

## Summary of Papers Presented and General Discussion

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The overwhelming impression from the previous papers is of the importance of Lake Gregory both as a conservation area for birds, and perhaps aquatic invertebrates, and as a site in which to study climatic history. However, in spite of its importance there has been little biological or geological work at the lake so that much of what has been said in the previous papers is speculative.

### SPECIAL FEATURES OF LAKE GREGORY

It has become apparent during the workshop that Lake Gregory possesses a number of unusual features. Some of these are listed below.

- (1) Birds - The lake supports some of the largest concentrations of waterbirds of any Australian wetland and, on a regular basis, contains the highest number of waterbirds of any wetland other than some coastal wader sites. It is an important refuge for ducks, coots and fish-eating birds.  
  
The lake is an important breeding area for fish-eating birds and it is possible that the lake and the many anastomosing channels of Sturt Creek constitute an important breeding area for ducks.
- (2) Productivity - The lake is a highly productive system, as attested by the very large numbers of birds it supports, the extensive algal mats that develop and anecdotal accounts of the lake teeming with invertebrates.
- (3) Inflow of water - One of the reasons for the high productivity of the lake is that water inflow occurs in summer when temperatures are high. Even during winter daytime temperatures are comparatively high. The lake contains water almost permanently; 1979 is the only year during the past 20 the lake is known to have dried and even then the lake mud did not dry out. There is probably some inflow most years and substantial inflow every few years.
- (4) Closed system - The lake is on the Mandora Palaeoriver. The westward part of the system became filled in during the Late Tertiary so that Sturt Creek (the headwaters of this ancient system) now empties into Lake Gregory, which has no surface outflow although there is some leakage into the underlying groundwater and loss of groundwater westward along the palaeoriver channel. Lake Gregory is the best example of a closed drainage system in Australia.
- (5) Salinity - Although the lake was originally named 'Gregory Salt Sea' and 'Gregory Salt Lake' these were misnomers; the lake varies from fresh to brackish depending on the amount of water it contains. There has not been the long-term build-up of salt expected in such an old closed system because of leakage.
- (6) Water chemistry - As in most Australian wetlands, the water at Lake Gregory is dominated by sodium chloride but the water chemistry is unusual in that there is a surplus of sodium, which forms various salts (e.g.  $\text{Na}_2\text{CO}_3$ ,  $\text{Na}_2\text{SO}_4$ ). The surplus sodium, in conjunction with the high photosynthetic activity, results in the lake having water of high pH. Silica levels in the water are very high, which suggests that the lake supports large populations of diatoms.
- (7) Invertebrate fauna - The lake may contain an aquatic invertebrate fauna that is largely restricted to the Kimberley area and which contains specialisations to adapt it to tropical arid-zone lakes.

- (8) Wetland model - Lake Gregory is comparable to several of the major arid zone lakes in other parts of the world (e.g. Lake Tchad in Africa).
- 9) Aboriginal culture - Another asset at Lake Gregory is that Aboriginal culture there is intact and the combination of studies of very recent sedimentary history with anthropological studies may prove fruitful.

### POSSIBLE STUDIES

There are a number of topics, some of which have wide application, that could be or need to be researched at Lake Gregory. Topics that have broad implications include:

- (1) Palaeohydrology and palaeoclimatology - Being a closed system the lake is particularly amenable to a study of its previous hydrological regimes and, by inference, previous climates. These studies are relevant to the general study of desert formation and the changing productivity of landscapes as a result of changing climates but their applicability to predicting some of the 'Greenhouse' effects increases their importance substantially.
- (2) Invertebrate biogeography - Lake Gregory has a long history as a regularly-filled lake in the tropical arid zone. Most of the surface of the earth outside the polar zones is arid but there has been little study of the way in which aquatic systems function in arid areas. It appears likely that north-western Australia was a centre of invertebrate speciation in the same way as south-eastern and south-western Australia were. Lake Gregory is the only large natural lake in the north-west (or any part of the Australian arid zone) that fills regularly and may act as a refugium for a suite of species endemic to the north-west. Knowledge about its role as refuge, the pattern of speciation among animals living there and their adaptations to the hydrologic regime of the lake can be extrapolated to other arid zone situations as well as substantially improving our knowledge of the Australian fauna.
- (3) Waterbird refuge - Waterbird counts in Lake Gregory are sufficiently high to suggest it may act as an important refuge in some years. Furthermore, it appears that the lake may be a very significant site for the breeding of piscivorous birds and that, in years of floods, Sturt Creek could be an important area for duck breeding. Waterbird numbers are high enough

and the possible breeding activity great enough to mean that waterbird population dynamics at Lake Gregory have Australia-wide implications for waterbird management, which makes Lake Gregory an important area for further waterbird research.

The demonstrated importance of Lake Gregory also justifies research into the best methods of managing it and maintaining it as a functioning ecosystem. The general studies outlined above will contribute to this but additional studies would also be most useful. Some are listed below.

- (1) Riparian vegetation - The trees surrounding the lake are very important for the breeding of many bird species. When the lake is very full and floods out to the sand dunes, the trees drown. Under normal circumstances seedlings germinate as the lake recedes and trees re-establish but this does not appear to be happening currently because of heavy grazing by cattle. There is a need to clarify the role of trees in maintaining bird numbers and breeding, assess the impact of loss of the trees and examine ways of ensuring regeneration.
- (2) Catchment degradation - Sturt Creek and Lake Gregory probably offer an excellent opportunity to examine the larger scale effects of the introduction of cattle (such as sheet erosion) in the Kimberley on the environment, particularly wetlands.

### BASELINE DATA

One of the general comments to emerge from the workshop was the need for baseline data. If some of the early explorers had collected modern scientific data on their visits to Lake Gregory we would be in a much better position to manage the lake than we are in today. Without baseline information there is great difficulty pinpointing the major problems requiring management and assessing their urgency as well as difficulty putting the biological and geological values of an area into context. Therefore, it is important that we begin compiling an inventory for Lake Gregory immediately and establish a monitoring program. Among the first priorities for inventory are:

- (1) Collections of aquatic invertebrates, aquatic angiosperms and algae.
- (2) Collections of fish.
- (3) Water chemistry data.

(4) Collection of shallow cores of the lake bottom to determine recent lake levels, the aquatic fauna within the lake in recent times and surrounding vegetation.

(5) Compilation of a bathymetric map of lake.

A longer-term monitoring program should include data on waterbirds, aquatic flora and fauna and water chemistry as well as:

- (1) Water levels in the lake.
- (2) Groundwater levels in Lens Bore and Homestead Bore.
- (3) Effect of cattle on the riparian vegetation.
- (4) Monitoring of the flow in Sturt Creek.

## CONCLUSION

Lake Gregory is one of the most important conservation areas in Western Australia. It supports larger numbers of waterbirds than any other lake in Western Australia and has a rich invertebrate fauna. It has extremely interesting and varied water chemistry and constitutes a most unusual hydrological system. There is a need for multi-disciplinary research to be conducted there, with the permission and co-operation of the Mulan Aboriginal Community, to provide a thorough understanding of how the lake functions so that the best possible management can be achieved. In addition to providing management-related information there is scope for research at Lake Gregory, because of its unique characteristics, to examine questions of national and international importance, such as providing insight into the implications of climatic changes likely to occur as a result of the Greenhouse Effect.