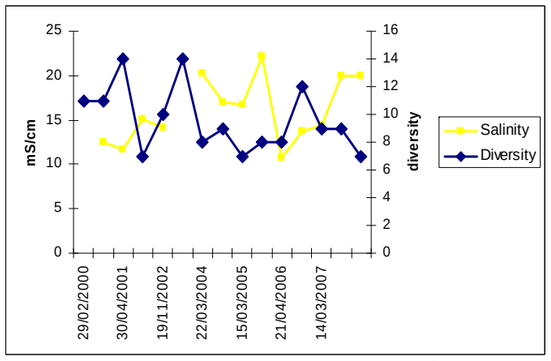
Lake Nunijup

diversity tended to be highest when salinities were lowest which coincides with the trend that higher diversities relate to low salinities as illustrated when salinity is graphed against macroinvertebrate diversity at Nunijup Lake. Each group of Macroinvertebrate play a different role in the food chain, some feed on organic material (Shredders), others feed on fine organic particles (Collectors/filter feeders), others graze on algae (Scrapers), some feed on each other (Predators), others are parasitic (Parasites) and some are Macrophyte piercers that feed off living plants and algae fluids. These groups are called Functional Feeding Groups (FFG). Some Macroinvertebrates fit into more than one of these groups, for example the Water Boatman is a Predator, a Scraper and a Macrophyte piercer.

A healthy wetland should have a representative of each functional feeding group. A loss or dominance in a particular group may indicate a change in ecology of the wetland. The



Macroinvertebrate diversity vs. Wetland Salinity

composition of these groups at Lake Nunijup are displayed in the below graph. There appears to be a high number of collectors / filter feeders which could relate to high amount of suspended decomposing fine particulate organic matter in the wetland. The high number of shredders may be present due to the aquatic plants, *Ruppia megacarpa* (seagrass) and *Nitella spp.* (stoneworts) in the wetland.

Conclusion

Lake Nunijup was previously a fresh, intermittently dry wetland perched above the regional water table. The wetland now rarely dries and ranges in salinity from saline to highly saline. The causes of this hydrological and salinity change are complex but may be attributed to early abstraction of water from the lake, diverting of saline water into the lake and the rising saline groundwater table interacting with the lake. The regional water table has risen significantly since clearing for agriculture and is continuing to rise at 20cm per year. Total nitrogen levels were moderately high however phosphorus was usually low and the forms of both nutrients available for plant growth were both consistently low. Riparian vegetation has altered and parts of the foreshore are eroding due to the lack of vegetation. The lake has high social and environmental values and is at risk of further deterioration in water quality and possible ecological impacts.

Some knowledge gaps were identified during the investigation, monitoring and data analysis for this wetland which should be addressed to improve understanding of the water quality and biodiversity and to detect changes over time. The monitoring period was relatively short and some effects of previous and current land use change and management may not yet be evident. Macroinvertebrates would need to be identified to family or species level to allow more detailed analysis of ecological condition and relationship to other wetland characteristics. The hydrology of the wetland and its catchment is not fully understood or monitored, particularly the interaction between groundwater and surface water. A future monitoring program should be developed to address these issues.

Acknowledgements

The Department of Water would like to sincerely thank and acknowledge the following people for their assistance and contribution toward the South Coast Wetland Monitoring Program and production of this report.

- Ruhi Ferdowsian (Department of Agriculture and Food, Albany) for providing knowledge of the hydrogeology associated with Lake Nunijup.
- Ania Lorenz, Sherrie Randall, Kevin Hopkinson, and Albany Department of Water team who conducted the monitoring.
- Kevin Hopkinson, Naomi Arrowsmith, Andrew Maughan and others for their support and editing assistance.
- Sherrie Randall and Tracy Calvert for data analysis and report compilation.

For further information please contact Tracy Calvert at the Department of Water Albany (08) 9842 5760.

South Coast Wetland Monitoring Project June 2008

This report card summarises the Department of Water's current state of knowledge of the physical, chemical and biological characteristics of Lake Nunijup based on the knowledge gained from investigation and monitoring conducted by the Department of Water through the South Coast Wetland Monitoring Program.

Accompanying this document are appendices providing more detailed information about the wetland monitoring program, terminology of wetland classification, parameters monitored, methodology and the ANZECC&ARMCANZ guidelines used in this report.

Funding for this program has been provided through the South Coast Natural Resource Management Inc. - supported by the Australian Government and the Government of Western Australia.

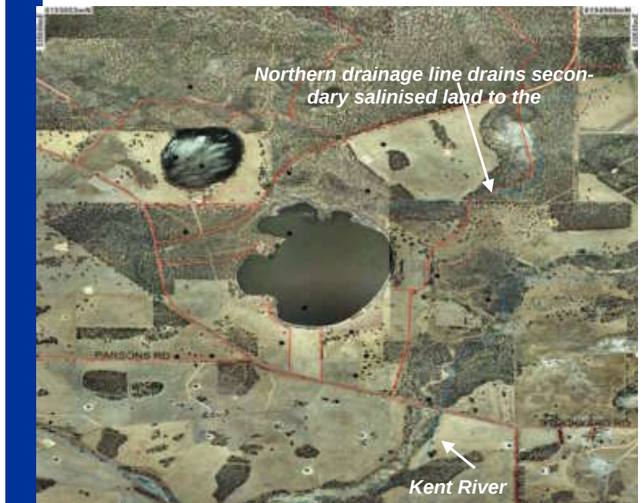
About Lake Nunijup

Lake Nunijup is located approximately 35km north west of Mount Barker Western Australia within the Irwin Inlet Catchment and the sub-catchment of the Kent River. The wetland is approximately 230m AHD (Australian Height Datum) and the area receives an annual average rainfall of 530mm.

Wetland Suite	GPS Location Coordinates		
	Easting	Northing	MGA Zone
Unicup Suite	537369	6192874	50

Lake Nunijup is located on Unallocated Crown Reserve land within a catchment of approximately 75.5km^2 which is under the jurisdiction of the Shire of Cranbrook. The wetland lies within an unfenced wetland vegetation buffer zone that ranges between 0-95m from the wetland edge (including the reserve area).

Vegetation includes Eucalyptus wandoo in the upper storey, *Melaleuca cuticularis* in the mid storey with a sparse understorey of *Baumea juncea*. There are a number of dead trees and regenerating trees scattered on the wetland perimeter with areas of eroding foreshore due to the lack of vegetation. *Ruppia megacarpa* (seagrass) and *Nitella spp.* (stoneworts) also occurs in the wetland.



Lake Nunijup

Riparian vegetation in the north west of the Lake

Approximately 65% of the catchment has been cleared of native vegetation for stock, cropping and

Department of Water
Government of Western Australia

SOUTHCOAST NATURAL RESOURCE MANAGEMENT
southcoastnrm.com.au
Australian Government

Lake Nunijup

now plantation forestry. The lake is a popular recreational area used for water skiing and picnics as well as wetland educational purposes.

Water quality monitoring commenced in November 2005 however the wetland was dry until the summer storm in February 2007. Monitoring included physical, chemical and biological parameters as outlined in the appendices.

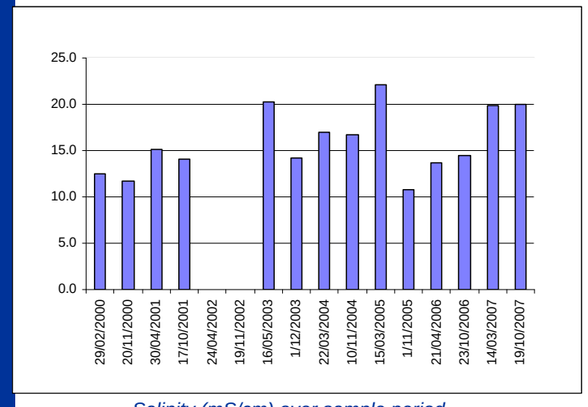
Wetland Classification

Wetland type	*Water Salinity*	*Consistency of Salinity*	*Size (Metres)*	*Shape*
Lake	Hypersaline - Brine	Poikilohaline	Macroscale 1540 x 1255	Irregular - Round

Classification of Lake Nunijup has been evaluated on the basis of guidelines developed by V & C Semeniuk Research Group. For further explanation please refer to the appendices.

Salinity

Salinity over the sample period fluctuated between saline (10.76mS/cm) and highly saline (22.1mS/cm). Fluctuations in salinities relate to seasonal fluctuations in rainfall and the complex behaviour of surface and groundwater interactions. Water is contributed by groundwater discharge and inflows from the watercourses to the north. During the onset of winter rains, stored salt loads are initially flushed into the lake and as flows increase during winter the incoming salinity reduces which tends to freshen the wetland salinity.



Salinity (mS/cm) over sample period

Changes in the lakes characteristics and salinities have been observed for over 100 years. Con Parsons observed in the early days the area of open water was much smaller and surrounded by thick stands of rushes that provided habitat for many tiger snakes - hence the lake's name (Nuni=snake, Nunijup=the place of snakes). Con reported anecdotal evidence that dry periods were observed in the late 1800's and early 1900's. The lake was completely dry in the 1980's which was exacerbated by abstraction and transportation of the lake water as a drought refuge for Cranbrook. The lack of water in the lake was remedied by diverting flows from the Kent River through an artificial drainage scheme and then salinities in the lake increased to double the maximum salinity recorded before diversion.

It is not known whether the increasing salinity in the lake was caused by diverting saline water from the Kent River or whether rising saline groundwater was able to interact with the lake due to the reduced hydraulic pressure when the lake was dry.

Lake Nunijup lies within the geological formation of the Plantagenet group which is made up of marine derived Pallinup Siltstone overlaying the deeper Werillup formation made up of lignite, clays and coarse sand. The lakes in the area are situated in the tertiary sediments that occur mainly on ancient drainage channels. Before 1970 Nunijup Lake was a freshwater system, perched above the groundwater and seasonally inundated. Monitoring of bores in the vicinity of the lake show there is connection between the lake and groundwater. During winter months water flows through the underlying sediments of the lake due to winter recharge of the groundwater creating a situation of salt loss, while during summer months and low water levels in the lake groundwater may discharge into the lake contributing to the higher salinity. Salinities of the groundwater vary from 6500mg/L to 14000mg/L which corresponds with the saline to highly saline conditions of the lake water. The regional groundwater in this area has risen up to 6m since catchment land clearing and is rising at a rate of 20cm per year.

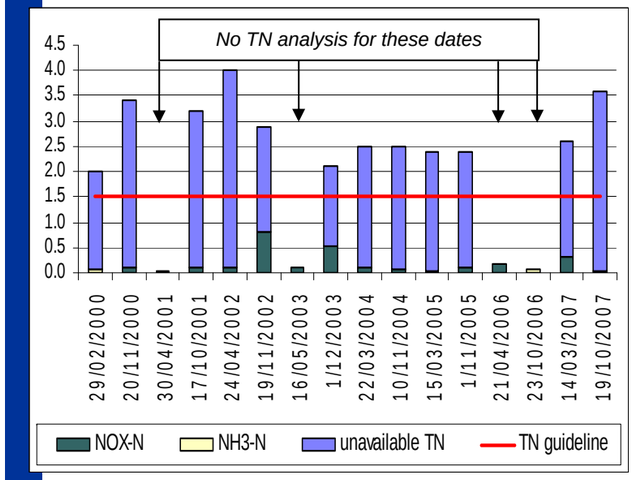
Nutrients

Total Nitrogen (TN) concentrations ranged between 2.0-3.6mg/L which exceeded the guidelines developed for ecosystem protection for southwest Australian wetlands for slightly disturbed systems of 1.5mg/L on all sample occasions.

Lake Nunijup

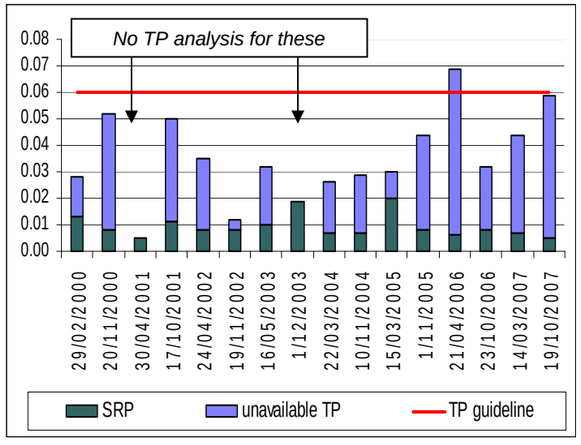
South Coast Wetland Monitoring Project June 2008

Dissolved inorganic nitrogen fractions of ammonia (NH_3-N) and total oxidised nitrogen (NOx-N), ranged between 0.17-0.5mg/L and 0.01-0.03mg/L respectively which did not exceed the recommended guideline values of 0.04mg/L and 0.1mg/L.



Nitrogen fractions in mg/L over the sample period with TN guideline illustrated

Total Phosphorus (TP) concentration ranged between 0.01-0.069mg/L which exceeded the water quality guidelines of 0.06mg/L on one occasion.



Phosphorus fractions in mg/L over the sample period with TP guideline illustrated

Soluble Reactive Phosphorus (SRP) (available form of phosphorus for uptake by plants) ranged between 0.005-0.013mg/L which did not exceed the recommended water quality guideline value of 0.03mg/L.

Nutrients are recycled naturally through the swamp due to uptake and assimilation of nutrients by plants and animals and through release of nutrients for example through microbial breakdown of organic material.

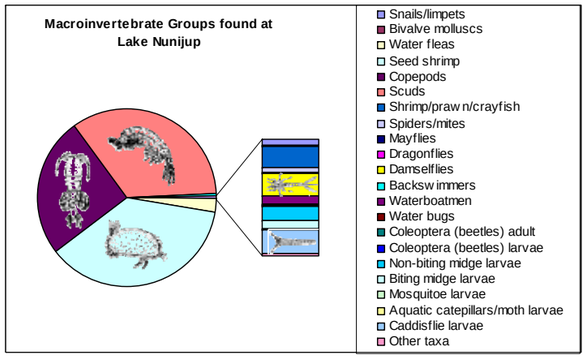
Large amounts of nutrients may be stored in the catchment soils as the area has been farmed for many years. Nutrients may enter Lake Nunijup through inflow via watercourses, sub-surface flow from surrounding agricultural lands and via groundwater. The presence of birds can also contribute to the nutrient content in the lake.

Low amounts of phosphorus and available phosphorus may indicate nutrients are readily taken up by plants or due to the high phosphorus absorption potential of the clays beneath the agricultural land.

Macroinvertebrates

Twenty two groups of macroinvertebrates were found at Lake Nunijup during the monitoring period of which the most abundant included; Cladocera (water fleas), Ostracoda (seed shrimp), Copepoda (copepods), Amphipoda (scuds), and Notonectidae (backswimmers).

Other groups of less abundance were found including; Gastropoda (snails/limpets), Bivalvia (bivalve molluscs), Decopoda (shrimp/prawn/crayfish), Acarina (spiders/mites), Ephemeroptera (mayflies), Epiproctophora (dragonflies), Zygoptera (damselflies), Corixidae (waterboatmen), Hemiptera (water bugs), Coleoptera (beetles) adult, Coleoptera (beetles) larvae, Chironomidae (non-biting midge larvae), Ceratopogonidae (biting midge larvae), Culicidae (mosquitoe larvae), Lepidoptera (aquatic catepillars/moth larvae), Trichoptera (caddisflie larvae) and Other taxa.



The diversity of macroinvertebrates found over the sample period ranged between seven to fourteen groups with a median of nine which rates as average based on the Ribbons of Blue Wetland Habitat Score. Macroinvertebrate