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CHAPTER 7 IMPLICATIONS FOR RECREATIONAL WATERS

BACKGROUND

Although the main purpose of this manual is the management of cyanobacteria in drinking water, it is recognised that the presence of cyanobacteria in recreational waters can also be an issue for water authorities that allow recreational use of their drinking water sources. As there is a potential risk to human health from recreational use of contaminated waters, some of the protocols and procedures for monitoring, analysis, and risk assessment are similar to those described in Chapters 2, 3, 4, and 6. This chapter deals specifically with the problems posed by cyanobacteria and their toxins for recreational users of inland freshwater lakes and reservoirs.

WHY ARE CYANOBACTERIA A PROBLEM IN RECREATIONAL WATERS?

For recreational users of freshwater bodies, cyanobacteria can present hazards that other types of algae do not. In some conditions, and at certain times of the day, cyanobacteria can float to the surface and form scums which, driven by prevailing breezes, can accumulate in bays around the shore edge. This can be particularly problematic for recreational water bodies as the shoreline is the most heavily used area, particularly by young children. Figure 7-1 shows a toxic *Anabaena circinalis* bloom in a recreational water body in Adelaide, South Australia. All recreational use of the lake was banned for several weeks, impacting on local business and the public's enjoyment of surrounding parklands.

Figure 7-1 Closure of a recreational lake due to a toxic cyanobacteria bloom

Problems are not confined to planktonic cyanobacteria. Benthic cyanobacteria can grow and form large mats on the bottom of reservoirs and lakes where the water is sufficiently clear to allow sunlight to penetrate to the bottom of the water column. Periods of strong sunlight, and the consequent increase in photosynthesis and oxygen production, can cause mats of algae on the bottom of lakes, reservoirs or slow flowing rivers to lift to the surface, and potentially accumulate at shore edges.

The recreational use of lakes and reservoirs can be significantly impaired through the aesthetic impacts of scums, water discolouration, turbidity and odour as the scums decay. However, it is the accumulation of cyanobacteria at the water surface and shore edge and the consequent potential for high levels of cyanobacterial toxin that pose the biggest risks.

PUBLIC HEALTH CONCERNS

Anecdotal evidence and case reports pre-dating World War II have described a range of illnesses associated with recreational exposure to cyanobacterial toxins. These include hay-fever like symptoms, gastrointestinal illness and skin rashes. Some of the more severe symptoms include; myalgia, pneumonia, severe headaches, vertigo and blistering of the mouth. However, it must be recognised that generally symptoms are likely to be minor and self-limiting in nature, and as a result many minor health impacts associated with contact with cyanobacterial toxins are probably unreported.

RECREATIONAL ACTIVITIES AND LEVEL OF EXPOSURE

In mitigating and reducing the risks posed to recreational users it is important to understand the exposure risk of different activities. There are three types of exposure to cyanobacterial toxins, ingestion, inhalation and dermal contact. The exposure of greatest concern for health is through ingestion - whether intentional or incidental. Incidental ingestion of water is a particularly high risk for children, and activities such as swimming and diving in the shore areas where scums accumulate are considered high risk for exposure to toxins. Although not considered to be a common occurrence, intentional ingestion can be a problem for campers and picnickers who may use lake water for cooking or drinking purposes. However due to the rarity of occurrence, i.e. campers intentionally ingesting lake water and therefore toxin, it is generally classified as a low potential for exposure.

Aspiration of water, and therefore toxin, is more commonly associated with activities in which water aerosols are formed, such as windsurfing, canoeing, and sailing. Dermal exposure is likely for all of the recreational uses of lakes and reservoirs involving contact with the water. Where wet-suits or bathing suits trap cyanobacterial cells against the body, skin reactions are more likely due to the prolonged contact.

Table 7-1 summarises the level of risk for recreational exposure to water contaminated with toxic cyanobacteria.

Table 7-1 Risk levels associated with recreational exposure to cyanobacteria in freshwaters.

Exposure Risk	Recreational Activity
High	Swimming, diving, wind-surfing. Activities that involve immersion and therefore high potential for ingestion, inhalation and dermal exposure
Moderate	Canoeing, sailing, rowing, Activities where risk of ingestion is small, exposure to aerosols and appreciable dermal contact is limited.
Low	Camping, picnicking, sightseeing Non-contact activities, unlikely that any exposure takes place.

MANAGING AND RESPONDING TO THE RISK

Organisations and companies responsible for freshwater lakes and reservoirs have a duty of care to members of the public utilising the lake or reservoir for recreational purposes.

The WHO guidance document for recreational water is the 1998 Guidelines for Safe Recreational Water Environments (Vol.1 : Coastal and fresh-waters) [1]. Chapter 8 details the “Guidelines for Safe Practice in Managing Recreational Waters”. These have been reproduced in the management strategies for recreational waters of relevant authorities in a number of countries including; Australia, USA and the UK, which have formed the main reference materials for this chapter.

MONITORING

When formulating a monitoring program for recreational waters, decisions on the level and type of monitoring need to be guided by the history of cyanobacteria blooms, the type of usage, as well as reviewing the likelihood of future blooms given the nutrient status etc. A suggestion for a formal risk assessment to determine monitoring requirements is shown in Table 7-2. For reservoirs and lakes also used for drinking water supplies sampling and monitoring are more than likely already established. If monitoring is required then this may include some of the following;

- Select monitoring sites to ensure that the main public access locations are included, as well as those areas prone to scum build-up due to prevailing winds
- Visual inspection and physical checks such as;
    - water clarity using Secchi discs
    - location of scums
    - any evidence of benthic populations of cyanobacteria in swimming areas
    - temperature profiles through water body to determine stratification
    - prevailing wind direction and weather conditions
- Samples
    - algal identification/enumeration
    - nutrients such as phosphates, nitrates, silica etc.
    - toxin

It is important that a record of the various risk factors and conditions are maintained with which to build up an understanding of the reservoir ecology and therefore effective reservoir management. Maintenance of records and regular review of information for trends should be considered an important part of the monitoring objective.

Table 7-2 Suggested risk assessment for determining monitoring requirements for recreational water.

Classification	Algal history	Cyanobacteria presence	Nutrient Status	Likely planned monitoring
1	No significant algal growth. No history of algal blooms (benthic or planktonic)	Cyanobacteria absent or in extremely low numbers	Oligotrophic / stable	Not usually required as samples likely to be negative. If it is carried out likely to be an infrequent check on nutrient levels as part of overall catchment management.
2	Algal growth present with only very rare blooms which do not always occur each year	Cyanobacteria not normally the dominant species within the bloom	Oligotrophic / mesotrophic. Stable or increasing eutrophication	Monitoring required and should include; Visual inspections of main entry areas. Sampling & analysis for chl-a and cyanobacteria at strategic sites, these should take into account the prevailing winds to ensure that areas prone to scum build up are monitored.
3	Algal growth present with algal blooms occurring most years.	Cyanobacteria may be the dominant species in one or more of the algal blooms.	Mesotrophic / eutrophic. Stable or increasing eutrophication	In shallow lakes and reservoirs consideration of the presence of benthic blooms and requirements for monitoring made.
4	Large populations of algal /algal blooms for many months of the year.	Cyanobacteria are the dominant algae for the majority of the blooms.	Eutrophic to Hyper-eutrophic	Not usually required as samples would likely confirm presence of cyanobacterial bloom and therefore potential for toxins. In lieu of monitoring it may be appropriate to erect permanent warning signs and permanently limit the type of recreational activities at these sites to Low/Moderate exposure risks.

GUIDELINE LEVELS AND ACTIONS

The 1998 WHO guidelines for recreational waters [1] indicate that due to the different levels of severity of exposure to cyanotoxins, from "chiefly irritative" to the "potentially more severe hazard of exposure to high concentrations of known cyanotoxins", a single guideline value is not considered appropriate. WHO has therefore recommended "a series of guideline values associated with incremental severity and probability of health effects." A modified version of the "Guidelines for Safe Practice in Managing Recreational Waters" is shown below (Table 7-3).

Table 7-3 Guideline levels and risks associated with cyanobacteria in recreational waters. Modified from WHO [1]

Guidance level	Health Risks	Typical Actions
20,000 cyanobacterial cells mL^{-1} *or* 10 ug L^{-1} chlorophyll-a with dominance of cyanobacteria	• Short-term adverse health outcomes,	• Post on-site risk advisory signs • Inform the relevant authorities
100,000 cyanobacterial cells mL^{-1} *or* 50 ug L^{-1} chlorophyll-a with dominance of cyanobacteria	• Potential for long- term illness with some cyanobacterial species • Short-term adverse health outcomes, e.g. skin irritations and gastro-intestinal illness	• Watch for scums or conditions conducive to scums • Discourage swimming and other full immersion activities, further investigate hazard • Post on site risk advisory signs • Inform relevant authorities
Cyanobacterial scum formation in areas where whole-body contact and/or risk of ingestion/aspiration occur	• Potential for acute poisoning. • Potential for long term illness with some cyanobacterial species • Short-term adverse health outcomes, e.g. skin irritations and gastro-intestinal illness	• Immediate action to control contact with scums; possible prohibition of swimming and other activities • Public health follow-up investigation • Inform public and relevant authorities

The guideline levels for management of recreational waters sit well within an Alert Level Framework (*Chapter 6*). If the reservoir/lake is also used for water supply purposes, the guideline levels and actions can be included alongside those for managing drinking water quality.

Informing the public of the risks associated with cyanobacterial scums and toxins is important. The information needs to be readily available to recreational users of water bodies at the time of the risk, and should include the affects and actions the public need to take to minimise the risk of exposure. It must be noted that not all water bodies are monitored; therefore information leaflets that raise the general level of awareness of how to recognise a bloom and what precautions to take are valuable in minimising risk.

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