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LAKE CLIFTON MONITORING PROGRAM

Report prepared for the Department of Conservation and Land Management November 2003

by

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INTRODUCTION

Lake Clifton is part of the Yalgorup Lakes System which is listed under the Ramsar Convention's list of Wetlands of International Importance as they provide habitats of high conservation value for migratory species of waterfowl. It is also included on the Register of the National Estate (Australian Nature Conservation Agency 1996). A Management Plan was written for the Yalgorup National Park in 1995 and includes general management specifications for Lake Clifton (Department of Conservation and Land Management 1995).

Lake Clifton is also of regional significance since it contains the largest community of living microbialites in the southern hemisphere (Moore 1991). Microbialites are rock-like structures built by microorganisms. The structures in Lake Clifton are known as thrombolites, a form of microbialite with an unlayered internal structure unlike the more widely known stromatolites which have a layered internal structure. As the microbes photosynthesise, calcium carbonate is drawn out of the lime-enriched lake water to form the rock-like material.

Environmental Protection Authority Bulletins (788, 864) have been produced with criteria to protect the water quality and hydrological balance of Lake Clifton. They provide environmental criteria for land use planning on private land within the catchment of the lake. In addition, the thrombolite community was assessed by Western Australian Threatened Species and Communities Unit as critically endangered in February 2000 and a Recovery Team was established in May 2002 to prepare an Interim Recovery Plan and implement recovery actions for the thrombolites.

The most recent data have shown an increase in salinity (Knott, B unpublished data; Lane, J unpublished data) and a decline in lake level (Barr, 2003).

OBJECTIVES OF THE MONITORING PROGRAM

The objectives of this monitoring program are to:

- Monitor water quality and compare with earlier studies
- Record lake levels
- Record groundwater levels
- Undertake ongoing monitoring of physical condition and microbial assemblage of the thrombolites

SITE CHARACTERISTICS

Lake Clifton is the second largest and the most northern lake in the Yalgorup National Park. It is poikilosaline (seasonal variation in salinity) and located southwest of Mandurah on the southern Swan Coastal Plain. Lake Clifton is approximately 21.5 km long and up to 1.5 km, with the waterbody covering about 17.8 km^2 in maximum extent (Moore 1991,Commander 1988). Most of the lake is less than 1.5 m deep, with certain areas up to 3.5 m in depth. Both the deep basin and the mean annual water level are generally lower than sea level (Moore 1991).

Most of the other Yalgorup lakes are seasonally or permanently hypersaline. Lake Preston ranges in salinity up to 90 g L^{-1} TDS in the southern part of the lake. The salinity of Martins Tank Lake ranges up to 190 g L^{-1} TDS (Commander 1988; Shams 1999). Lake Clifton shows strong seasonal trends in salinity but until about a decade ago, was predominantly hyposaline throughout the year (Moore *et al.* 1984). Lake Clifton is a groundwater sink, with a fresh water flow system and an underlying body of hypersaline water (Commander 1988).

There are no natural drainage channels into Lake Clifton. The lake is replenished by winter rains and groundwater, with an extensive aquifer emptying into the lake along the eastern shoreline (Moore *et al.* 1984). This inflow of fresh groundwater probably provides calcium-enriched water critical to the survival of the microorganisms and the growth of the thrombolites.

The thrombolites occur in a zone about 15 m wide on the eastern side of the lake, occupying a total area of over 4 km^2 (Moore 1991). They exhibit a range of external morphologies and vary in size up to 1.3 m high. Their external morphology is controlled primarily by fluctuations in water depth, sedimentation rates and prevailing winds and currents (Moore 1991). The minimum net growth rate of the thrombolites at Lake Clifton is around 0.1 mm per year (Moore 1993; Moore and Burne 1994).

There is concern that the increasing salinity, nutrients and a reduction of the input of fresh, highly alkaline groundwater may lead to the demise of the microbes forming the thrombolites or a change in species composition within the microbial community.

METHODOLOGY

Water Quality

During the summer months Lake Clifton consists of three spatially distinct basins, with a wide partly vegetated spit constricting the southern basin to about 200 m in width (Rosen, *et al.* 1996). For this reason water samples should be collected from at least these three sites. Replicate samples will be required.

The water should be analysed for the following:

Chlorophyll a (Chl a)
Ammonia -N (NH_4-N)
Nitrate-N (NO_3-N)
Total Kjeldal Nitrogen (TKN)
Total Nitrogen (TN)
Total Phosphorus (TP)
Filtered Reactive Phosphorus (FRP)
Total Suspended Solids (TSS)

These analyses can be carried out by Analytical Reference Laboratory (ARL) for a total of $148.00 per water sample or by WA Chemistry Centre for $155.00 per water sample plus a registration cost of a minimum charge per batch of $120.00 plus GST.

ARL would be the preferred choice as they supply all sampling containers, eskies and also do the filtering.

The following water quality parameters should be measured in the field (surface and bottom):
:

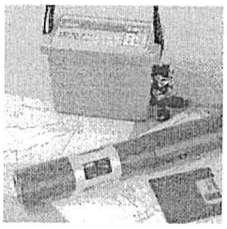
- dissolved oxygen
- pH
- salinity
- conductivity
- turbidity
- temperature
- redox potential

A Yeo-Kal data logging water quality meter is available for hire from Envirorent for $110.00 per day.

YEO-KAL 611 DATA LOGGING WATER QUALITY ANALYSER

The Yeo-Kal 611 measures temperature, conductivity, dissolved oxygen, turbidity, pH, ORP and salinity.

Ranges:	pH	Salinity	ORP	Conductivity	DO	Turbidity	Temperature
	0-14pH	0-60PPT	-900mV-+900mV	0-80 ms/cm	0-200%	0-600NTU	0-50°C
Accuracy:	0-1pH	±.1PPT	±2mV	5us/cm	1·0%	±1% of reading	±1°C



Sampling frequency should be four times in the first year and may be reduced to bi-annually depending on the first year's results.

Major Ions

Rosen *et a.l* (1996) reported the order of ionic abundances in lake waters was Na > Mg> Ca > K and Cl > SO4 > HCO3, in proportions similar to seawater. Williams and Buckney (1976), McArthur and Bartle (1980), Moore (1987) and Burke and Knott (1989) have all recorded this same order of ionic abundance for previous years. However, as noted by Moore (1987), the regional ground water flowing into the Lake Clifton has ionic abundances of Na > Ca > Mg > K and Cl > HCO3 > SO4. Given the number of previous studies, it is not necessary to undertake an analysis of major ions.

Lake Water Levels

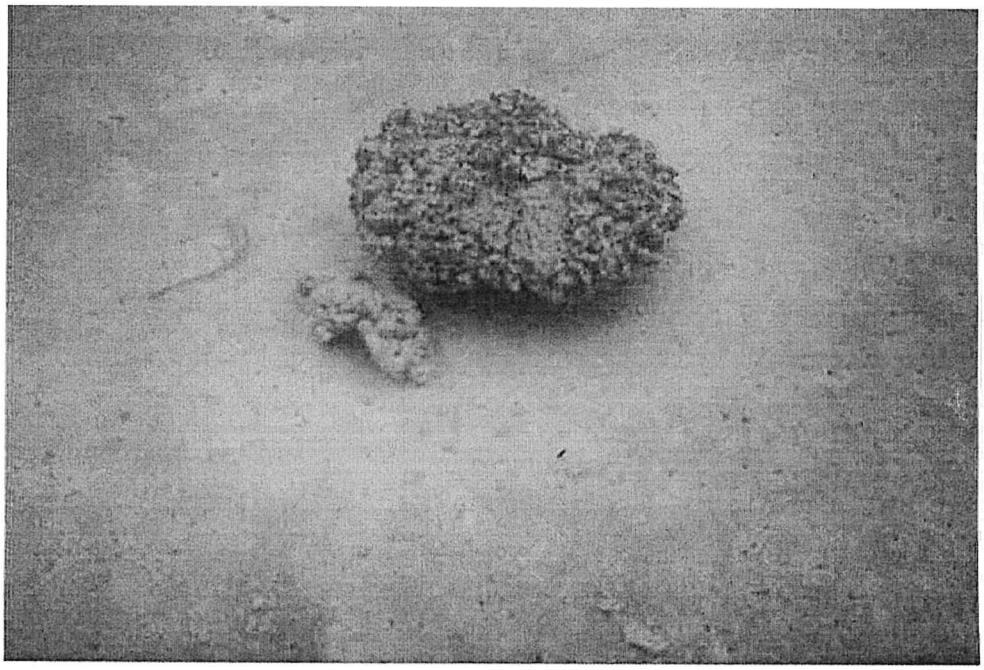
Water levels can be measured near the boardwalk at the end of Mt John road using the standard staff gauge. This should be done at least on a monthly basis. It may be possible for one of the local residents or someone from Water and Rivers Commission to undertake this.

Groundwater Levels

Groundwater levels can be measured using piezometers set up in the lake. These comprise the outer sleeve of two lengths of PVC tubing which can be installed via the method of Tratt and Burne (1980). A piezometer established near the staff gauge will allow the level to be tied to Australian Height Datum (AHD).

Monitoring of Physical Condition and Microbial Assemblage of the Thrombolites

The health of the thrombolites should be monitored through compositional and structural studies. Assessment of the physical condition of the thrombolites in the most trafficked areas should be undertaken looking for evidence of damage and crushing. Studies will also include identification of whether macro-algae occur in the lake and whether they are a threat to the survival of the thrombolites.



Water quality parameters are to be correlated by the appointed consultant with the occurrence of any changes that occur in the microbial community. Nutrient status and increased salinity are likely to be the most important determinants of the health of the thrombolites (L. Moore personal observation).

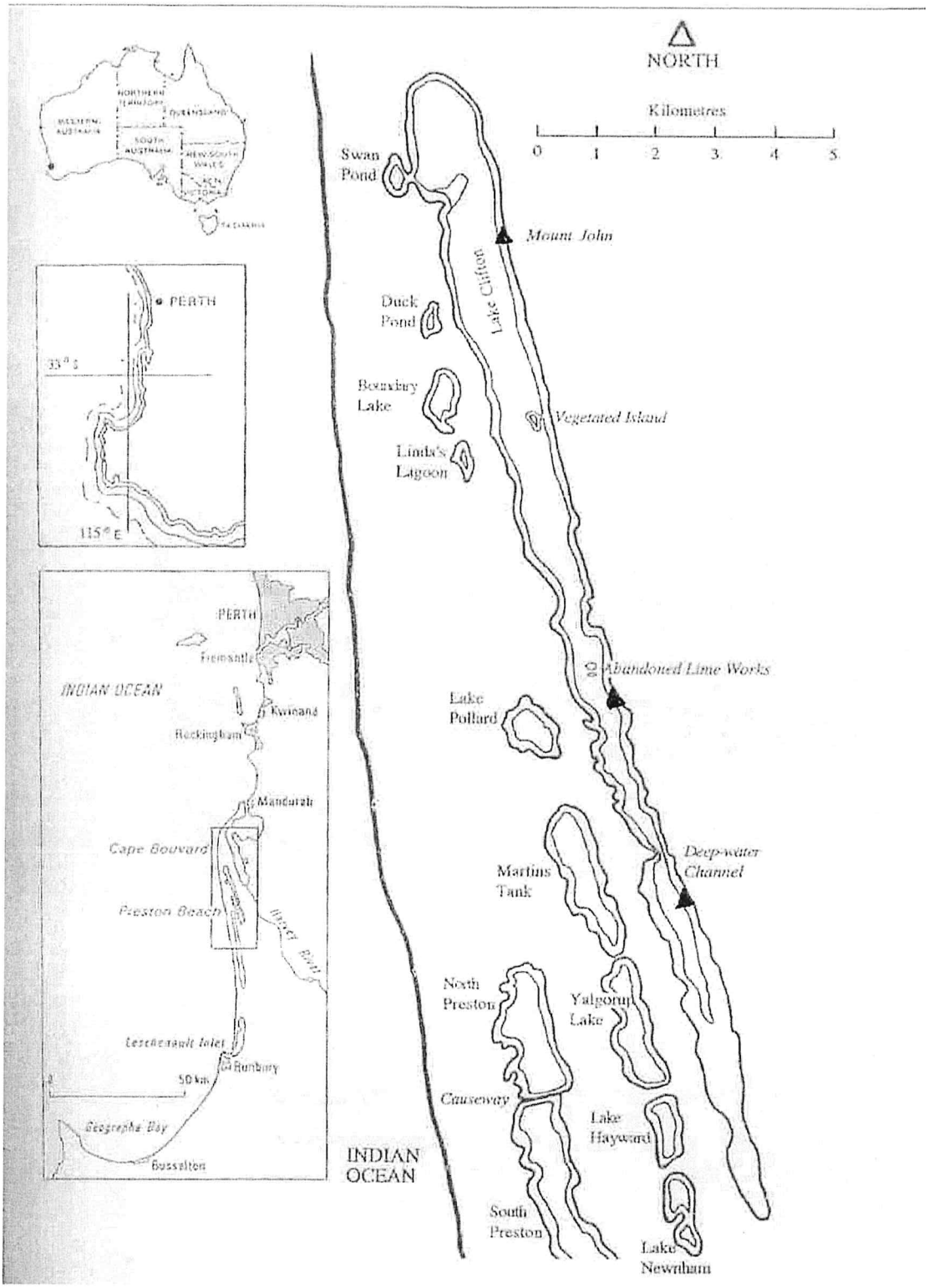
Lithified and unlithified microbialite samples are to be collected from the three sampling stations. Replicate samples should be taken, one to be placed in plastic whirl packs and kept refrigerated at 4°C, the other to be placed in a glass vial and fixed in 4% formalin. Neil (1984) reported that live samples remained viable for up to 6 months, however, relative species abundances may have been influenced hence the fixed sample should be collected for comparison.

Fresh material can be decalcified at room temperature in 5% EDTA (pH 8.0) before examination by light microscopy for microbial composition. Microscopy should also be carried out on wet mounts of formaldehyde-preserved (4% in lake water) samples.

Summary of Monitoring Program

Parameters	Sites	Frequency	Responsibility	No Hours	Cost
Water Quality	3	Quarterly			
Chlorophyll a (Chl a) Ammonia -N (NH_4-N) Nitrate-N (NO_3-N) Total Kjeldal Nitrogen (TKN) Total Nitrogen (TN) Total Phosphorus (TP) Filtered Reactive Phosphorus (FRP) Total Suspended Solids (TSS) In the field: • dissolved oxygen • pH • salinity • conductivity • turbidity • temperature • redox potential					
Lake Water Level	1 (near boardwalk)	Monthly			
Groundwater Level	1 (near boardwalk)	Monthly			
Microbialite Physical Condition	1 (near boardwalk)	Yearly (summer)			
Microbial Assemblage	3	Quarterly			

Location of sampling sites



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