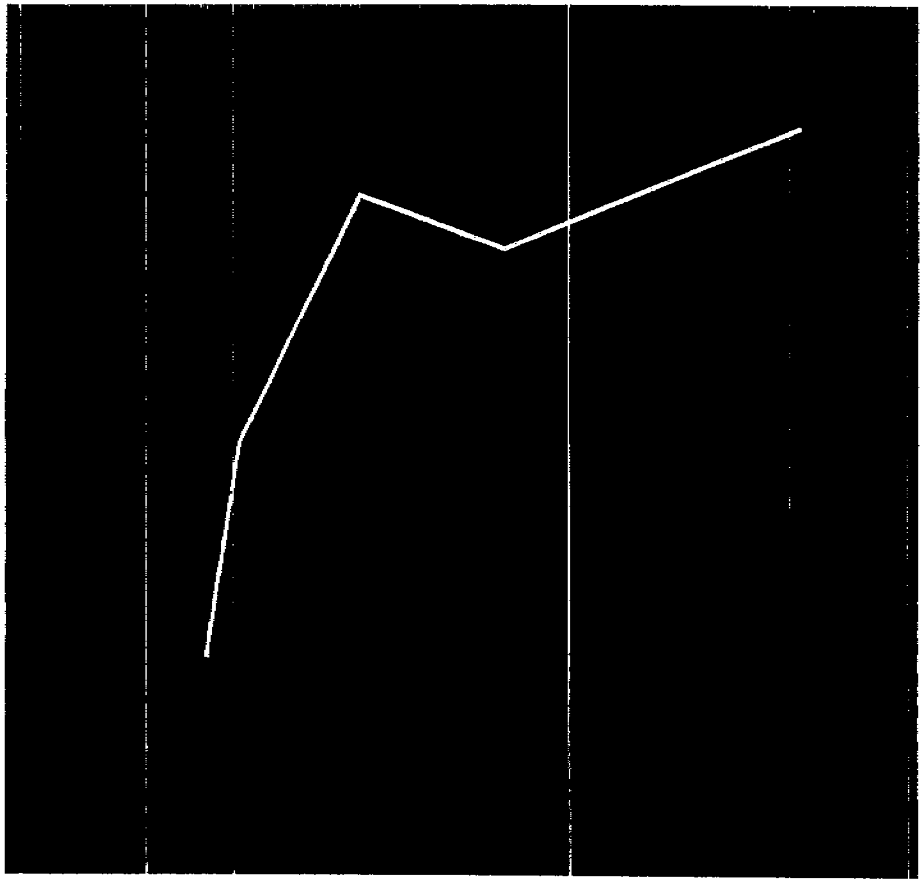


Adult purple spotted gudgeon
Mogurnda mogurnda



Purple spotted gudgeon <12 hours old

Results: laboratory toxicity testing and Al speciation modelling



- Sac fry survival vs increasing Si
- Bioavailable Al vs Si

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Results (cont)

- These results do not support the hypothesis that Al-silicate complexation is reducing or preventing Al toxicity (ie a decrease in bioavail Al would be observed

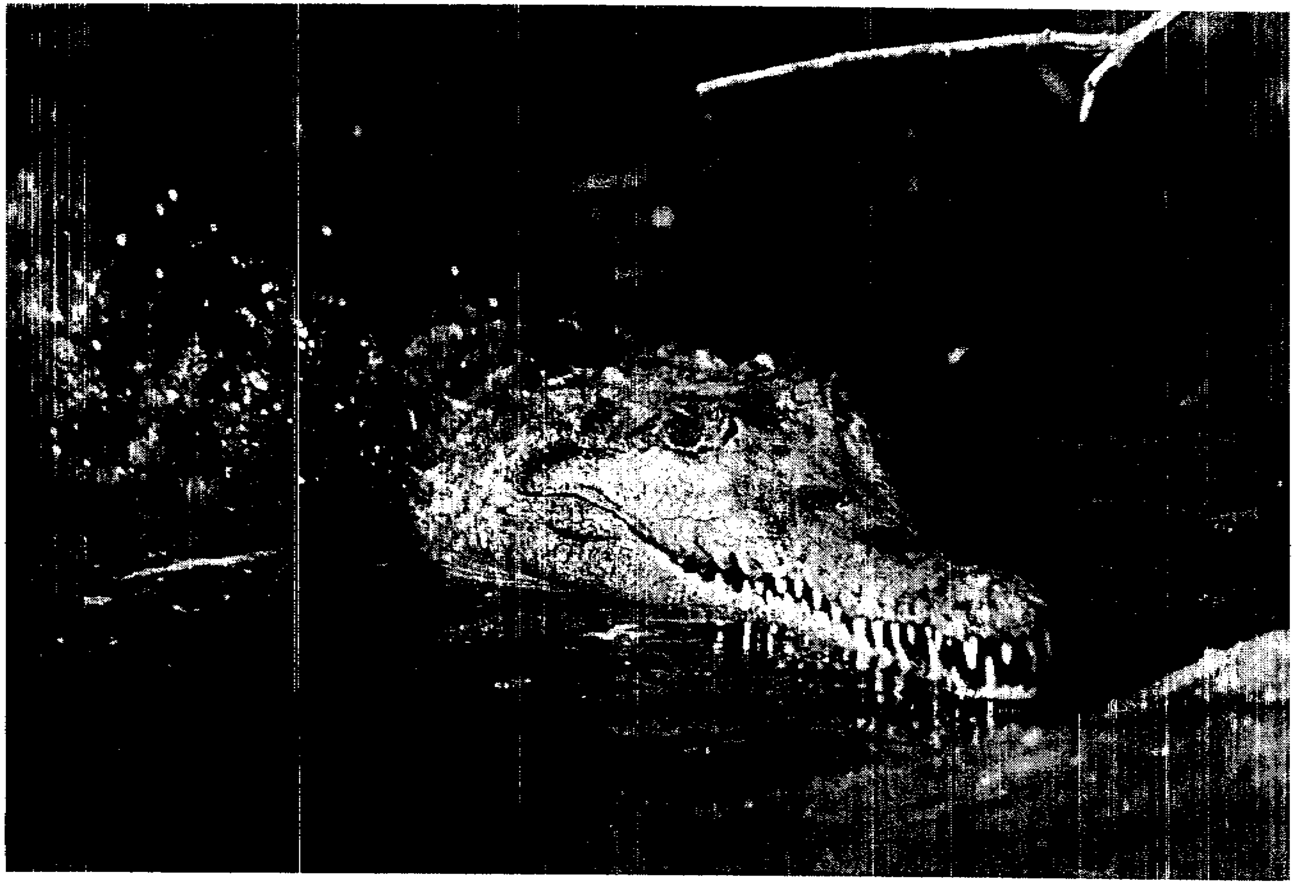
Discussion of results

- Two possible mechanisms for Si-related reduction in acute Al toxicity:
  - i) competition for binding sites between Al^{3+} and Si^{4+}
  - ii) formation of hydroxy aluminosilicate species
- However neither was operating in Gadji Ck as there were high amounts of DOM

Alternate hypothesis and further research

- Hypothesise that Si is actually inhibiting Al uptake
- Test by carrying out radiotracer experiments with Al-26 and Si-32.

Thankyou



The vulnerability of Kakadu's wetlands to climate change and sea level rise

M Finlayson, I Eliot & M Saynor

The vulnerability of the freshwater wetlands in Kakadu National Park to climate change and sea level rise was assessed using an extensive information resource that was collected principally for other purposes. As the coastal lands of the region are low in elevation they are susceptible to sea level rise and storm surge. Within the limits of the model scenario for climate change and sea level rise the freshwater wetlands of Kakadu National Park could be inundated by seawater and hence lose many of their current values. Specifically, sea level rise, shoreline erosion and saltwater intrusion could combine to remove or relocate both the salt and freshwater wetland resources. This would be manifest in:

- reduction or loss of some components of the mangrove fringe on the coast line;
- extensive loss of *Melaleuca* (paperbark trees) stands on the margins of some wetlands;
- colonisation of mangrove species along creek lines as an accompaniment to salt water intrusion; and
- replacement of freshwater wetlands with saline mudflats.

With changes in the wetland plant communities and habitats there would also be changes in animal populations. Additionally, there would be changes in morphology of the streams and billabongs and in the composition of the fish and other aquatic species. However, detailed analyses of habitat-species interactions have not been done. Changes in the natural vegetation and faunal resources may also have cultural, social and economic consequences for the Aboriginal and non-Aboriginal people living in or visiting the area.

Given that a massive loss of freshwater wetland could occur, or even be occurring, we need to rapidly assess whether or not our management regimes are able to cope with such change and if we need further data to corroborate or disprove the models that have been proposed. The scenario painted by this assessment identifies many issues common to the coastal margins of the Australian wet-dry tropics in general and underlie the possible management responses required to address the expected extent of ecological change in the wetlands. For appropriate mitigation and adaptation to occur these issues need to be embrace.

The vulnerability of Kakadu's wetlands to climate change and sea level rise

Max Finlayson[1]
Ian Eliot[2] & Michael Saynor[1]
National Centre for Tropical Wetland Research

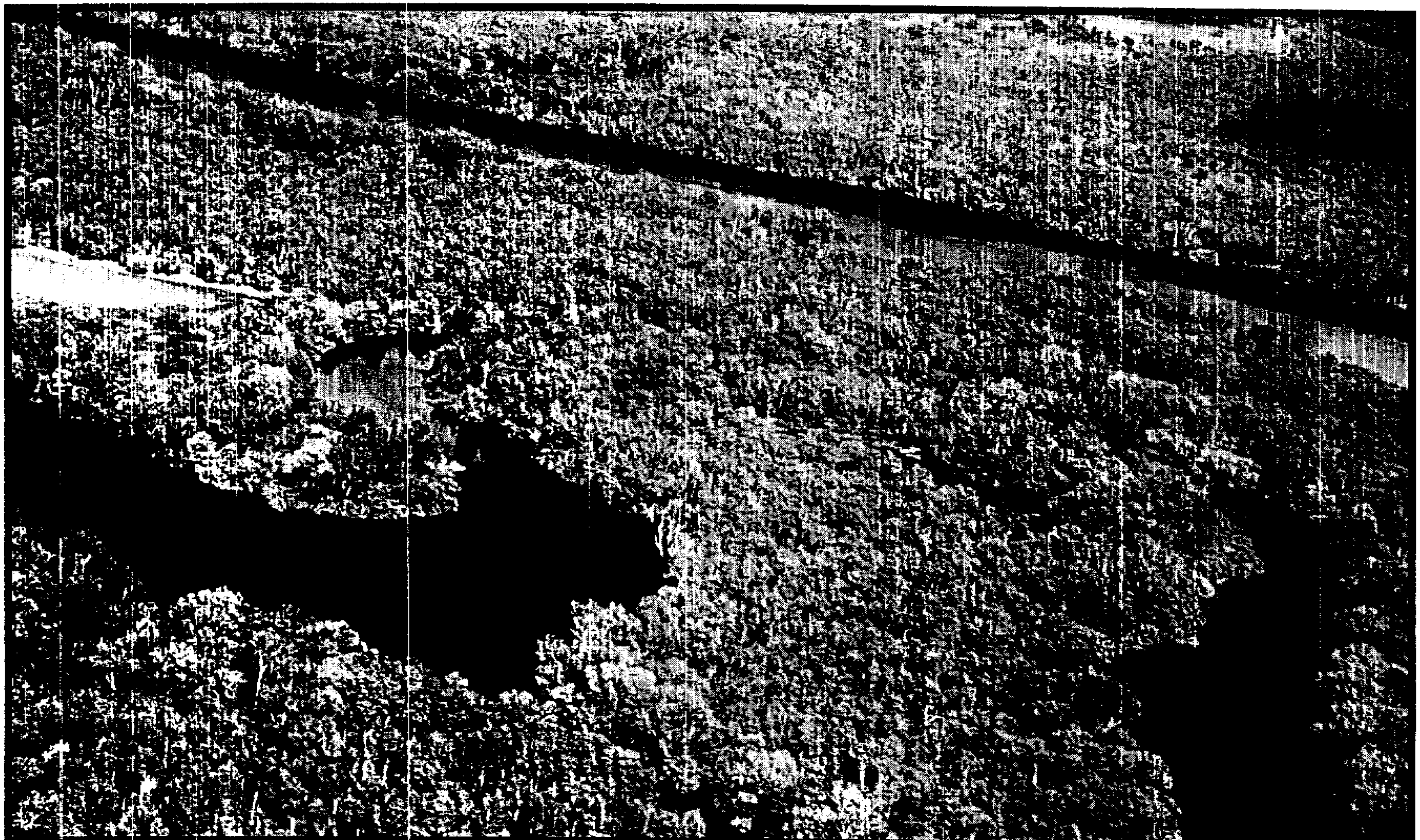
[1]Environmental Research Institute of the Supervising Scientist
[2]The University of Western Australia

The vulnerability of Kakadu's wetlands to climate change and sea level rise

- National and international recognition
- Cultural & natural environmental values
- Mangroves, saltflats, floodplains & rivers
- Regular seasonal flooding/drying cycle
- Diverse and profuse plants/animals
- Productive and highly valued

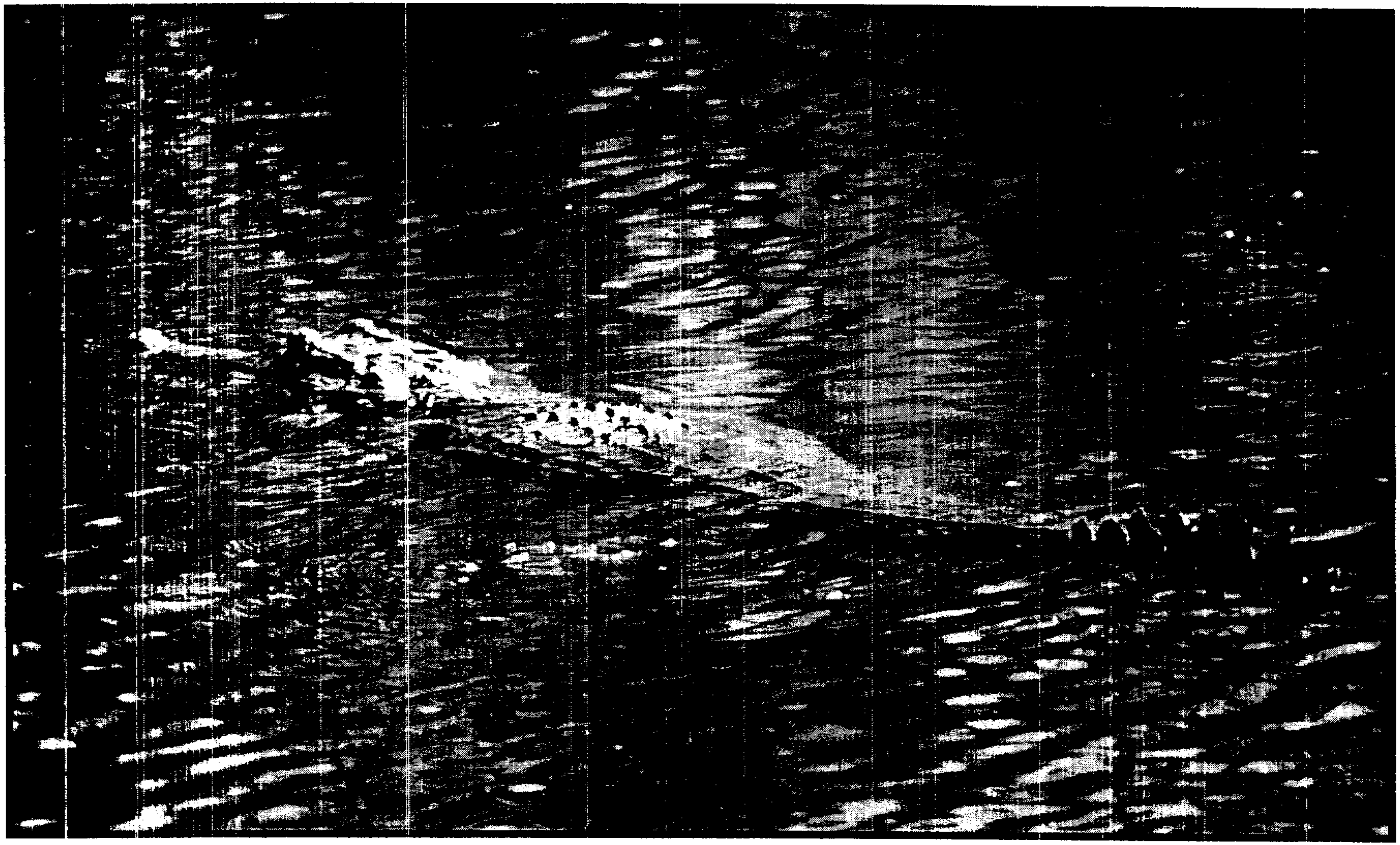
The vulnerability of Kakadu's wetlands to climate change and sea level rise

The vulnerability of Kakadu's wetlands to climate change and sea level rise



The vulnerability of Kakadu's wetlands to climate change and sea level rise

The vulnerability of Kakadu's wetlands to climate change and sea level rise



The vulnerability of Kakadu's wetlands to climate change and sea level rise

Climate change scenario - CSIRO/IPCC

- 1-2°C increase in temperature
- increase in monsoonal rainfall intensity
- uncertain effect on tropical cyclones
- increased magnitude/frequency of extreme storm events
- 20 ± 10 cm increase in sea level - 2030 AD

The vulnerability of Kakadu's wetlands to climate change and sea level rise

Vulnerability assessment

- Scope climate and other changes
- Identify resources and values
- Describe biophysical changes
- Determine range of responses
- Determine management actions

The vulnerability of Kakadu's wetlands to climate change and sea level rise

Resources potentially affected

- Retreat of coastal mangrove fringe
- Reduction of freshwater forests and swamps on the floodplains
- Growth of mangroves along extending tidal channels
- Extension of saline mudflats/marshes

The vulnerability of Kakadu's wetlands to climate change and sea level rise

The vulnerability of Kakadu's wetlands to climate change and sea level rise

Management responses and options

- Cultural/natural values - high/politicised
- Hazards and risk - high/vulnerable
- Acquisition/access to information - muddled
- Research and monitoring - not strategic/holistic
- Perceptions and awareness - low/disbelieving
- Mitigation - expensive/difficult/few options

The vulnerability of Kakadu's wetlands to climate change and sea level rise

The vulnerability of Kakadu's wetlands to climate change and sea level rise

Governance responses

- community consultation and awareness
- environmental monitoring and confirmation of change and options
- cross sectoral management and cooperation
- adaptation and low level mitigation
- community-wide or individual/sector costs?

The vulnerability of Kakadu's wetlands to climate change and sea level rise

A field program to determine the geomorphic changes in the catchment containing the Jabiluka uranium mine

M Saynor, K Evans, W Erskine & I Eliot

There are only limited data on catchment geomorphology, channel stability, sediment movement and hydrology of the Swift Creek catchment, which contains the portal, retention pond and other head works of the Jabiluka Mine. The Swift Creek channel network, debouching into the World Heritage Area Listed Magela Creek, will be the conduit for the runoff and sediment leaving the mine site and the mine site tributaries will be the first part of the catchment to experience potential environmental impacts.

Catchment monitoring was commenced to determine baseline conditions of Swift Creek and subsequently assess environmental impacts of the mine and natural variability within the catchment. Several study reaches were selected along Swift Creek and its tributaries and three stream gauging stations were installed. Two of the gauging station sites, Upper Swift Creek Main and East Tributary are upstream of any influence that the Jabiluka minesite might have on them. A third gauging station, Swift Creek is located downstream of the Jabiluka minesite. Experimental design assumes that any change in stream condition at the downstream Swift Creek site not reflected at the two upstream sites will be due to mine site disturbance.

During the dry of 1998 stream cross sections were established and surveyed at each of the reaches where the gauging stations were installed. Stream cross sections were also established on two small creeks (left bank tributaries of Swift Creek) that flow past the Jabiluka Minesite. These sections are surveyed on an annual basis to measure bedload sediment movement and storage. At some of these sites bed scour chains and bank erosion pins have been installed to measure bed level fluctuations and bank erosion during the Wet season.

A comprehensive field program has been established to determine the geomorphic baseline of the catchment and any temporal or spatial changes that may occur.

A FIELD PROGRAM TO DETERMINE THE GEOMORPHIC CHANGES IN THE CATCHMENT CONTAINING THE JABILUKA MINE

M Saynor, K Evans,

W Erskine & I Eliot

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GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Where is the Jabiluka mine
- Swift (Ngarradj) Creek Catchment
  - Tributary of Magela Creek
  - Flows in to Kakadu National Park
  - The Wetlands of KNP have World Heritage Listing

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Need to determine how the catchment has evolved
  - Aerial Photography Interpretation
  - Stratigraphic work
  - Current geomorphic character

- However given that the construction of the mine was imminent

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Determine the present baseline conditions

- Two phases of data collection
  - Wet Season Work
  - Dry Season Work

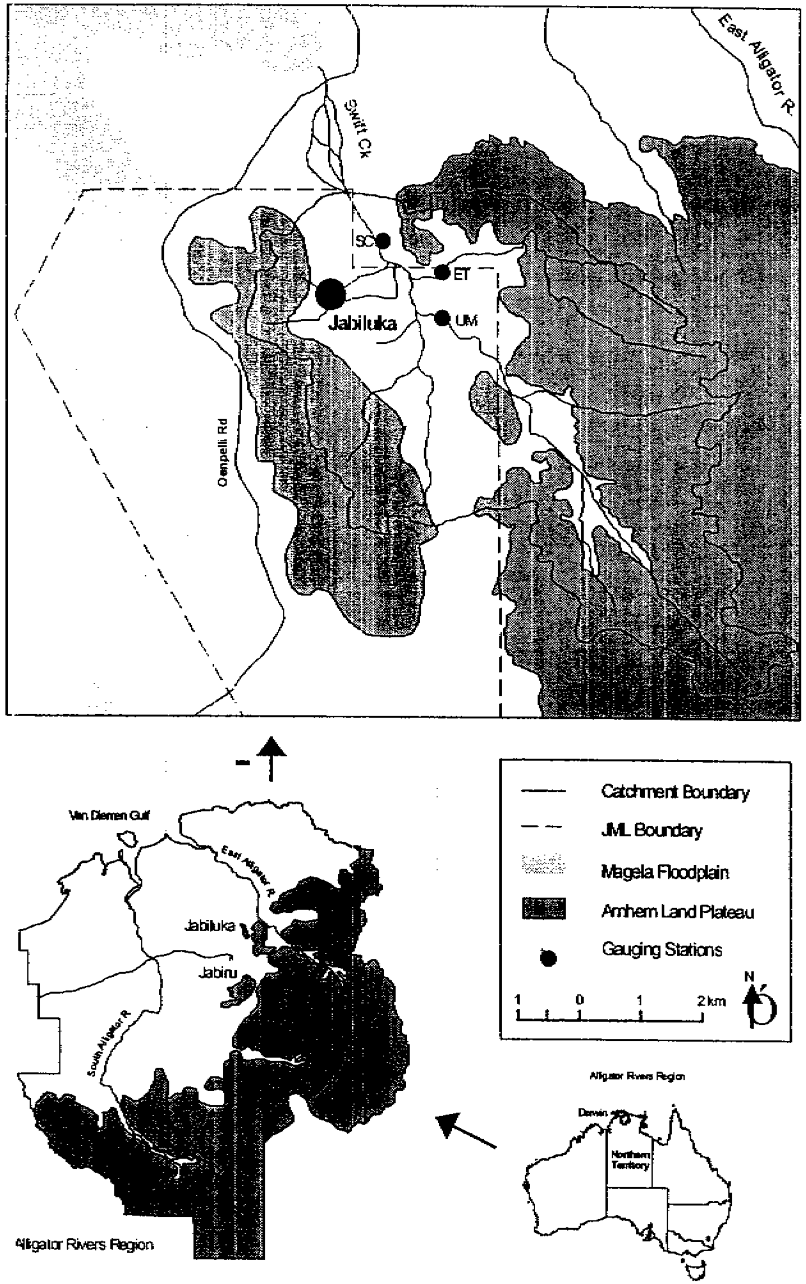
GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

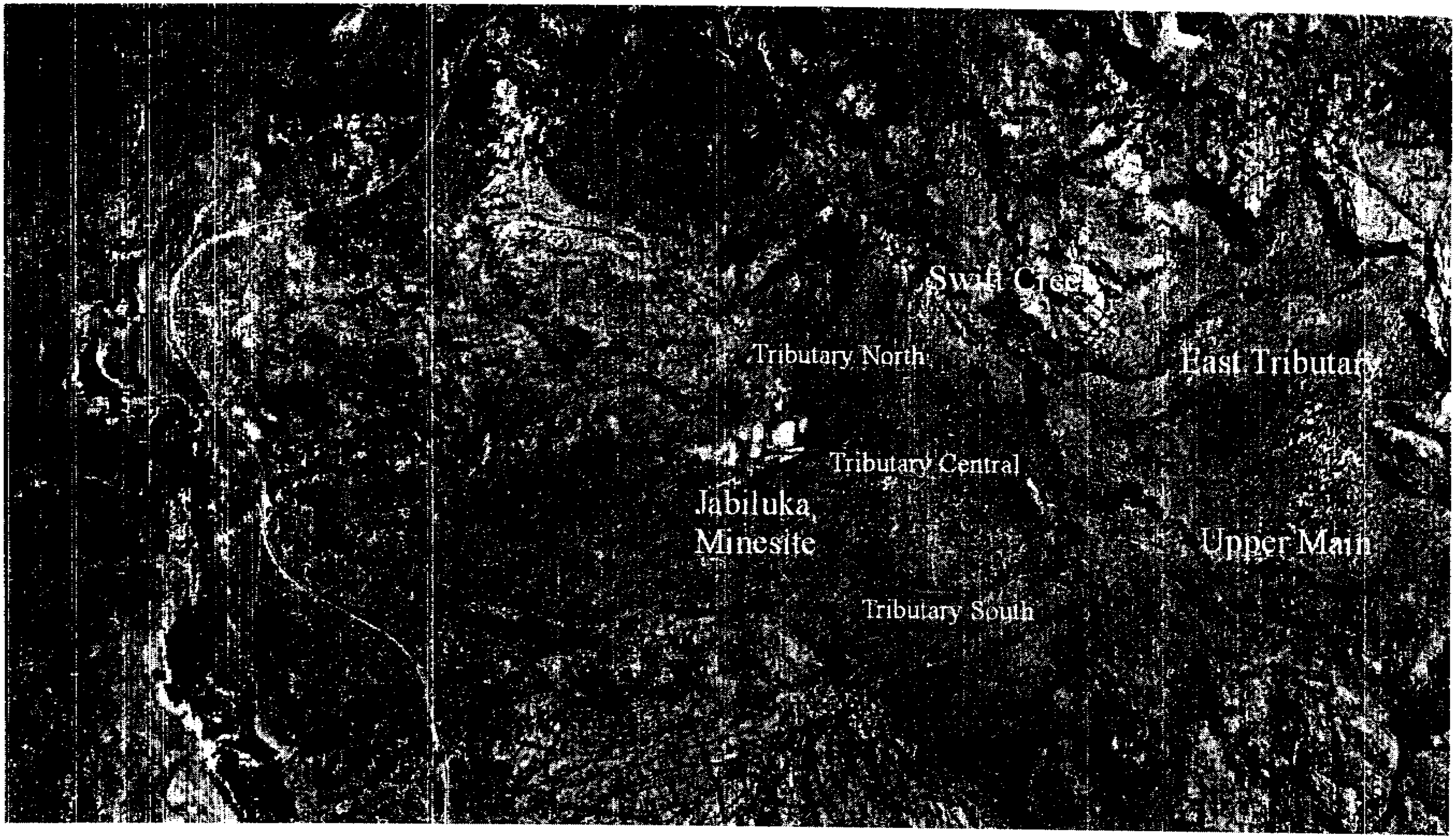
- Initial field reconnaissance
  - Dry season of 1998

- Identified sites suitable for the establishment of gauging stations

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Established 3 gauging stations
  - Swift Creek (SC)
  - East Tributary (ET)
  - Upper Main (UM)
  - West Tributary
  - Mine Tributaries


East Alligator R.
Swift Ck
SC
ET
UM
Jabiluka
Oenpelli Rd
Catchment Boundary
JML Boundary
Magela Floodplain
Arnhem Land Plateau
Gauging Stations
1 0 1 2 km
N
Van Diemen Gulf
East Alligator R.
Jabiluka
Jabiru
South Alligator R.
Alligator Rivers Region
Alligator Rivers Region
Darwin
Northern Territory


Swift Creek
Tributary North
East Tributary
Tributary Central
Jabiluka
Minesite
Upper Main
Tributary South

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Prior to the 1998/99 wet season
  - gauging stations installed
  - cross sections established
  - bed material samples collected
  - erosion pins installed
  - scour chains in bed

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- The following parameters are collected at six minute intervals
  - Rainfall
  - Stage Height
  - Turbidity
  - pH
  - Conductivity

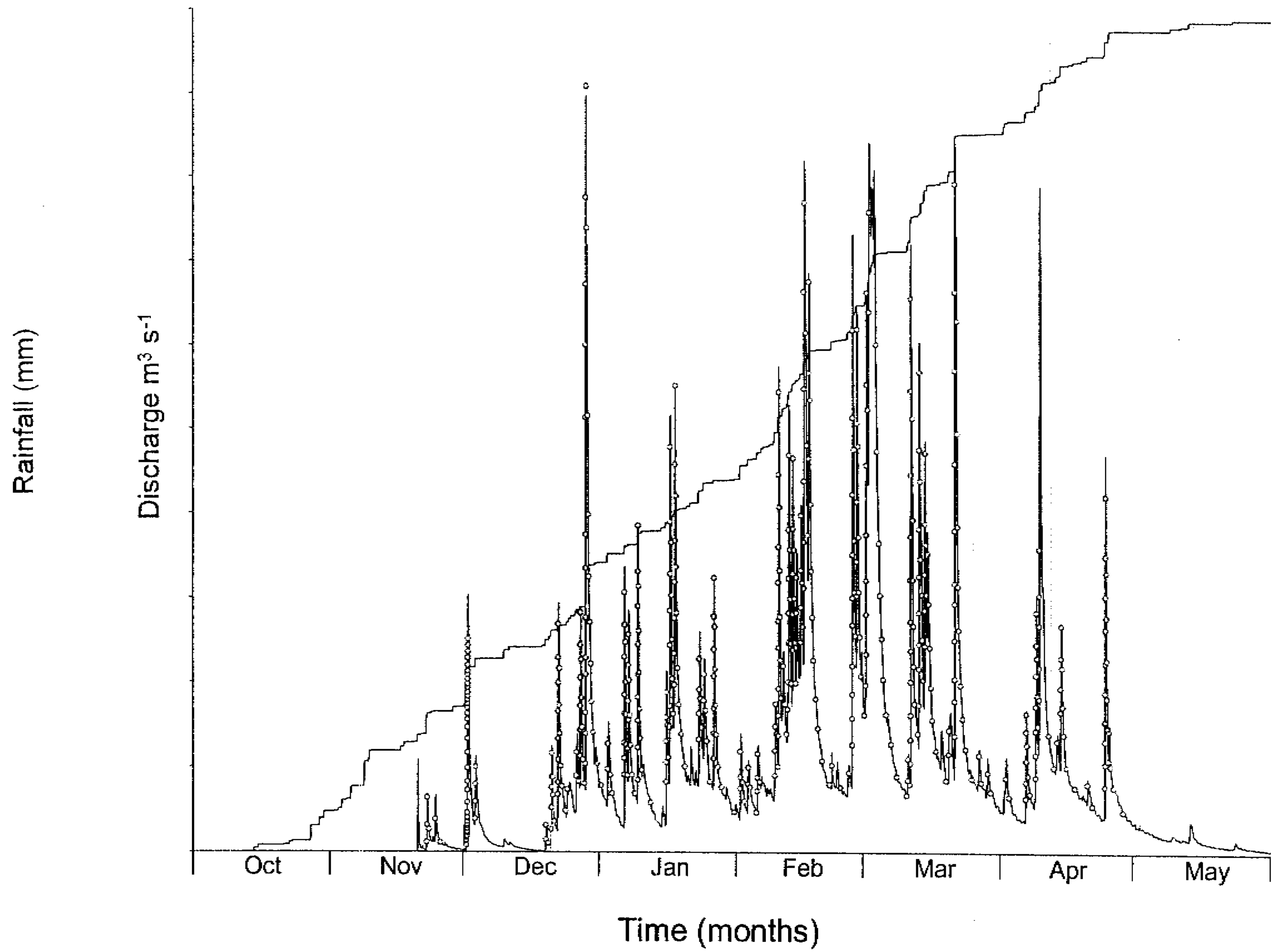
GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Water samples collected by an Automatic Water Sampler (GAMET)
  - Triggered by stage rise and fall
  - Capacity of 24 at ET & UM
  - Capacity of 48 at SC
- Analysed in the laboratory

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Sites visited weekly to
  - download the data
  - change the sample bottles
  - velocity-area gauging
  - depth integrated suspended sediment sample (USDH-48)
  - Bedload sample (Helley Smith)

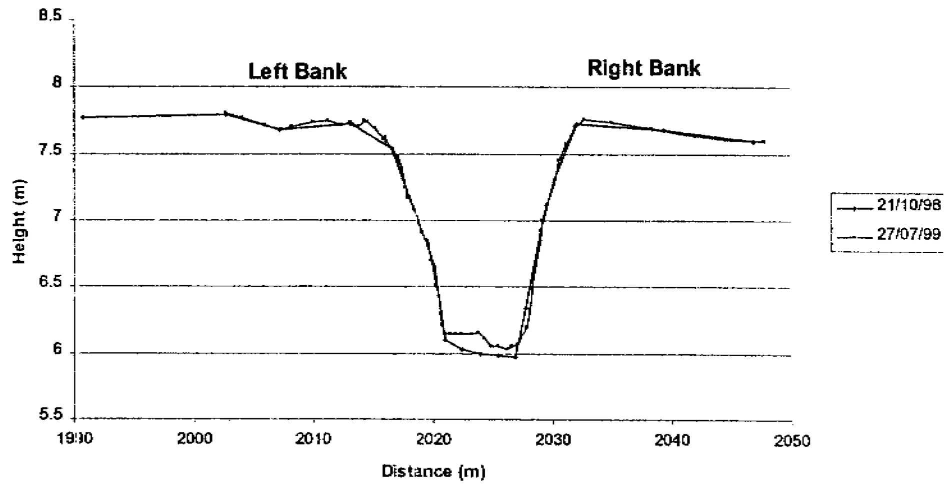
Swift Creek Gauging Station
1999/2000



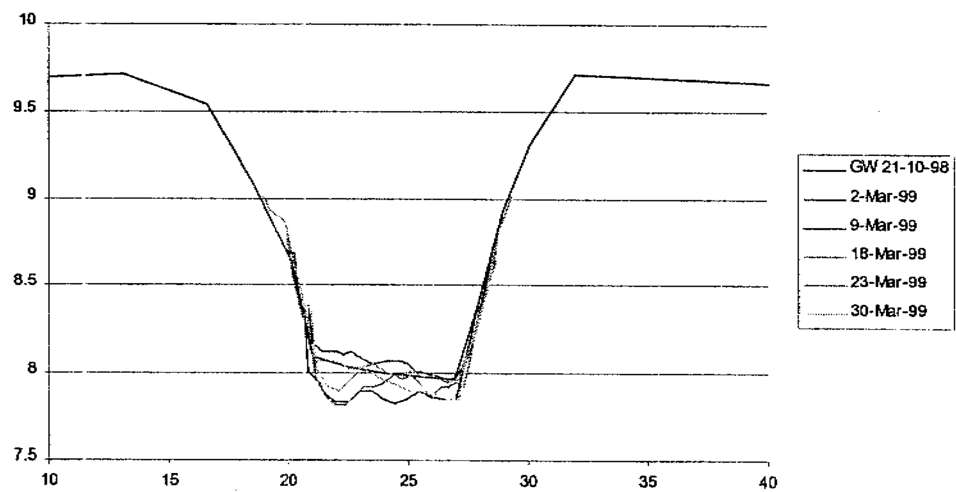
GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- After the creeks have ceased to flow, the dry season work is commenced
  - erosion pins measured
  - cross sections surveyed
  - areas mapped using dGPS
  - bedload samples collected

SM06



Swift Creek Gauge Gauging Wire (SM06) March 1999

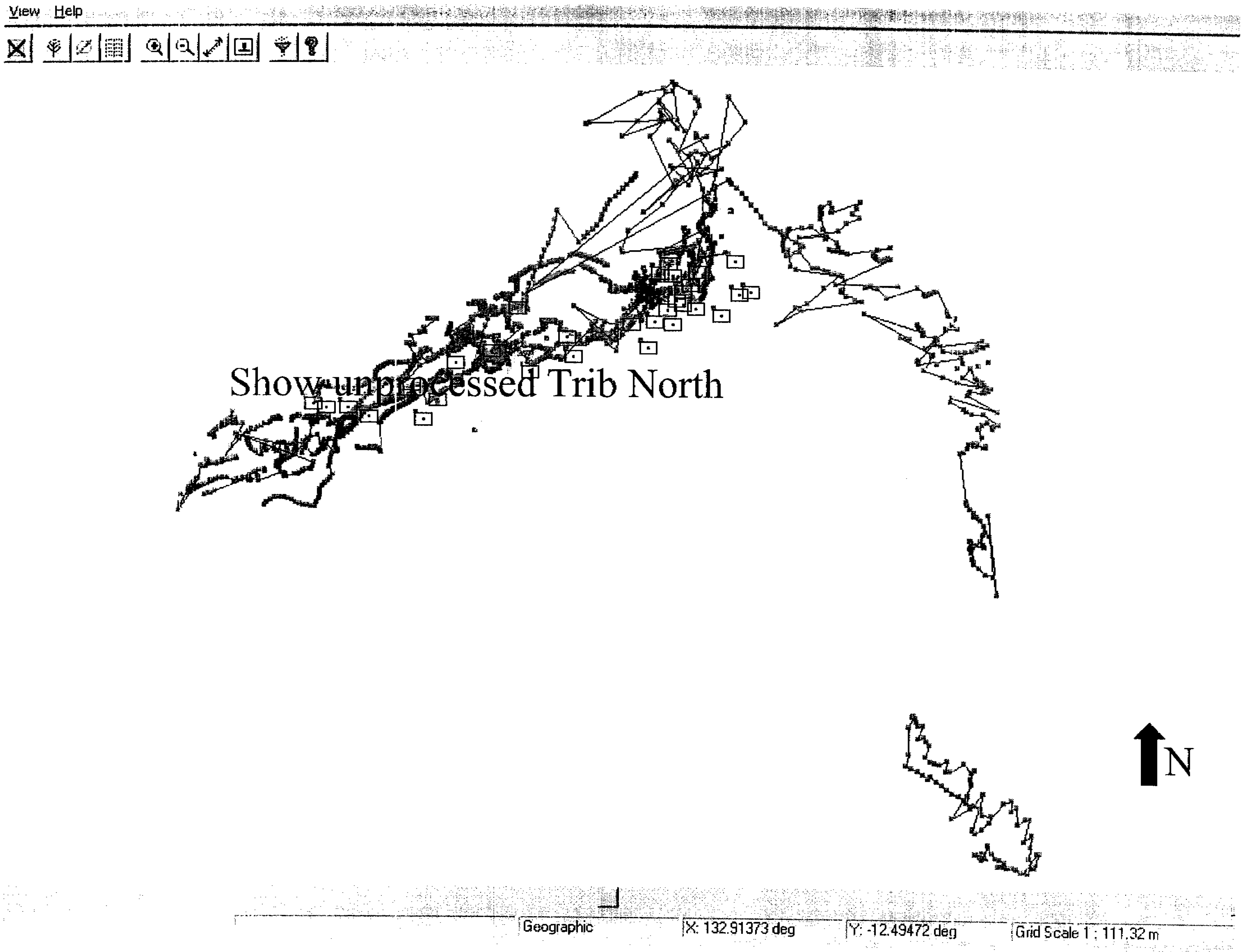


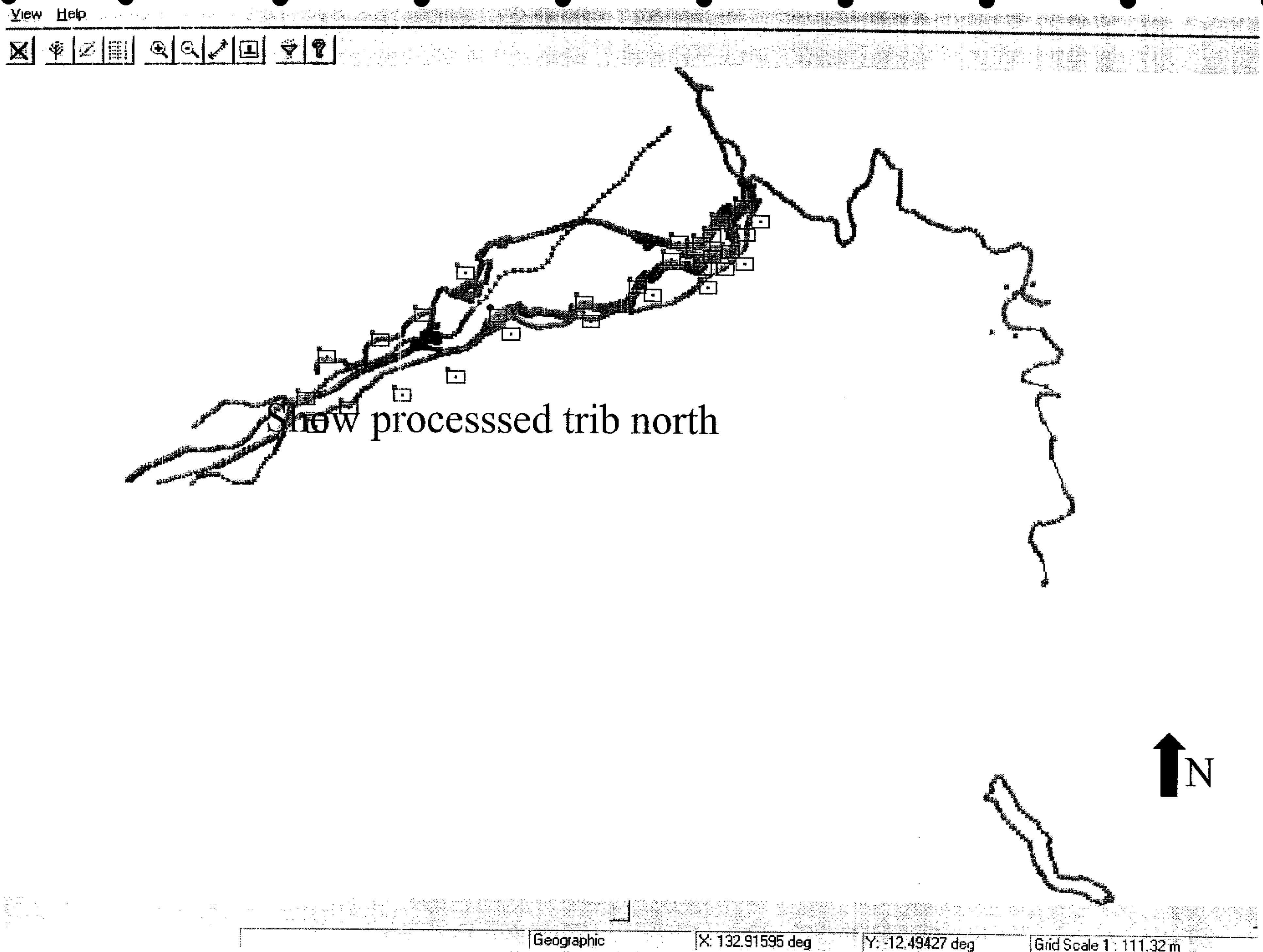
GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Late in the dry season
  - Scour chains
  - erosion pins measured and reset
  - Gauging stations prepared for the wet season

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Geomorphic Mapping
- Tributary North mapped in detail using a DGPS
  - Areas mapped in the field by walking around them
  - Downloaded to computer
- Post Processed i.e. back in the office


View Help
Show unprocessed Trib North
N
Geographic
X: 132.91373 deg
Y: -12.49472 deg
Grid Scale 1 : 111.32 m


View Help
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N
Geographic
X: 132.91595 deg
Y: -12.49427 deg
Grid Scale 1 : 111.32 m

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Comprehensive field program has been established
  - Data from two full years have been obtained
  - All laboratory analysis of water samples has been completed
  - All particle size analysis on bedload samples has been completed

GEOMORPHIC CHANGES IN THE SWIFT CREEK (NGARRADJ) CATCHMENT

- Initial results have been obtained on suspended sediments concentrations
  - Other data currently being analysed
  - Creeks still flowing JUST!

- Preparing to start 2000 dry season work

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Assessment of the environmental impacts of Jabiluka mine waste rock dump erosion on Swift Creek (Ngarradj)

K Evans, M Saynor, D Moliere, B Prendergast & W Erskine

Construction of proposed silos at the Jabiluka mine for under ground storage of tailings will result in above-grade waste rock dumps (WRDs) as proposed for the Jabiluka Mill Alternative. These WRDs will have a combined area of 41 ha that will be progressively rehabilitated over 30 years. The peak erosion rate will occur during the 29th and 30th years after construction when 2.7 ha will not be revegetated and 38.3 ha will be revegetated. The gross erosion rate from the 41 ha area at this time is 363.2 t/y. The catchment area impacted by the WRDs is 4.15 km^2 and application of a sediment delivery ratio (26.4%) for this area indicates that 95.9 t/y will enter Swift Creek at the downstream gauging site. This results in an 11.3% increase above the stream background total suspended sediment (TSS) load of 846 t/y (31 mg/L, σ = 23 mg/L). At the confluence of Swift Creek with Magela Creek there will be a 0.4% increase in mean annual TSS flux due to maximum WRD erosion. The 11.3% increase in Swift Creek equates to 3.5 mg/L which gives an altered mean TSS concentration of 34.5 mg/L. Based on local water quality guidelines, of an increase of one standard deviation being acceptable, the altered mean TSS concentration could be 54 mg/L. There should be no observable impact in Swift Creek due to WRD erosion if the progressive rehabilitation strategies assumed here are implemented.

Impact of Jabiluka waste rock dump erosion on Swift Creek

Ken Evans, Mike Saynor, Dene Moliere, Bernard Prendergast
Environmental Research Institute of the Supervising Scientist.

Wayne Erskine
State Forests of New South Wales

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The Environmental Research Institute of the Supervising Scientist

Acknowledgements

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Gary Fox

Environmental Research Institute of the Supervising Scientist.

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Background

- Swift Creek catchment contains Jabiluka uranium mine and will be the first catchment affected should any impact occur as a result of mining operations.
- Swift Creek is a major downstream right-bank tributary of the Magela Creek which flows directly into the Magela Creek floodplain.
- Magela Creek and floodplain: Wetlands of International Importance (RAMSAR Convention) and recognised under the World Heritage Convention.
- Initial ground surveys of the Swift Creek catchment indicate that coarse sediment is stored in a system of splays increasing in size through transition from the slopes immediately below the Jabiluka mine to channel areas near the confluence with Magela Creek.
- It is likely that fine sediment will be stored further downstream in the catchment or on the Magela Creek floodplain.

Catchment Management

To be able to manage the catchment responsibly and control any adverse affect of mining it is necessary to;

1. understand catchment evolution history
2. understand contemporaneous catchment baseline conditions of sediment movement and hydrology and be able to manipulate and interpret these baseline data,
3. update data to quantify temporal and spatial change that may occur in the catchment, and
4. use the evolution history and collected data to predict future catchment changes for various scenarios of disturbance thereby enabling pro-active management of catchment change.

AIMS:

1. Obtain baseline data on the channel network, channel stability, channel boundary sediments, sediment storages, sediment transport and hydrology of the Swift Creek catchment.

2. To use data to assess observed changes and/or potential changes in catchment morphology.

3. Establish a geographic information system (GIS) on sediment movement and hydrology of the Jabiluka Mineral Lease (JML) and neighbouring catchments.

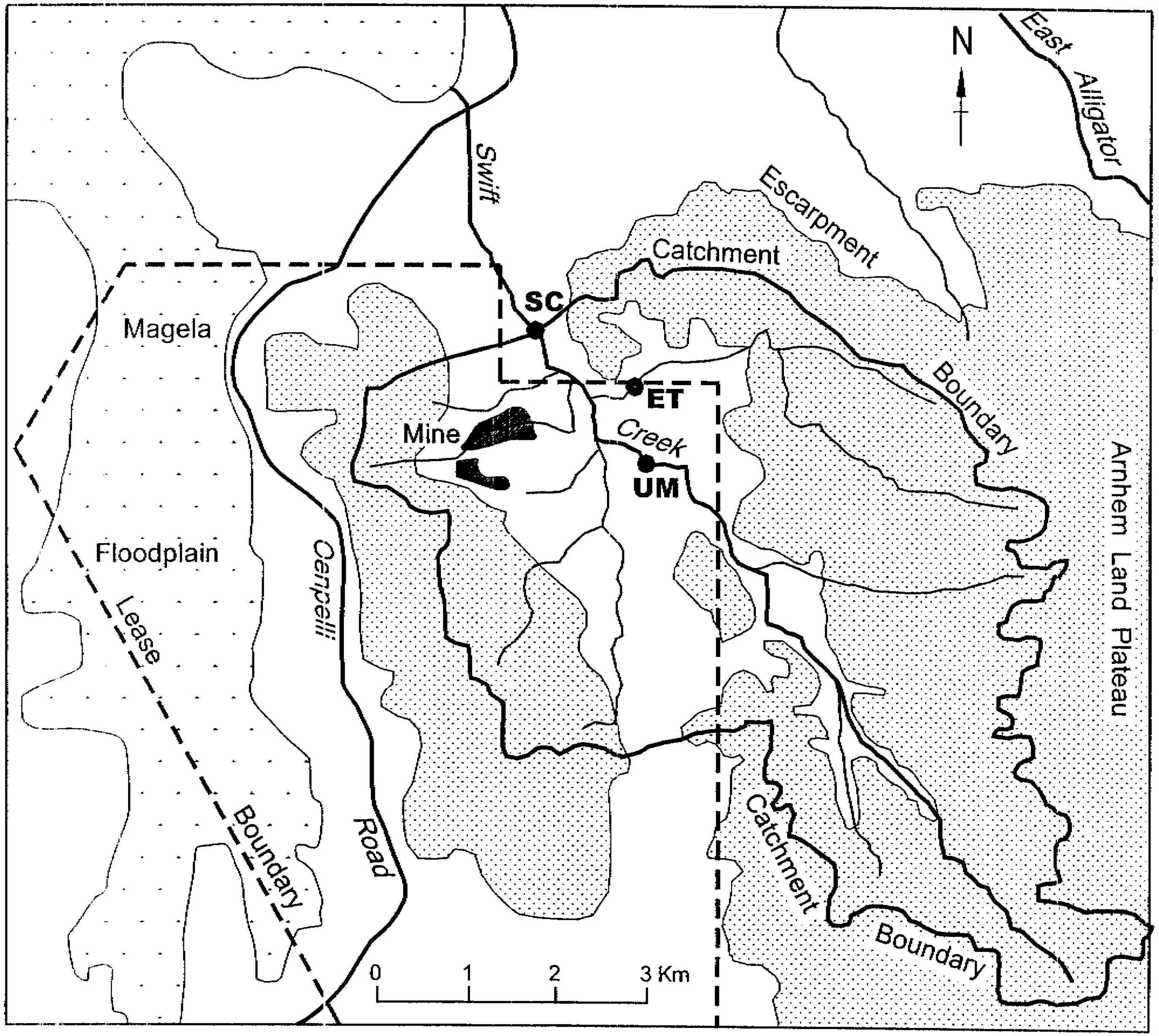
4. Develop an interactive GIS linked to calibrated erosion, hydrology and topographic evolution models that can be used for long term total catchment management of the JML with respect to sediment movement and runoff.

Swift Creek data collection

- Identification of streams and catchments likely to be affected by mining.
- Collation of background information, existing hydrological, sediment and topographic data.
- Field studies
  - Geomorphic mapping using dGPS,
  - dry season survey of channel x-sections,
  - wet season stream velocity gauging and sediment load sampling,
  - field description of channel and floodplain sediments,
  - laboratory analysis and data storage.
- Annual field mapping and assessment of temporal changes.

Waste rock dump impact assessment

- Two years of monitoring data are used to estimate background stream TSS loads in Swift Creek,
- WRD erosion estimated using the RUSLE,
- Incremental sediment yield in Swift Creek above background resulting from WRD erosion is derived.



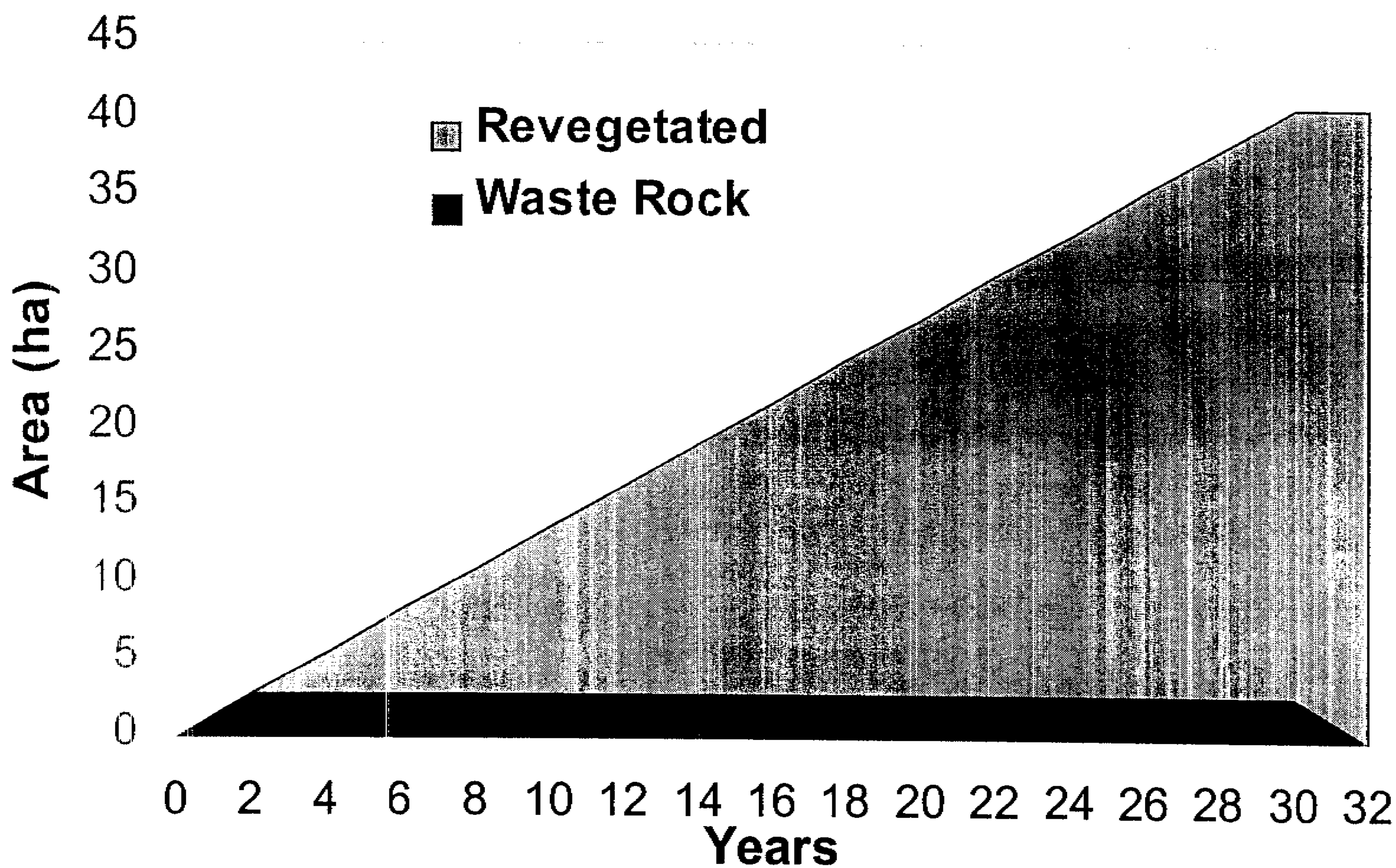
● Gauging Station

Waste Rock Dump Erosion

Details of silo construction and WRD dimensions are not finalised. Erosion calculations are based on the following assumptions:

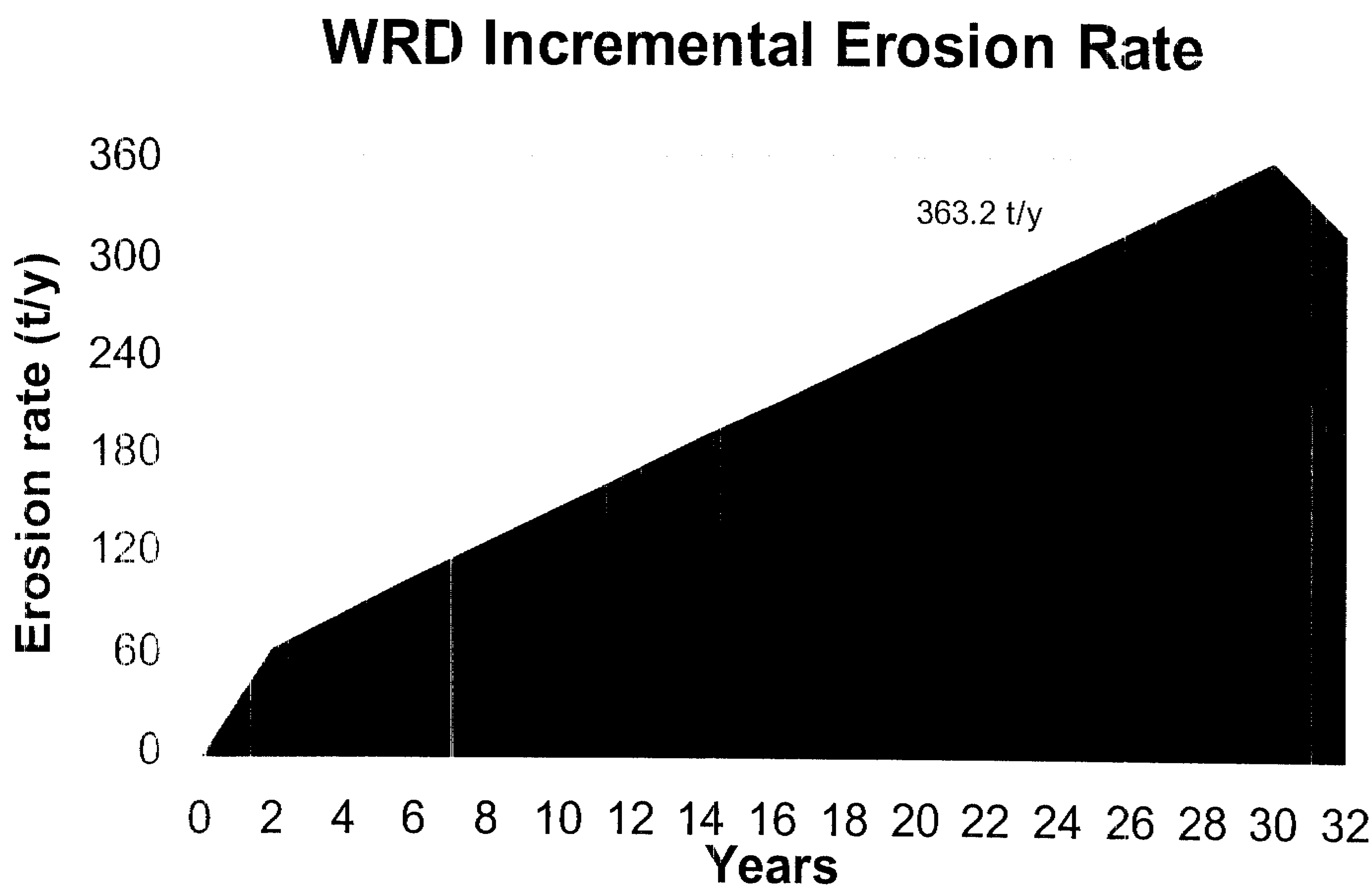
- Silos constructed progressively and waste rock placed on surface west of Swift Creek,
- Area of WRDs similar to description in PER i.e. 41 ha,
- WRDs constructed and revegetated progressively over approximately 30 years with any one area only being unrevegetated for a period of 2 years, and
- The implementation of sediment management features are not considered.

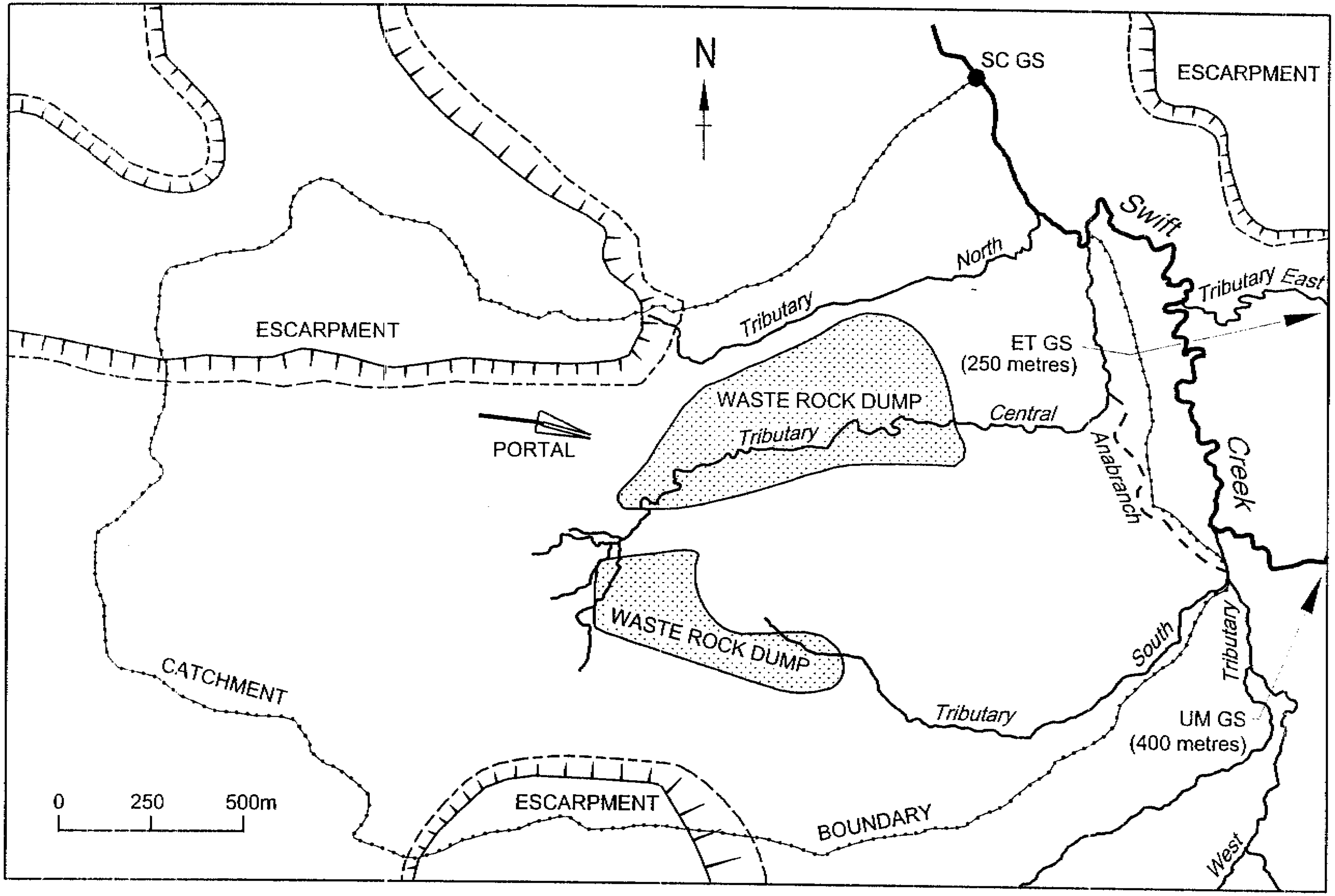
Incremental Waste Rock Dump Revegetation



WRD erosion rates

	Fresh waste rock (t/ha/y)	Ripped and revegetated (t/ha/y)
Cap (1-2%)	31.4	1.4
Batters (20%)	16.3	14.2
Mean	23.9	7.8


WRD Incremental Erosion Rate
Erosion rate (t/y)
360
300
240
180
120
60
0
363.2 t/y
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
Years



N
SC GS
ESCARPMENT
Swift
Creek
North
Tributary
Tributary East
ET GS
(250 metres)
ESCARPMENT
WASTE ROCK DUMP
Central
Tributary
PORTAL
Anabranch
WASTE ROCK DUMP
South
Tributary
Tributary
UM GS
(400 metres)
CATCHMENT
BOUNDARY
ESCARPMENT
0
250
500m
West

Waste Rock Dump Erosion - sediment delivery

Sediment delivery ratio = ratio of sediment delivered at the catchment outlet to the gross erosion within the catchment.

$$\mathrm{Ln(SDR)} = 4.54 - 0.21 \ln A$$

SDR is sediment delivery ratio (%), A is area (ha),

Catchment containing WRD = 4.15km^2

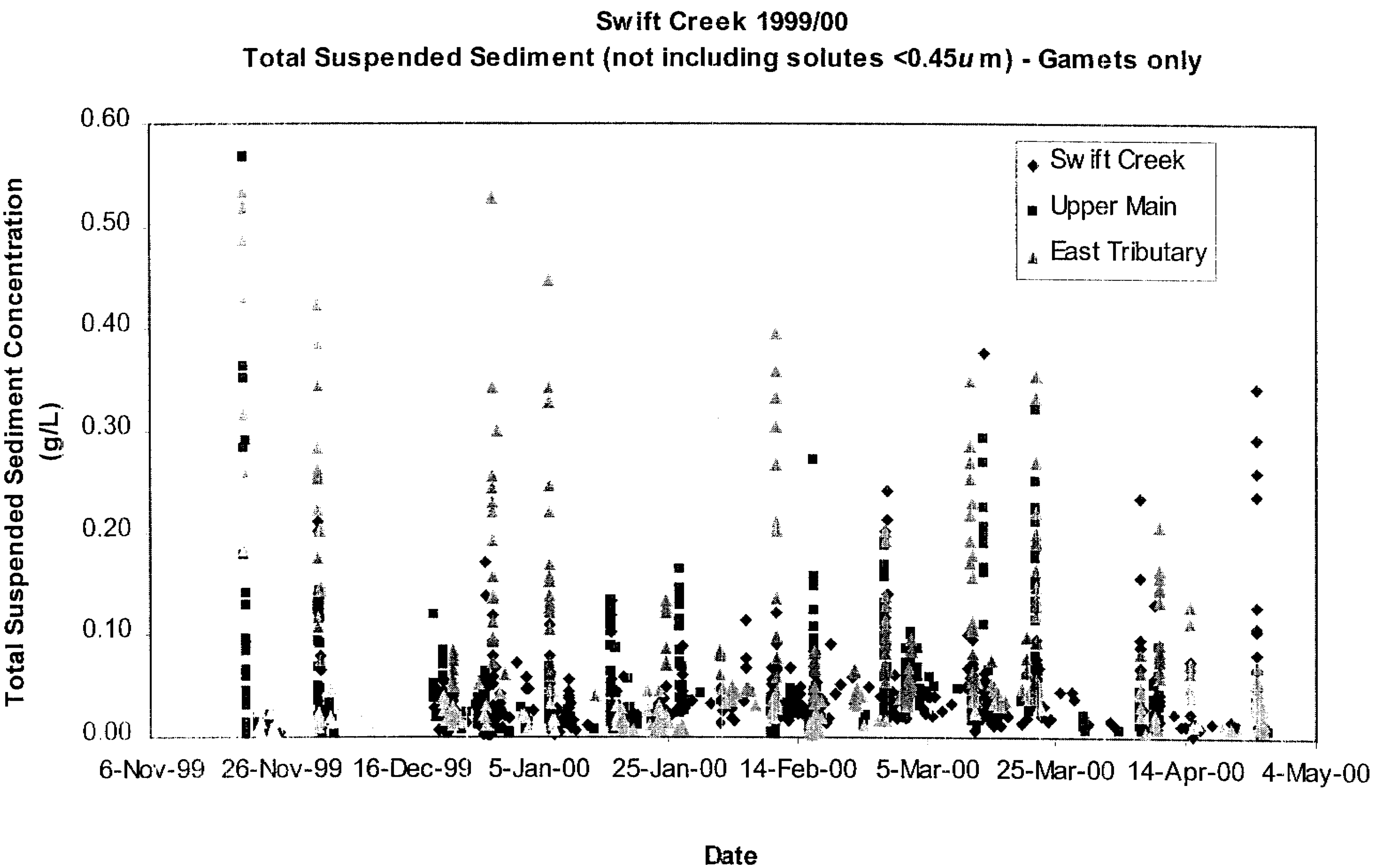
SDR = 26.4%

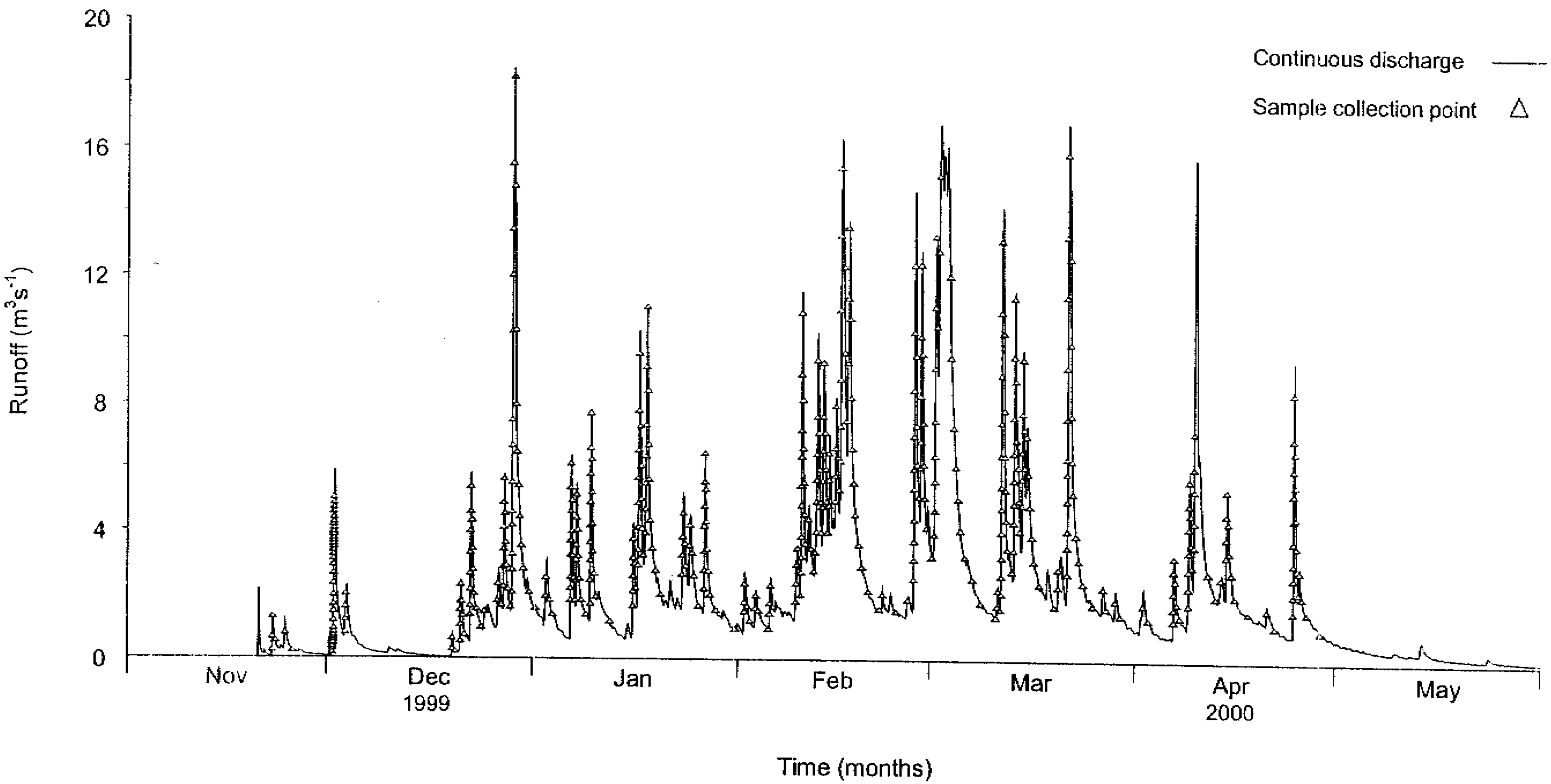
Max gross erosion = 363.2 t/y

Elevated sediment yield at Swift creek = 95.9 t/y

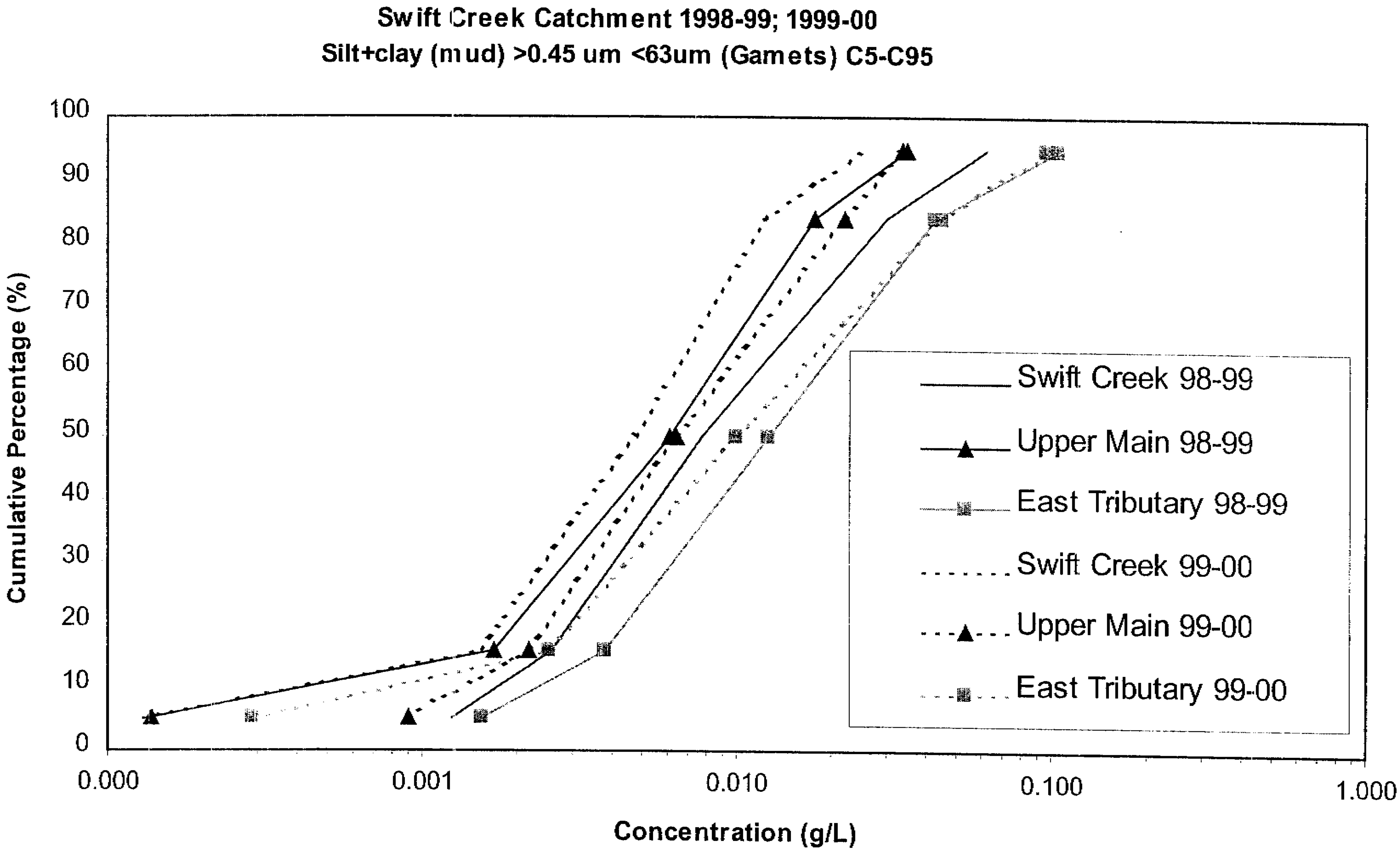
Background sediment loads in Swift Creek

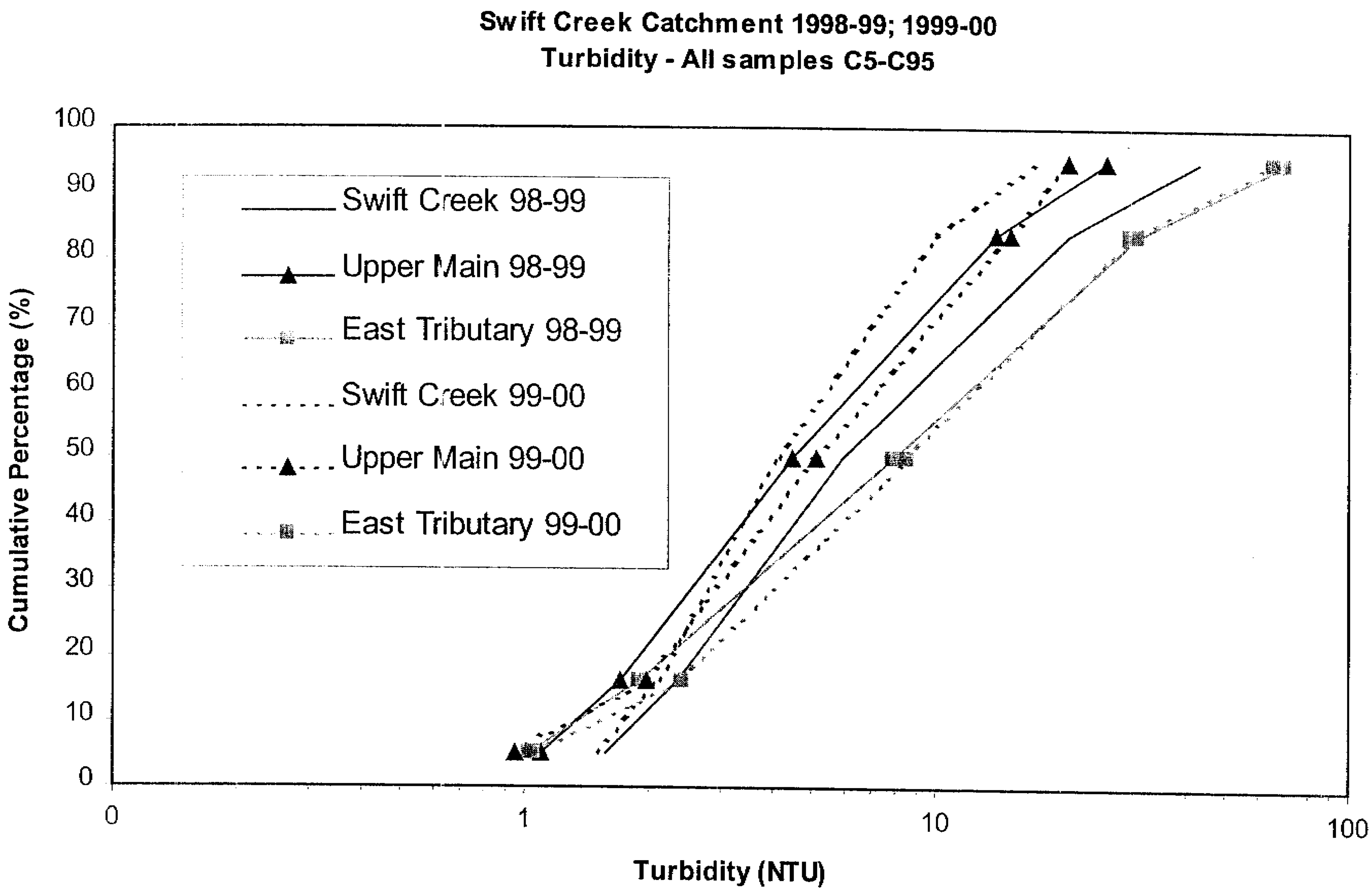
- Background TSS = average TSS in stream in undisturbed state
- 1998 eriss established stream gauging system
- rainfall, runoff, suspended load

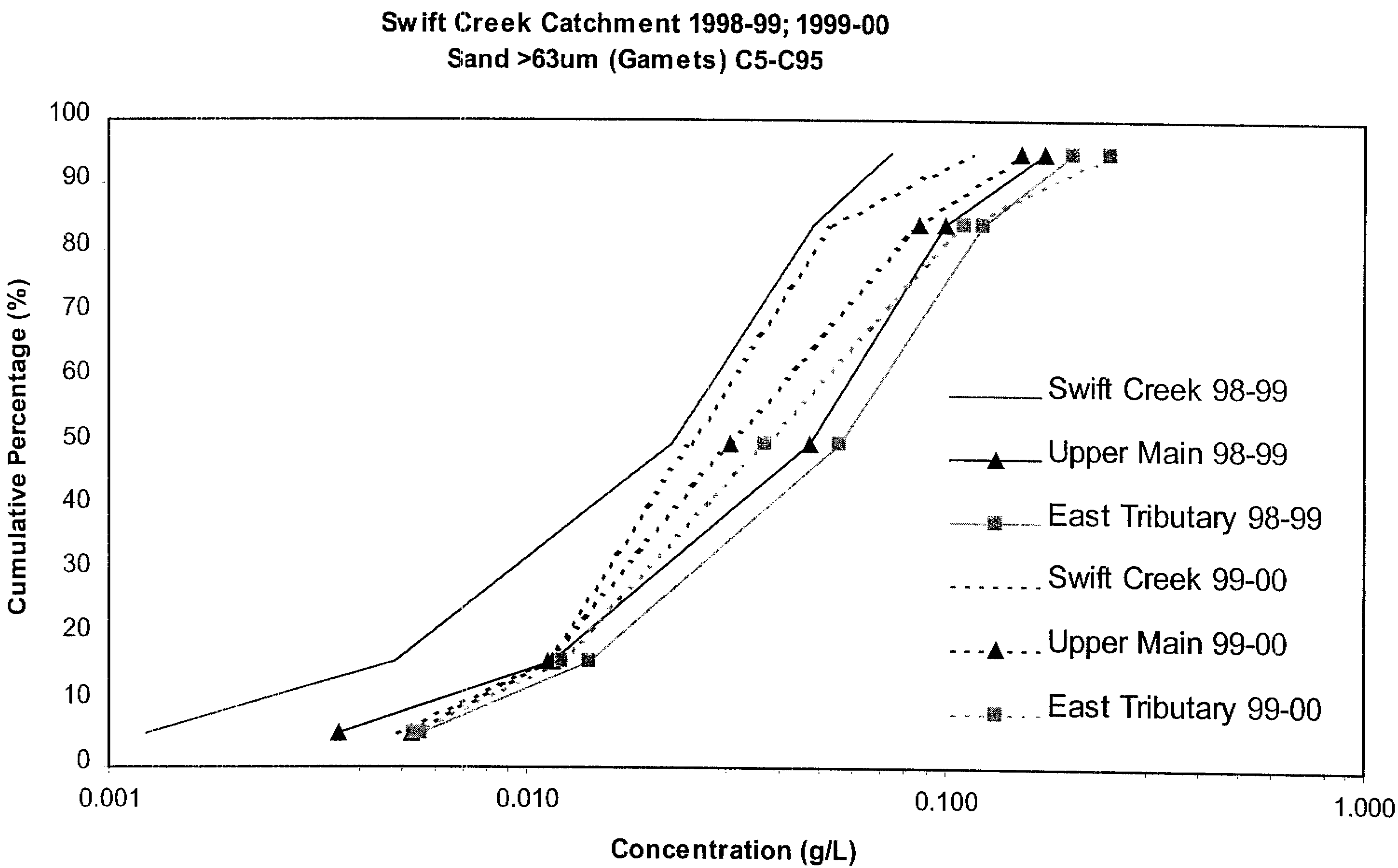

Swift Creek 1999/00
Total Suspended Sediment (not including solutes <0.45u m) - Gamets only
Total Suspended Sediment Concentration (g/L)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
6-Nov-99
26-Nov-99
16-Dec-99
5-Jan-00
25-Jan-00
14-Feb-00
5-Mar-00
25-Mar-00
14-Apr-00
4-May-00
Date
Swift Creek
Upper Main
East Tributary

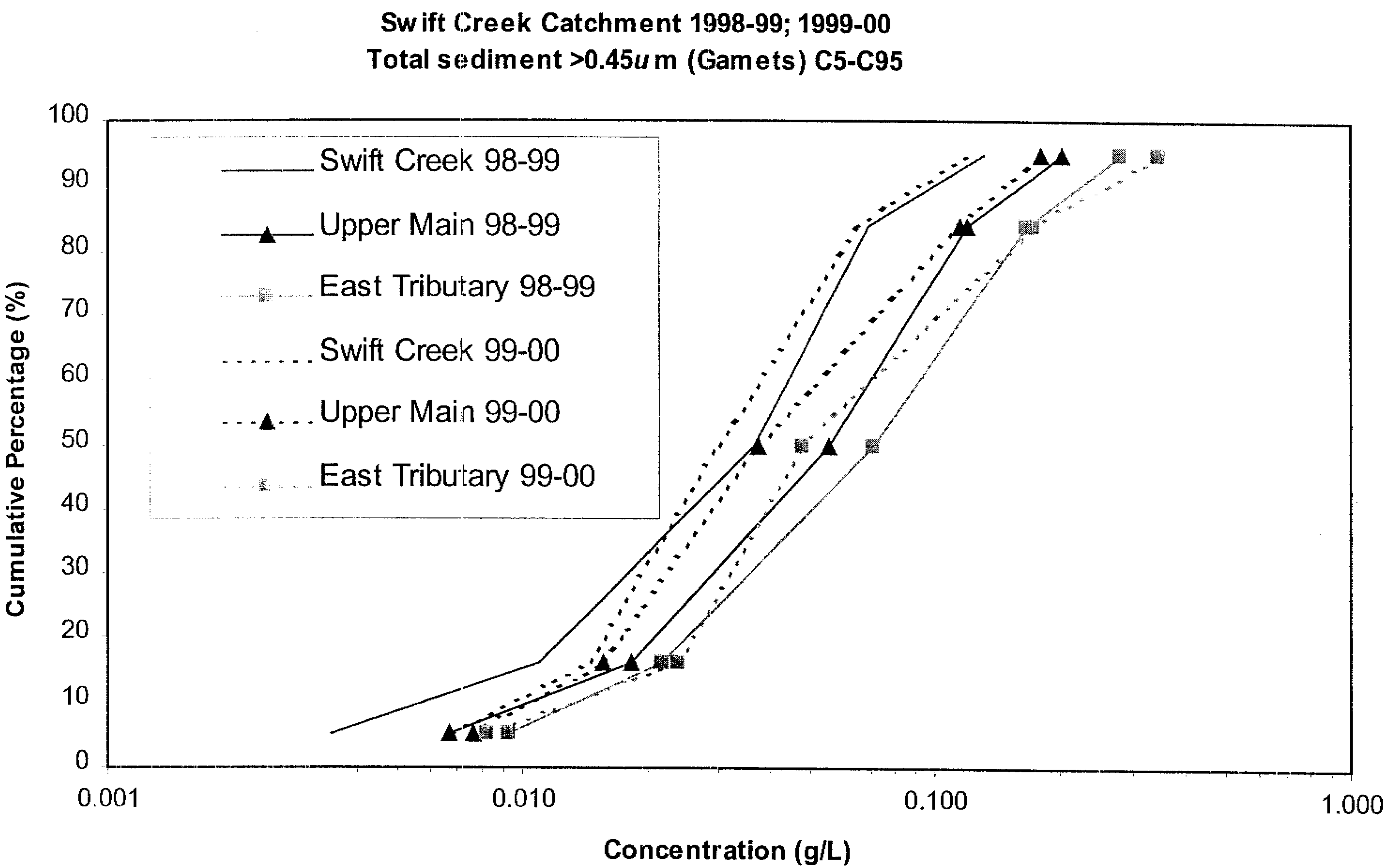


Continuous discharge
Sample collection point
Runoff (m^3s^{-1})
20
16
12
8
4
0
Nov
Dec
1999
Jan
Feb
Mar
Apr
2000
May
Time (months)


Swift Creek Catchment 1998-99; 1999-00
Silt+clay (mud) >0.45 um <63um (Garnets) C5-C95
Cumulative Percentage (%)
100
90
80
70
60
50
40
30
20
10
0
0.000
0.001
0.010
0.100
1.000
Concentration (g/L)
Swift Creek 98-99
Upper Main 98-99
East Tributary 98-99
Swift Creek 99-00
Upper Main 99-00
East Tributary 99-00


Swift Creek Catchment 1998-99; 1999-00
Turbidity - All samples C5-C95
Cumulative Percentage (%)
100
90
80
70
60
50
40
30
20
10
0
0
1
10
100
Turbidity (NTU)
Swift Creek 98-99
Upper Main 98-99
East Tributary 98-99
Swift Creek 99-00
Upper Main 99-00
East Tributary 99-00


Swift Creek Catchment 1998-99; 1999-00
Sand >63um (Gamets) C5-C95
Cumulative Percentage (%)
100
90
80
70
60
50
40
30
20
10
0
0.001
0.010
0.100
1.000
Concentration (g/L)
Swift Creek 98-99
Upper Main 98-99
East Tributary 98-99
Swift Creek 99-00
Upper Main 99-00
East Tributary 99-00


Swift Creek Catchment 1998-99; 1999-00
Total sediment >0.45um (Gamets) C5-C95
Swift Creek 98-99
Upper Main 98-99
East Tributary 98-99
Swift Creek 99-00
Upper Main 99-00
East Tributary 99-00
Cumulative Percentage (%)
0
10
20
30
40
50
60
70
80
90
100
0.001
0.010
0.100
1.000
Concentration (g/L)

	Sand+mud >0.45*u*m (g/L)				Sand >63*u*m (g/L)				Mud <63*u*m >0.45*u*m (g/L)			
Swift Ck	M	SD	M_z	SD	M	SD	M_z	SD	M	SD	M_z	SD
1998-99	0.045	0.043	0.039	0.034	0.029	0.032	**0.025**	0.022	0.016	0.020	0.013	0.016
1999-00	0.043	0.045	0.037	0.030	0.035	0.042	0.030	0.028	0.007	0.009	**0.006**	0.007
Upper main												
1998-99	0.070	0.059	0.064	0.055	0.058	0.053	0.053	0.048	0.010	0.012	0.009	0.009
1999-00	0.060	0.065	0.056	0.051	0.049	0.057	0.043	0.041	0.011	0.010	0.010	0.010
East Trib.												
1998-99	0.097	0.091	0.086	0.077	0.071	0.065	0.065	0.057	0.026	0.039	0.020	0.025
1999-00	0.097	0.138	0.081	0.088	0.073	0.125	0.053	0.061	0.023	0.034	0.019	0.025

Swift Creek background TSS loads

Season	Rainfall (mm)	Runoff (ML)	C_r	TSS yield (t)	TSS concentration (g/L)	M_z (σ) (g/L)
1998-99	1780	33760	0.44	1334	0.040	0.039
1999-00[1]	1997	34943	0.41	1364	0.039	0.037
Mean[2]	1483	27293	0.43	846	-	0.031 (0.023)

M_z = Graphic mean

σ = Standard deviation

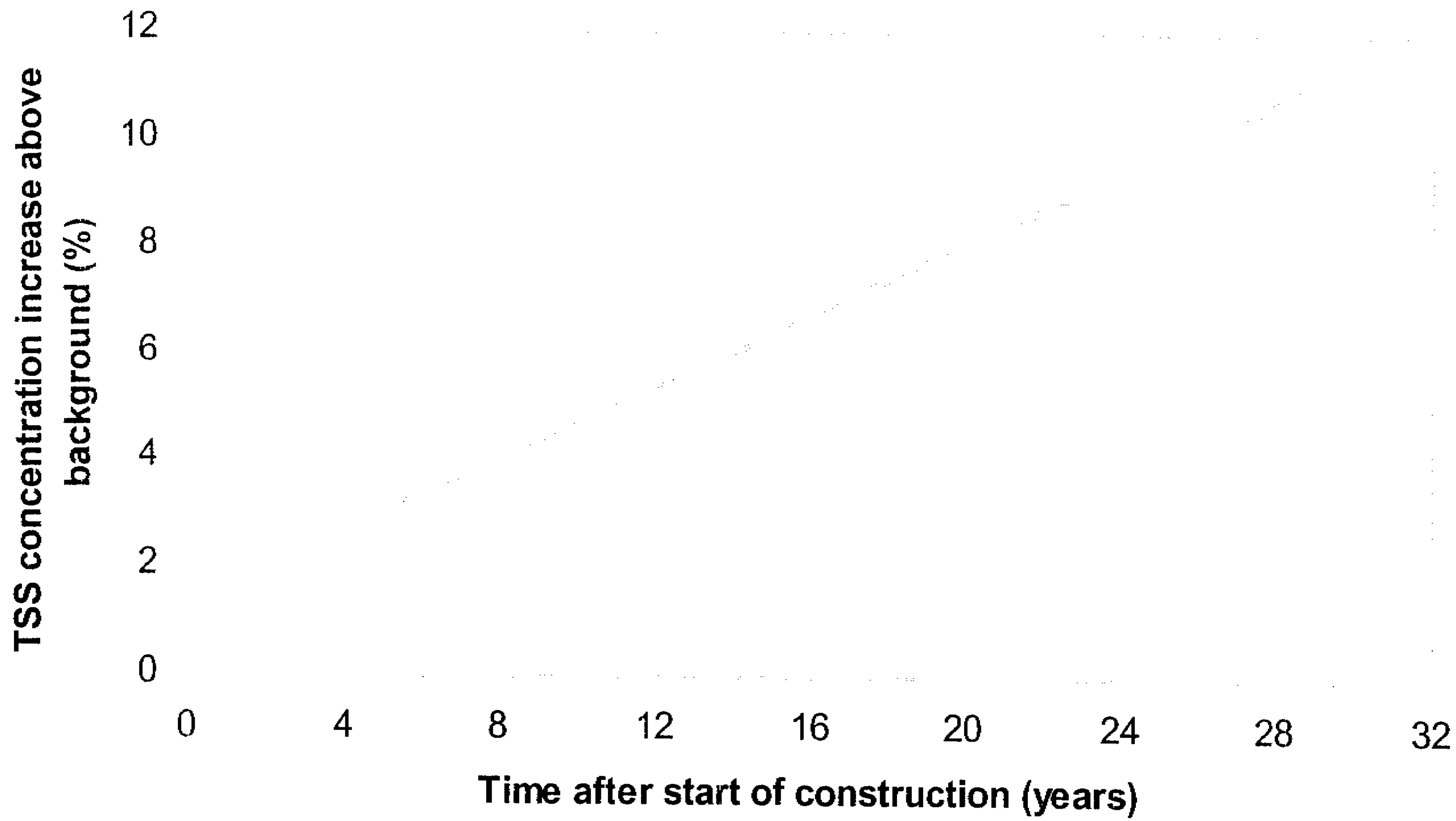
[1] Incomplete

[2] Based on Jabiru rainfall

Maximum elevated sediment yield at Swift creek = 95.9 t/y

Percentage elevated above background = $\frac{95.9t/y}{846t/y} x100 = 11.3\%$

Incremental TSS elevation above background



Conclusions

- Area of WRDs similar to description in PER i.e. 41 ha
- Maximum erosion period Swift Creek mean TSS concentration = 34.5 mg/L,
- Maximum allowable altered TSS concentration = 54 mg/L (local WQG Mean + σ),
- Confluence of Magela Creek and Swift Creek (67.8 km^2, SDR = 14.7%), Magela mean annual TSS flux (≈3 650 t/y) increases by 14.1 t/y (0.4%), and
- Assumed progressive rehabilitation strategies of ripping and revegetation required.

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Radiological impact assessment of uranium mining operations in the Alligator Rivers Region

P Martin

The major aim of the current regime for control of radioactive materials is the protection of human health. For a full radiological impact assessment of a situation, all pathways by which radiation can reach humans must be addressed. For uranium mining and milling operations, this includes surface water transport of radionuclides (whether dissolved or on suspended particulates), uptake in the human food chain, dispersion in groundwater, vector transport of material (by animals or by humans), atmospheric dispersion of dust and of the noble gas radon and its progeny, and direct irradiation of people assessing the minesite.

This talk will focus primarily upon the pathway involving surface water transport of radionuclides followed by bioaccumulation by aquatic organisms, using the Ranger uranium mine/Magela Creek system as a case study. Studies of natural radionuclides and metals in the Magela Creek system have shown that there is likely to be only negligible deposition of any released activity on the sandy creek bed, but that most or all of the dissolved and particulate activity can be expected to be deposited on the floodplain. Bioaccumulation studies have shown that for release of pond waters from the minesite the most important pathway is uptake of Ra-226 by freshwater mussels, followed by uptake of Ra-226 by fish.

Radiological Impact Assessment of U Mining Operations in the ARR

Paul Martin

Environmental Research Institute of the Supervising Scientist

Jabiru, Northern Territory, Australia

Environment Australia

Department of the Environment and Heritage

Radiological Impact of Mining on People

Major Pathways

Atmospheric transport

- Radon-222 and progeny
- Dust

Water-based transport

- Surface water/bioaccumulation
- Groundwater

Direct irradiation

Approximate dose rates to members of the public from the Ranger mine

Dose rates in mSv/yr for present-day operations

Dose limit: 1 mSv/yr

Radon & radon progeny	0.05
Dust	0.01
Surface water/bioaccumulation	0.0005
Groundwater	0.0
Direct irradiation	very low

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Dose estimation: Surface water/bioaccumuation pathway

Required data & models

- Release conditions
- Radionuclide dispersion
- Critical group diet
- Bioaccumulation
- Dose conversion factors (ICRP)

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Important radionuclides: Concentrations in RP2 and dose conversion factors

	Conc (Bq/L)	DCF (μSv/Bq)
U-238	7.4	0.068
U-234	7.9	0.074
Th-230	0.02	0.21
Ra-226	2.5	0.28
Pb-210	0.16	0.69
Po-210	0.02	1.2

Dose estimation: Surface water/bioaccumuation pathway

Required data & models

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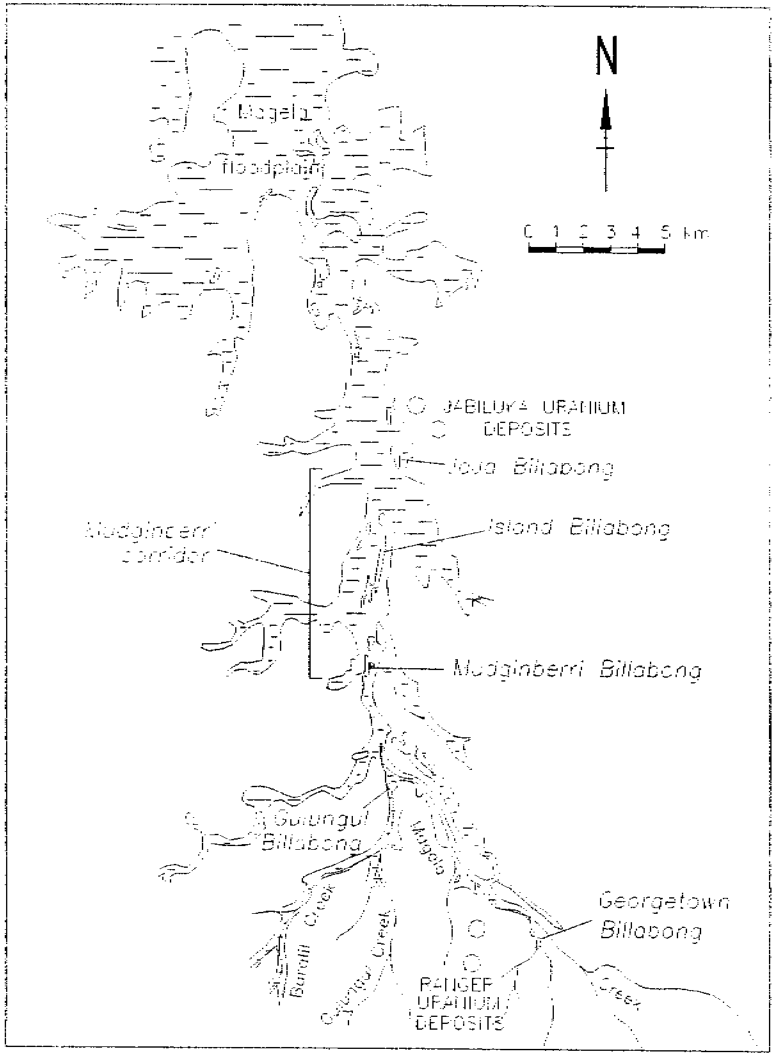
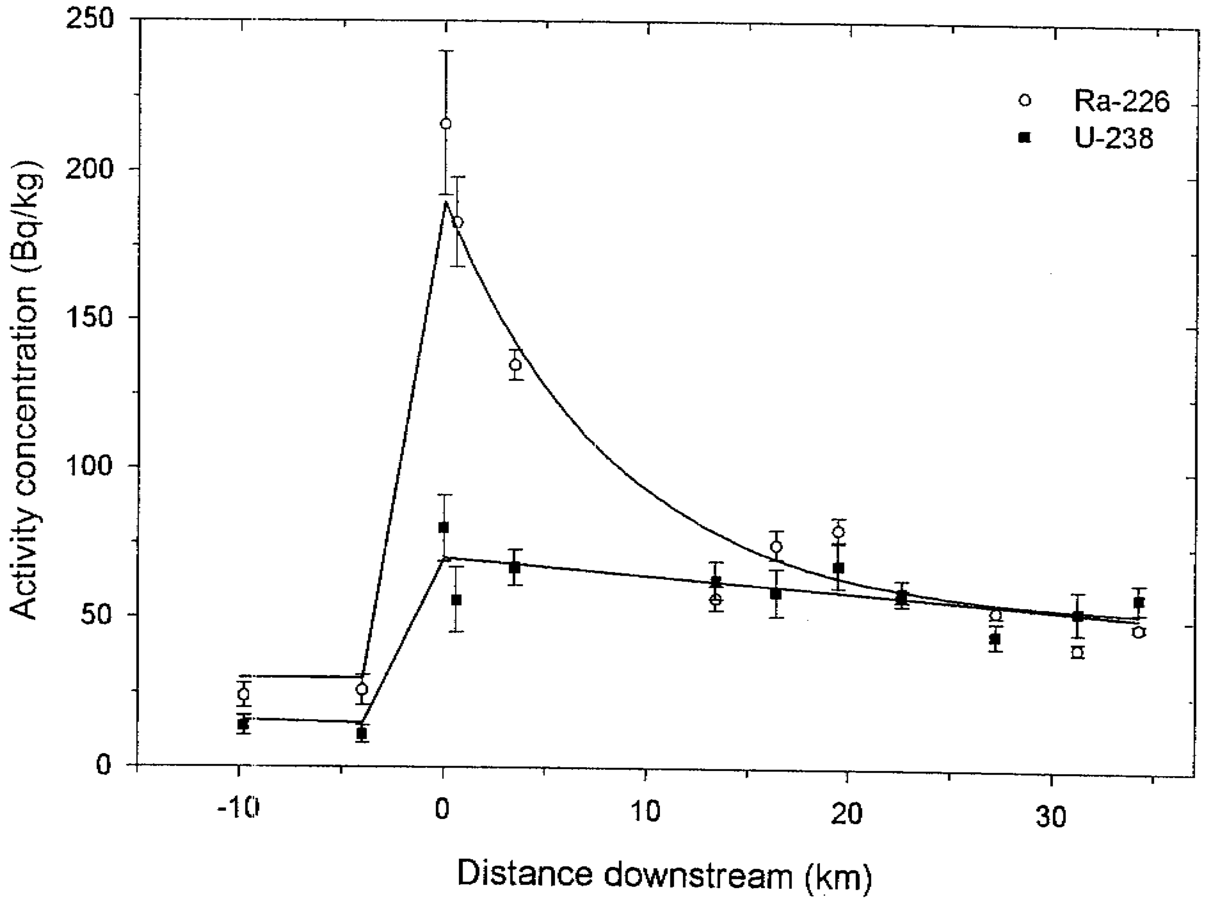
Magela Creek and floodplain



Radionuclide concentrations in surface (3cm) sediment of Magela Creek



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Dose estimation: Surface water/bioaccumuation pathway

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Bioaccumulation: concentration factor approach

Basic equation:

$$CF = \frac{C_f}{C_w}$$

where

CF = concentration factor

C_f = concentration in the food item

C_w = concentration in the water

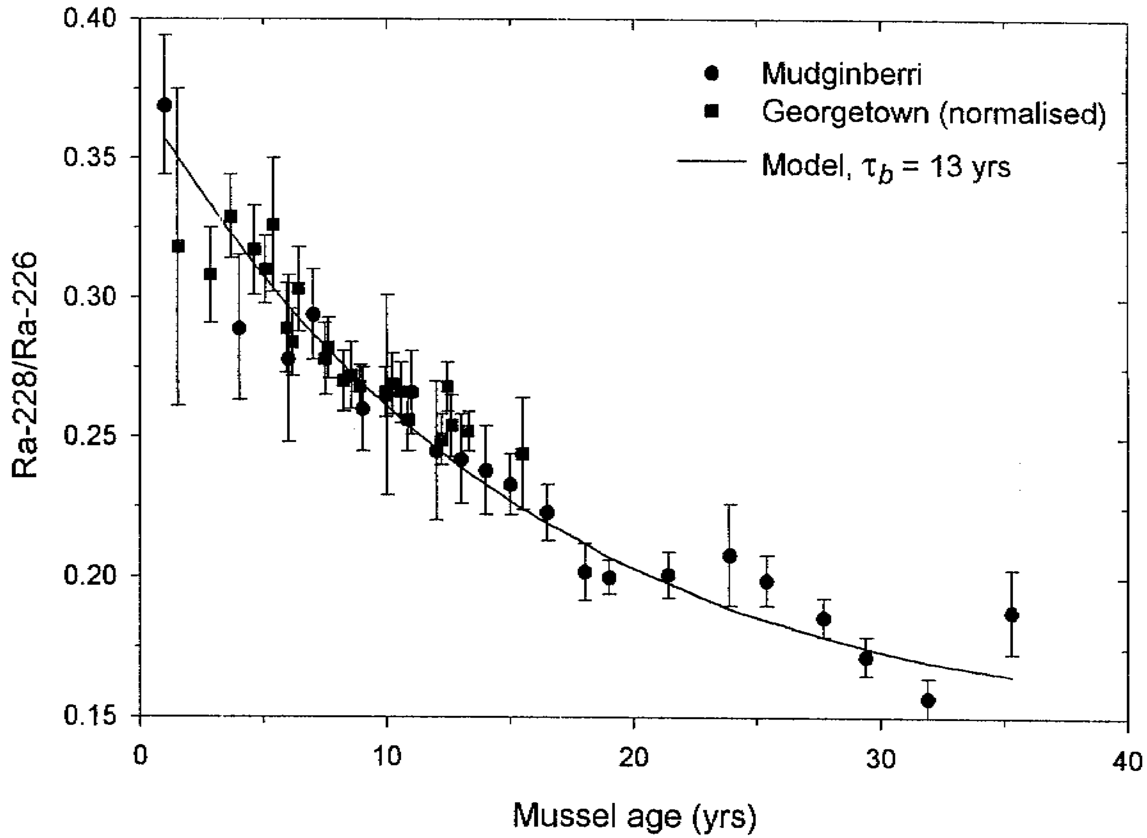
Concentration factors relative to water concentration for Magela Creek

	Fork-tailed catfish	Freshwater mussels
U-238	15	100
Th-230	3	500
Ra-226	50	19000
Pb-210	20	5100
Po-210	80	10000

Contributions to predicted dose (%)

By radionuclide		By food item	
Ra-226	92	F/W Mussel	85
Pb-210	4	Fish	11
Po-210	1.5	Water	1
U-234	1	Water lily	1
U-238	1	Turtle	1

Mean biological lifetime of Ra in freshwater mussels (*Velesunio angasi*)



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Summary

Radiological impact assessment

- Primary focus is on protection of humans.
- Work is multidisciplinary in nature.
- Importance of different pathways varies over the mine lifecycle. All pathways must be examined.
- Isotopes can be useful in examining environmental transport mechanisms.

Derivation of a site-specific water quality guideline for uranium based on local species toxicity data

RA van Dam

The draft revised Australian and New Zealand Water Quality Guidelines (WQGs) encourage the derivation of site-specific guideline trigger values (TVs) for toxicants. This paper represents a case study based on uranium in the Alligator Rivers Region (ARR), and highlights the associated benefits and problems.

Due to an inadequate toxicity database, the WQGs recommend a *low reliability* TV for uranium of 0.5 µg/L. Given that the ARR is considered of high conservation/ecological value, a *low reliability* TV is inadequate, and site-specific assessment was considered essential. In order to derive a *high reliability*, site-specific TV for uranium, chronic toxicity data for at least five local species from at least four taxonomic groups was required. Based on historical and new toxicity data, no-observed-effect concentrations (NOECs) for five local species ranged from 15 to 810 µg L^{-1}. Based on the newly adopted statistical extrapolation method, the resultant site-specific TV (to protect 99% of species) for uranium was 0.1 µg L^{-1}. This value is significantly lower than the historical site-specific guideline value of 3.8 µg L^{-1} for Magela Creek (within the ARR), but is still 2–3 times above recently determined natural background concentrations. However, the new TV is highly influenced by the small dataset and associated high uncertainty. This problem, and the associated benefits and costs of further toxicity assessment will be discussed.

Derivation of a site-specific water quality guideline for uranium based on local species toxicity data

Rick van Dam
Wetland Ecology & Conservation
Environmental Research Institute of the Supervising Scientist
Jabiru NT Australia

The revised Aust/NZ Water Quality Guidelines for Toxicants (in press)

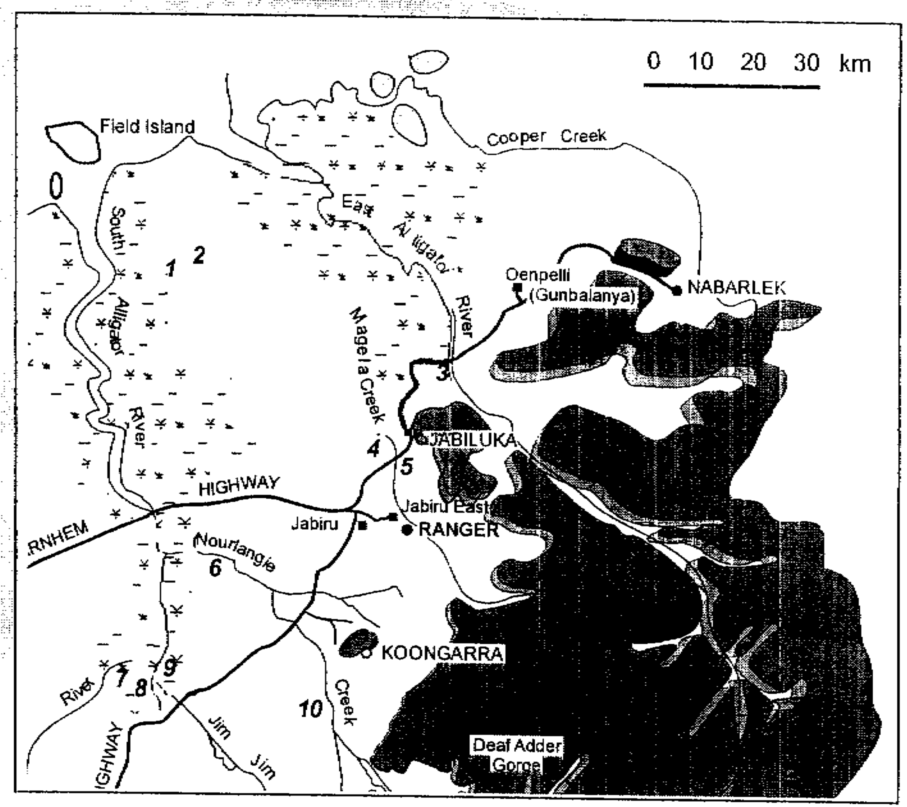
- Provide default/generic ***trigger*** values for Toxicants
- Encourage derivation of site-specific ***trigger*** values ("tailoring guidelines for local conditions")
- Integrated approach:
  - chemical-specific guidelines coupled with water quality monitoring;
  - direct toxicity assessment;
  - biological monitoring

Applying the guideline trigger values to sites: *Factors to consider*

- Determine ecosystem condition/level of protection
- Sample filtration
- Practical quantitation limit (PQL)
- Natural background concentrations
- Bioaccumulation
- **Locally important species**
- Water chemistry (eg pH, hardness, DOM)
- Multiple contaminant effects

Magela Creek (Alligator Rivers Region)

- Seasonally flowing tributary of the East Alligator River
- Passes near Ranger Uranium Mine and Jabiluka uranium lease
- Characterised by very soft, low EC water, pH 6-7
- Major toxicant of concern
  → Uranium



Derivation of Toxicant Trigger Values

2 methods:

Statistical extrapolation - preferred method

- fits a statistical distribution to all relevant toxicity data
- calculates the concentration that will protect x% of species (eg 95%, 99%)
- minimum data requirements: chronic toxicity data for 5 species from 4 taxonomic groups

Assessment factor

- safety factor applied to NOEC of most sensitive species
- fall-back method if insufficient data for statistical extrapolation method

Default Trigger Values

High reliability

- Statistical extrapolation
- calculated from chronic no-observed-effect concentration (NOEC) data

Moderate reliability

- Statistical extrapolation
- calculated from acute toxicity data (eg LC_{50}) after applying acute-to-chronic conversion factors

Low reliability

- Assessment factor method
- interim working levels - require further data

Default trigger value for uranium

- Inadequate toxicity data set
- Many toxicity values, but:
  - pH range too wide
  - most values were acute LC_{50}s
  - insufficient trophic levels/taxonomic groups covered
- Low reliability trigger value → **0.5 μg L^{-1}**
- Inadequate for an area of high conservation/ ecological value such as the ARR

Uranium toxicity studies in the ARR

Number of local species tested for uranium toxicity

Organism type	No. species tested	No. relevant for site-specific trigger value
Cnidaria (hydra)	2	1 (1988)
Mollusca (mussel)	1	-
Crustacea	6	1 (1999)
Chordata (fish)	10	2 (1992)
Chlorophyta	2	1 (in prep)
Total	*21*	*5*

→ Chronic toxicity data for 5 local species from at least 4 trophic levels/taxonomic groups in Magela Ck water

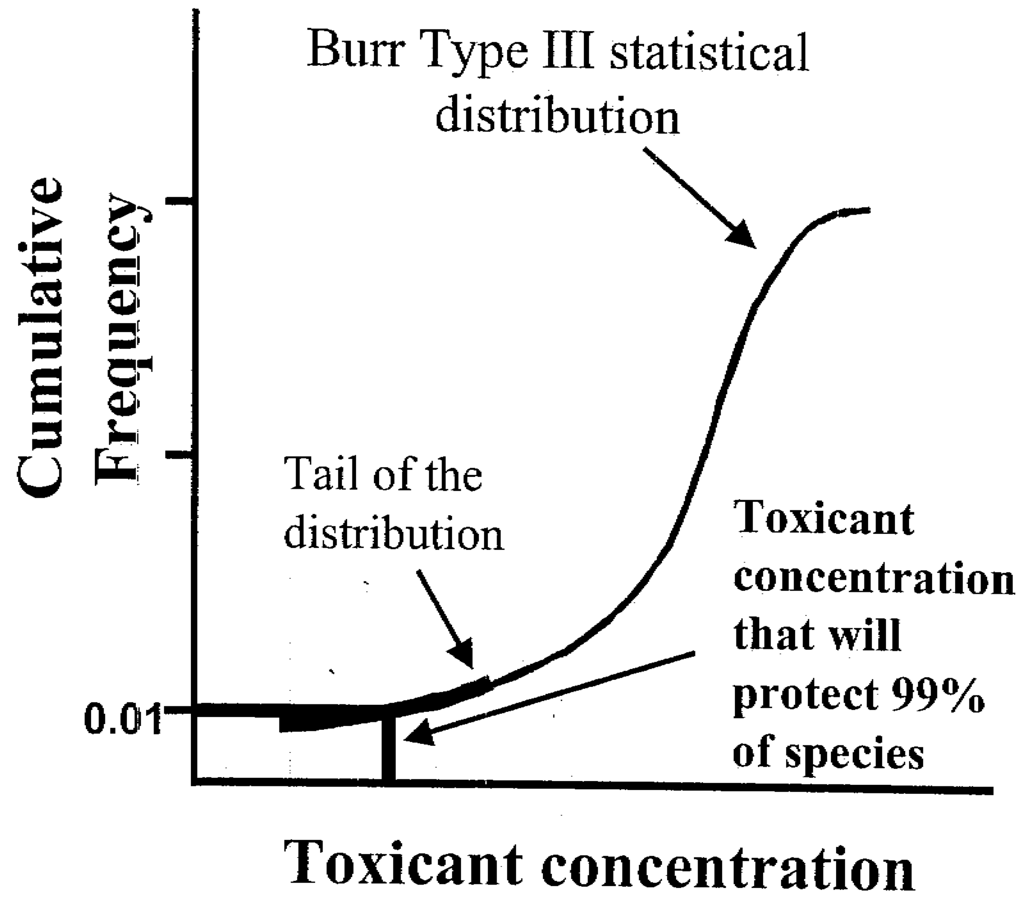
Uranium toxicity studies in the ARR

Chronic toxicity of uranium to local species, using Magela Creek water as diluent

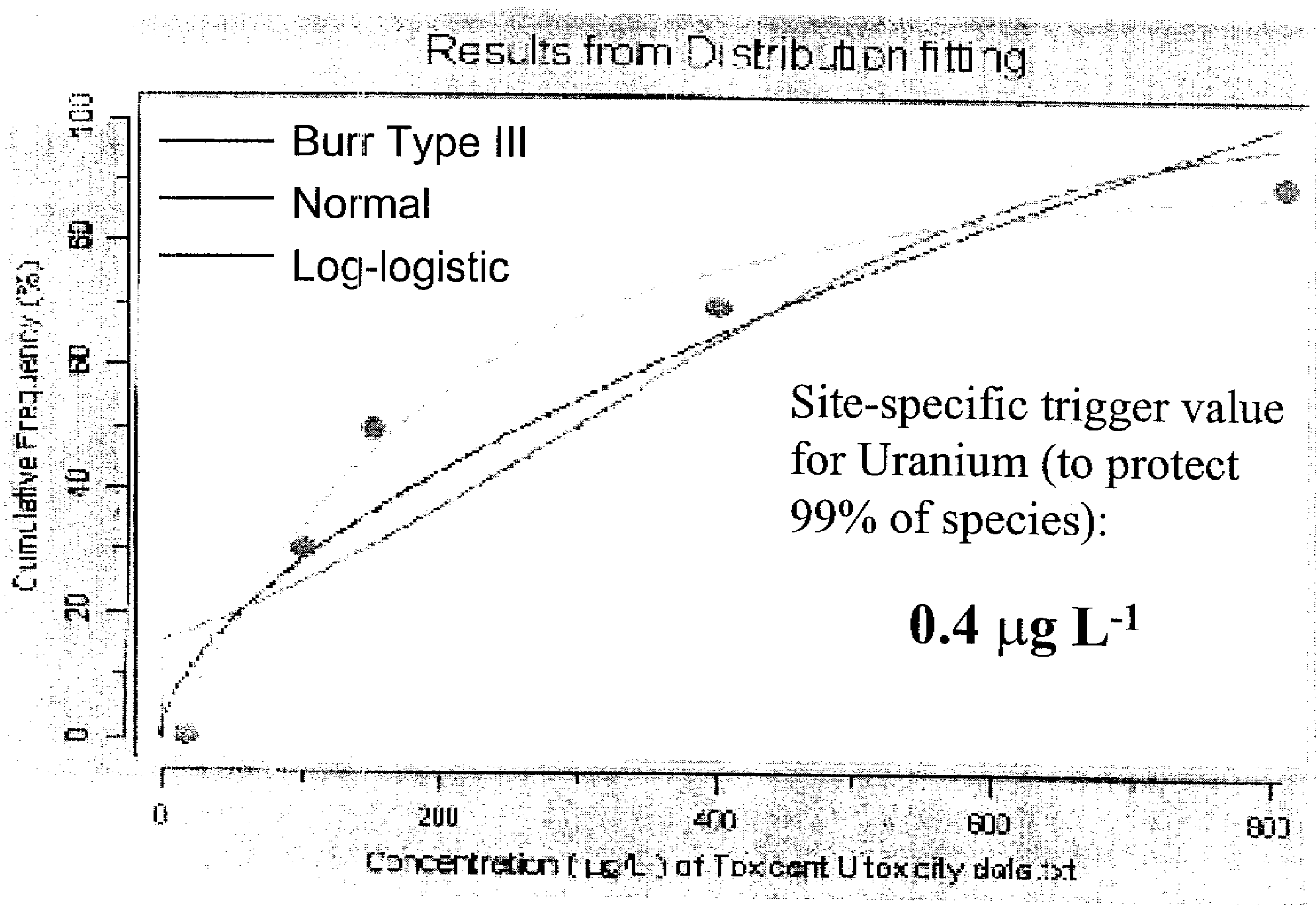
Species	Test endpoint	NOEC ($\mu g\ L^{-1}$)	Reference
Hydra viridissima	Population growth	150	Supervising Scientist (1988)
Moinodaphnia macleayi	Reproduction	18	Semaan (1999)
Mogurnda mogurnda	Growth	400	Holdway (1992)
Melanotaenia splendida splendida	Growth	810	Holdway (1992)
Chlorella sp.	Cell division rate	101*	in prep

* Preliminary result; to be refined.

The Statistical Extrapolation method



A site-specific trigger value for uranium



Uranium in Magela Creek

- General background concentrations:

Total	0.05 $\mu g\ L^{-1}$
Dissolved	0.02 $\mu g\ L^{-1}$

- Historical guideline value for Magela Ck, downstream of Ranger:

3.8 $\mu g\ L^{-1}$

- based on Assessment factor method using *Hydra* toxicity data

Discussion of the statistical extrapolation approach

- Assumes the distribution describes the range of sensitivities of all species in the environment

- Size/spread of the data set can influence the number

  → 18, 101, 150, 275, 400, 605, 810: 1.4 µg L^{-1}

  → 18, 101, 120, 150, 180, 400, 810: 6.1 µg L^{-1}

  → 16, 18, 90, 101, 135, 150, 360, 400, 730, 810: 0.3 µg L^{-1}

- Influence of 2 chronic fish data points (out of 5)

Summary

- One of the first ‘real life’ trials of the new WQGs approach to deriving site-specific trigger values

- The new value is markedly lower than the current guideline values for uranium in Magela Creek, but still higher than background

- Further toxicity assessment ideal, but not urgent:

  → aquatic macrophyte (eg *Lemna*), macroinvertebrate

Thanks to: Caroline Camilleri
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Arthur Johnston

An overview of requirements for environmental monitoring and assessment of the proposed Jabiluka uranium mine

CL Humphrey

Programs for environmental monitoring are being put in place to detect and assess potential impacts upon aquatic ecosystems that might arise in future as a consequence of mining at Jabiluka. These are modelled on best-practice advice and guidance for high conservation sites as provided in the revised and soon-to-be-published, Australian and New Zealand Water Quality Guidelines. The focus in chemical and biological assessment programs is on 'no change to biodiversity' with incorporation of the elements: prediction and early detection of possible effects, and assessing the ecological importance of change through measurement of 'biodiversity' indicators.

The one constraint to this best-practice framework for water quality monitoring at Jabiluka is a lack of baseline data gathered from aquatic ecosystems downstream of the mine prior to mine site disturbance. Compensatory monitoring and a current halt to all activities on the site may alleviate this problem.

UNESCO's Independent Science Panel (ISP) highlighted biological cycling of contaminants as one of the uncertainties associated with the proposed Jabiluka mine and sought both a full ecosystem analysis and an ecological risk assessment at the landscape scale. The match or mis-match of these issues and the design and nature of the environmental monitoring and assessment program proposed for Jabiluka, are discussed.

An overview of requirements for environmental monitoring and assessment of the proposed Jabiluka uranium mine

Chris Humphrey

Focus of talk

- Potential risks greatest for aquatic ecosystems; focus of most effort in environmental protection

- Placing the environmental monitoring and assessment program for the proposed Jabiluka mine in the context of the revised *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

Key features of the new Guidelines' philosophy: Aquatic ecosystems

- Water quality only one aspect of aquatic ecosystem health
- Promote cooperative best management approach
- Encourage formulation of, provide guidance for deriving, *local, site-specific* guidelines rather than use of default values
- Holistic, integrated assessment, measuring physical, chemical and biological indicators in water and sediment
- Three different levels of protection

Water quality management framework

[illegible] primary [illegible]
[illegible] the water [illegible]

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[illegible] the [illegible]

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[illegible] the Water [illegible]

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[illegible] ish monitor [illegible]

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Initiate management [illegible]

Management regime and stakeholder involvement in ARR

- Stakeholders:
  - Mining company
  - Supervising Scientist
  - NT Dept Mines & Energy
  - Northern Lands Council
  - Parks Australia
- Key stakeholders negotiate environmental requirements and monitoring and reporting regime
- MTC, ARRTC, ARRAC
- Regulator and SS conduct annual environmental audits

Defining primary management aims

- **Define water body**
  - Swift Ck, Magela floodplain, streams traversing access/haul road
- **Identify environmental values**
  - Aquatic ecosystem protection
  - Drinking water
  - Human consumption of aquatic foods
  - Recreational water quality and aesthetics
  - *Cultural and spiritual values*
- **Determine level of protection**
  - High conservation value
- **Identify environmental concerns**
  - Toxic effects in water and sediment
  - Suspended solids, sedimentation, etc
- **Define management goals**
  - 'No change' to key indicators of biological diversity

Environmental values: Holistic issues

- **Inter-, intradependence of environmental values (EVs)**

  - consider fate of contaminants and cumulative effects (downstream but also upstream)

  - role of integrated catchment management

- **Apply the most conservative guidelines for designated EVs**

  - e.g. aesthetic guidelines vs suspended solids guidelines for aquatic ecosystems. ANZECC (1992): "… almost all people can detect a change of 30% in visual clarity"

Indicators of water quality for aquatic ecosystems

Integrated assessment using:

- Biological indicators

- Physical and chemical stressors (natural indicators: pH, turbidity, DO, nutrients etc)

- Toxicants (metals, pesticides etc)

- Sediments (toxicant conc'ns)

Management goal for sites of high conservation value

‘No change’ to key indicators of biological diversity

- biological criteria (especially field-derived) override physical and chemical criteria
- preferable that guidelines/standards for phys-chem indicators of water and sediment based on local biological effects data
- cannot test a hypothesis of ‘no change’, hence set conservative (arbitrary) effect sizes

Deriving standards for physical and chemical indicators

Toxicants:

- U derived from local biological effects data (laboratory toxicity tests)
- statistical modelling, derive concentration to protect 99% of species

Other toxicants, physical and chemical stressors, & sediments:

- too few local biological effects data available
- conservative changes to the natural distribution of concentrations (pre-impact and/or from suitable reference sites)

Formulating guidelines for biological assessment around key ESD tenets

- **Precautionary management**

  - Key aspect of the management goal; through cooperative best management, responsiveness to early and clear trends in all indicators

  - Indicators for biological assessment provide prediction & early detection/warning

- **Conserving and maintaining biological diversity**

  - changes to species richness, community composition/structure;

  - changes to species of high conservation value, species important to ecosystem integrity;

  - changes to ecosystem processes

- **Set conservative statistical decision criteria**

Pre-disturbance, baseline data

- **Gather 'adequate' baseline data:**

  - Ideally, detect small changes with small likelihood of missing real impacts or attributing impact when none has occurred. (Default statistical criteria provided; minimum of 3 years baseline recommended.)

- **Where opportunities to gather 'adequate' baseline data are not available:**

  - Gather data for *multiple lines of evidence*, i.e. intensify spatial sampling, create potential disturbance gradients, measure additional indicators.

Recommended monitoring for sites of high conservation value

- Water and sediment physico-chemistry
- Direct toxicity assessment
- Early detection indicator for water or sediment (preferably biological)
- Quantitative biodiversity indicator (preferably species-level)

If applicable and available

- Community metabolism indicator, and
- Rapid biological assessment

Recommended monitoring for sites of high conservation value

Sites where few pre-disturbance data are available

- Often indicative of poor EIA processes in Australia
- Additional monitoring to compensate for lack of baseline or pre-disturbance data.
  - Use 'multiple lines of evidence' concept
  - incorporate more indicators and/or sites
  - incorporate potential disturbance gradients in experimental designs

World Heritage assessments of Jabiluka

- **Some key issues raised by independent scientific experts to the WH Committee. Need to:**
  - Identify conservation values of Swift Ck catchment; subject key elements to risk analysis; set in place management strategies to protect these values
  - Synthesise existing information by way of ecological modelling; identify potential cumulative or interactive effects of the Jabiluka mine
  - Design and implement long-term broad-based monitoring that would detect and assess changes resulting from mining *and* other causes

Use of macroinvertebrate communities for monitoring and assessing potential impacts of the Jabiluka uranium mine on aquatic ecosystems

F Bouckaert, G Davidson, C Humphrey, R Batterham & J Boyden

In order to monitor and assess potential impacts on downstream aquatic ecosystems arising from the Jabiluka uranium mine during development and operational phases, ***eriss*** and EWLS have commenced a baseline sampling program using stream macroinvertebrate communities. First-year baseline data were collected from two potentially 'impacted' sites in nearby Swift Creek, downstream of vegetation clearing activities at the mine site, and from a number of control sites (2 upstream sites, 6 sites from three adjacent creeks) at 3 weekly intervals during the 1998–99 Wet season. A Multiple-Before-After-Control-Impact-Paired differences (MBACIP) experimental design has been established. Only some limited pilot data, collected in 1998, were available from the streams prior to vegetation clearing. Nevertheless, preliminary hypothesis-based and descriptive analyses indicate that increased suspended sediment loadings arising during the Wet season from the vegetation clearing were not sufficient to have altered community structure in Swift Creek downstream of the mine site. Similar data from the 1999–00 Wet season have been analysed and results will be presented and compared with year-one data. With a halt to all activities at Jabiluka, accruing data of this type should allow the collection of an adequate baseline dataset for measuring and assessing change.

Macroinvertebrate communities for monitoring and assessing potential impacts of the Jabiluka uranium mine on aquatic ecosystems

Frederick Bouckaert (ERISS), James Boyden (ERISS), Gael Davidson (NTU), Chris Humphrey (ERISS) and Robert Batterham (EWLS)

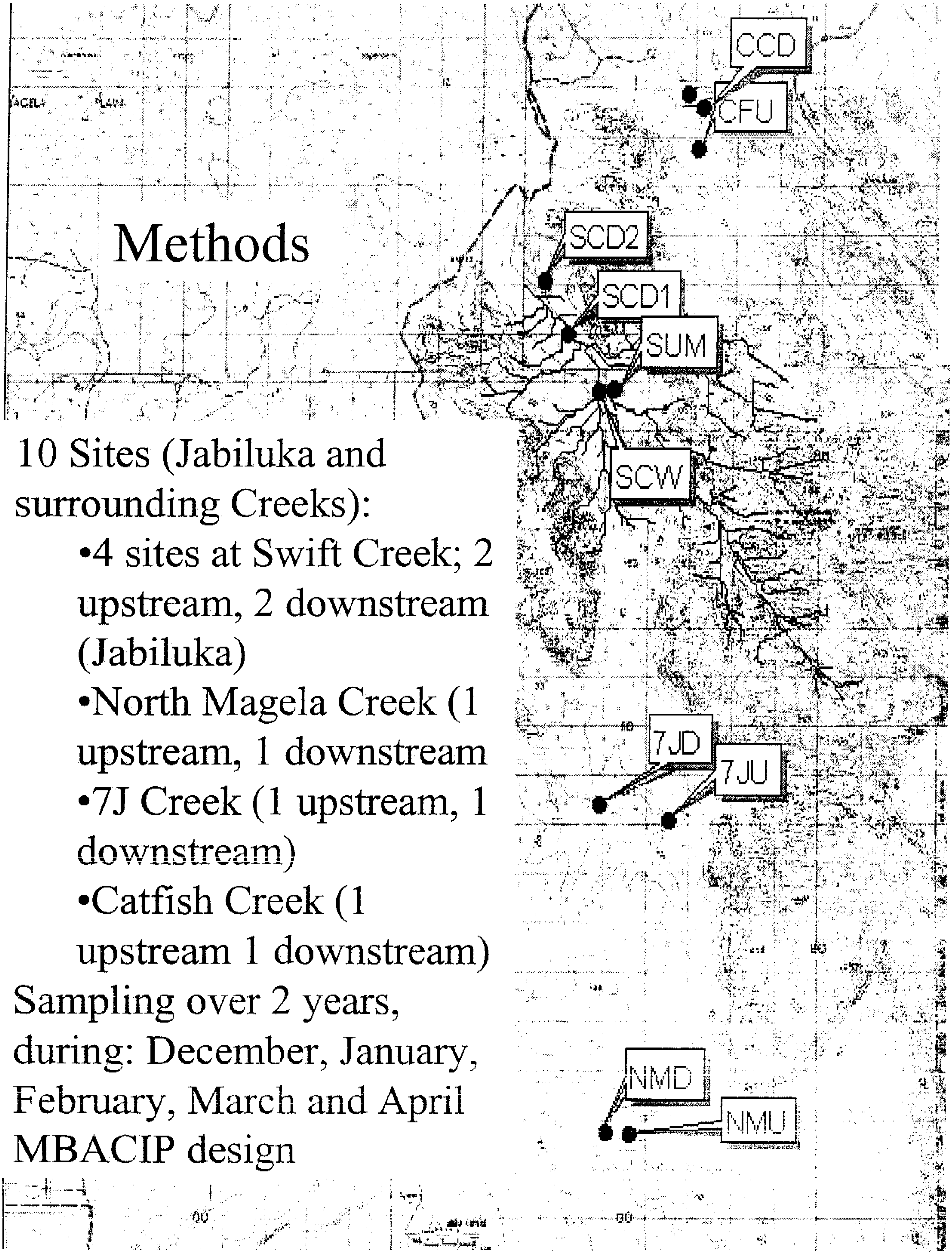
Objectives

To collect baseline information to enable detection of possible impacts from mining (and milling) of uranium ore at Jabiluka, by:

- Determining community structure (intensive wet season sampling) at family level
- Establishing natural variability:
  - within and between sites
  - within and between wet seasons

Methods

- 10 Sites (Jabiluka and surrounding Creeks):
    - •4 sites at Swift Creek; 2 upstream, 2 downstream (Jabiluka)
    - •North Magela Creek (1 upstream, 1 downstream
    - •7J Creek (1 upstream, 1 downstream)
    - •Catfish Creek (1 upstream 1 downstream)
- Sampling over 2 years, during: December, January, February, March and April
- MBACIP design



Aspects of experimental design using macroinvertebrate communities in ARR streams

- **Ideally, apply MBACIP design - Multiple controls, Before, After, Control, Impact, Paired differences**

  - Basis of statistical test for impact, two-factor, asymmetrical ANOVA

  - Dissimilarity values the measure of paired site difference

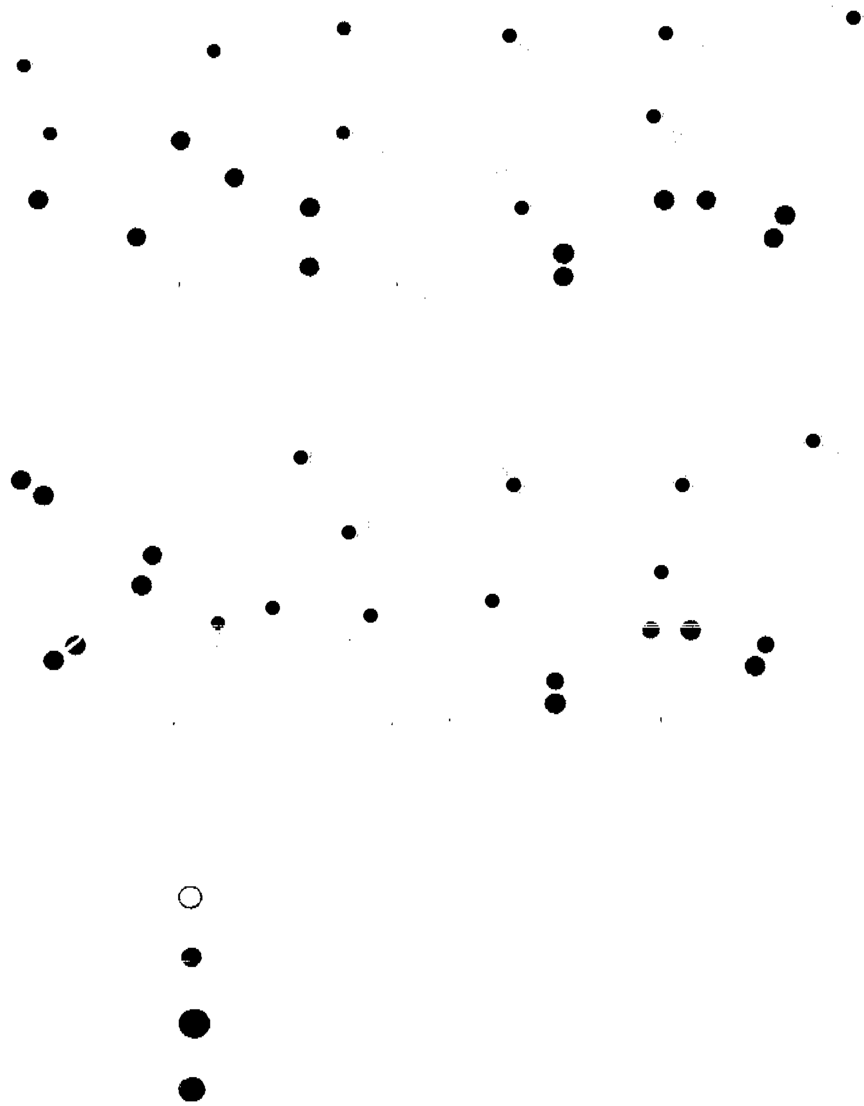
- **Dissimilarity and discharge positively correlated (community structure between paired sites becomes more similar as flow declines)**

  - Dissimilarities 'high' but constant in wet season

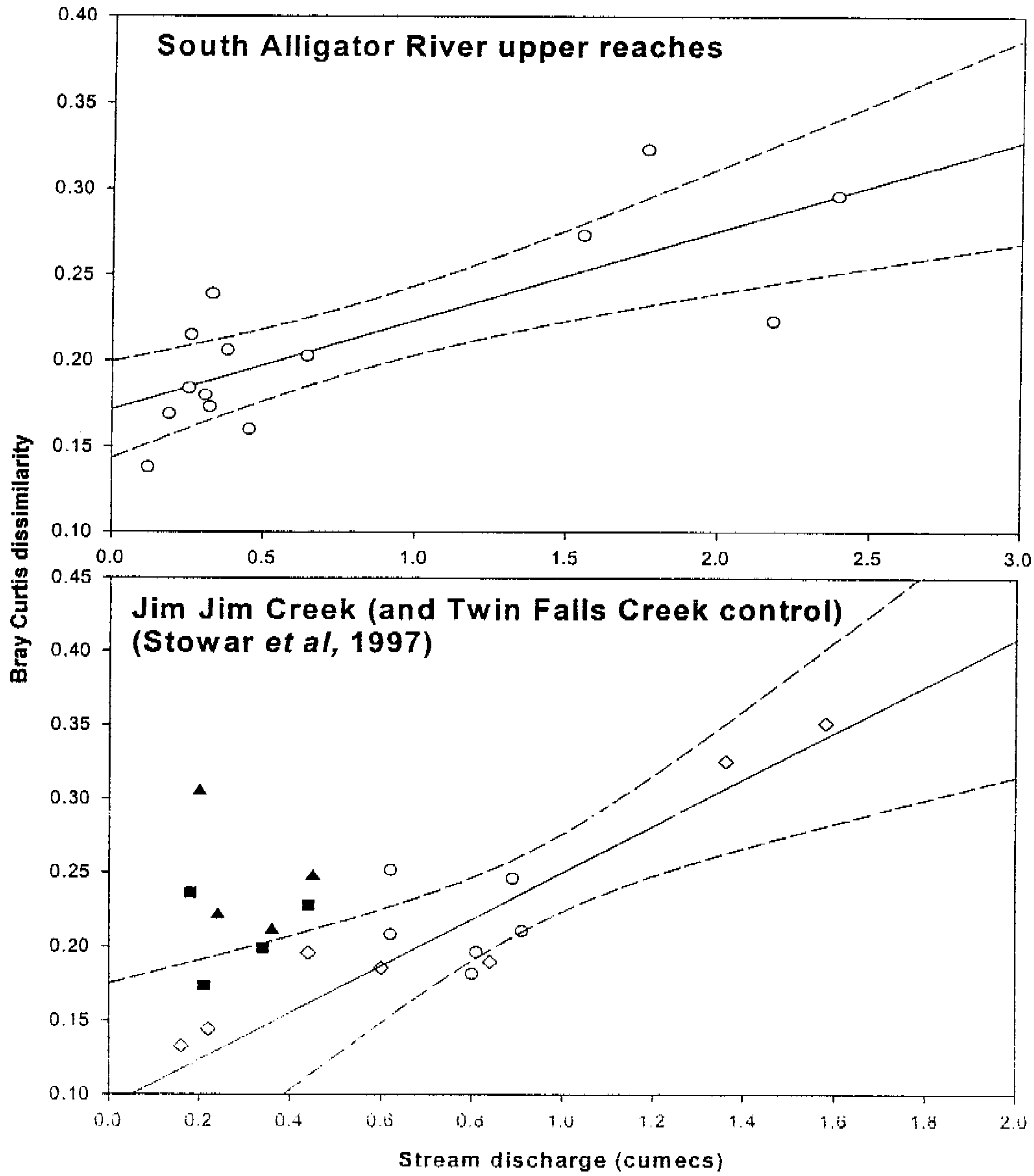
  - Dissimilarities decline in recessional flow period (lack of temporal independence of 'replicates'); apply ANCOVA

Principle of monitoring using community structure

(MBACIP design: Hypothetical and idealised scenario)



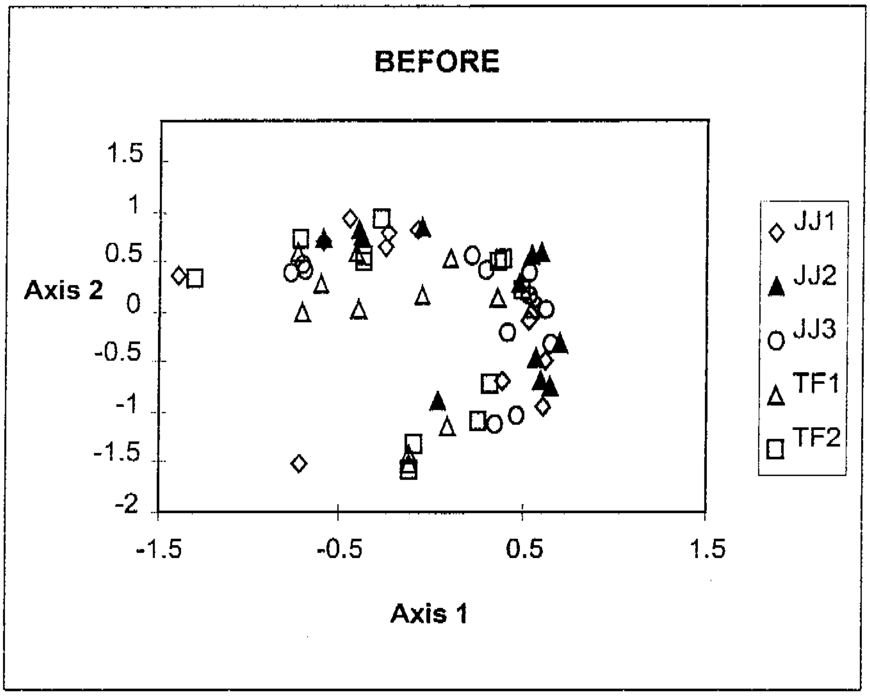
Effects of suspended solids on stream biota in Jim Jim Creek, 1996

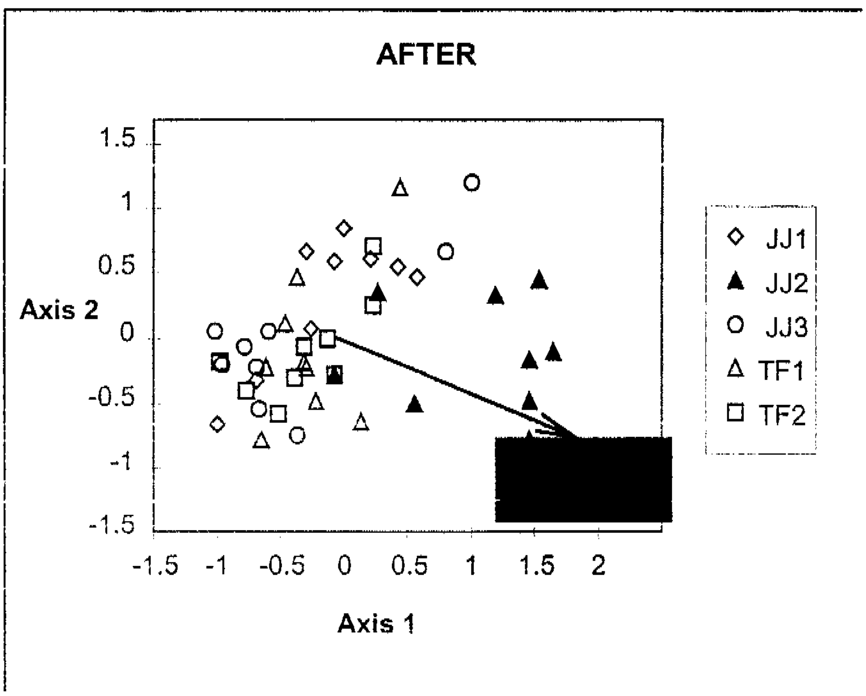


Closed red symbols = Jim Jim Ck sites, downstream, after road opening

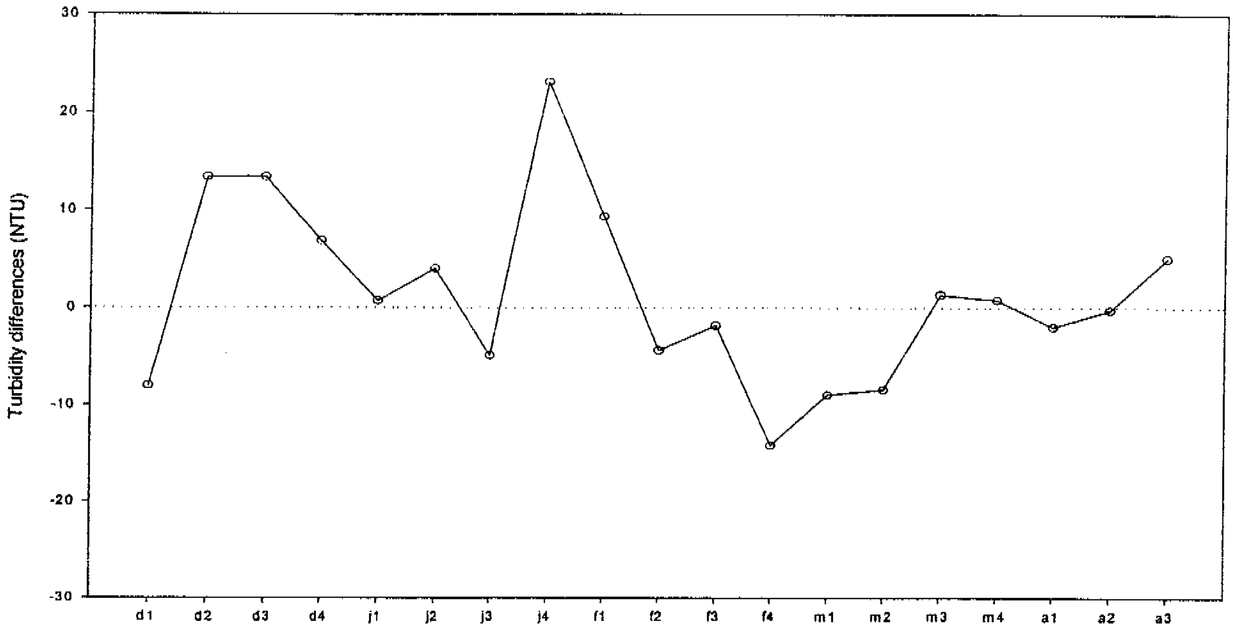
Open symbols = All sites, both creeks before, Twin Falls Ck all sites after

Ordinations of macroinvertebrate communities: Jim Jim and control creek before and after

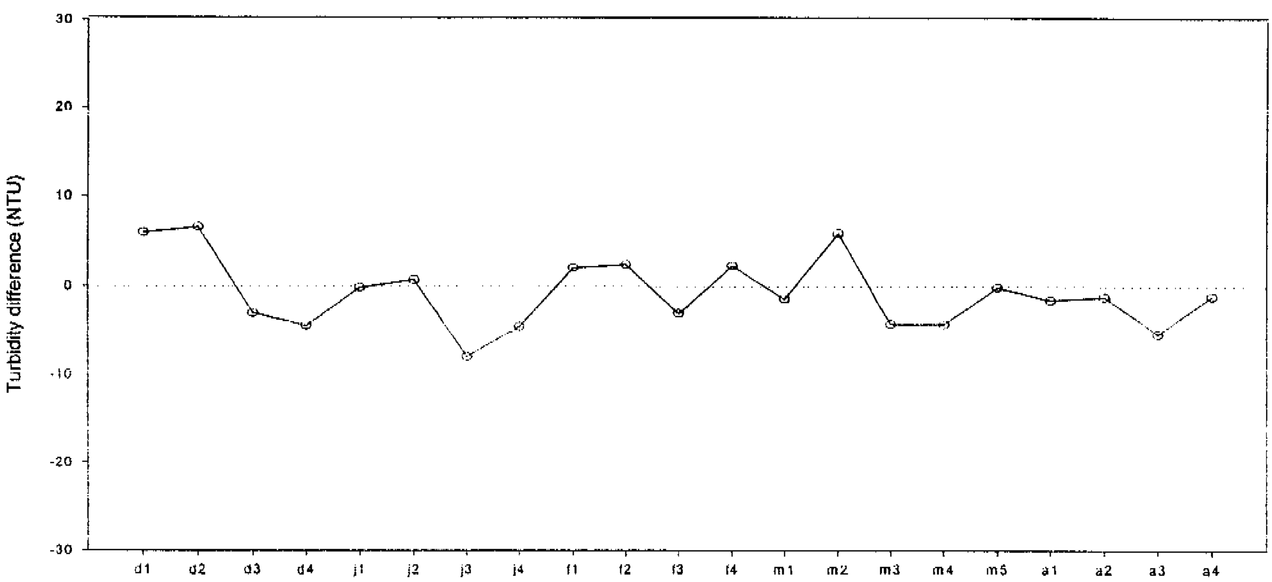




Average turbidity differences

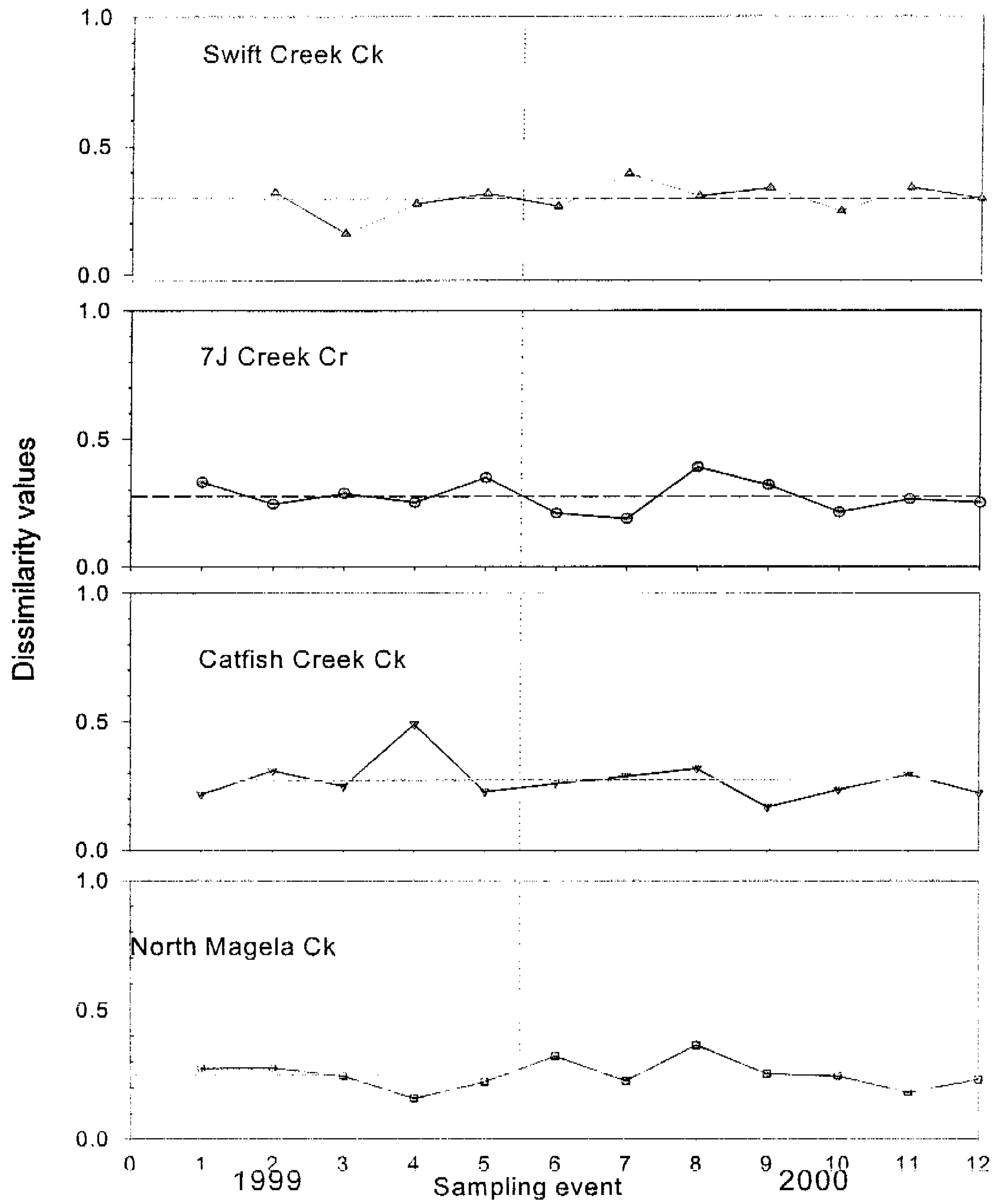


Weekly average Turbidity differences Swift Creek Down 1- Swift Creek up Main, 89-99

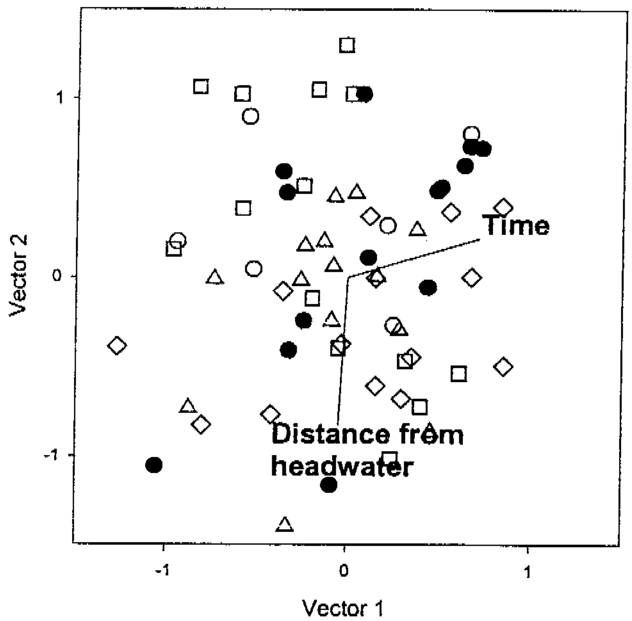


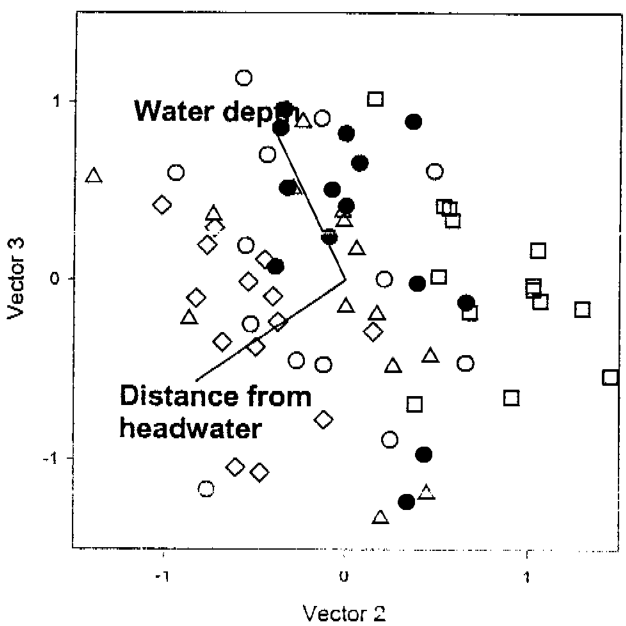
Weekly average Turbidity differences Swift Creek Down 1-Swift Creek up Main, 99-00

Paired site dissimilarity for Swift Ck and control creeks: sampling occasions 1999 and 2000



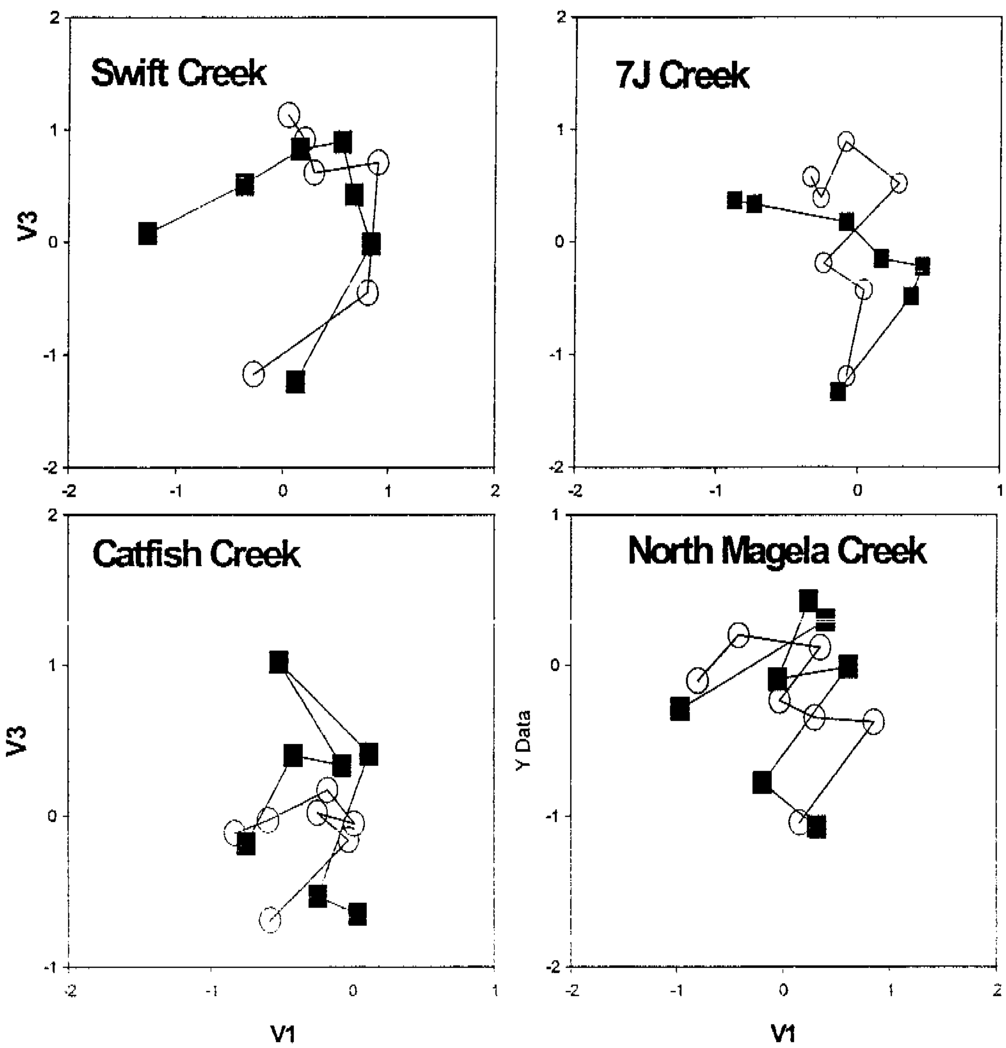
Ordinations of macroinvertebrate communities: sites in Swift Creek and three control creeks, 1998-99





Open symbols = control sites
Red symbols = Swift Ck downstream

Temporal succession patterns in SSH ordinations for Swift Creek and control streams



Comparison of Jim Jim and Jabiluka studies

- **Jim Jim Ck:**

  - site 1, 200 m downstream, effects observed at 60 NTU above background (a.b.)

  - site 2, 1 km downstream, marginal effects observed at 30 NTU a.b.

- **Swift Ck:**

  - site 1, 300 m downstream of North tributary confluence, no effects observed at ~6 NTU a.b.

Conclusion

- Multivariate analysis of macroinvertebrate communities in combination with turbidity records provides a quantitative tool to assess possible impacts arising from elevated turbidity levels.

A preliminary assessment of the potential impacts of the introduced cane toad (*Bufo marinus*) in Kakadu National Park

G Begg, D Walden & R van Dam

For a number of years Territory and Commonwealth agencies have been aware of the impending arrival of the cane toad (*Bufo marinus*) in Kakadu National Park and the Top End of northern Australia. With cane toads presently only 70 km south east of the Park, an ecological risk assessment which is now nearing completion, has been undertaken to predict the key species and habitats at risk in the Park. The overall goal of the assessment is to provide information from which new monitoring programs can be developed and the relevance of existing monitoring programs assessed. Albeit preliminary, this paper provides a brief insight into the potentially negative impacts that could become associated with the possible arrival of cane toads in the Park in the next few years.

Issues to be highlighted include possible effects on cane toad predators, prey species, competitors, World Heritage values and the cultural values of Aboriginal communities living in the Park.

A preliminary assessment of the potential impacts of the introduced cane toad (*Bufo marinus*) in Kakadu National Park

by

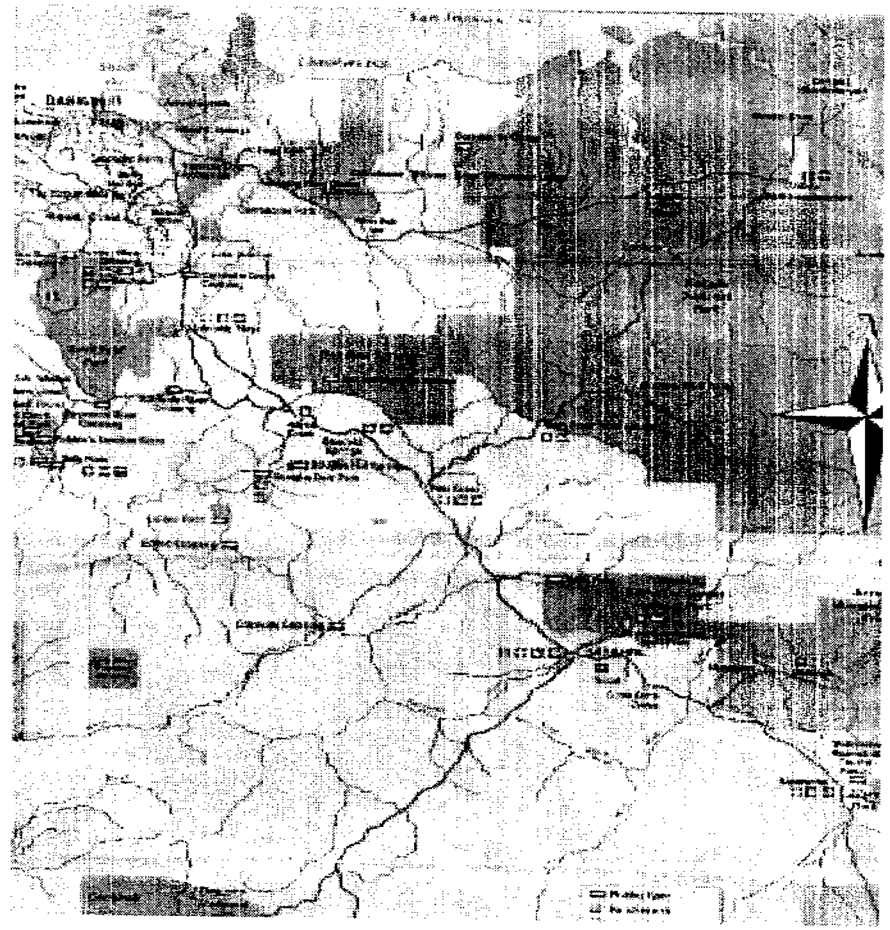
George Begg
Dave Walden
&
Rick van Dam

National Centre for Tropical Wetland Research

Present location of cane toads

- Range expansion

- Currently 70km from Katherine
- Next invasion zone
  - Daly basin?
  - Kakadu?
  - Mary river?



Background

- speculative nature of impacts foreseen
- based on literature review
- no detailed quantitative impact studies
- long term impact of cane toads is inconclusive
- recovery of certain species after initial population decline

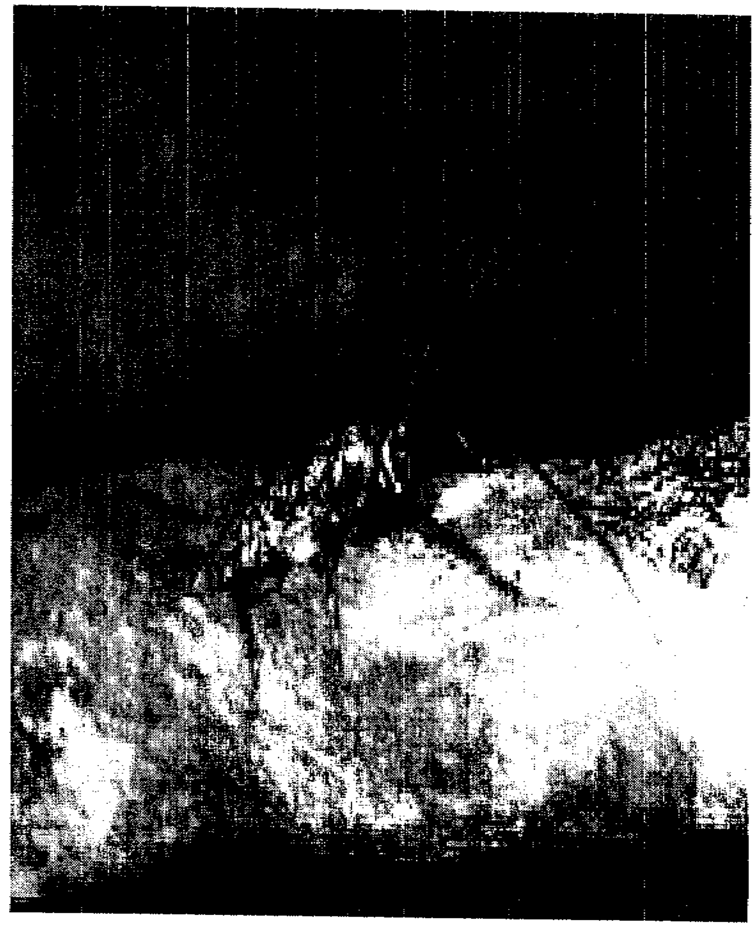
Potential impact of cane toads in KNP

- Predators
  - freshwater molluscs
  - fish (gudgeon ...)
  - reptiles (varanids, elapid snakes ...)
  - birds (frog-eating species; carrion feeders ...)
  - mammals (northern quoll; dingo....)

Potential impact of cane toads in KNP

- Prey

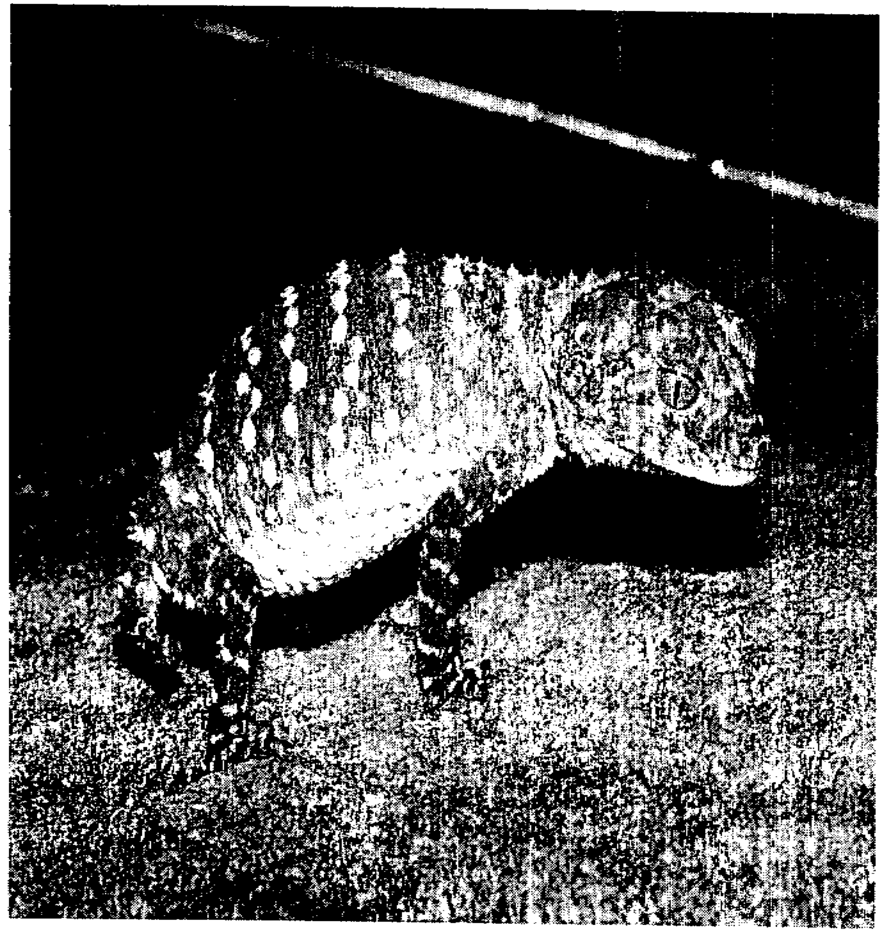
- Annelida
- Mollusca
- Arthropoda
- Insecta
- Chordata



Potential impact of cane toads in KNP

- Competition for food, shelter and breeding sites

  - insect-eating birds
  - insect-eating lizards
  - native amphibia



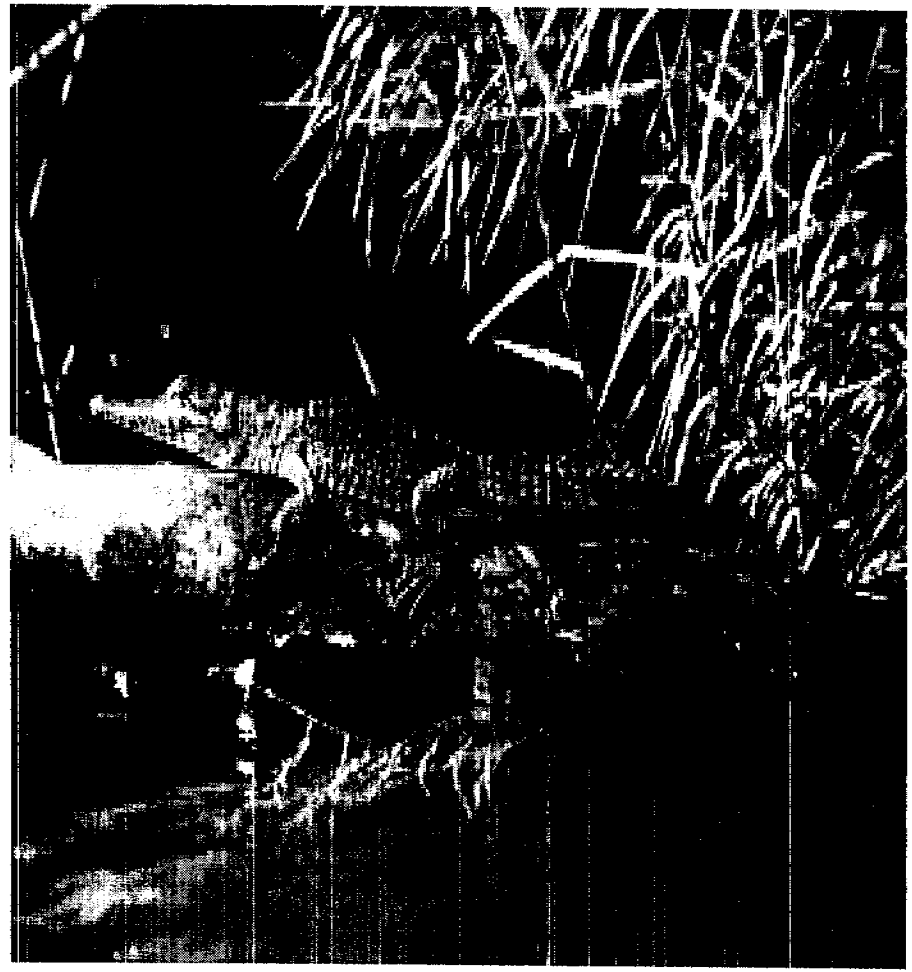
Potential impact of cane toads in KNP

- World Heritage Values
  - rare and endangered species
  - endemic species (masked frog ...)
  - aesthetic

Potential impact of cane toads in KNP

- Cultural values

- decline in bush-tucker (goannas....)
- decline in totem species
- contamination of sacred sites
- impact on religious ceremonies



Potential impact of cane toads in KNP

- Human health

- spread of disease in bush settlements
- spread of human parasites
- poisoning (possible mortality)

Potential impact of cane toads in KNP

- Invenomation of water supplies

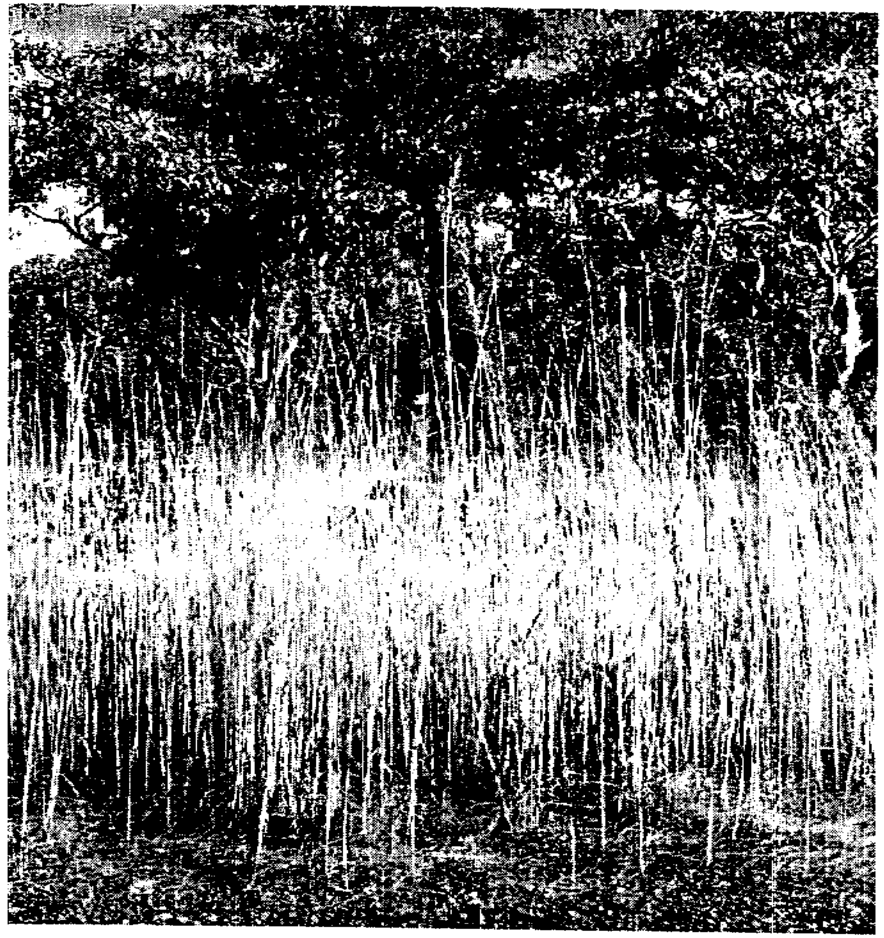
- drinking water
- springs
- waterholes

Potential impact of cane toads in KNP

- Nearshore islands
  - Depauperation of resident fauna
  - loss of biodiversity

Potential impact of cane toads in KNP

- Significant vegetation types
  - annual grasses (granivore reduction ....)



Potential impact of cane toads in KNP

- Socioeconomic impacts
- residential areas
- caravan parks & camping sites
- swimming pools
- sewage treatment ponds
- sportsfields
- domestic pets (dogs)

Potential impact of cane toads in KNP

- How is this information to be used?

- devise a cane toad monitoring program
- assess the relevancy of existing programs
- help formulate a control strategy and threat abatement plan (if possible)

Bioturbation effects in a natural fish kill in Kakadu National Park, NT

R Pidgeon, C leGras & G Lindner

In the Top End of the NT the two most commonly attributed causes of natural fish kills are anoxic water conditions and aluminium toxicity resulting from leachates of acid sulphate soils. This paper describes an unusual situation that involved both these parameters and also implicated bioturbation effects of water buffalo, magpie geese and an exotic weed *Salvinia molesta* as contributing factors to the outcome of an influx of acidic water into a Kakadu billabong after early Wet season storms. It provided an indication of the relative importance of aluminium toxicity and anoxia in that fish kill and casts some doubt on the role of aluminium in fish mortality elsewhere in this region.

Bioturbation effects in a Kakadu fish kill

Bob Pidgeon, eriss Darwin
Chris Le Gras, eriss Jabiru
Garry Lindner, PAN Jabiru

Introduction

- Behavioural response of fish to chemical contamination and hypoxia
- Influence of bioturbation and some other biotic perturbations on fish survival in seasonally flowing waterbodies

Bioturbation

- Definition: Physical disturbance of sediments by activities of organisms?

Gindjela (Goose Camp Billabong)

- **Permanent waterhole on floodplain of Nourlangie Creek, Kakadu National Park**

- **Adjacent to large sedge swamp used by Magpie geese in late Dry season**

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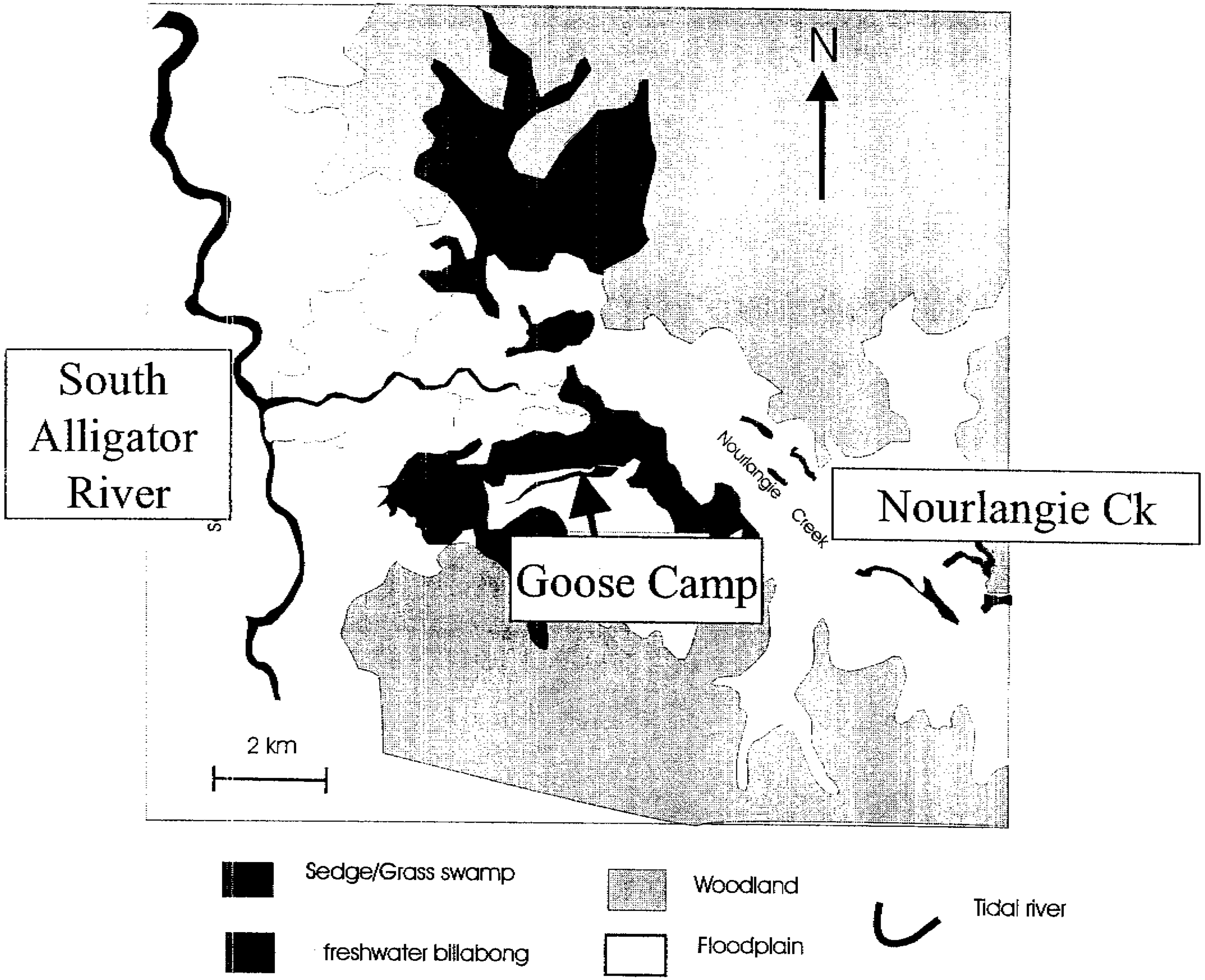
Location of Gindjela (Goose Camp) in Kakadu National Park



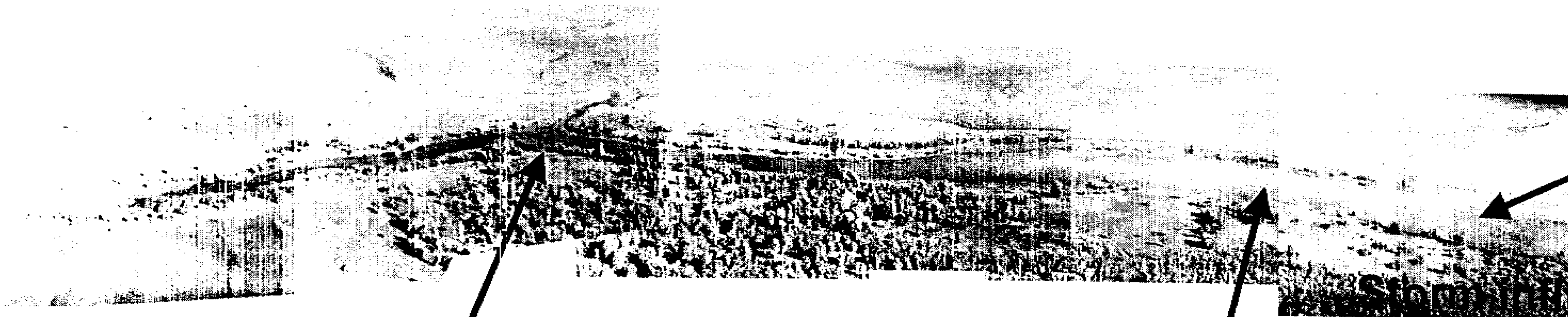
Perturbation 1. - Water buffalo

- 1970's - overgrazing by buffalo damaged natural levees allowing salt water onto floodplain
- removal of buffalo in 1980's restored the levees
- legacy of sea water salts in flooplain soils

Goose Camp fish kill - Oct 1996

- Sedge swamp still partially inundated at start of Wet season - unusual conditions
- First storms caused influx of very acid water with high levels of metals and other solutes
- Fish began dieing after 24 hours

Aerial view of Gindjela (Goose Camp billabong), October 1996



Storm influx

Downstream Limit of contamination

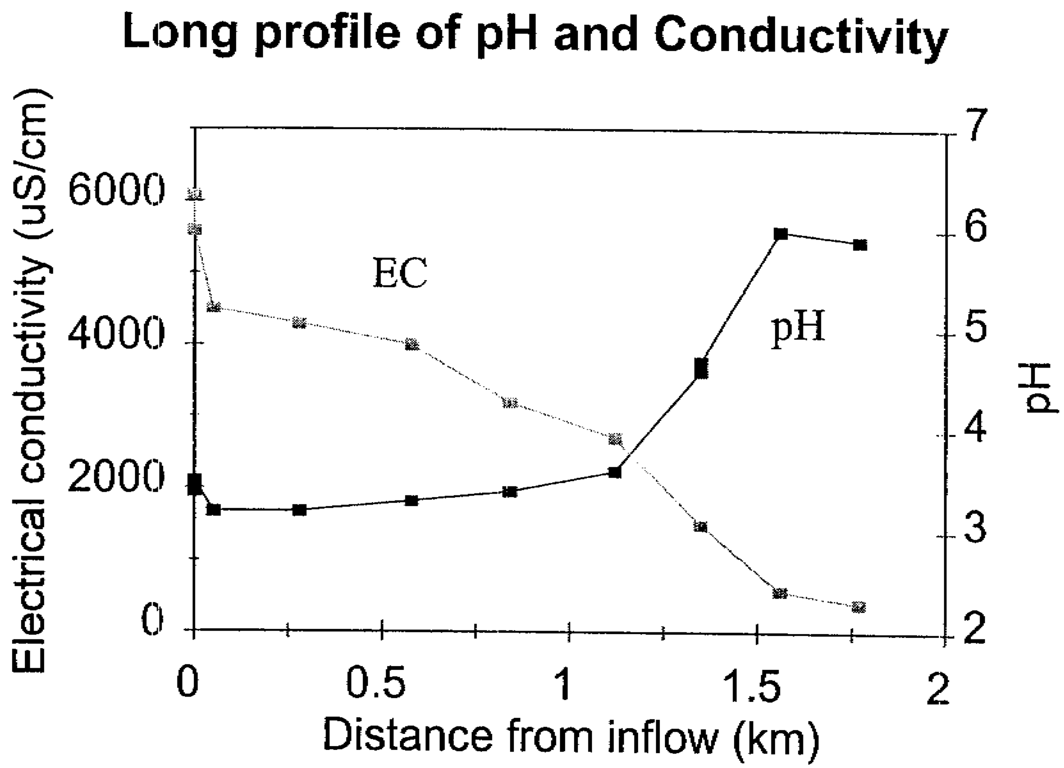
Plume of turbid water from sedge swamp

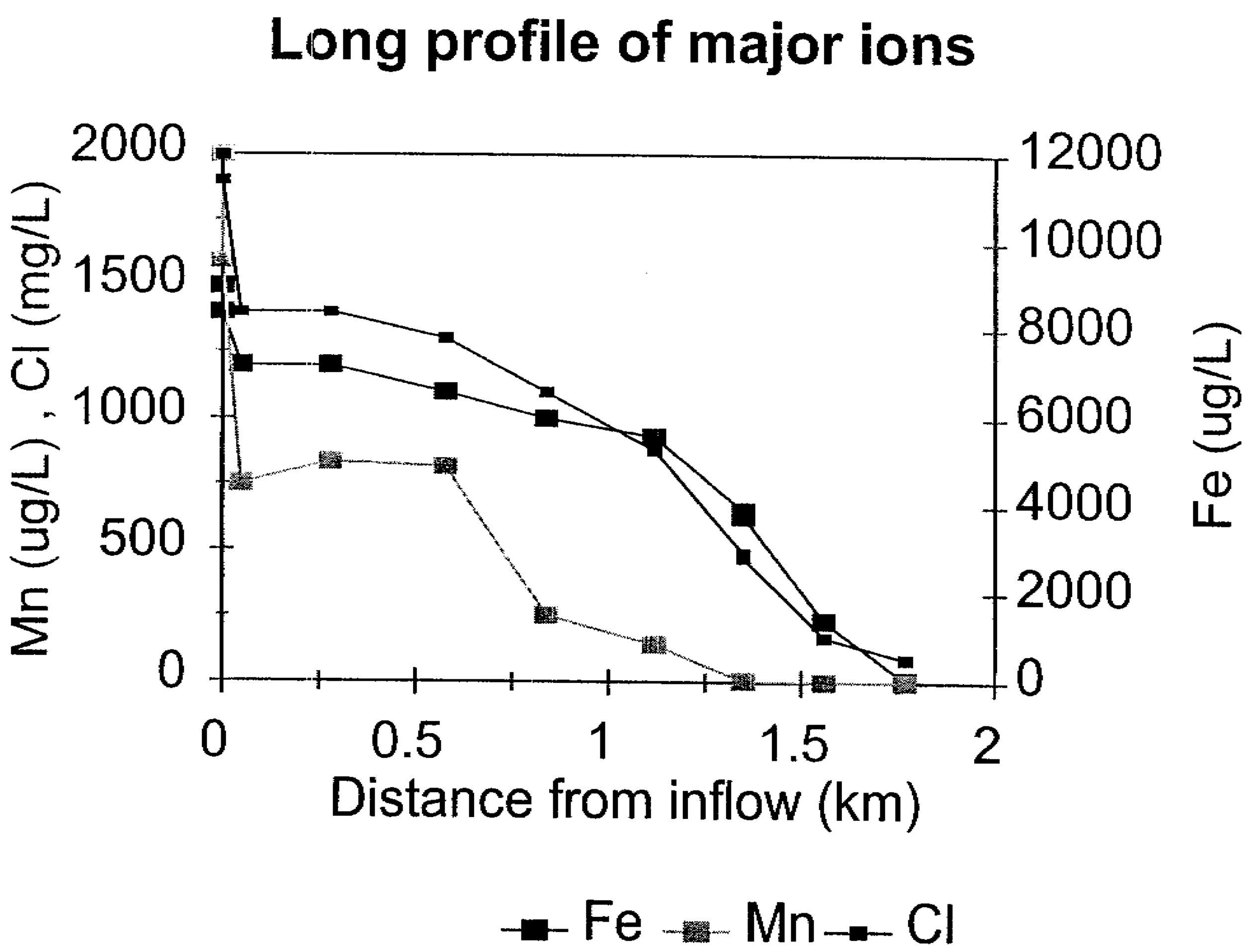
(Photos courtesy of Leo Duivenvoorden)

Goose Camp influx water chemistry

	Influx water	ANZECC trigger value
Conductivity (uS/cm)	6100	
pH	3.4	
Sulphate (mg/L)	80	
Chloride (mg/L)	2000	
Soluble Iron (ug/L)	12000	na (300?)
Manganese (ug/L)	1500	47
Aluminium - filtered (ug/L)	92	1.2
Silica (mg/L)	28	
Dissolved Organic Carbon (mg/L)	3.8	

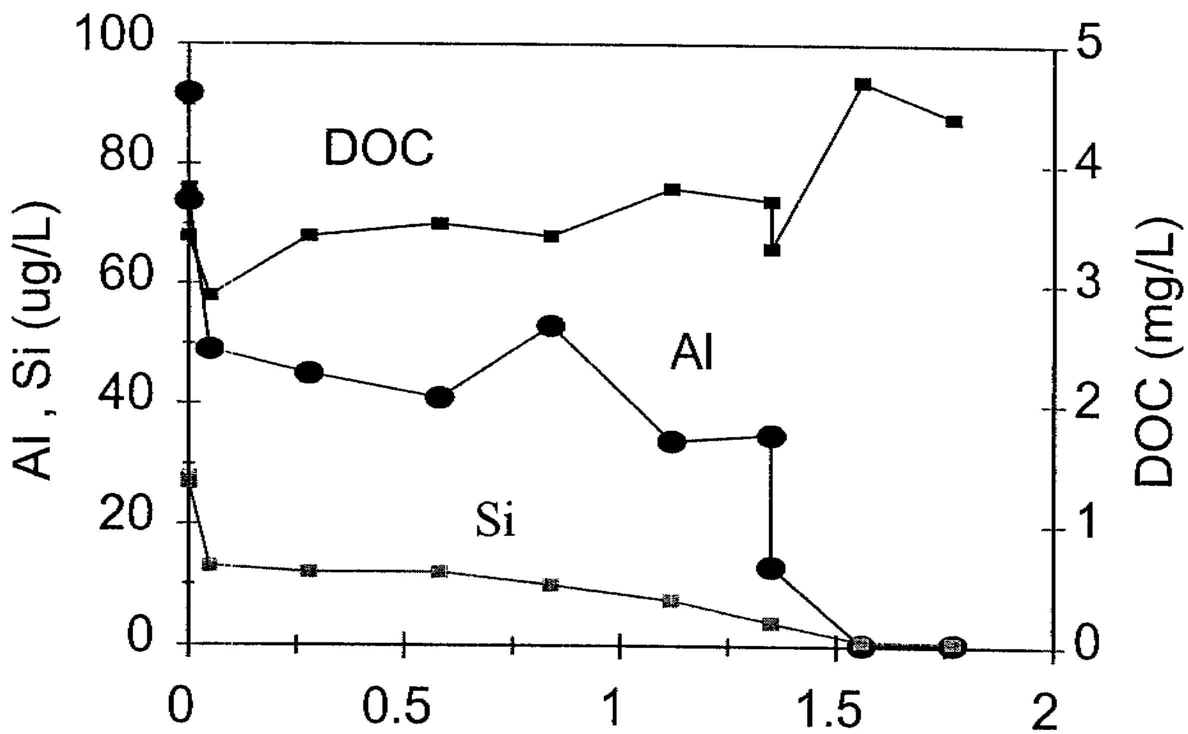
Gradient of influx water





Long profile of major ions
Mn (ug/L) , Cl (mg/L)
Fe (ug/L)
2000
1500
1000
500
0
12000
10000
8000
6000
4000
2000
0
0
0.5
1
1.5
2
Distance from inflow (km)
Fe
Mn
Cl

Long profile of Al, SiO2 & DOC



Influx water - ion ratios

- Mg/Cl ratio identical with sea water - indicates sea water source
- Lower SO4/Cl ratio in influx indicates reduction of sea water SO4 to S in floodplain sediments

Ion ratio	Sea water	Influx water
Mg/Cl	0.199	0.198
SO4/Cl	0.104	0.035

Bioturbation 2 - Magpie geese

- Oxidation of Sulphide most likely source of acidity
- Wet condition would normally keep sediment anoxic and prevent S oxidation
- Digging for *Eleocharis* corms by Magpie geese likely cause of sediment aeration

Magpie geese at Gindjela 20/10/96

Goose diggings

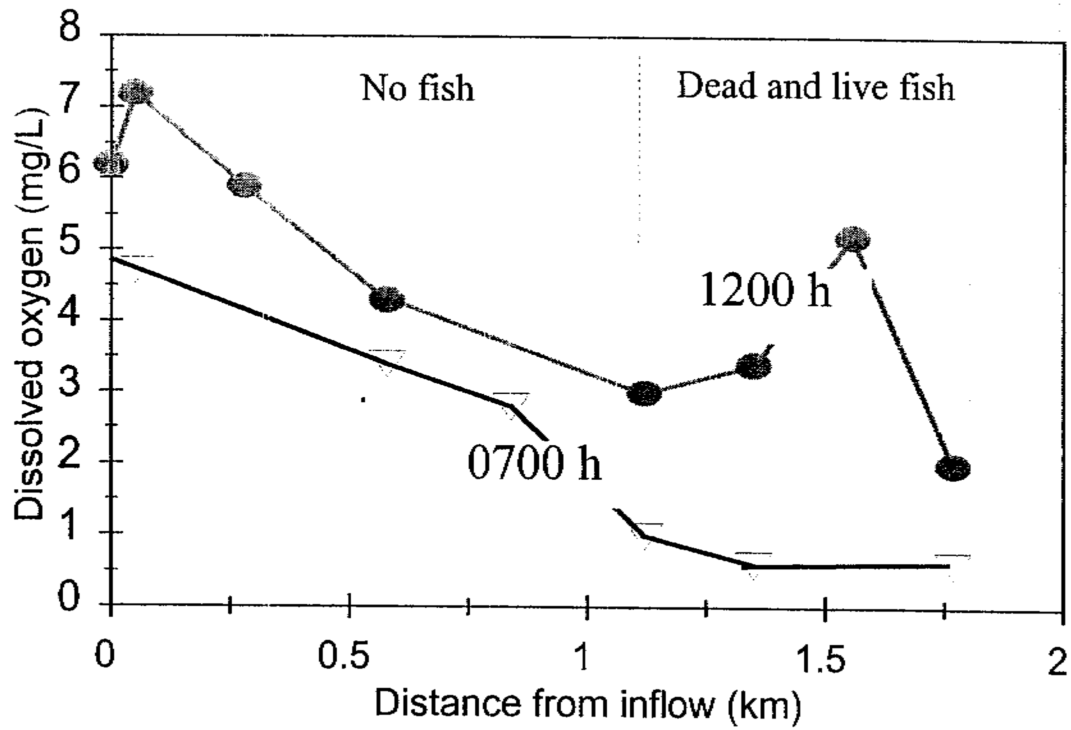
Goose(?) digging

Effects of influx on fish

- Larger fish avoided contaminated water and moved to outflow end
- Fish engaged in surface breathing for about 1 h at dawn with anoxic conditions
- Some fish died: barra jumped out
- Remainder recovered as sun hit water
- Pattern continued for 7 days at least

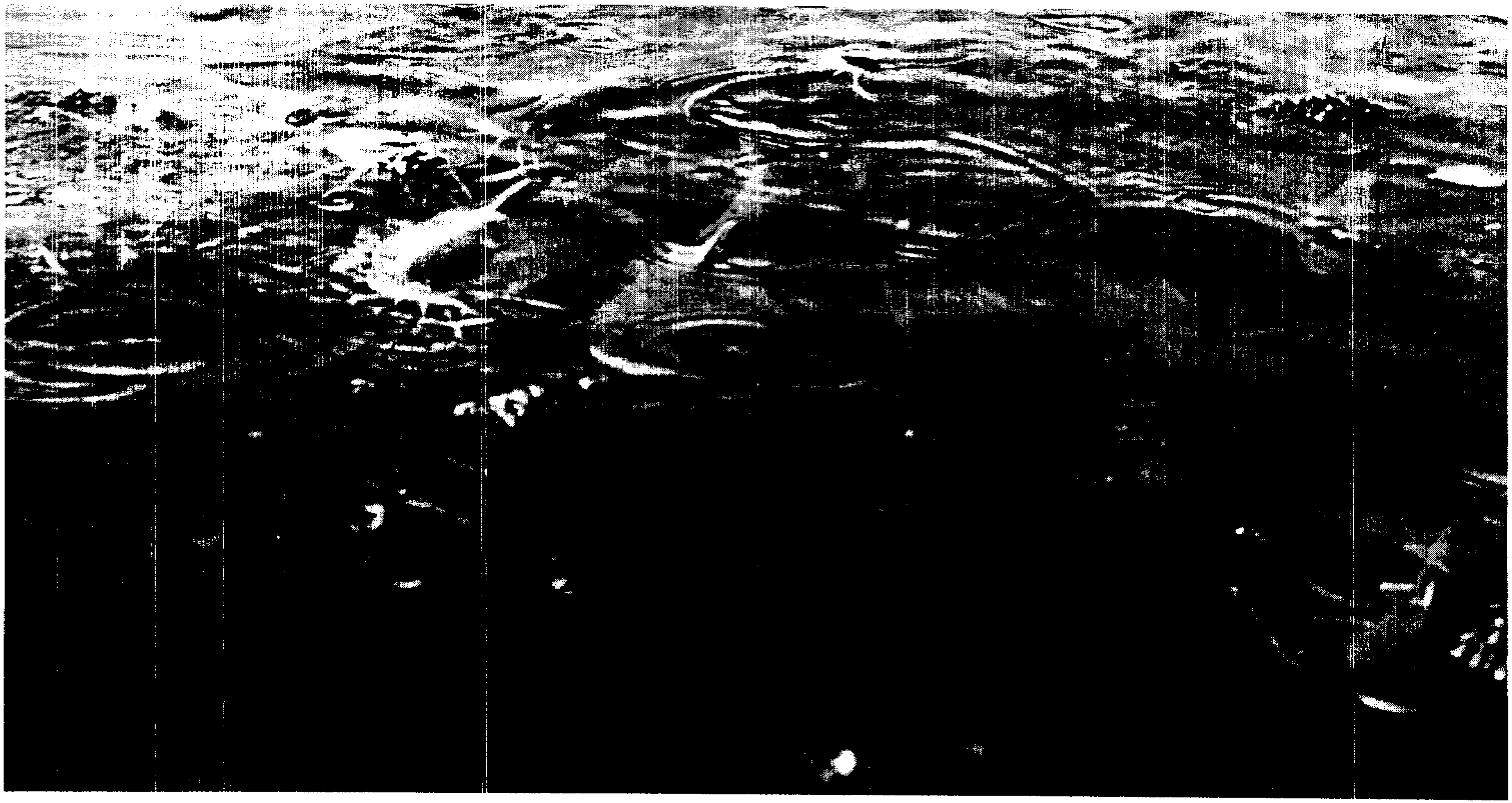
Longitudinal gradient in Oxygen levels along billabong

Goose Camp Billabong, 22/10/96



Surface breathing barramundi

Surface breathing ariid catfish



Count the heads - a new fish census method

Dead and dying fish

Salvage - harvesting dying fish

Cause of Dissolved Oxygen depletion

- Nocturnal respiration of dense growth of submerged macrophytes (mostly *Ceratophyllum* and *Utricularia*) in shallow water (2-3 m)

- High fish biomass wouldn't help either

Sequential effects on different species

Another natural experiment - a second event in October 1998 !

- Almost identical event in terms of water chemistry occurred in 1998

- However, only one fish species, Sleepy cod, affected this time.

- Reasons?

“Perturbation” 3 - Salvinia

- The outflow end of the billabong was densely covered by *Salvinia molesta*
- Shading by the floating fern had eliminated the benthic macrophytes
- High levels of DO at dawn under *Salvinia* provided safe refuge for fish

Conclusion

- Avoidance response of fish to non lethal contaminants is very strong
- Bioturbation can affect water quality and influence fish behaviour and survival
- Strong evidence that anoxia was dominant cause of fish death rather than abnormal water quality