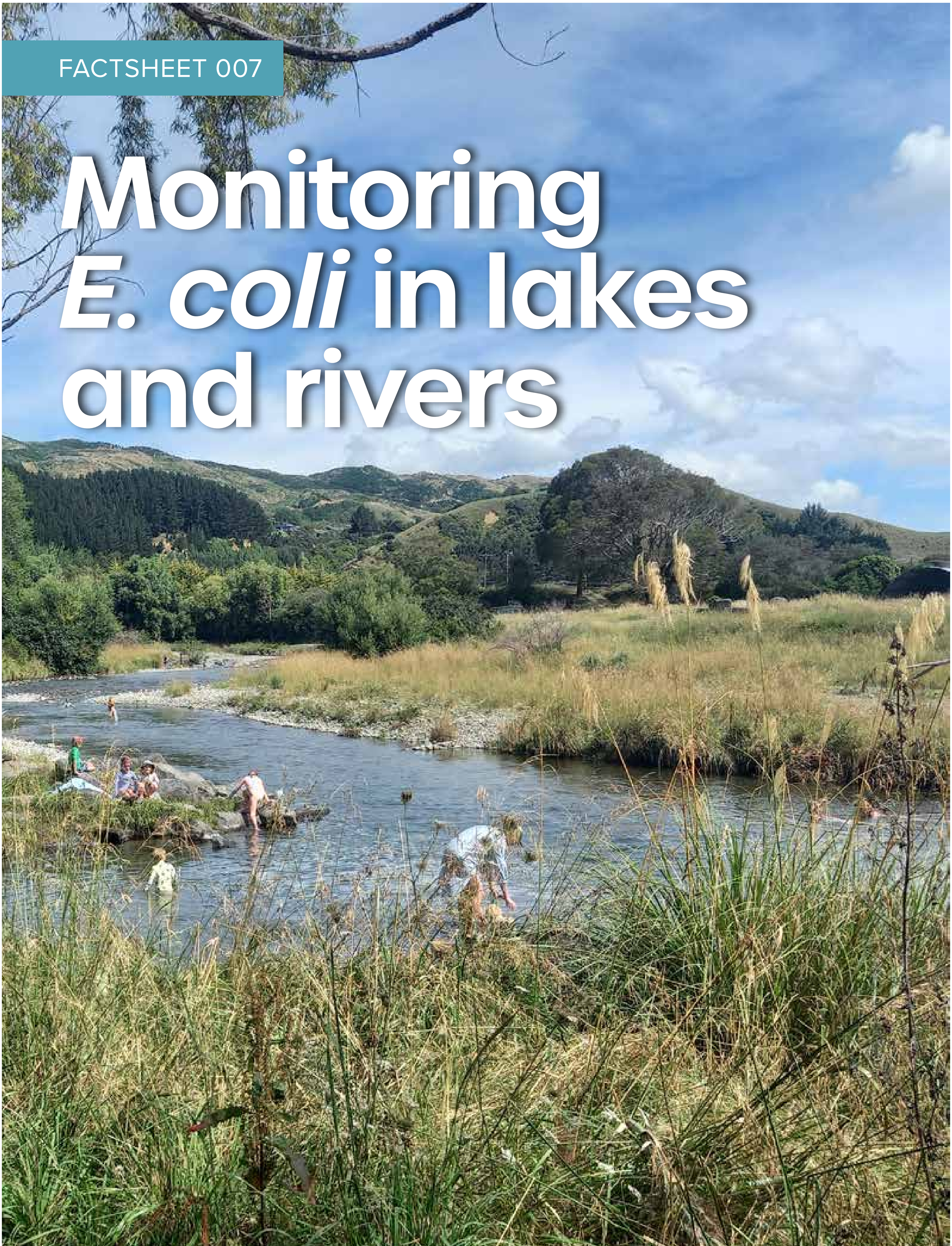
FACTSHEET 007

Monitoring *E. coli* in lakes and rivers



OUR LAND AND WATER | Toitū te Whenua, Toiora te Wai

National Science Challenges

Monitoring Freshwater Improvement

Escherichia coli (*E. coli*) is a common bacteria found in the digestive system of warm-blooded animals, including humans. Because E. *coli* can survive for a few weeks in freshwater environments it is a useful indicator of the presence of faecal matter of human or animal origin. If *E. coli* is detected, there may be other pathogens present that can cause illness.

Common sources of *E. coli* in rivers and lakes are discharges of human wastewater, livestock faeces, bird droppings and stormwater. Management practices to reduce *E. coli* in waterbodies include stock exclusion, riparian planting, erosion control and pest eradication.

E. coli is a key attribute in the National Policy Statement for Freshwater Management 2020 and councils are required to monitor recreational sites in lakes and rivers at monthly intervals, or more frequently, according to the level of risk of infection. Long-term monitoring of *E. coli* may be useful for assessing the effectiveness of land mitigation actions.

Proximity of mammals to water increases risk of E. coli contamination. Provision of a buffer (e.g., fencing, riparian vegetation) between the potential source of contamination and a waterway can reduce risk of E. coli contamination and its associated human health impacts.

Wildfowl can be a significant source of E. coli in some rivers, lakes and estuaries.

How do we monitor *E. coli*?

An *E. coli* monitoring programme involves taking a water sample in a sterile bottle and having it tested in a laboratory. The laboratory will give the result as an *E. coli* count, reported as Colony Forming Units (cfu) or Most Probable Number (MPN) per 100 ml. Due to the culturing process required, results take up to two days.

For information on how to collect, store and transport water samples for *E. coli* analysis in a laboratory, see the relevant National Environmental Monitoring Standards[1].

Photo credit to J Milne

How much will routine monitoring cost?

The cost of an *E. coli* sampling programme will depend on site location, whether boating is required, and the areal extent of the programme (if sampling from a lake). It will also depend on sampling frequency: more frequent monitoring may be required for precise detection of long-term improvements resulting from remedial actions.

Some approximate operational costs for a single sampling occasion, based on average results from a survey of regional councils and commercial laboratories in New Zealand in 2022/23, are shown in the table (excluding vehicle-related costs). Using these estimates, monthly monitoring of *E. coli* will cost about $2,600 per year at a river site and $8,200 at a lake site. In addition, some initial expenditure will be required for sampling equipment. For more information on the costs associated with running a monitoring programme, see the Monitoring Costs document on the Monitoring Freshwater Improvements website.

Estimated average operational costs for a single E. coli sampling occasion from a lake or river.

	Lake sampling	River sampling
Laboratory analytical testing	$35*	$35
Boat operational costs	$260	n/a
Staff time – sampling and data processing	$330	$140
Mileage and consumables (e.g., ice, courier charges)	$60	$40
Total per sampling occasion	**$685**	**$215**

**For one sample.*

Monitoring E. coli is vital for assessing risk to human health where recreational use of a river or lake is high.

Opportunities for high-frequency monitoring of *E. coli*

A portable instrument, ColiMinder, can provide estimates of *E. coli* concentrations within 30 minutes and collection of up to 50 samples per day. It is being tested for high-frequency monitoring of lakes and rivers[2]. While the ColiMinder can support near-real-time variation of *E. coli*, it is time consuming and expensive at potentially more than $200,000 for a single comprehensive monitoring station. In the context of being comparable to a routine *E. coli* monitoring programme based on manual samples, it is considered prohibitively expensive for widespread adoption and rollout.

Other new technologies for automated or semi-automated *E. coli* monitoring include optical tryptophan sensors and mobile molecular assays. Optical tryptophan sensors provide real-time results and negate consumable costs but are at an experimental stage of field deployment. Mobile molecular assays can provide fast results but are not automated and are expensive due to high consumables costs.

Automated culture-based technologies have been developed to reduce sample-to-result time. TECTA[3] is an automated microbial detection system that provides single-cell detection sensitivity for *E. coli* and total coliforms. ALERT[4] (Automatic Lab-in-vial *E. coli* Remote Tracking) allows quantification of viable and culturable *E. coli* without the need for multiple dilutions and human intervention. The fully automated Colifast ALARM[5] system can be used for daily monitoring for the presence/absence of *E. coli*. These technologies typically produce results within 1 to 18 hours depending on the initial concentration of culturable bacteria in the sample.

While high-frequency *E. coli* monitoring technologies offer many advantages related to reduced sample-to-result time, their application is limited, further testing is required, and validation of their accuracy with field measurements is limited. At the present time their application is largely experimental and requires testing across different environments, including demonstration of their value-for-money against conventional sampling methods.

Further Reading

[1] *National Environmental Monitoring Standards Water Quality, Part 2 of 4: Sampling, Measuring, Processing and Archiving of Discrete River Water Quality Data; and National Environmental Monitoring Standards Water Quality, Part 3 of 4: Sampling, Measuring, Processing and Archiving of Discrete Lake Water Quality Data. Both documents available at: https://nems.org.nz/documents/*

[2] *Cazals et al., 2020. Near real-time notification of water quality impairments in recreational freshwaters using rapid online detection of β-D-glucuronidase activity as a surrogate for Escherichia coli monitoring. Science of the Total Environment 710: 137303. https://doi.org/10.1016/j.scitotenv.2020.137303*

[3] *Bramburger, A.J., Brown, S.R., Haley, J., Ridal, J.J. 2015. A new, automated rapid fluorometric method for the detection of Escherichia coli in recreational waters. Journal of Great Lakes Research 41: 298-302. https://doi.org/10.1016/j.jglr.2014.12.008*

[4] *Angelescu, D.E., Huynh, V., Hausot, A., Yalkin, G., Plet, V., Mouchel, J.M., Guérin-Rechdaoui, S., Azimi, S., Rocher, V. 2018. Autonomous system for rapid field quantification of Escherichia coli in surface waters. Journal of Applied Microbiology, 126: 332-343. https://doi.org/10.1111/jam.14066*

[5] *Tryland, I., Fiksdal, L. 1998. Enzyme characteristics of β-D-Galactosidase and β-D-Glucuronidase-positive bacteria and their interference in rapid methods for detection of waterborne coliforms and Escherichia coli. Applied Environmental Microbiology 64(3): 1018-1023. https://doi.org/10.1128/AEM.64.3.1018-1023.1998*

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