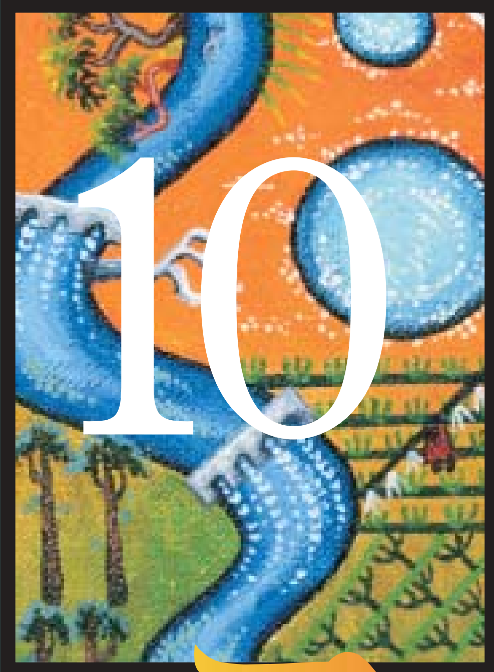
FACT SHEET 10

River flows and blue-green algae



Blue-green algae (*cyanobacteria*) are a natural part of Australia's river systems. When in balance they are not a problem, but increased nutrients and low flows have contributed to severe algal bloom outbreaks in many of our river systems and water storage areas. The conditions that favour algal blooms are now well understood. Algal growth depends on the availability and supply of the nutrients nitrogen (N) and phosphorus (P), light and warm water temperatures. These conditions result in blooms of blue-green algae often coinciding with long periods of warm, sunny weather, high nutrient levels and still water.

Recent research suggests that another factor that affects bloom formation is the management of flows in both rivers and water storage areas. Rivers rarely experience algal bloom outbreaks during periods of high flow. This means that new approaches to manipulating the flow of rivers and water reservoirs may hold the key to preventing algal blooms, saving millions of dollars in water treatment costs and environmental damage caused by algal bloom outbreaks.

This Fact Sheet is the tenth in a series dealing with the management of rivers and riparian land.

RiverLandscapes

Algae and river flow

Australian rivers generally have low flows and are controlled or regulated for water supplies at different times of the year. During storms and flood events, large amounts of nutrients (nitrogen and phosphorus) are delivered to rivers and reservoirs from surface and subsurface erosion of soils and gully networks. These nutrients are either recycled within the water, or released from the sediments when bottom waters become anoxic (lacking oxygen) as a result of poor mixing between water temperature layers (stratification) and the decomposition of organic matter by bacteria. Algal growth is sustained by nutrients, and once a large flood event is over, the combination of increased nutrients and low flows create ideal conditions for algal bloom outbreaks to occur.

In a national study of 24 rivers in Australia, the links between river flow and blue-green algae abundance were researched and two dominant trends emerged. The first trend, identified in the temperate rivers of NSW and Victoria, showed that as flows decreased blue-green algae abundance increased. The second trend, found mainly in tropical rivers in Queensland, showed that prolonged low flow conditions led to more blue-green algae being present. Notably, there were no instances where blue-green algae were recorded during high flow periods.

Large flood events deliver nutrients such as nitrogen and phosphorus from soils and gullies. Flood photo (left) Ian Rutherfurd. Gully photo (right) Nick Schofield.

Why do low flows favour blue-green algae?

Most inland rivers in Australia are slow flowing due to the very low slope of the landscape. Weirs placed along rivers to provide water storage slow the flow even further. This creates an environment that encourages blue-green algal growth. During low flows, stratification develops and the water forms layers with a warm surface layer, on top of a cold bottom layer. Stratification often develops during the summer months due to high solar radiation during the day. Australia's inland rivers are also quite turbid due to high concentrations of suspended clay. This results in low light penetration through the water, limiting algal growth to the region near the surface.

The combination of low flows, stratification and turbidity favour blue-green algal growth. When rivers are stratified, a population of buoyant blue-green algae will float into the well-lit water layer close to the surface where they will receive the light necessary for growth. This is in contrast to the non-buoyant algae (e.g. diatoms and green algae) that are distributed throughout the water column, often in the dark where they will not survive. The ability of blue-green algae to stay at the surface means that in still, warm waters they can grow to sufficient numbers to develop surface scums and cause management problems. For these reasons, blue-green algae tend to bloom when flow is reduced and stratification occurs.

stratification — layers of different water temperature, warm at top and cool at bottom

turbidity — 'dirty' water as a result of suspended soil and sediment

Algal bloom in reservoir. Photo Greg Heath.

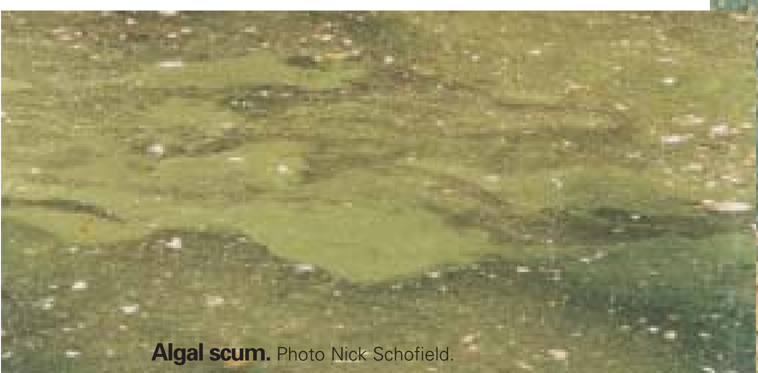
Why does high flow favour other algal species?

During high flows, the turbulence caused by the flow over the river bottom is often strong enough to mix the entire water column from top to bottom. Other non-buoyant algae are dominant in these higher flows, as they are heavier than water and require well-mixed conditions to stay in suspension. They are also adapted to low-light conditions and can successfully compete against blue-green algae. Once high flows recede, and the water column stratifies, they slowly sink to the bottom away from the light and cease to grow.

Algal growth and flow management

Algae grow rapidly, and under favourable conditions it takes very little time for a population to reach nuisance levels. A typical blue-green algae population can start at 100 cells/mL and reach 10,000 cells/mL in around 10 days. This rapid growth over a short time period means that the length of low flow period associated with persistent stratification is critical to monitor.

Models can now be used to assess whether a river section is likely to be stratified or mixed under different flow and weather conditions. These models have been applied to the Murray and Murrumbidgee rivers of south-eastern Australia, and have recently been extended to coastal Queensland rivers such as the Fitzroy River. One of the main outcomes of the projects on the Murrumbidgee and Murray Rivers was the development of a 'mixing criterion' for turbid rivers. This criterion is a numerical value that can determine the time for the on-set of stratified or mixed conditions. It is based on estimates of river depth, flow, solar radiation, depth of light penetration and wind speed. Whether a river is stratified or not is determined by the relative balance between solar radiation (which has a tendency to stratify the system) and wind, evaporation and flow (which have a tendency to mix the system).



Algal scum. Photo Nick Schofield.

The recent application of this model in the weir pools of the Fitzroy River Basin confirms that the management of flows has very important implications for the control of blue-green algal blooms. In the Dawson River, a tributary of the Fitzroy, managed flow releases increased the turbidity of the river for sufficiently long periods to decrease the light available for blue-green algal growth, even when the flow releases contained high nutrients. It was found that daily flows greater than the capacity of the weir pool were required to ensure mixing of the entire water column, thereby removing the stratified conditions required for blue-green algal growth. In contrast, ad hoc flow releases had a short term impact (days) on light conditions and algal growth, as it failed to mix the entire water column.

Flow management in reservoirs

Blue-green algae outbreaks also commonly occur in water storage areas and reservoirs. Stream flow plays a key role in determining the pattern and form of nutrients discharged into reservoirs. Under high flow conditions, nutrients will be discharged into the reservoir as organic material. The mixing of nutrient-rich (nitrogen and phosphorus) bottom waters into the warmer surface layer may occur as a result of strong winds, autumn cooling of surface waters, or rapid drawdown of reservoir water levels. Nutrients can also build up in the surface layer when wastewater effluent is discharged directly into surface waters of reservoirs.

Algal scum. Photo W. Van Aken.

Weirs and reservoirs need to be actively managed so that the conditions under which blue-green algae thrive are reduced. Photo Nick Schofield.

The relationship between nutrient availability and blue-green algal growth means that it is important to limit excessive organic material entering reservoirs. This is to prevent the water turning anoxic (no oxygen). Oxygen levels can also be improved by allowing the growth of plants (e.g. phragmites) along the edge of the reservoir, or mechanically mixing the water. If the level of organic material loading cannot be immediately reduced, it may be necessary to use chemicals such as nitrate to prevent decomposing organic material creating anoxic conditions in the bottom water sediments.

For further information

Bailey, P., Boon, P. & Morris, K., 2002, ‘Managing nutrients in floodplain wetlands and shallow lakes’, River and Riparian Management Technical Update No. 2, Land & Water Australia, Canberra.

Lovett, S. (ed.), 2001, ‘River Contaminants’, RipRap, No. 20, Land & Water Australia, Canberra.

Both these publications are available in pdf on the website www.rivers.gov.au and in hard copy from CanPrint Communications, freecall 1800 776 616.

Recommended management practices

A number of options for managing flows to minimise the extent of algal blooms have been identified from studies in weir pools on the Murrumbidgee and Fitzroy Rivers, they are to:

Increase base flows

Maintain sufficient base flows through weir pools to prevent thermal stratification from occurring. Increased base flows will also ensure the water in the weir pool is mixed and turbid, thereby eliminating the light and temperature conditions favourable for blue-green algal growth.

Use pulsing flows

Release pulses of flow into weir pools that are of sufficient size and duration to cause mixing of the water from the surface to the bottom.

Above: Anabaena circinalis. Photo CSIRO.

Nodularia spumigena. Photo S. Blackburn.

Use water off-take points near the bottom of reservoirs

Water supply off-take points near the bottom of reservoirs are where blue-green algal concentrations are likely to be much lower than near the surface. Sometimes this management practice has to be balanced against possible water quality problems (e.g. high colour due to manganese, bad odours due to hydrogen sulfide) that develop if these bottom waters are anoxic.

Limit organic material entering reservoirs

In reservoirs, it is important to limit the organic material discharge (direct and indirect) from catchments into reservoirs. Priority should be given to reducing wastewater effluents, organic fertilisers, grass clippings and leaves from deciduous trees that promote blue-green algal growth. Managers should also ensure that when well-nitrified wastewater effluent or drainage is discharged it is low in ammonia and organic material.

It is important to manage waste disposal so that it does not enter reservoirs, or is dispersed as widely as possible. Photo W. Van Aken.

Stormwater management

High stormwater discharges from urban areas increase the amount of organic material deposited in the reservoir inlet. Various stormwater management techniques such as infiltration and buffer zones can be used to reduce this problem.

A stormwater pipeline. Photo DNRE.

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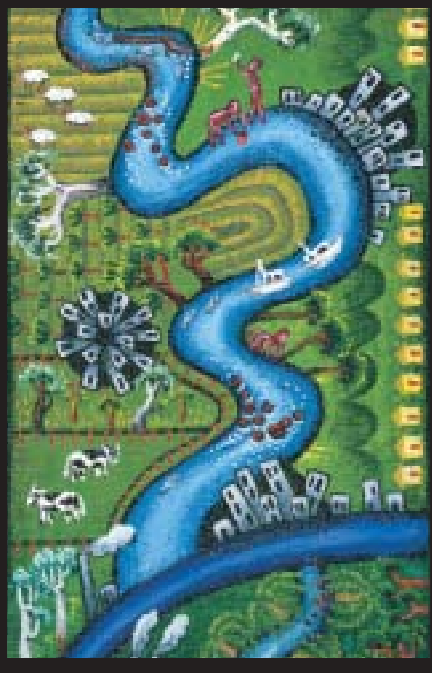

These **Fact Sheets** are grouped according to whether they deal with riparian land, in-stream issues, river contaminants or other matters. They aim to set out the general principles and practices for sound management. Other information that focuses on local conditions and management issues is available from state government agencies, local governments, catchment management authorities, rural industry bodies and community organisations. Together, this information should assist users to understand the key issues in river and riparian management, and enable them to adapt general management principles to their particular situation, and to know where to go for advice specific to local conditions.

Other relevant Fact Sheets

1 Managing riparian land
2 Streambank stability
3 Improving water quality
4 Maintaining in-stream life
5 Riparian habitat for wildlife
6 Managing stock
7 Managing woody debris in rivers
8 Inland rivers and floodplains
9 Planning for river restoration
11 Managing phosphorus in catchments
12 Riparian ecosystem services
13 Managing riparian widths

Fact Sheets 10 and 11 are largely based on work conducted in the former National Eutrophication Management Program.

Further information on river and riparian management can also be found at the Land & Water Australia 'River Landscapes' website.

www.rivers.gov.au

This website provides access to projects, fact sheets, guidelines and other information designed to assist people to better manage river and riparian areas across Australia.

RiverLandscapes

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