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internal report **472**

Monitoring of fish communities in shallow back-flow billabongs in relation to Ranger Uranium Mine, Northern Territory

Presentation given at the Australian Society for Limnology (ASL) and New Zealand Limnological Society (NZLS) Joint Congress, December 2003, Warrnambool Victoria

D Buckle, B Pidgeon, D Walden, R Luxon & K Bishop

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Note: This Internal Report contains two additional slides to the presentation on the day – the 11th and 15th slides had been removed to meet the 12 minute time allowance.

Acknowledgments

Duncan Buckle gave the presentation at Warnambool.

Bob Pidgeon and Robert Luxon assisted in data analysis and preparation of this presentation.

The use of Dave Walden and Keith Bishop's 1979–1987 fish community data in this presentation is acknowledged.

Monitoring of fish communities in shallow back-flow billabongs in relation to Ranger Uranium Mine, Northern Territory.

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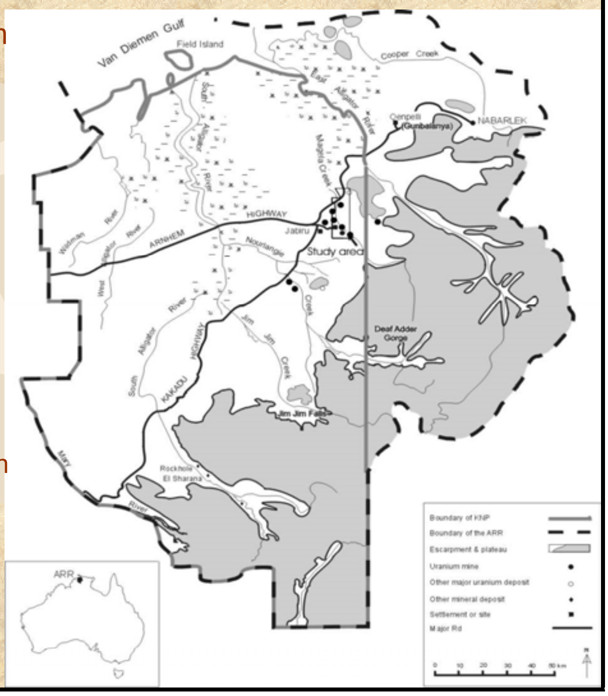
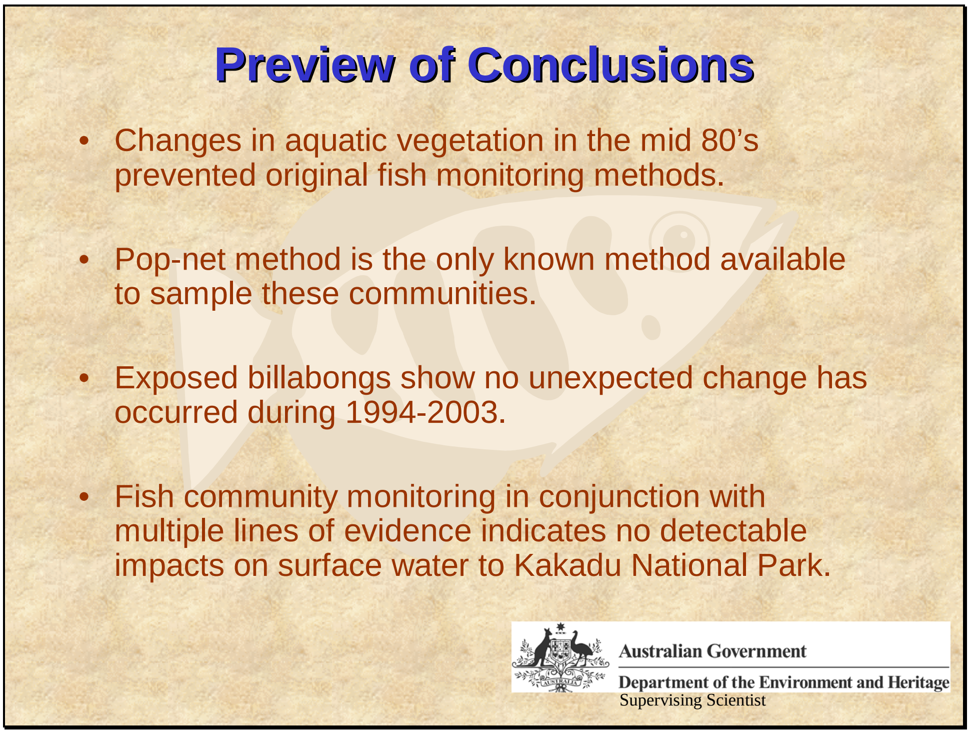
Background

- Ranger Uranium mine is 260km east of Darwin in Kakadu N. P. on Magela Creek.
- Mining Commenced at Ranger Uranium mine 1980, Kakadu N.P. established at same time.
- OSS - supervision and auditing of mine operations.
  - *eriss* (Environmental Research Institute of the Supervising Scientist) conducts the current Monitoring program.

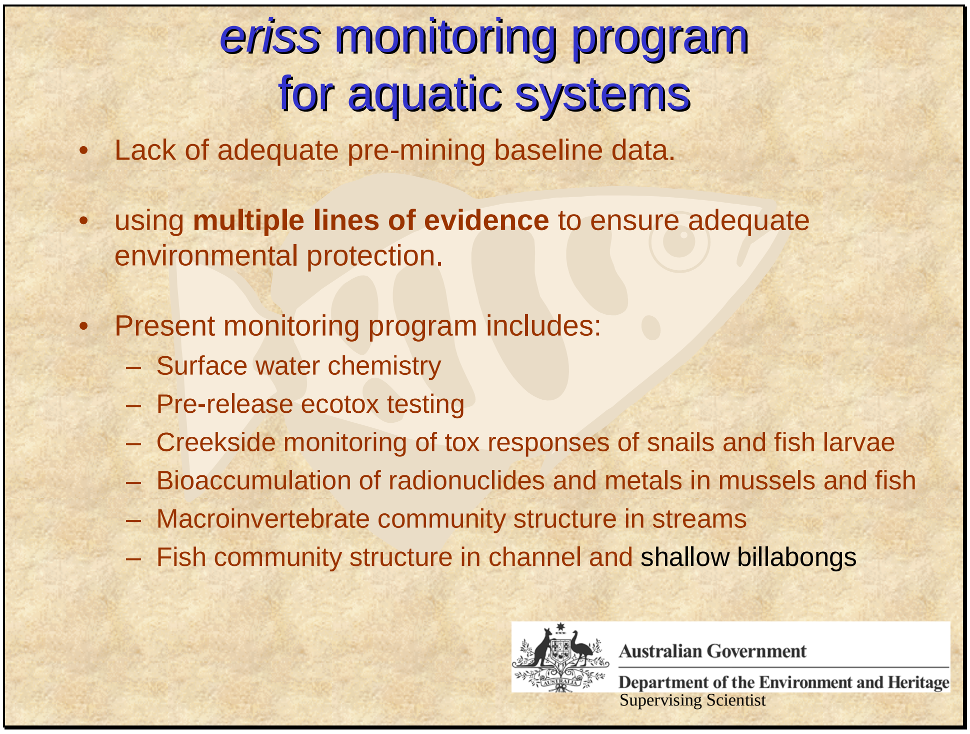


General introduction

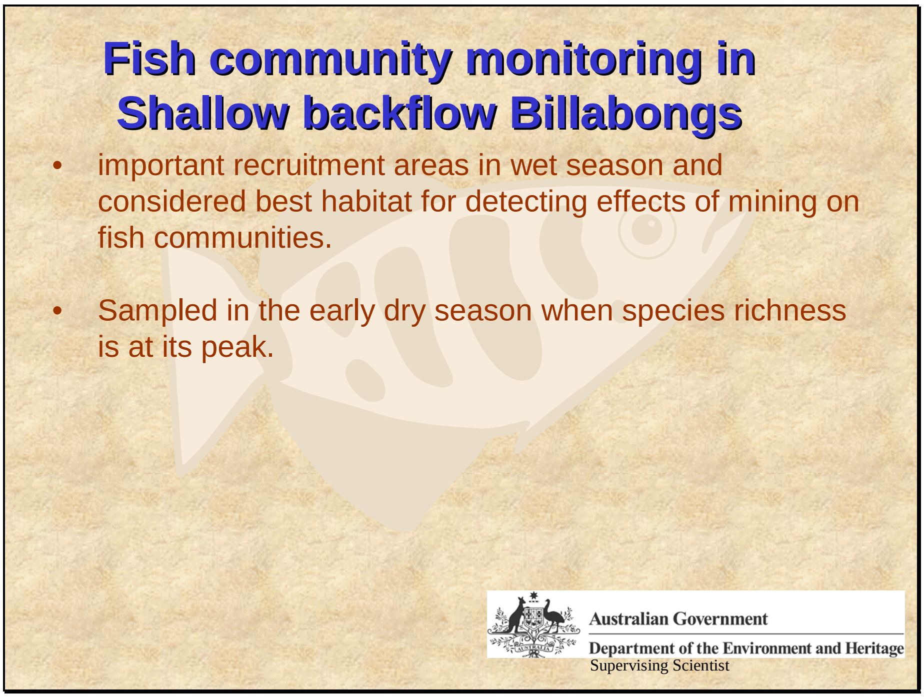
Major points: Kakadu National Park and the Supervising Scientist were established at the same time Ranger mine was given the go ahead. ***eriss***, formed under the Supervising Scientist , originally only conducted research, but since 2001 has also conducted a monitoring program.



A preview of the conclusions was used as an outline of the talk.



Due to a lack of pre mining data. Monitoring of Ranger Uranium mine has adopted a multiple lines of evidence approach. This method uses a four-tiered approach (1) deriving site-specific water quality guideline trigger values; (2) determining 'safe' release dilutions of waste water; (3) early warning monitoring following waste water release; and (4) longer-term monitoring to determine the ecological significance of any impacts (van Dam, Humphrey et al. 2002). This method provides greater safe guards for the local traditional owners and broader community with the preservation of Kakadu National Park.

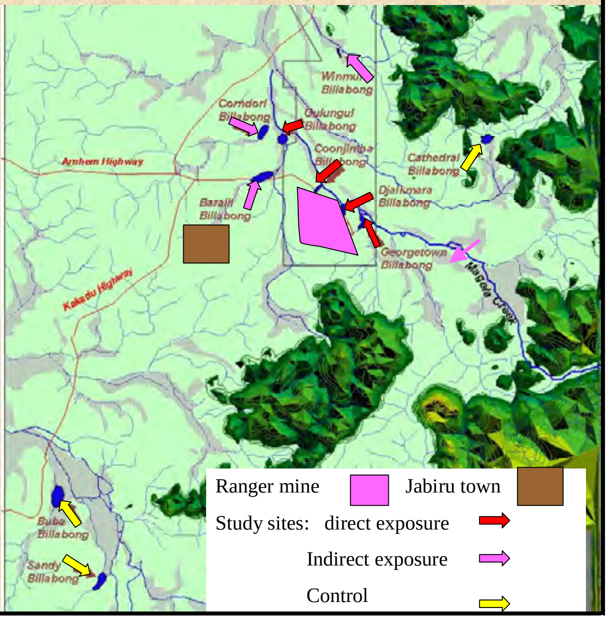


Fish community monitoring, long term monitoring, is regarded as a surrogate of ‘ecosystem-level’ and ‘biodiversity change’(van Dam et al 2002). Shallow backflow billabongs are considered important habitats for the detection of mining related impacts because they are deposition sites likely to accumulate heavy metals and toxicants. Fish species richness is highest in the late wet / early dry season (Bishop et al 1990). This corresponds with accessibility to sites by 4x4 vehicle.

Shallow backflow billabongs are subject to extreme habitat changes in the monsoonal conditions of northern Australia. As a result billabongs flood, and reside to shallow or even dry mud-crusted depressions. All billabongs vary in size, depth, aquatic vegetation structure and susceptibility to drying out. This has dramatic impacts upon the fish communities between billabongs and between years.

Site Locations

- Exposed sites on Magela Ck
  - Direct exposure
  - Indirect exposure
- Control sites on separate catchments – (1994-2003)



Sampling sites are located around Ranger mine. Due to massive yearly migration of fish any impact upon Magela creek can potentially affect fish migrations within the Magela catchment. True control sites were included in the sampling design in 1994. Exposed sites have been divided into directly exposed sites (directly receiving mine water form discharges), or indirectly exposed sites (back flowing or disruption to migration patterns) and control sites (separate catchments). No process water has been released from Ranger Mine to date.

Fish monitoring from 1979 to 1987

- Sampled using - multi-panel gill nets
- 8 billabongs included, no true control site.
- Results confounded by Buffalo eradication for Brucellosis and TB control.

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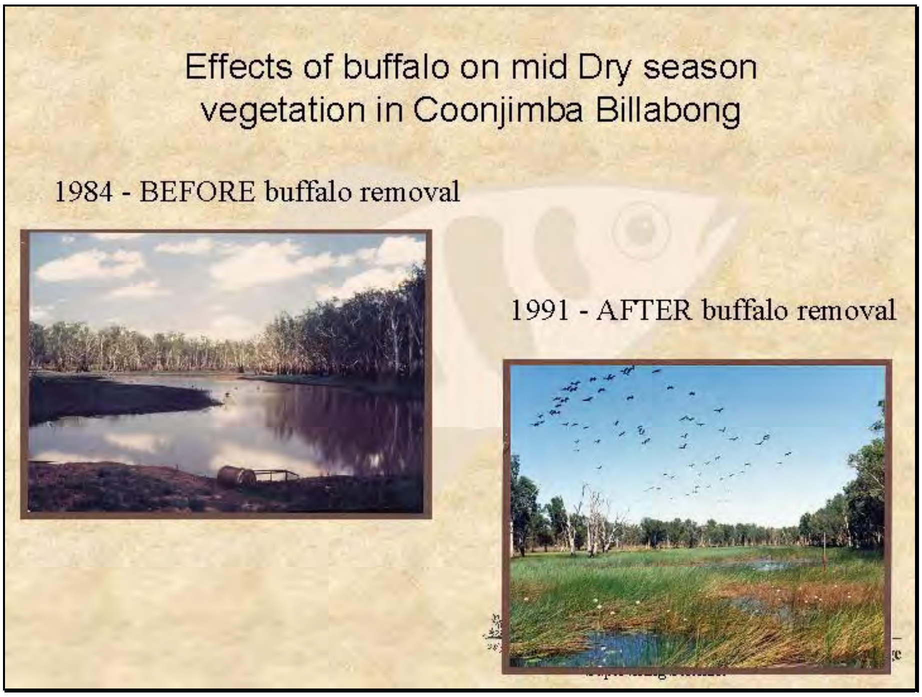
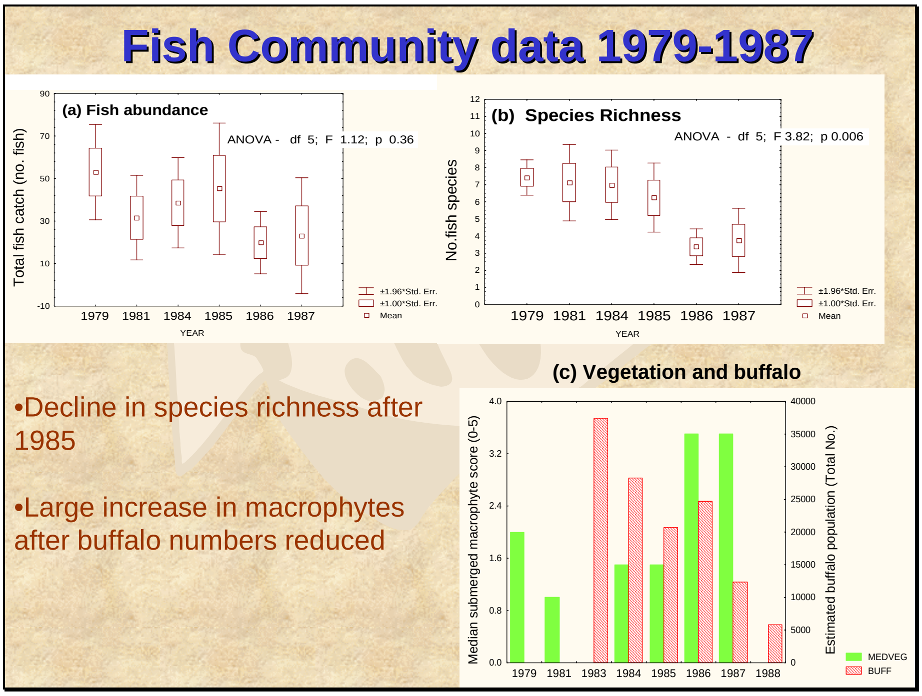
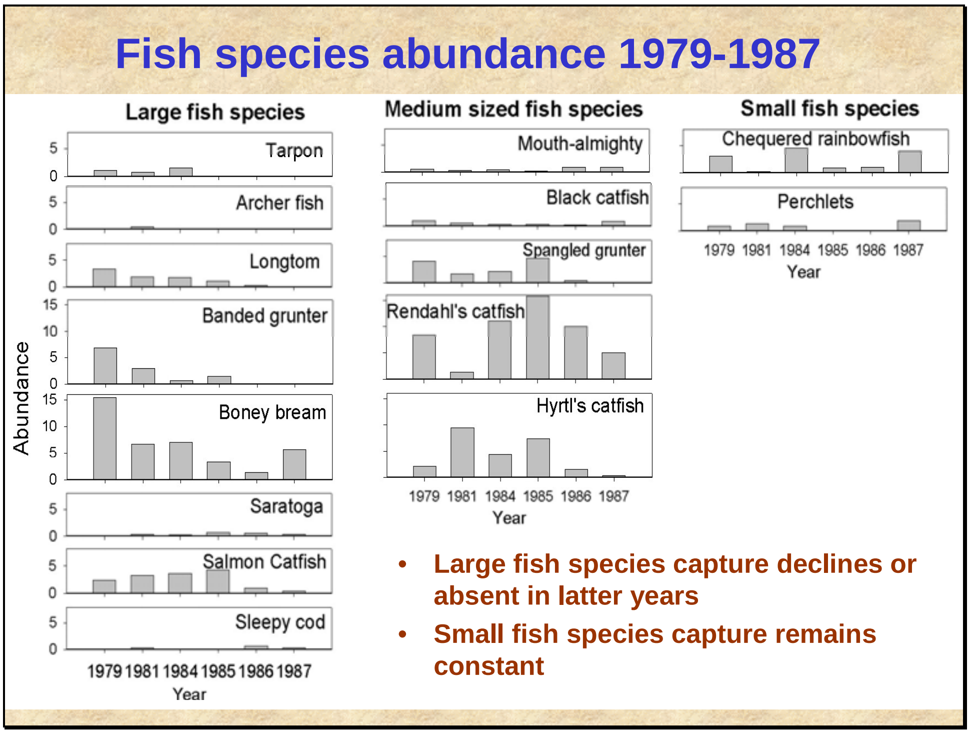
Early fish monitoring from 1979-1987 utilised Multi-panel gill nets (Bishop et al 1986). Eight sites were sampled, however, this did not include any true control sites. Sampling coincided with the eradication of feral water buffalo to remove the threat of Brucellosis and Tuberculosis spreading to the Bovine meat industry. Buffalo numbers were greatly reduced and as a result aquatic plants in shallow billabongs began to flourish.



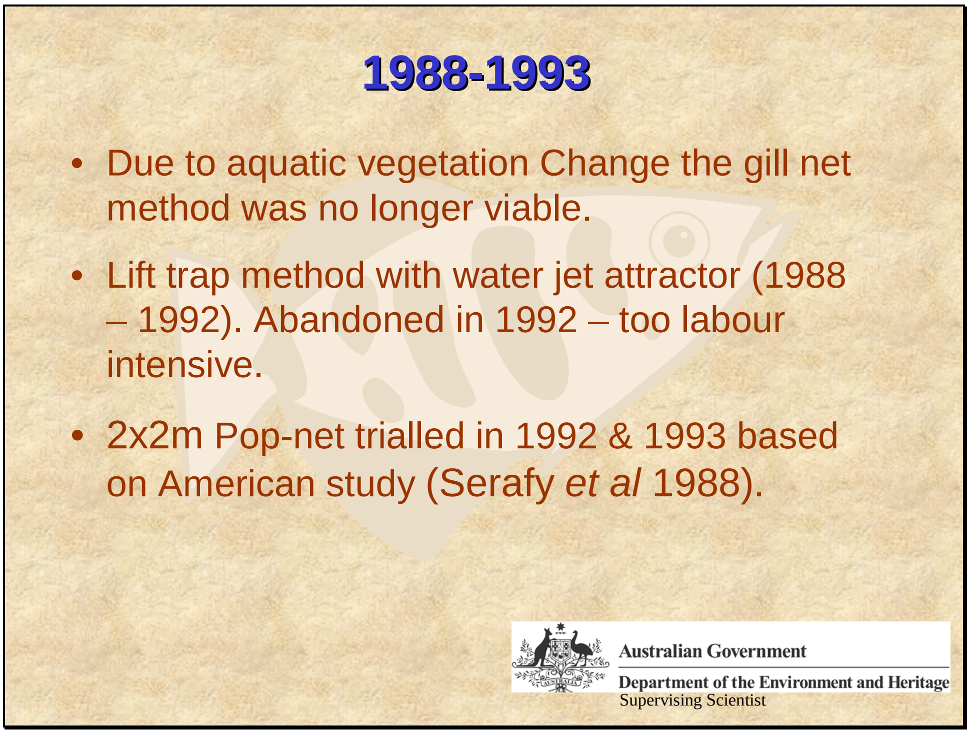
These photos depict an extreme case of habitat change corresponding with the reduction in buffalo numbers. Buffalo with wallowing, trampling and grazing resulted in increased turbidity of water ways and the reduction of vegetation biomass, in some cases complete removal (Skeat et al 1996). With buffalo removal the pressure on shallow billabongs was greatly reduced enabling aquatic plants to proliferate.



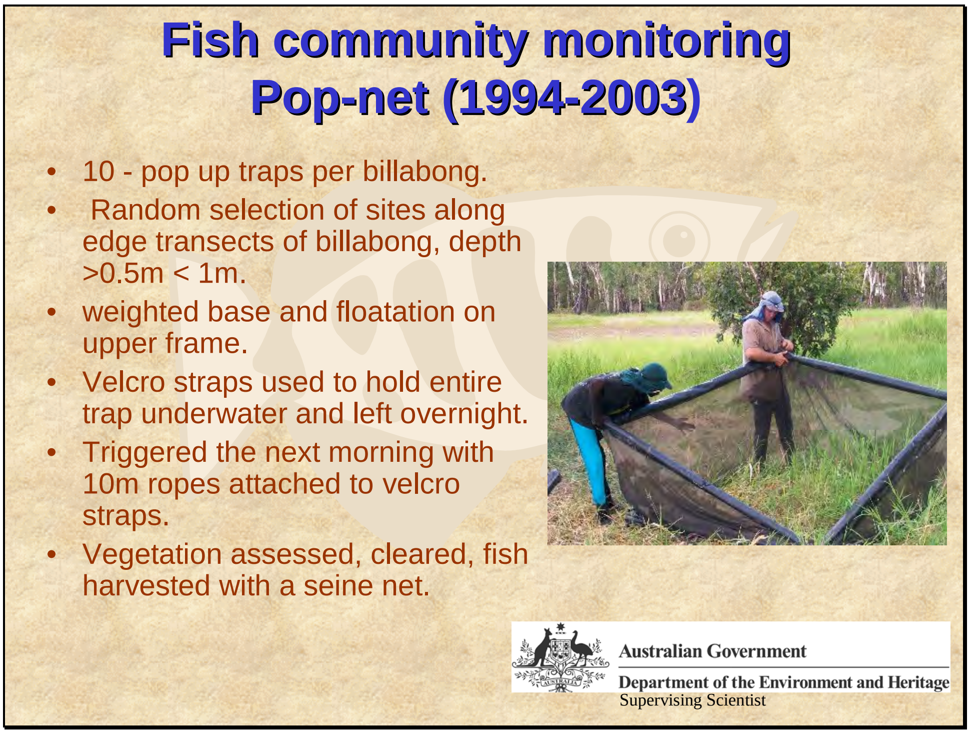
A significant decline in species richness occurred within the sampling period. The number of species captured using gill nets reduced in 1986 and 1987. This corresponds with a dramatic increase in the macrophyte score for the same years (0 = no cover, 4 = complete coverage of sample area). Macrophyte score increases correspond with a decline in the surveyed water buffalo populations. Increased biomass in aquatic plants made gill netting impossible (Humphrey et al 1990).



The reducing efficiency of gill nets in these changing conditions is evident in the catch records. It is evident that larger species particularly those that prefer open water (Tarpon, Archerfish, Banded grunter, Bony bream and salmon catfish) are less occurrent or absent when macrophytes increased. Smaller fish species favouring aquatic vegetation are less affected. This may also indicate an avoidance response of some fish species as habitat became less tolerable.

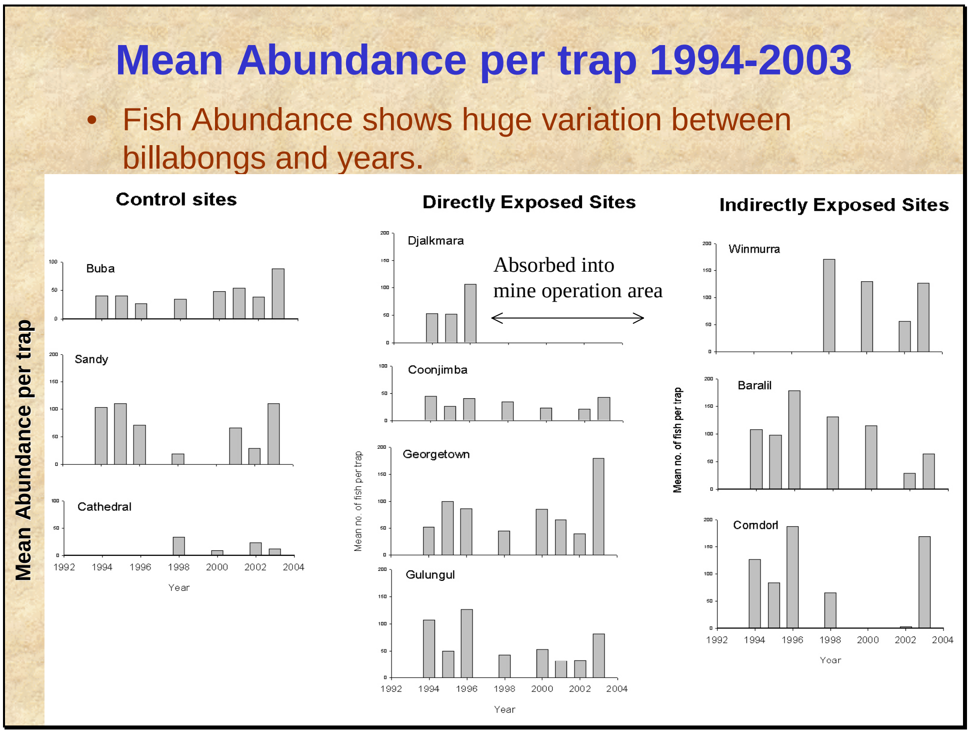


New methods needed to be considered. A lift trap method was utilised at Gulungul billabong from 1988–1992. This method was labour intensive, time consuming and not applicable to more than one billabong. In 1992 a 2x2 pop-net method was trailed. This method was based on an American study by (Serafy et al 1988).

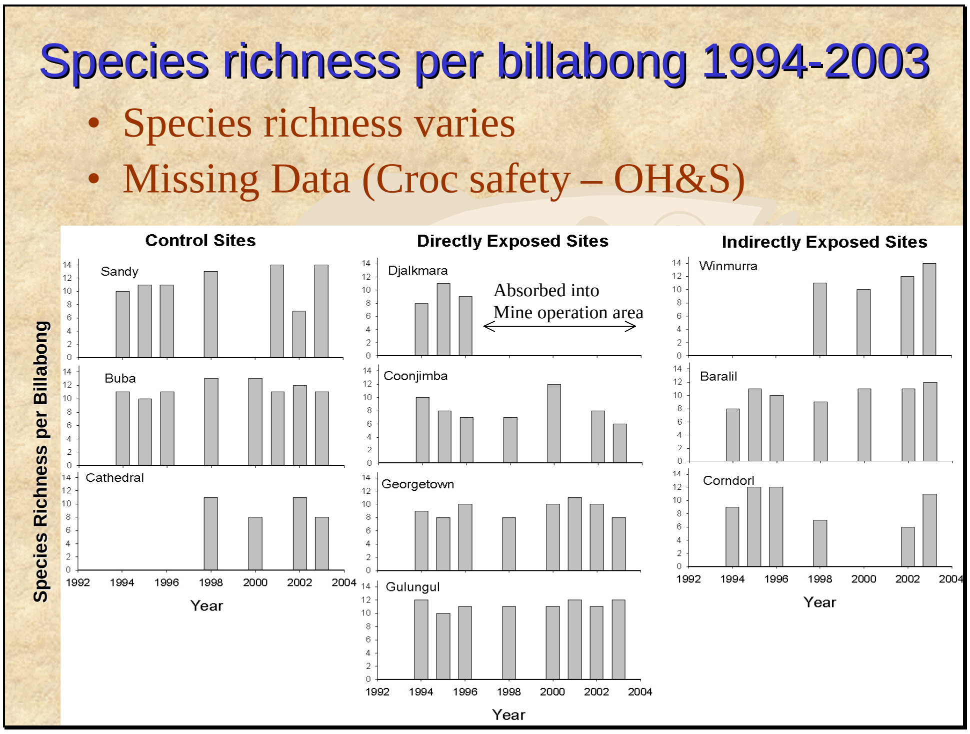


Brief introduction to the pop-net and methodology. For more information see (Pidgeon et al 2003) and the pop-net protocol.

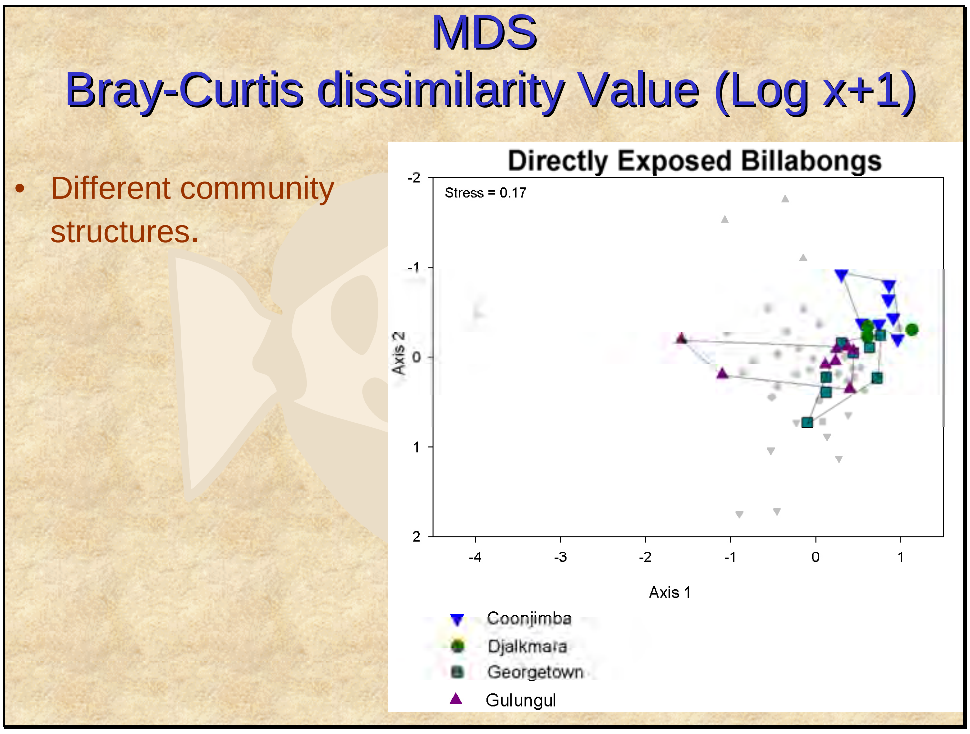
Pop-netting is very labour intensive involving a team of 8-10 in order to sample nine billabongs in a four week period. With the protection of the salt water crocodiles in the early 1970s numbers have been increasing rapidly. In 2000 the inclusion of crocodile safety enclosures for personnel safety increased the workload required. Deployment of these large nets takes time and requires the use of the Argo semi aquatic vehicle to provide safety for the workers.



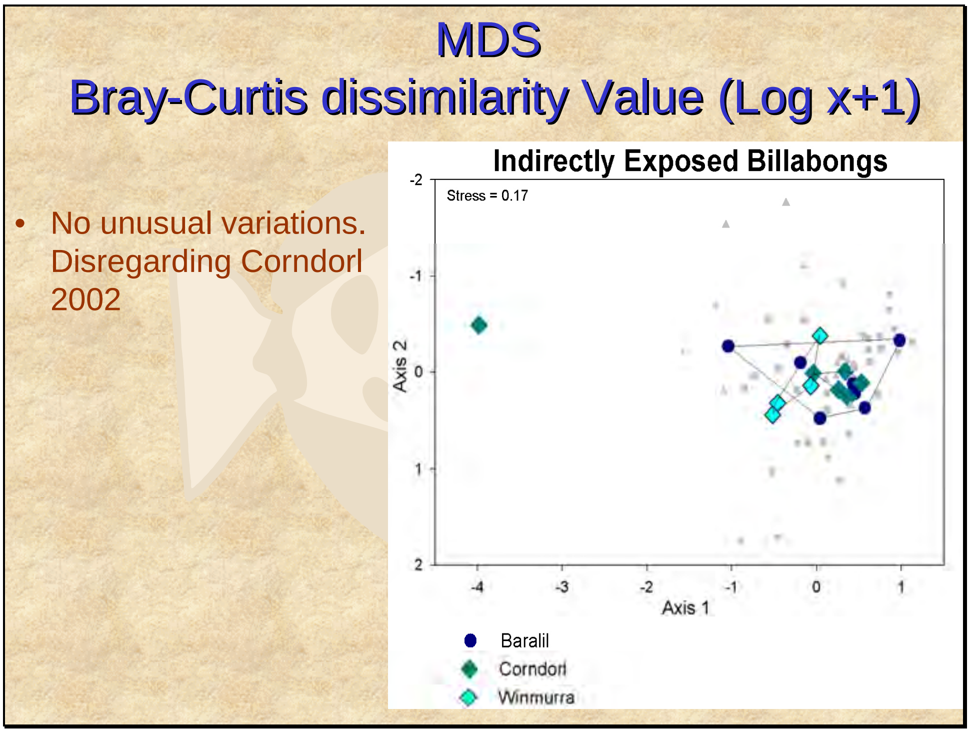
Abundance per trap shows huge variations between billabongs and between years. Temporal changes do not differ from control sites indicating they are natural variations. The very low abundances in Corndorl Billabong 2002, corresponds with increased aquatic vegetation biomass and salvinia and is not replicated in other exposed billabongs.



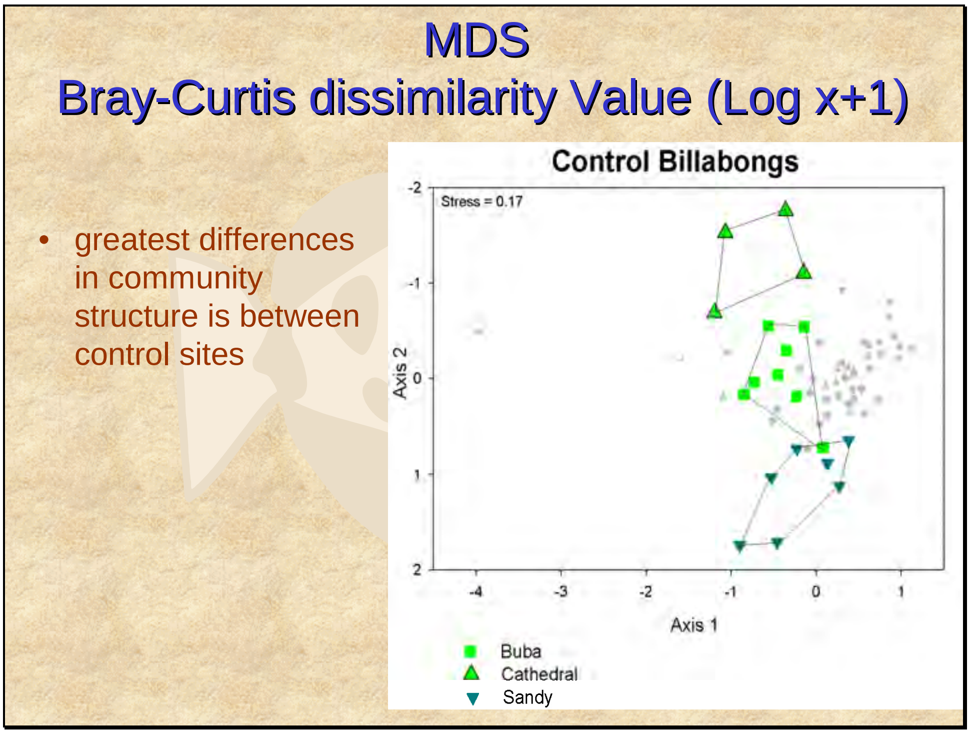
Species richness varies but shows no changes that would indicate a mining related impact. The data set is incomplete due to crocodile safety and the inability to access sites on some years. Species richness is relatively high in all billabongs giving good opportunities for community analysis.



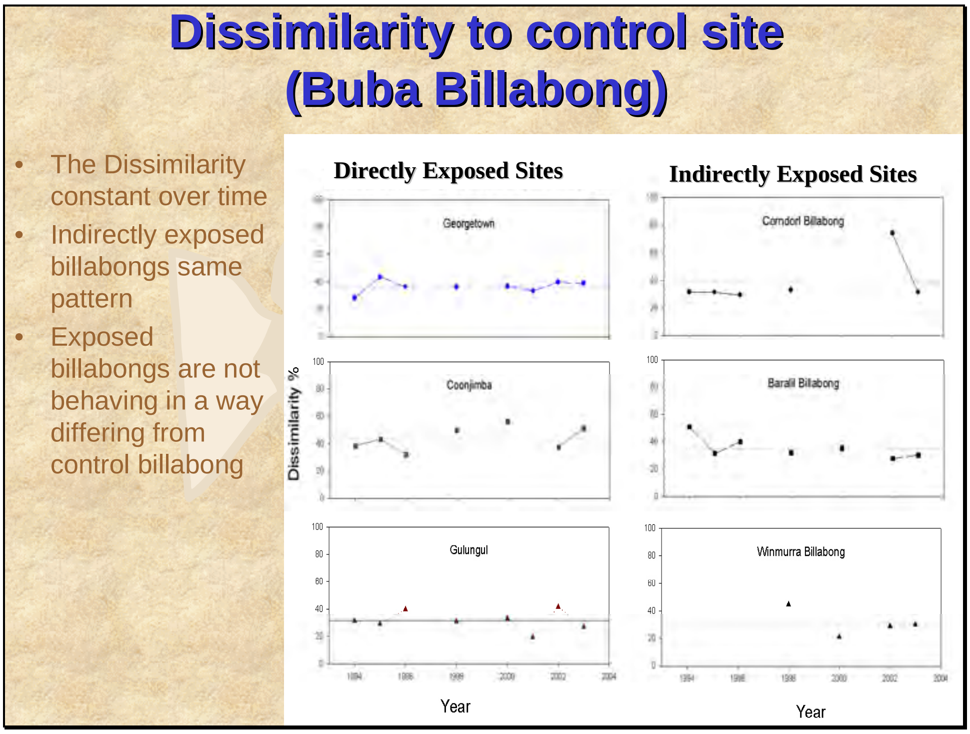
Using a Multi dimensional Scale analysis (Clarke 1993) a visual relationship of the community structures in each billabong can be established. The lines connecting billabong points are only a visual aid and have no significance. The directly exposed billabongs show no difference in fish communities that would suggest a mining related impact.



Points on an MDS are plotted by their similarity or dissimilarity to other points (years, billabongs). The further apart the points the greater the community differences. Indirectly exposed billabongs show less variation between billabongs than directly exposed billabongs. The exception being Corndorl 2002 that has greatly reduced abundances and species richness – as mentioned due to natural causes.



Control sites have the greatest variations between billabongs and considerable variation between years. This indicates these fish communities are naturally variable. Temporal variation in community structures can be expected to follow similar patterns in all billabongs.



Buba Billabong has the largest number of sampling years. Comparing all billabongs dissimilarity to it, we can determine if an unexpected change has occurred. The dissimilarity of all billabongs remains relatively constant, with the exception of Corndorl 2002. If an impact were occurring we would expect the dissimilarity value to change over time with the changing fish community.

Conclusions

- Changes in aquatic vegetation in the mid 80's prevented original fish monitoring methods from continuing.
- Pop-net method is at present the only known method available to sample these communities.
- Dissimilarity of control to Exposed billabongs shows that no unexpected change has occurred during the pop-net sampling (1994-2003).
- Fish community monitoring in shallow backflow billabongs in conjunction with other monitoring programs (multiple lines of evidence) indicates no detectable impacts on surface water to Kakadu National Park.

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Conclusions Cont.

- To help understand the driving forces in fish communities, more work defining the relationship of aquatic vegetation is required.

2003 pop-net team at Buba Billabong

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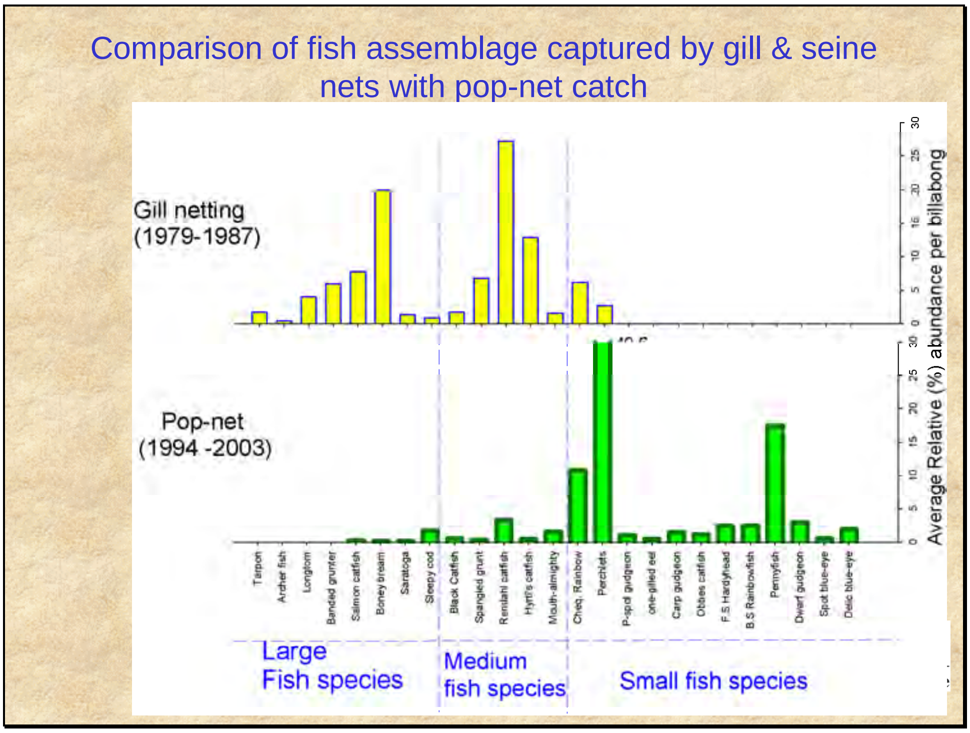
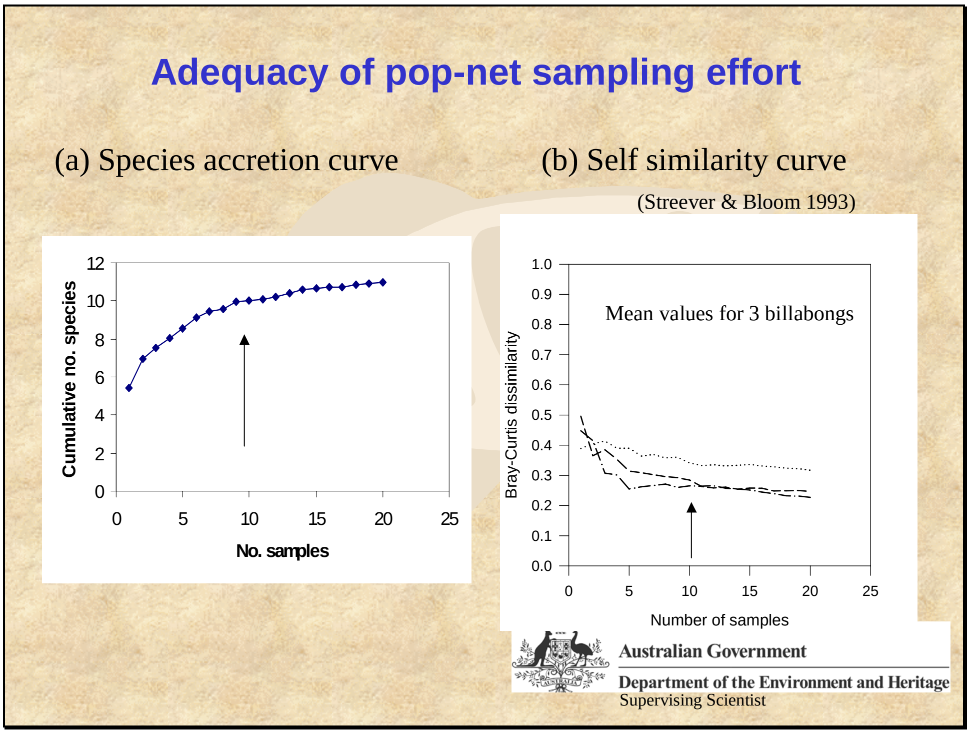
Appendix



Spare slides in preparation for questions. This figure shows a comparison of species captured using gill nets and pop-nets. It clearly shows species composition differs between the two methods. Gill nets capture larger species, and pop-nets capture smaller species.



Reason for using 10 pop-net traps

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