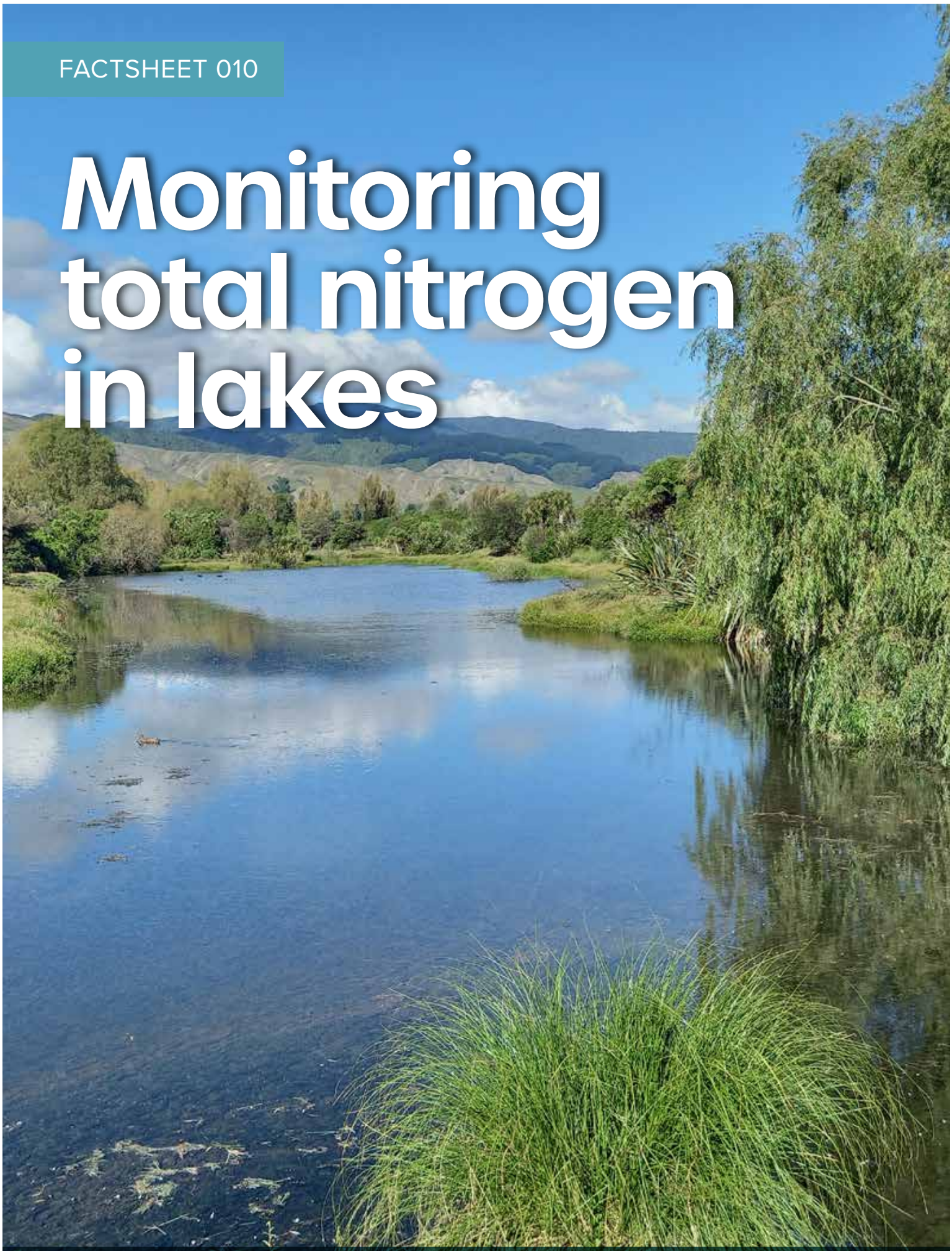
FACTSHEET 010

Monitoring total nitrogen in lakes



OUR LAND AND WATER

Toitū te Whenua, Toiora te Wai

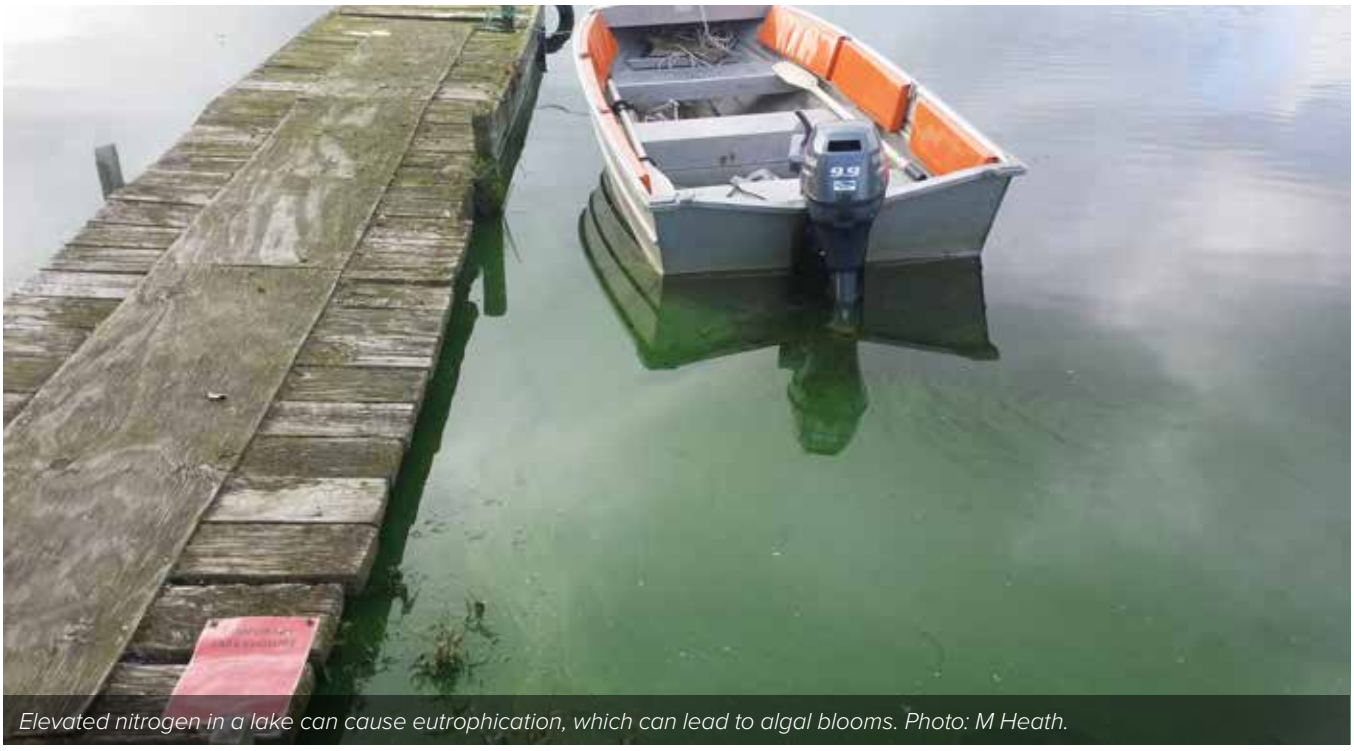
National Science Challenges

Monitoring Freshwater Improvement

Nitrogen is an essential nutrient for the growth of plants and algae. Whilst nitrogen is present naturally in lakes, concentrations may be elevated due to diffuse discharges from agricultural and horticultural land (e.g., due to fertiliser use) and wastewater discharges. Elevated nitrogen concentrations can cause eutrophication (excess nutrients), a process that can lead to excessive growth of macrophytes, or algae and cyanobacteria blooms, which can impact the ecological, recreational and cultural values of lakes.

Total nitrogen (TN) is the sum of all forms of nitrogen in water: nitrate nitrogen (NO_3–N), nitrite nitrogen (NO_2–N), ammoniacal nitrogen (NH_3–N and NH_4–N) and organic nitrogen (nitrogen in amino acids and proteins, which may be present in dissolved or particulate form). Nitrogen gas dissolved in water is not included as part of the TN.

Nitrogen enters lakes from inflows (rivers, streams and groundwater) and atmospheric deposition. It can also come from within the lake, from decaying plant debris and from the bottom sediments (for example, due to wave or wind action causing resuspension of particulate organic nitrogen). Total nitrogen concentrations can vary within a lake, particularly when there is seasonal stratification in deep lakes, leading to marked differences in concentrations and forms of nitrogen between the warm surface waters and cooler bottom waters.



Elevated nitrogen in a lake can cause eutrophication, which can lead to algal blooms. Photo: M Heath.

Why is it important to monitor total nitrogen in lakes?

Monitoring total nitrogen is a key part of evaluating the trophic status of a lake, which is a common measure used to describe lake health in New Zealand. Trophic state provides an indication of how much growth or productivity occurs in the lake, productivity being directly related to the availability of nutrients. Total nitrogen is one of four attributes (along with total phosphorus, Secchi depth (visual clarity) and chlorophyll *a*) used to determine the 'Trophic Level Index' for New Zealand lakes[1].

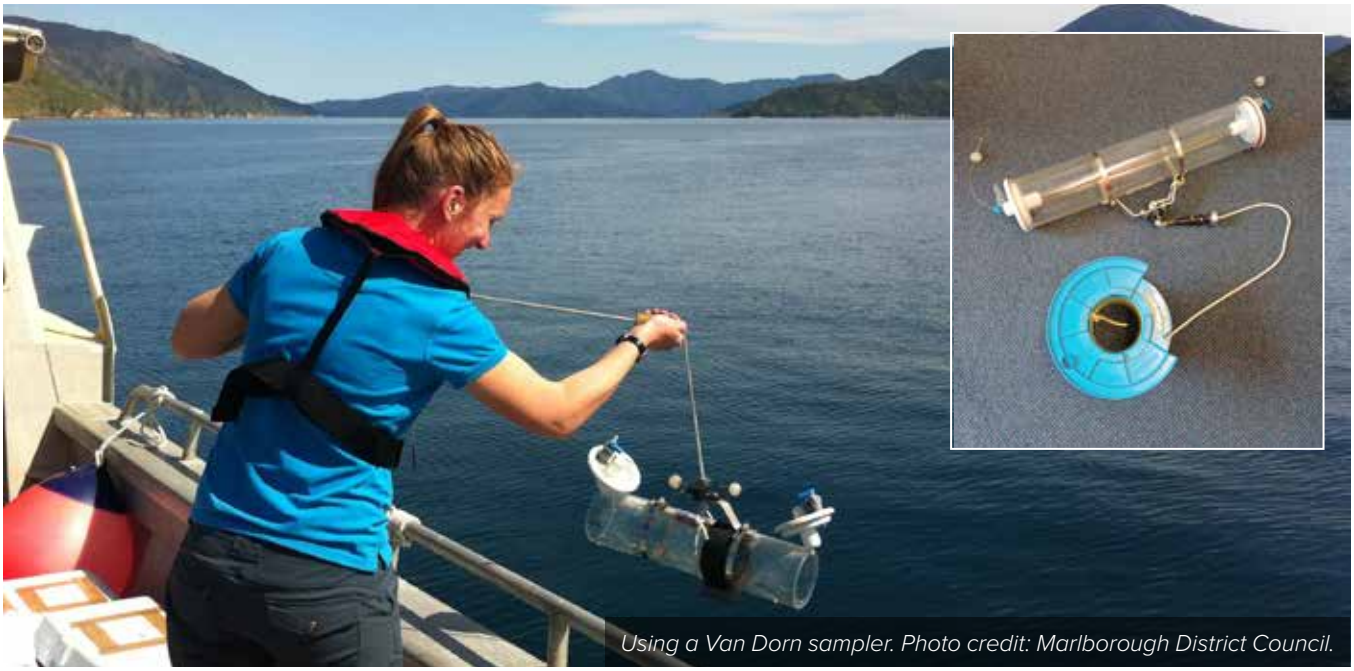
Total nitrogen is both an indicator of the potential for eutrophication, particularly when associated with elevated levels of nitrate and ammonium, and an outcome of eutrophication, as nitrogen is contained in phytoplankton cells. For this reason, strong positive linear correlations have been demonstrated between concentrations of chlorophyll *a* and total nitrogen, with the former used as a surrogate for phytoplankton biomass (see the factsheet *Monitoring chlorophyll a in lakes*).

How do we monitor total nitrogen in lakes?

Monitoring total nitrogen concentrations in lakes involves taking water samples at known depths (usually monthly) and sending them to a laboratory for testing. For information on how to collect, store and transport lake water samples for analysis in a laboratory, see the relevant National Environmental Monitoring Standard[2].

The need to carry out sample combustion or oxidation prior to spectrophotometric analysis imposes a strong constraint on analysis of total nitrogen in the field using autonomous methods (e.g., portable sensors). While autonomous ultra-violet and ion selective electrode sensors are well advanced for nitrate and ammonium, these dissolved inorganic forms of nitrogen are usually only a small component of the total nitrogen in lake water samples. Therefore, sampling is the only practical method available for total nitrogen monitoring in lakes.

In some small or shallow lakes, sampling may be possible by wading from the lake edge. However, in many cases, a boat, drone or helicopter will be required to sample from an appropriate site, often located at the deepest point of the lake. Special sampling equipment, such as a sampling pole and a Van Dorn sampler (a type of sampler that enables samples to be taken from specific depths), may be required.



Using a Van Dorn sampler. Photo credit: Marlborough District Council.

[1] *Burns, N.M., Rutherford, J.C., Clayton, J.S. 1999. A monitoring and classification system for New Zealand lakes and reservoirs. Lake and Reservoir Management 15:4: 255-271, DOI: 10.1080/0743814990935412.*

[2] *National Environmental Monitoring Standard (NEMS): Water Quality, Part 3 of 4: Sampling, Measuring, Processing and Archiving of Discrete Lake Water Quality Data. Available from: https://nems.org.nz/documents/*

How much will it cost?

The cost of carrying out total nitrogen monitoring at a lake site will depend on how often samples are collected, the location and characteristics of the monitoring site (e.g., whether a boat or helicopter and special sampling equipment are required) and laboratory charges for analysing the samples. Approximate operational costs for a single sampling occasion using a boat, based on a survey of regional councils and commercial laboratories in New Zealand in 2023, are shown in the table. Using these estimates, monthly monitoring of total nitrogen by boat will cost about $8,000 per year. However, in addition there will be costs involved to purchase sampling equipment such as a Van Dorn sampler. For more information on the costs associated with running a lake water quality monitoring programme, see the Monitoring Costs information sheet on the Monitoring Freshwater Improvements website.

	Cost per sampling occasion
Laboratory analytical testing	$25*
Boat (running or hire cost)	$260
Mileage*	$35
Staff time – sampling and data entry	$330
Consumables (e.g., ice, courier charges)	$20
Total per sampling occasion	**$670**

**Laboratory cost is for one sample. However, depending on depth and stratification of the lake, several samples may be required at each site. Mileage is based on average distance to a lake monitoring site, derived from regional council survey results.*

Note many of these costs will stay the same regardless of how many other indicators are monitored.

Monitoring Freshwater Improvement

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