BAY OF PLENTY REGIONAL COUNCIL
TOI MOANA

Recreational Waters Surveillance Report

2019/2020 Bathing Season

Bay of Plenty Regional Council
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Recreational Waters Surveillance Report 2019/20

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Executive Summary

The Bay of Plenty Regional Council (BOPRC) undertakes annual water quality surveys of 68 popular recreational bathing sites, and 11 shellfish collection areas over the summer period (October to March). In addition, 13 lake bathing sites, with a history of algal blooms, are tested for the presence of potentially harmful cyanobacteria (blue-green algae). This information is used by public health and local authorities to advise the community on the suitability of water for bathing or shellfish collection.

Bathing water quality

The 2019/20 bathing season saw a similar climate pattern to 2018/19, with an extended 'drier than normal' period from January to March. The main climatic difference between the two seasons was absence of the heavy rainfall events that occurred in November and December 2018.

Similar to the 2018/19 season, Kaiate Falls was the worst performing river site, however, the percentage of samples exceeding the red (action) mode threshold increased from 52% to 86%. Other poor performing sites included: Utuhina at Lake Road, Ngongotaha at Railway Bridge, Uretara at Henry Road Ford, and Kopurererua at McCord Avenue, all of which breached the amber (action) mode threshold for at least 50% of samples.

Ngongotaha at Railway Bridge shifted down a band for the human contact attribute (Table 9 in the NPS-FM), to join Kaiate at Kaiate Falls with an 'E' ranking. Statistics from this site show that contamination events have become larger and more frequent with time, causing the percentage of samples exceeding the red (action) mode threshold to breach the 30% limit between a 'D' and 'E' band.

Overall, 53.3% of the regions' river bathing sites were classed as suitable for primary contact over the 2015-2020 analysis period. This figure represents all monitored river bathing sites, and may differ from the figure presented in the Long Term Plan (LTP) KPI which is based on a smaller subset of sites, and uses different analysis methods. This figure is lower than the national 2030 target of 80%, and the 2040 target of 90% of sites suitable for primary contact.

No river bathing site improved from 'un-suitable' for primary contact to 'suitable' between 2018/19 and 2019/20 analysis periods, although the following sites declined from 'suitable' to 'un-suitable': Utuhina at Pukehangi Road, Pongakawa at SH 2, and Whakatāne at Landing Road.

In addition to the traditional human contact attribute, which covers all sites in the region, the new amendment to the National Policy Statement (NPS) introduces a more stringent attribute to assess primary contact sites (Table 22 in the NPS-FM), which saw 53% of river sites breaching the national bottom line. Many of these sites breached due to one-off events that increased the 95th percentile value above the national bottom line of 540 cfu/100 ml.

Only four lake sites in total breached the amber (alert) mode threshold in 2019/20, a reduction from six sites in 2018/19. However, three of those four sites experienced greater levels of contamination, with Lake Rotorua at Ngongotaha, Lake Rotorua at Holdens Bay, and Lake Rotorua at Hamurana breaching the red (action) mode threshold on at least one occasion. Contamination at Lake Rotorua at Ngongotaha, and Lake Rotorua at Holdens Bay is likely a consequence of inputs from agricultural watersheds, with some unknown local sources (in the case of Holden's Bay), while observations of increased birdlife in comparison with previous years around the Hamurana jetty, may explain elevated results at that site. Lake Rotorua at Ngongotaha was the only lake site to be classed as unsuitable for primary contact under Table 9 of the NPS-FM, but all three Lake Rotorua sites breached the national bottom line for the primary contact attribute (Table 22 of the NPS-FM).

Estuarine sites performed better than the previous season, with no site breaching the red (action) mode threshold, and all sites having median enterococci levels lower than 50 cfu/100 ml. The reason for the reduction from 2018/19 is unknown, but is possibly liked to climatic variables resulting in less large run-off events in contributing catchments.

Four coastal bathing sites breached the amber (alert) mode threshold in 2019/20, an increase from two sites in 2018/19. Conversely, the two sites that breached in the previous season returned to 100% compliance with the green (surveillance) mode, indicating that breaches are likely random events. However, one site, Ōhope at Surf Club, also breached one of the thresholds for shellfish monitoring, and may require further investigation if high results persist.

Shellfish water quality

Five shellfish sites (45%) breached both thresholds in the New Zealand Microbiological Guidelines for Recreational Waters and are considered unsafe areas for collecting shellfish for human consumption. These sites are: Waihi Estuary at Main Channel, Tauranga Harbour at Tilby Point, Tauranga Harbour at Anzac Bay, Maketū at Surf Club, and Waiōtahe at Estuary. However, median results from two of the worst performing sites in 2018/19, Waihi Estuary at Main Channel, and Waiōtahe at Estuary have improved remarkably in the 2019/20 season.

Cyanobacteria monitoring

Cyanobacteria biovolumes were much reduced this season, compared with last season. This was particularly so for Lake Rotoehu, which did not breach the 'total biovolume' red (action) mode threshold over the entire season, after spending most of 2018/19 under a health warning. Overall, there were two health warnings for Lake Okaro, and a broad health advisory that covered minor blooms in Ōhau Channel, Okere Arm, Rotoehu, Okawa Bay, and Lake Rotoiti, put in place due to logistical constraints associated with the COVID-19 lockdown.

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Part 1: Introduction

Overview

The Bay of Plenty Regional Council (BOPRC) undertakes annual water quality surveys of popular recreational (bathing) sites and shellfish beds over the warmer months (October to March). These surveys assist in identifying the risk to public health from faecal contamination at these areas. The information is then used by public health and local authorities, to advise the community on the suitability of water for bathing or shellfish consumption.

There are a number of regional plans that have objectives based on a contact recreation standard, these are:

- On-site Effluent Treatment (OSET) Regional Plan,
- Operative Regional Natural Resources Plan,
- Regional Coastal Environmental Plan, and
- Regional Policy Statement.

Planktonic cyanobacteria (blue-green algae) are also monitored in lakes due to the health risk they present to public recreating in river and lake waters. This report summarises the annual recreational water quality monitoring results for the 2019/20 season and also presents recent shellfish monitoring results.

Legislative framework and responsibilities

The National Policy Statement for Freshwater Management (NPS-FM) (2020) has the objective to safeguard the health of the environment, people and communities. Appendix 2 of the NPS-FM sets thresholds for numeric attributes, ranked into four or five bands (A-D or E), defining water quality for ‘human contact’, ‘ecosystem health’, ‘threatened species’, and ‘mahinga kai’ (Ministry for the Environment, (MfE), 2020).

The Microbiological Water Quality Guidelines (NZMWQG)(MfE, 2003) provides a recommended framework of roles and responsibilities of the agencies involved in recreational water quality monitoring. Based on this framework, a protocol for monitoring and reporting has been developed for the Bay of Plenty, which involves: the Bay of Plenty Regional Council (BOPRC), district councils, and the district health board (Toi Te Ora).

Recreational water quality objectives

The objectives of the BOPRC's recreational water quality monitoring programme are to:

- Assess the suitability of popular swimming sites in the Bay of Plenty, for contact recreation over summer.
- Provide information on the suitability of shellfish for human consumption.
- Assist in safeguarding the life-supporting capacity of water, including public health.
- Provide a mechanism to determine the effectiveness of regional plans.
- Provide information for State of the Environment monitoring, regionally and nationally.
- Assist in identifying areas of poor water quality and help to identify the causes of this so remedial action can be initiated.

Bathing surveillance, shellfish, and cyanobacteria sites that were monitored over the 2019/20 season are shown in Figure 1.1.

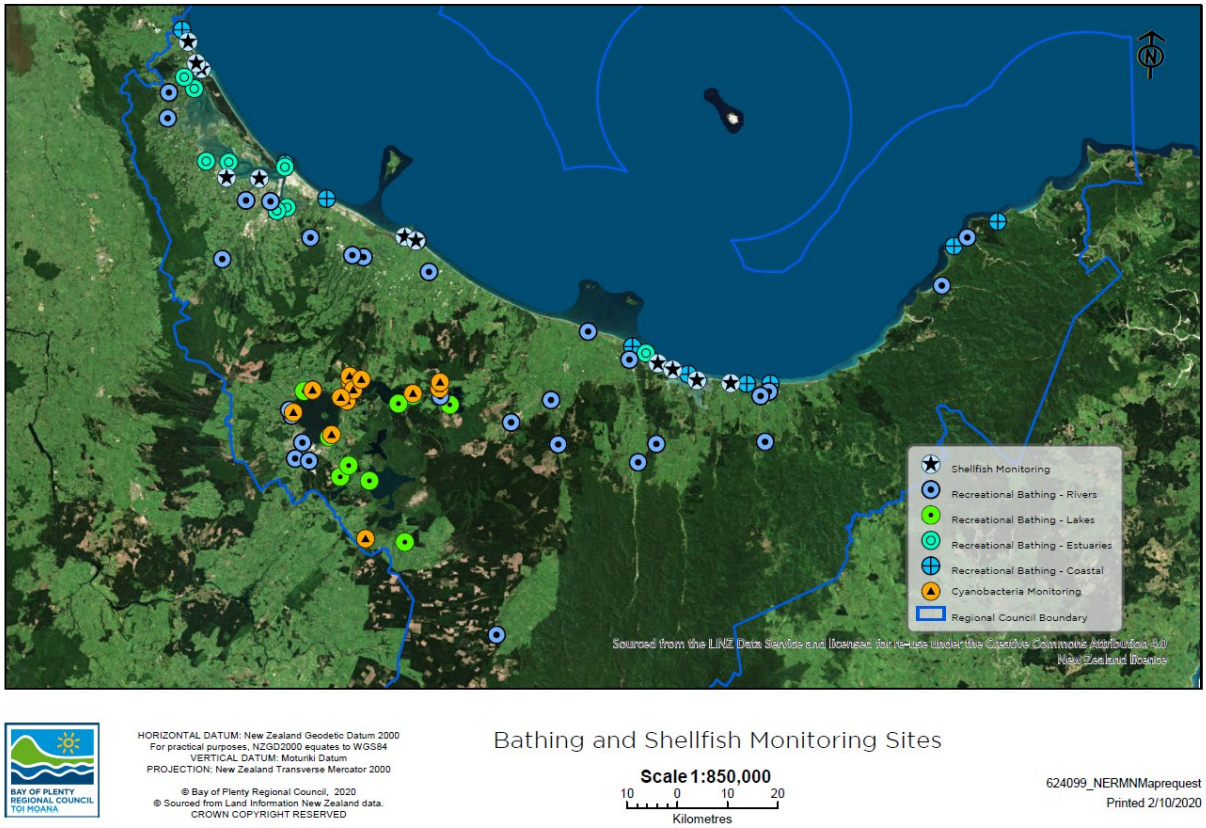


Figure 1.1 Bathing surveillance monitoring sites for the 2019/20 monitoring season, Bay of Plenty.

Part 2:
Bathing Water Quality

Introduction

If human or animal faecal matter finds its way into waters of recreational value, there is a risk that water users will be exposed to a diverse range of pathogenic (disease causing) micro-organisms. A variety of organisms are present in faecal matter such as viruses, bacteria, protozoa (single cell organisms), and helminths (nematodes). These can reach water bodies via a variety of pathways and in varying concentrations.

The impacts of pathogenic micro-organisms on human health are commonly manifested as gastro-enteritis, but other common illnesses include respiratory problems and skin rashes. Serious illness can also be attributed to infection from pathogens contained in waters, for example, hepatitis A, giardiasis, cryptosporidiosis, campylobacteriosis and salmonellosis (MfE, 2003).

As it is difficult and impractical to measure all potentially pathogenic micro-organisms in water, indicator bacteria are used to assess recreational water quality. Indicator bacteria give an indirect measure of pathogen levels. The bacteriological indicators chosen are associated with the gut of warm blooded animals and are common in faecal matter. While these indicator bacteria are not generally harmful themselves, they do indicate the presence of harmful pathogens. BOPRC uses two indicator bacteria:

- Freshwaters - Escherichia coli (*E. coli*), and
- Marine/Estuarine waters - Enterococci.

The use of these two indicators is stipulated in the New Zealand Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (NZMWQG) (MfE, 2003). Research that relates illness to indicator bacterial levels has been used to develop guideline levels for these indicator bacteria which are based on the tolerable risk to healthy people. The guidelines provide a method to grade recreational waters and trigger levels which can be used by water managers and the public to assess the potential health risk of using recreational waters. Single water sample results can be compared to guideline values to help determine if a health alert or other action should be undertaken.

Sampling and analysis

Before the start of the bathing season, a monitoring plan was designed and circulated for comment to Toi Te Ora Public Health, and city or district councils (Opotiki, Kawerau, Rotorua, Western Bay and Tauranga). The criteria for selection of sites included whether they were high-use bathing locations and whether there was known contamination risk. Other sites have been included in the monitoring list at the request of the community.

Monitoring began in late October 2019 and ran until the end of March 2020. Surface water samples were collected weekly or once every two weeks from 60 sites across the Bay of Plenty region. Sampling occurred between 8:00 am and 3:30 pm and was completed by either wading or use of a sample pole. Sterile 200 ml polyethylene bottles were used to sample water at a representative location in the water column. Finally, samples were transported on ice to BOPRC's laboratory1 for processing using the methods outlined in Table 2.1

Table 2.1 Methods used for analysis of water samples.

Parameter (abbreviation)	Method	Detection limit/units*
***Escherichia coli* (*E. coli*)**	Membrane filtration (APHA 2005)	1 cfu/100 ml
Faecal coliform (FC)	Membrane filtration (APHA 2005)	1 cfu/100 ml
Enterococci (Ent)	Method No 1600, USEPA1985 EPA-821-R-97-004	1 cfu/100 ml
***cfu/100 ml = colony forming unit/100 ml**		

Microbiological water quality guidelines

The NZMWQG provide the framework for assessing the health risk associated with faecal contamination of water. There are two analysis stages that compose the guidelines. The first is used to compare weekly monitoring results with the microbiological guidelines over a bathing season, providing water managers with a tool for assessing more immediate health risk to the public. The second analysis stage is a site grading providing the suitability for recreation over time, using a combination of information from microbiological bathing survey results and catchment characteristics. Each analysis stage is detailed below.

Analysis Stage One: Weekly grading

A three-level management framework has been adopted to help signal when recreational waters are potentially at risk to users. The system uses the colours green (safe mode, 'surveillance'), orange (cautionary mode, 'alert') and red (unsafe mode, 'action') to denote the level of risk to users. The indicator bacteria levels and recommended management responses to these modes are listed in Table 2.2. This framework is used to assess the weekly health risk of recreational waters as individual sample results are obtained.

[1] BOPRC's laboratory holds International Accreditation of New Zealand (IANZ) accreditation.

Table 2.2 Surveillance, alert and action modes for fresh and marine waters used in the three tiered management framework for weekly assessment of health risk of recreational waters (MfE, 2003).

Variant	Mode	Guideline	Recommended management response
Freshwater	Green/Surveillance	Single *E. coli* sample <= 260	Routine monitoring.
	Orange/Alert	Single *E. coli* sample > 260 and <=550	Increased monitoring, identify possible sources.
	Red/Action	Single *E. coli* sample > 550	Public warnings, increased monitoring, source investigation.
Marine	Green/Surveillance	Single enterococci sample <= 140	Routine monitoring.
	Orange/Alert	Single enterococci sample > 140	Increased monitoring, identify possible sources.
	Red/Action	Two consecutive single enterococci samples > 280	Public warnings, increased monitoring, source investigation.

Surveillance mode (green) indicates that there is an acceptable risk to recreational water users. Should waters be found to be in alert mode (orange) then there is an increased risk of illness if contact is made with recreational waters. Action mode (red) indicates that waters pose an unacceptable health risk to recreational water users. In such a case, the health authority will assess the risk to public health and if necessary, and issue health warnings in conjunction with local authorities. Use of NZMWQG and the issuing of health warnings are dependent on the circumstances surrounding any contamination event.

Analysis Stage Two: Suitability for Recreation Grade

The NZMWQG outline a process to grade the suitability of marine and fresh waters for recreational use. A Suitability for Recreation Grade (SFRG) is generated through a combination of qualitative assessment of susceptibility of recreational sites to faecal contamination and by direct weekly measurement of appropriate bacteriological indicators at the site. The alert and action levels described above provide a real time indication of the changing risk over a bathing season. In contrast, the SFRG describes the risk of faecal contamination at a given site over several bathing seasons.

The SFRG is made up of two components (Figure 2.1):

- The Sanitary Inspection Category (SIC) is composed of five ratings from very low to very high, which are dependent upon the presence and potential effect of faecal contaminant sources. It generates a measure of susceptibility of a water body to faecal contamination from potential water quality risk factors close to swimming spots, such as sewage outfalls, stormwater drains, stock in waterways and run-off from land; and
- Historical microbiological results (weekly indicator bacteria monitoring results) are used to generate the Microbiological Assessment Category (MAC), which provides a measurement of actual water quality over time.

These two components combine to give an overall SFRG, which describes the general condition of a site at any given time, based on both risk and indicator bacteria counts. The five grades in the SFRG range from 'Very Good' to 'Very Poor'. These grades help determine whether ongoing monitoring is required, and provide the basis for informing the community whether water is suitable for recreational use from a public health perspective. If there is an incompatibility between the SIC and the MAC, (this may be due to limited data) then a 'Follow Up' grade is given.

The SIC is developed from a Catchment Assessment Checklist (CAC) (see MfE and MoH, 2003) which explores land use, water use and characteristics, microbiological hazards, discharges, littoral drift, climatic influences, and other influences present in the catchment or the beach under analysis. Once a CAC has been completed, a SIC grade can be allocated. Bay of Plenty Regional Council updated the SIC grade for all bathing sites in early 2019. The SIC scores are calculated using the Bathewatch software developed by the Ministry for the Environment (MfE).

The grading system developed by MfE and MoH is prescriptive with a view to keeping it uncomplicated and user friendly. The only room for interpretation is within the CAC when determining microbiological hazards.

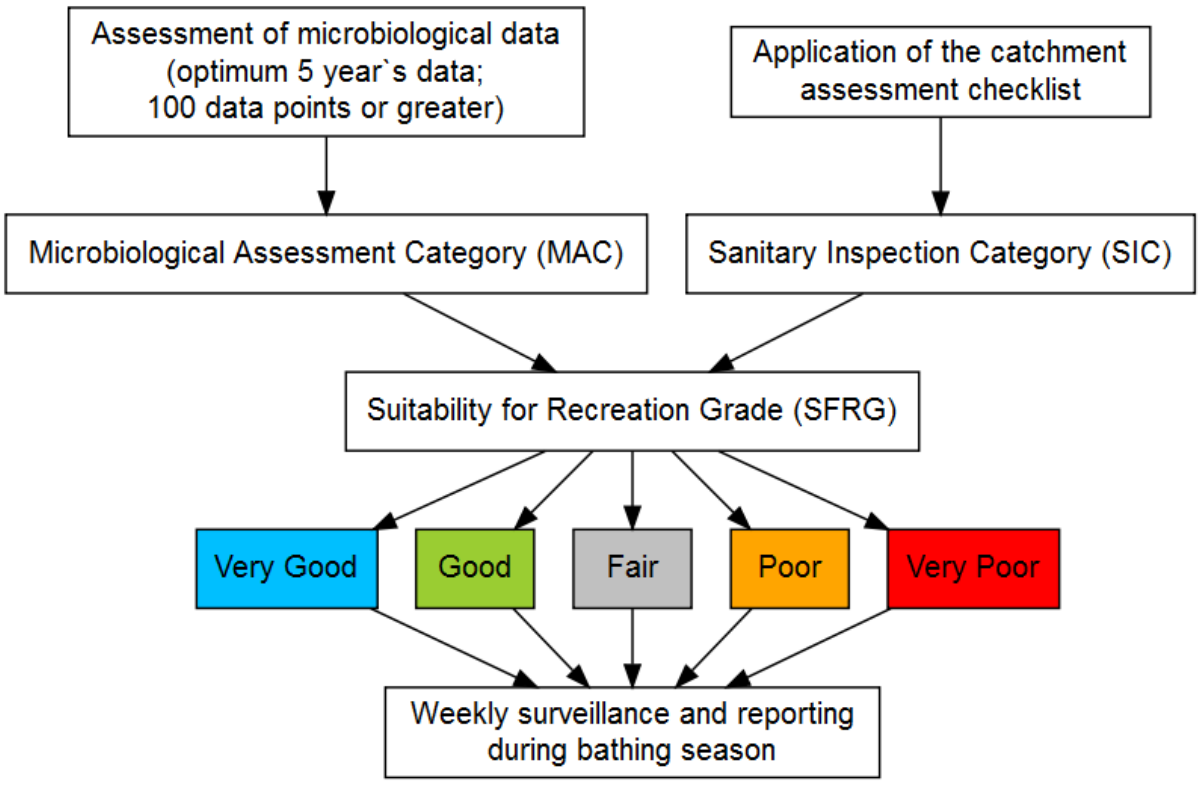


Figure 2.1 Components of the Suitability for Recreation Grade (SFGR) (From MfE and MoH, 2003)

The MAC is calculated as the 95th percentile of the last five years of historic faecal bacteria indicator data. Enterococci is the preferred indicator bacteria for marine waters and *Escherichia coli* (*E. coli*) is the indicator bacteria for freshwaters. Ideally, at least 20 samples collected from each site on a weekly basis during a bathing season, over a five year period to provide at least 100 sample points, are required for the MAC assessment. This has not occurred for all Bay of Plenty sites, so MAC evaluations are based on available data.

The SFRGs have been determined for recreational sites in the Bay of Plenty region since 2005. Updated SFRG's incorporating the most recent season's microbiological water quality results are summarised in Appendix 1a and 1b, which are based on the last five year's data.

National Policy Statement for Freshwater (NPS-FM)

There are two tables in the 2020 release of the NPS-FM (MfE, 2020) that are used to assess the state of bathing sites within the region. The first (Table 2.3; Table 9 in the NPS-FM) is intended to be applied to all National Environmental Regional Monitoring Network (NERMN) river and lake sites within the region. Attribute state is determined using a minimum of 60 samples over a maximum of five years, collected on a regular basis regardless of weather and flow conditions. However, where a sample has been missed due to adverse weather or error, attribute state may be determined using samples over a longer timeframe (MfE, 2020). This table is part of Appendix 2A of the NPS-FM which means that limits must be set to either: prevent sites from degrading, or improve sites to a level suitable for human contact (A-C).

Appendix 2A of the NPS-FM also states that the *E. coli* attribute state (A-E) must be determined by satisfying all numeric attribute states outlined in the *E. coli* attribute table. More often than not, numeric attribute states line up to provide a consistent *E. coli* attribute state. However, in some instances, numeric attributes can cross multiple *E. coli* attribute state bands, which violates the requirement stated above. This report deals with this problem by employing the following logical steps:

1 If all numeric attributes line up to satisfy the requirements of a single attribute state band, then that attribute state band is adopted.

2 If numeric attributes cross multiple attribute state bands, the band corresponding to the worst numeric attribute is adopted. In the case of the numeric attribute 'median concentration', attribute bands A-C (<=130 cfu/100 ml) are equal so an 'average' attribute band of 'B' is attributed. For the numeric attribute '95th percentile', bands D and E are equal (>1200 cfu/100 ml) and a 'D' attribute band is attributed.

Table 2.3 *The bands and attribute states for the E. coli attribute as outlined in the National Policy Statement for Freshwater (MFE, 2020; Table 9).*

Attribute State	Exceedances over 540 (%) (E. coli/100 ml)	Exceedances over 260 (%) (E. coli/100 ml)	Median (E. coli/100 ml)	95th Percentile (E. coli/100 ml)	Narrative
What it means	How often the river exceeds the acceptable threshold for swimming	How often the river goes over the point where additional monitoring is needed at primary contact sites	The mid-point (i.e. half the time *E. coli* is lower than this, half the time it is higher)	*E. coli* only rarely goes past this point (only 5% of the time)	Risk of Campylobacter infection (based on *E. coli* indicator)
A (Blue)	<5%	<20%	<=130	<=540	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 1%
B (Green)	5-10%	20-30%	<=130	<=1000	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 2%
C (Yellow)	10-20%	20-34%	<=130	<=1200	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 3%
D (Orange)	20-30%	>34%	>130	>1200	For at least half the time, the estimated risk is =50 in 1,000 (>5% risk). The predicted average infection risk is >3%
E (Red)	>30%	>50%	>260	>1200	For at least half the time, the estimated risk is =50 in 1,000 (>5% risk). The predicted average infection risk is >7%

The second table (Table 2.4; Table 22 in the NPS-FM) is intended only for primary contact (bathing) sites, and is therefore more stringent than Table 2.3 (Table 9 in the NPS-FM). This table has a single numeric attribute (95th percentile), and a shorter analysis period spanning a single bathing season. This table is included in Appendix 2B of the NPS-FM, which requires action plans be established for poor performing sites to ensure that community values are met in the future, rather than specifically requiring the setting of contaminant limits.

Table 2.4 The bands and attribute states for the E. coli (Primary contact) attribute as outlined in the National Policy Statement for Freshwater (MFE, 2020; Table 22).

Attribute State	Description	95th Percentile (*E. coli*/100 ml)
Excellent	Estimated risk of *Campylobacter* infection has a < 0.1% occurrence, 95% of the time.	<=540
Good	Estimated risk of *Campylobacter* infection has a 0.1 – 1.0% occurrence, 95% of the time.	<=1000
Fair	Estimated risk of *Campylobacter* infection has a 1 – 5% occurrence, 95% of the time.	<=1200
Poor	Estimated risk of *Campylobacter* infection has a > 5% occurrence, at least 5% of the time.	>1200

Data preening

Many of the monitored bathing sites are also regional NERMN sites or involved in catchment specific investigations. The objectives of these programmes differ from that of the bathing programme. For example, a catchment investigation objective may be to understand *E. coli* concentrations at different stages of the hydrograph, so a flood peak may be intensively sampled. Despite these data being collected at the same site and measuring the same parameter, these additional samples can affect analysis and be misleading to the person interpreting the results. For this reason, the current study is limited to samples that were collected as part of the bathing, shellfish, or cyanobacteria monitoring programmes.

Results

Overview

Lake sites were once again the best performing freshwater category, with nine of 12 sites (75%) categorised as ‘very good’ according to the SFRG grade, and only two sites being classed as a ‘poor’. This result is the same as the previous season, with the same sites, Lake Rotorua at Hamurana and Lake Rotorua at Ngongotaha, being attributed ‘poor’ SFRG grades.

The majority of river bathing sites were either rated ‘poor’ or ‘very poor’ (66.6% in total), compared to 56.7% in the 2018/19 season. Furthermore, only 23.3% were rated ‘good’ or ‘very good’, a reduction from 30% in 2018/19.

Estuarine sites defied the declining pattern seen in river and lake sites, with an increase in the number of sites rated ‘good’ or ‘very good’, from 53.3% in 2018/19 to 73.3% in 2019/20.

As expected, open coastal sites were the best performing group overall, although results were not as good as in 2018/19. The current season saw one site, Ōhope at Surf Club, ranked ‘poor’; in contrast 2018/19 had no sites ranked lower than ‘good’.

Detailed results of the monitoring are presented in tabular form in Appendix 1a–1d. These tables give information on the 95th percentile value, MAC score, SIC score, SFRG, as well as NPS-FM attribute banding (where applicable). The SFRGs are presented in Figures 2.2 and 2.3.

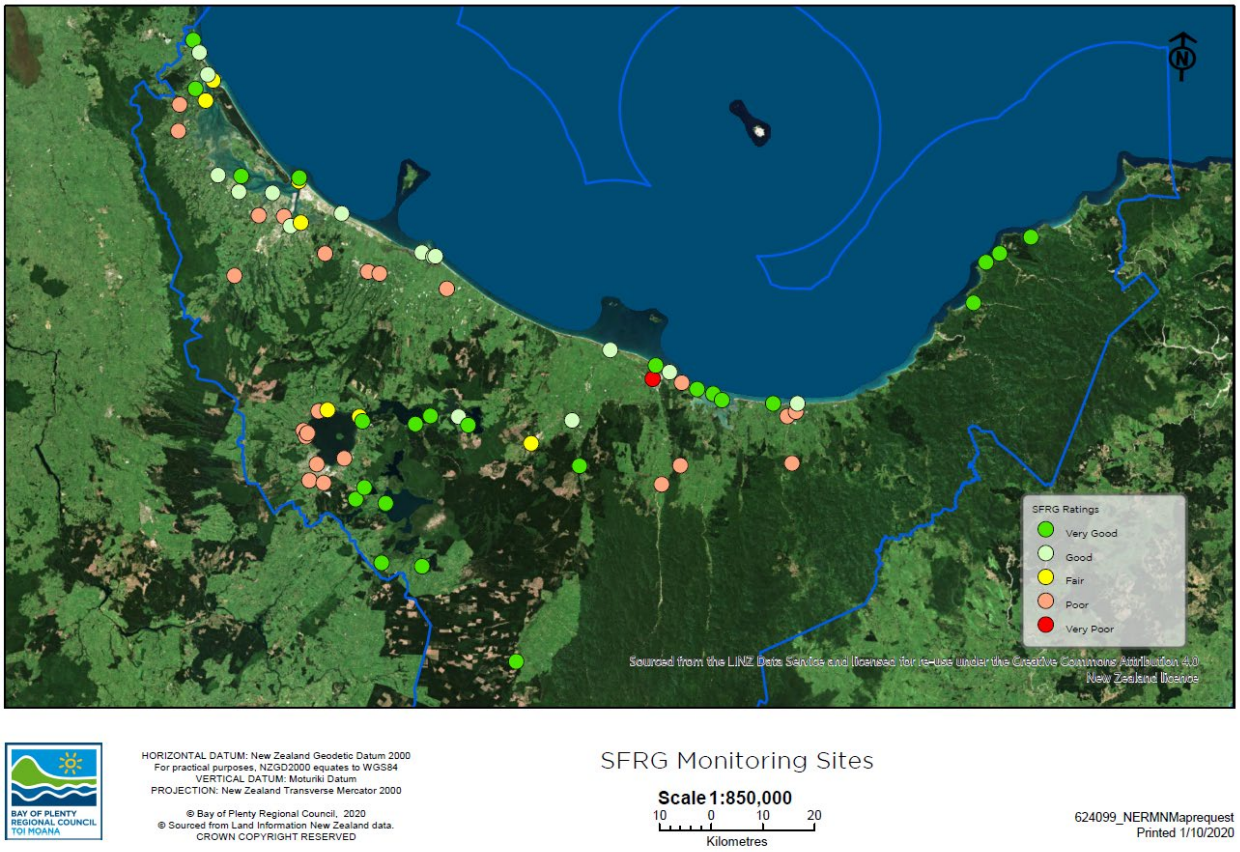


Figure 2.2 *Suitability for Recreation Grades for Bay of Plenty contact recreation monitoring sites, 2019/20.*

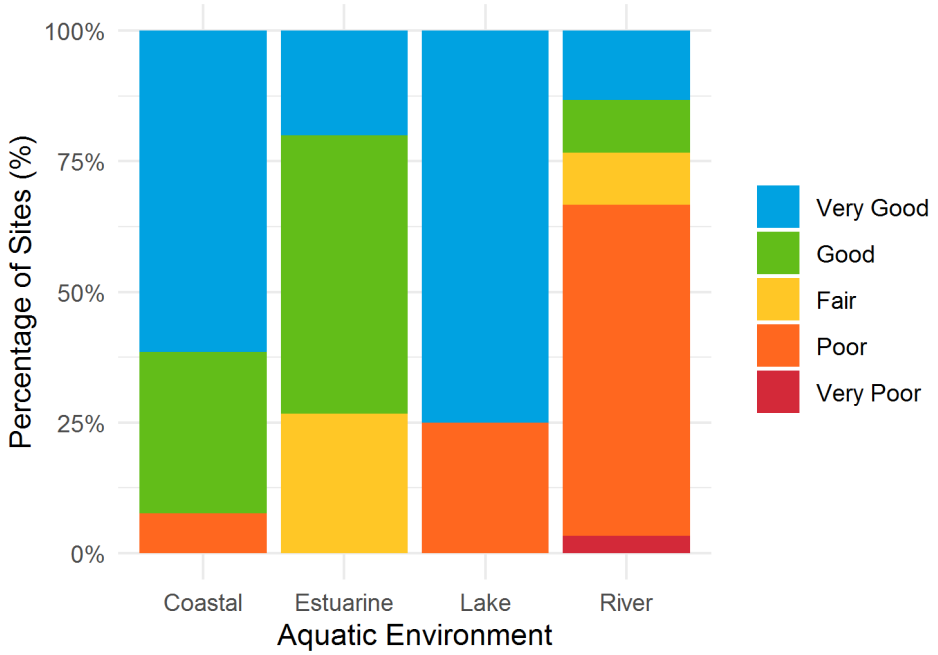


Figure 2.3 Comparison of the 2019/20 results for the SFRG across aquatic environments.

Table 2.5 shows the percentage of samples that were lower than the red (action) mode in the NZMWQG over the past season, and, for comparison, a summary of data from the past five years. This table suggests that river sites, lake sites, and open coastal sites performed worse in the 2019/20 season, compared to the past five seasons, while estuarine sites performed better.

Table 2.5 Percentage of weekly samples from monitored bathing sites with indicator bacteria levels less than the Red/Action Mode, as defined by the New Zealand Microbiological Water Quality Guidelines (MfE, 2003).

		Rivers	Lake	Estuarine	Coastal
Samples less than the Red/Action Mode (%)	**2019/20**	87.3	97.2	98.8	98.9
	Last 5 Years	89.2	97.8	97.5	99.1

River and stream sites

The percentage of samples per site falling within each level of the microbiological guidelines (i.e. green (surveillance), amber (alert), and red (action)), for the 2019/20 season is shown in Figure 2.4. Of the 30 monitored river sites, 20 (67%) had samples that exceeded the red (action) mode threshold on one or more occasions, while a further five sites (25 total; 83%) breached the amber (alert) mode threshold.

Kaiate Falls at Kaiate Road was the worst performing site for 2019/20, a continuation from 2018/19. However, results for this site were noticeably worse for the 2019/20 season compared with 2018/19, where the number of samples in the red (action) mode increased from 52% to 86%, while the number of samples in green (surveillance) mode remained relatively constant (approximately 5% for both seasons). These results describe a pattern where a number of amber (alert) mode results have elevated to levels that now exceed the red (action) mode threshold.

Utuhina at Lake Road was the next worst performing site, up from fourth worst in 2018/19, with 38% of samples in the red (action) mode, followed by Ngongotaha at Railway Bridge, Uretara at Henry Road Ford, and Kopurererua at McCord Avenue, all of which had greater than 50% of samples exceed the amber (alert) mode threshold.

Each of the aforementioned sites is the subject of a new (or existing) 'focus catchment' investigation. These investigations have been initiated by BOPRC to address declining water quality in the most vulnerable

catchments in the region. Outlines of focus catchment investigations which have relevance to bathing sites are provided in Part 5.

Eighteen of the 30 monitored river sites had 95th percentile values greater than the red (alert) mode threshold. Ngongotaha at Railway bridge had a 95th percentile of 7050 cfu/100 ml, more than double the 95th percentile value for the second highest site, Kaiate at Kaiate Falls. Both of these sites also have median values above the amber (alert) mode threshold, with the latter closer to the red (action) mode threshold.

The difference between the median and 95th percentile values for these two sites highlights the different response dynamics within each catchment. Results from the Ngongotaha site imply that a small number of short-lived, extreme events cause dramatic increases in faecal contamination above typical (median) values. The Kaiate Catchment also had a small number of extreme, elevated results, but the smaller difference between median and 95th percentile statistics shows that extreme results are more similar to 'typical' results for this catchment. This implies that contamination is supplied through a consistent vector, e.g. direct deposition of faecal matter, or re-supply of faecal bacteria from sediment reservoirs.

Hudson (2019) collated faecal bacteria results from the Kaiate Falls Catchment, collected from 16 sites since 2015. This author found that *E. coli* concentrations were diluted at higher flows, and the greatest proportion of bacterial contamination came from the Otawera Stream, specifically the Owairoa Sub-catchment, the upper part of which is known to have areas where stock can access the stream (R. Carter, personal communication, September 2020). Mahon et al. (2020) reanalysed these data and included the 2019/20 bathing season. These authors concluded that elevated results over the 2019/20 season was likely caused by a drier than normal summer, where the absence of run-off events meant that faecal matter, deposited directly into the upper Owairoa Stream, was less diluted than in previous years.

Of the 30 monitored river sites, five had median values equal to or greater than the amber (alert) mode threshold, highlighting the possibility of adverse health effects occurring on most occasions when visiting these sites. The other 25 river sites had median values within the green (surveillance) mode, which shows that at least 50% of the time these sites are suitable for recreational contact.

Table 9 in the NPS-FM

River bathing sites were also assessed against both *E. coli* attributes in the NPS-FM (Table 2.3; Table 2.4). The human contact *E. coli* attribute (Table 9 in the NPS-FM; see Table 2.3) uses the most recent five seasons' worth of data, with a minimum requirement of 60 samples. Results show that 13 sites (43.3%) were attributed an 'A' grade, two sites (6.7%) were attributed a 'B', one site (3.3%) a 'C', 12 sites (40%) a 'D', and the final two sites (6.7%) an 'E' band (Table 2.6; Appendix 1a). Although the number of 'A' band sites remained consistent between the 2018/19 and 2019/20 analyses, there was a general slip for sites previously classified as a 'B' (20% of sites in 2018/19; 6.7% of sites in 2019/20) towards lower grades, leading to an increase in the number of 'C' (0% of sites in 2018/19; 3.3% of sites in 2019/20), 'D' (33.3% of sites in 2018/19; 40% of sites in 2019/20), and 'E' grades (3.3% of sites in 2018/19; 6.7% of sites in 2019/20).

Appendix 3 in the NPS-FM (MfE, 2020) outlines a national target for primary contact for specified rivers and lakes in New Zealand. Specified rivers and lakes are further defined as 'rivers of fourth order or greater', or 'lakes with a perimeter of 1.5 km or more', and sites are classed as 'suitable for primary contact' if the *E. coli* attribute equals either an 'A', 'B', or 'C band. With this in mind, of the 26 monitored bathing sites on fourth order or greater rivers, 14 (53.8%) were classed as suitable for primary contact over the 2015-2020 period. Conversely 46.2% were not suitable for primary contact. This is a reduction in suitable sites from 65.3% in 2018/19, and fails to meet the 2030, and 2040 National Target, where the percentage of sites suitable for primary contact is required to be 80% and 90%, respectively. If all river bathing sites, regardless of order, are classified using the same definition, 53.3% of sites are deemed suitable for primary contact, and 46.7% are unsuitable (Table 2.6).

Sites that were 'suitable for primary contact' over the 2014-2019 period, but are 'un-suitable' for the 2015-2020 period include: Utuhina at Pukehangi Road, Pongakawa at SH 2, and Whakatāne at Landing Road, all of which shifted from a 'B' grade to a 'D'. No sites changed from 'un-suitable' to 'suitable' between these two periods.

Ngongotaha at Railway Bridge was the only new site to be classed within the lowest band ('E'), joining Kaiate at Kaiate Falls. The most noticeable site statistics changes for the Ngongotaha site were a large increase in the 95th percentile *E. coli* concentration (2896 cfu/100 ml in 2018/19; 6560 cfu/100 ml in 2019/20) and a moderate increase in the mean concentration (875.2 cfu/100 ml in 2018/19; 1048 cfu/100 ml in 2019/20), both of which suggest that contamination events are becoming larger with time. This caused 'the percentage of samples greater than 540 cfu/100 ml' attribute statistic to breach the 30% threshold for grade bands 'D'/'E'.

Table 22 in the NPS-FM

The NPS-FM revision that was released in August 2020 provided an additional *E. coli* attribute for assessing primary contact sites (see Table 2.4; Table 22 in the NPS-FM). This attribute uses a single statistic (95th percentile), and has an analysis period of the most recent season only. Results are summarised in Table 2.7 and detailed in Appendix 1a. In short, 53.3% of primary contact sites exceeded the National Bottom Line (NBL) of 540 cfu/100 ml and were rated 'Poor'. Furthermore, 13.3%, 10%, and 23.3% of sites were rated 'Fair', 'Good', and 'Excellent', respectively.

As mentioned previously, Table 22 in the NPS-FM is aimed at primary contact sites, where the risk of infection is greater than at other sites where non-immersive human contact may occur. Table 2.4 (Table 22 in the NPS-FM) reflects this by providing a more stringent assessment framework, where the NBL of 540 cfu/100 ml is less than half the 95th percentile numeric attribute value required for a site to move from 'C' to 'D', in the human contact *E. coli* attribute table (Table 2.3; Table 9 in NPS-FM). This tightened framework, in conjunction with the susceptibility of many bathing catchments to surface run-off caused by elevated rainfall, is the primary reason for the high percentage of sites exceeding the national bottom line.

The NPS-FM (MfE, 2020) requires action plans to be established to help improve sites that breach the NBL for this attribute. Some of the more obvious, poorly performing, sites are already the subject of a Focus Catchment investigation (e.g. Kaiate at Kaiate Falls; see Part 5), however, this assessment has highlighted that a number of seemingly well performing sites have one or two large contamination events per season, which is enough to breach the NBL. For example: Waioeka at Mouth of Gorge (median = 20 cfu/100 ml; 95th percentile = 3100 cfu/100 ml), Wairoa below McLaren Falls (median = 78 cfu/100 ml; 95th percentile = 1500 cfu/100 ml), or Kaituna at Te Matai (median = 90 cfu/100 ml; 95th percentile = 1400 cfu/100 ml). These infrequent, large, contamination events will be difficult to manage, and BOPRC needs to form a suitable method for addressing them.

Figure 2.4 *Percentage of samples from river and stream sites with E. coli concentrations (cfu/100 ml) in each of the modes of the Microbiological Water Quality Guidelines (MfE, 2003), 2019/20 bathing season.*

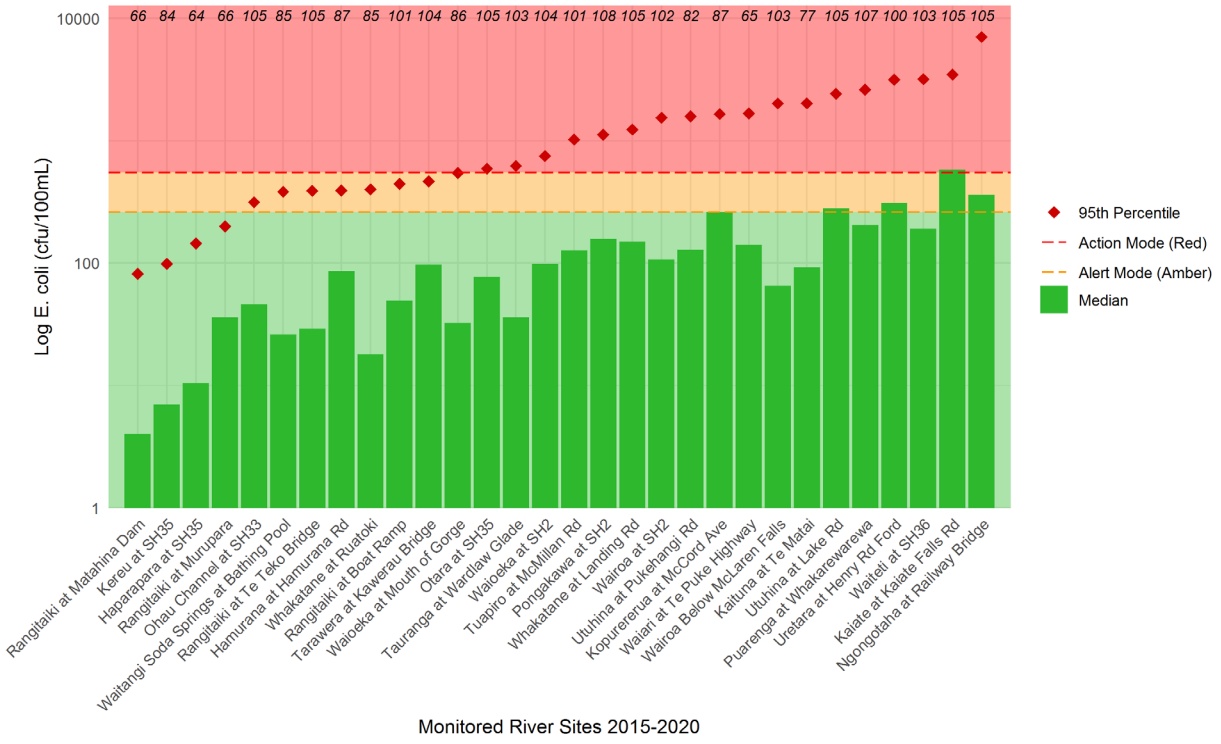


Figure 2.5 *95th percentile and median E. coli concentrations at river and stream sites over the past five years. The black numbers represent the number of samples available for the analysis period*

Table 2.6 *The percentage of river sites falling within each band specified in Appendix 2A of the NPS-FM, over the past five year period (2015-2020).*

Attribute State Band	A	B	C	D	E
Average infection risk	1%	2%	3%	>3%	>7%
% sites	43.3	6.7	3.3	40.0	6.7
n	13	2	1	12	2

Table 2.7 *The percentage of river sites falling within each band specified in Appendix 2B (Table 22) of the NPS-FM, over the past year (2019-2020).*

Attribute State Band	Excellent	Good	Fair	Poor
Estimated risk of Campylobacter infection	<0.1%	0.1-1%	1-5%	>5%
% sites	23.3	10.0	13.3	53.3
n	7	3	4	16

Lake sites

Figure 2.6 shows a summary of results from lake bathing sites for the 2019/20 bathing season. Of the 12 monitored sites, three Lake Rotorua sites (25%) (Lake Rotorua at Ngongotaha, Lake Rotorua at Hamurana, and Lake Rotorua at Holdens Bay) had samples that exceeded the red (action) mode threshold, with an additional site (Lake Tikitapu at Beach) breaching the amber (alert) mode threshold. The other eight sites had a 100% record within the green (surveillance) mode. This is an increase of one site breaching the red (action) mode threshold, and a reduction of two sites breaching the amber (alert) mode threshold, compared with the 2018/19 bathing season.

Lake Rotorua at Hamurana was the new addition to the list of lake sites reaching red (action) mode in 2019/20. This season was dramatically different from 2018/19 for this site, where samples were all below the amber (alert) threshold, suggesting that something may have occurred in the most recent season to cause elevation of faecal contamination results. Observations made by sampling staff, reiterated by BOPRC Lab Manager Adrian Spence (personal communication, August 2020), suggest that aquatic bird activity at the Hamurana site was much higher than in previous years, with evidence of avian excrement on the sampling jetty and local shoreline. This may be a driver behind the elevated results, although no definitive causal links have been identified.

Both of the other sites reaching the red (action) mode, Lake Rotorua at Ngongotaha and Lake Rotorua at Holdens Bay, did so on more occasions in 2019/20 than in 2018/19. Both of these sites are close to outflows from river systems (Ngongotaha River, Waingaehe Stream) draining catchments with significant agricultural land-use. Although faecal contamination is diluted by the volume of the lake, large rainfall events are known to cause elevated results at lake sites close to main outflows. In the case of Lake Rotorua at Ngongotaha, for example, the site experienced an *E. coli* concentration of 1400 on the 27th December 2019, a day after the Ngongotaha at SH 5 flow site recorded a discharge peak of close to 13m^3/sec (flow prior event = 1.0m^3/sec). The same site was elevated again on the 23rd March, following a much smaller discharge peak of 1.49 m^3/sec, however in this case, the peak was preceded by a period of low-flow beginning after the December event. This implies two things; firstly that the Ngongotaha Lake site responds to flow in the Ngongotaha Catchment, and secondly, the response may be influenced by the duration of the antecedent period where contamination can accumulate prior to the flushing event.

Similar to the 2018/19 season, Lake Rotorua at Ngongotaha, and Lake Rotorua at Hamurana had five year 95th percentile values that exceeded the red (action) mode threshold. However, the largest shift came from the Lake Rotorua at Holden's Bay site, where the five year 95th percentile increased from below the amber (alert) mode threshold in 2018/19 to just below the red (action) mode threshold in 2019/20, yet the median remained constant at around 10 cfu/100 ml for both years. This implies that a few large events have been captured in recent years, pushing the 95th percentile upwards, but overall conditions have remained relatively consistent. Further investigation into the results for 2019/20 revealed that Holden's Bay experienced two events where the *E. coli* concentration exceeded the red (action) mode threshold in 2019/20; one on the 20th January, and the other on the 23rd March. The March event coincides with a flow peak of 0.5m^3/sec on the Waingaehe Stream (an increase in pre-event flow by 100%), however there was no elevated flow recorded at the Waingaehe at SH 30 discharge site on the 20th January. This implies that this site may be influenced by a mix of sources, and further investigation may be needed.

Table 9 in the NPS-FM

Lake sites fared reasonably well when assessed against Table 9 in the NPS-FM (Table 2.3), with 11 out of 12 sites (92%) rated as suitable for primary contact (Table 2.8; Appendix 1b). This is worse than the 2018/19 analysis where all sites were ranked either an 'A' or 'B', with two main points of difference: degradation of the 'Lake Rotorua at Ngongotaha' site from a 'B' grade to a 'D', and degradation of 'Lake Rotorua at Hamurana' from an 'A' to a 'B'. Both of these sites scored lower due to an increased 95th percentile statistic.

Table 22 in the NPS-FM

Assessment against Table 22 in the NPS-FM (Table 2.4) was not as favourable, with all three Lake Rotorua sites (25%) breaching the national bottom line. This reflects the combination of: steep topography, elevated rainfall patterns, and agriculture in contributing sub-catchments, leading to short-lived 'event' conditions. All other sites were ranked either good (17%) or excellent (58%) (Table 2.9; Appendix 1b).

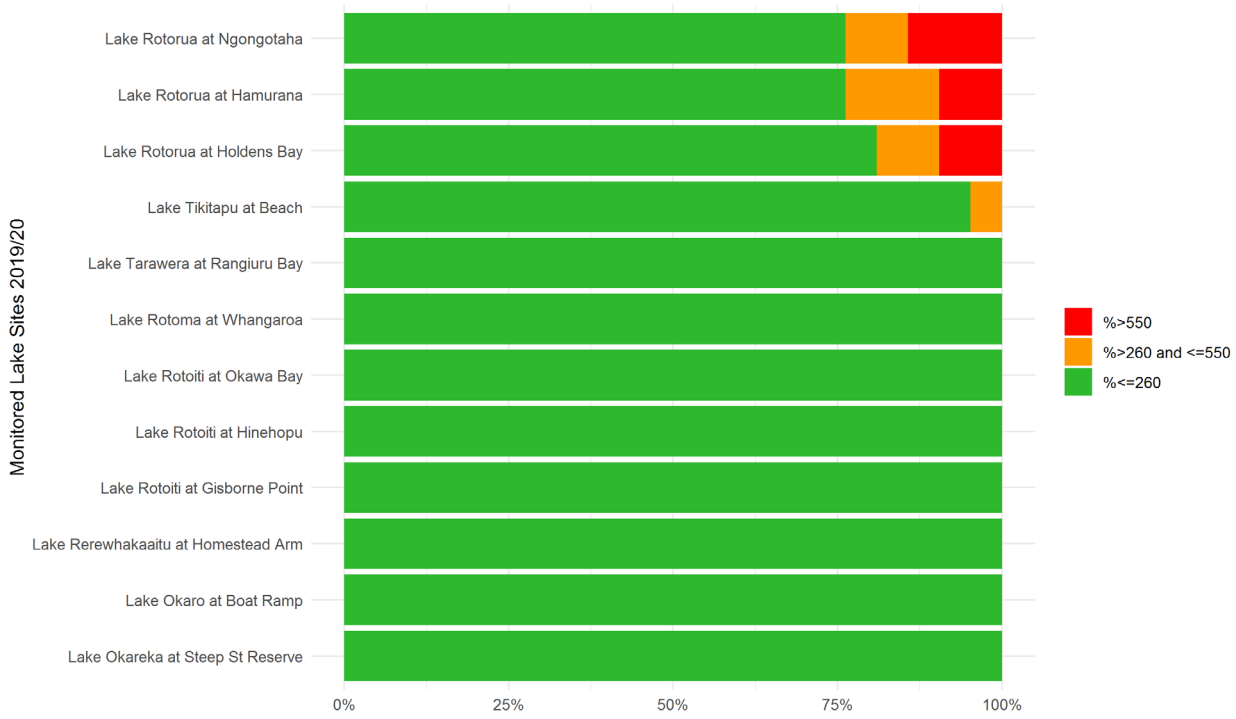


Figure 2.6 *Percentage of samples from lake sites with E. coli concentrations (cfu/100 ml) in each of the modes in the Microbiological Water Quality Guidelines (MfE, 2003), 2019/20 bathing season.*

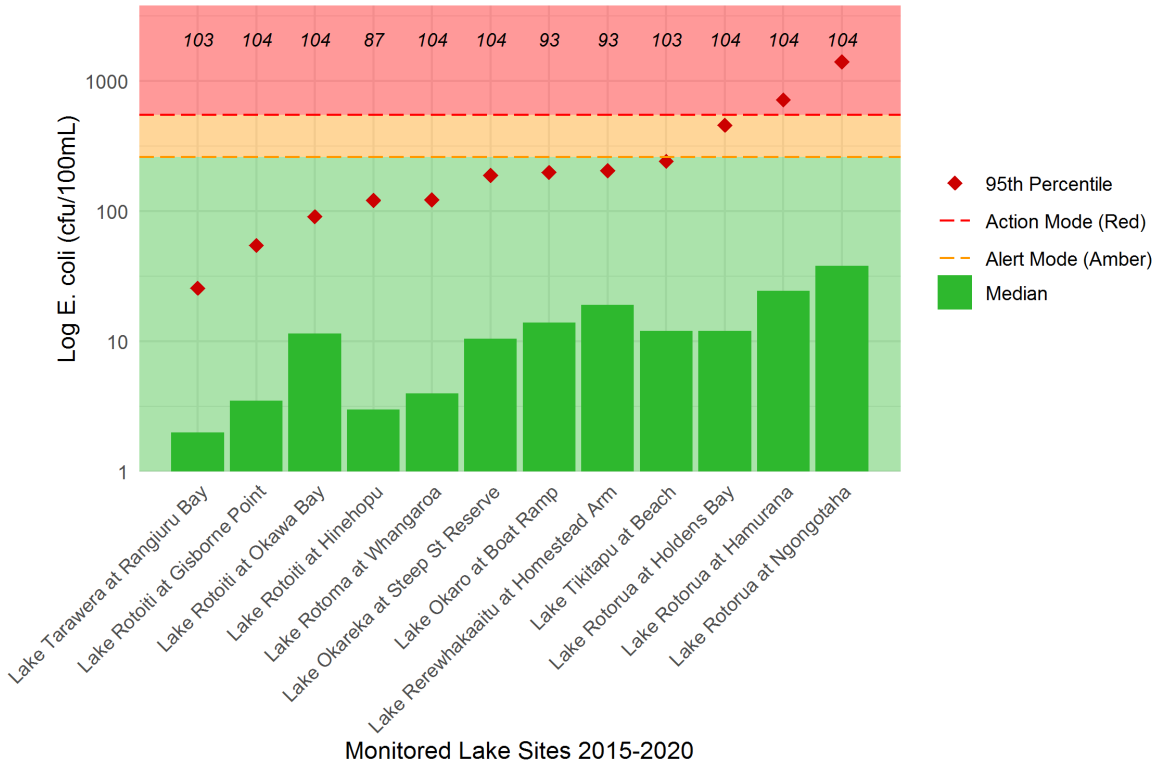


Figure 2.7 *95th percentile and median E. coli concentrations for lake sites over the past five years. The black numbers represent the number of samples available for the analysis period.*

Table 2.8 *The percentage of lake sites falling within each band specified in Appendix 2A of the NPS-FM for E. coli, based on 2015-2020 data.*

Attribute State Band	A	B	C	D	E
Average infection risk	1%	2%	3%	>3%	>7%
% sites	83.3	8.3	0.0	8.3	0.0
n	10	1	0	1	0

Table 2.9 *The percentage of lake sites falling within each band specified in Appendix 2B (Table 22) of the NPS-FM, over the past year (2019-2020).*

Attribute State Band	Excellent	Good	Fair	Poor
Estimated risk of Campylobacter infection	<0.1%	0.1-1%	1-5%	>5%
% sites	58.3	16.7	0.0	25.0
n	7	2	0	3

Marine sites

Open coastal

Four of the 13 monitored open coastal sites (31%) breached the amber (alert) threshold in 2019/20, compared with two sites (15%) in 2018/19. All four of these sites had 100% green (surveillance) mode compliance in the previous season. The only two sites to breach the amber (alert) mode threshold in 2018/19 Waihi Beach at 3 Mile Creek, and Hikuwai Beach at end of Snell Road, returned to 100% compliance in the 2019/20 season.

Overall, every monitored site had a median value below 10 cfu/100 ml, and a 95th percentile value less than the amber (alert) mode threshold (140 cfu/100 ml) suggesting that monitored open coastal sites have been in a healthy state for the past five bathing seasons. The amber (alert) mode exceedances mentioned previously are likely to be one-off events, possibly associated with adverse weather conditions. These sites were seen to quickly return to normal, and need not be of major concern to the general public at this time.

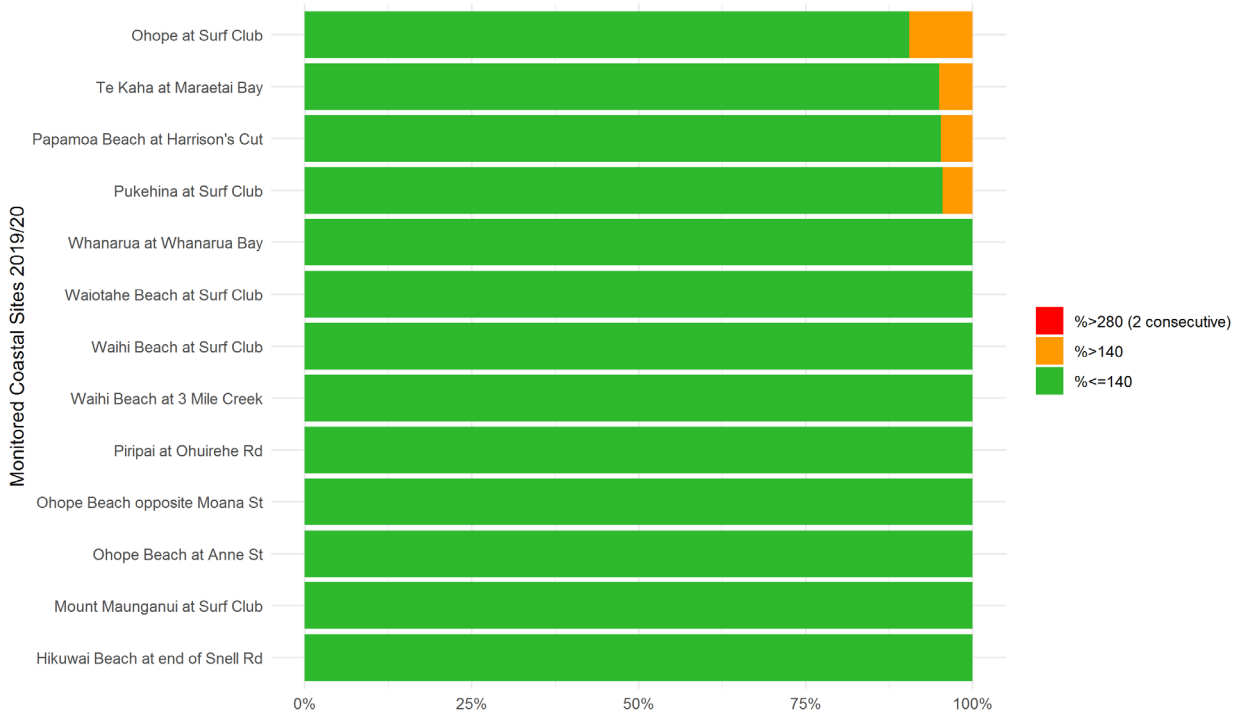


Figure 2.8 *Percentage of samples from open coastal marine sites with Enterococci concentrations (cfu/100 ml) in each of the levels in the Microbiological Water Quality Guidelines (MfE, 2003), 2019/20 bathing season.*

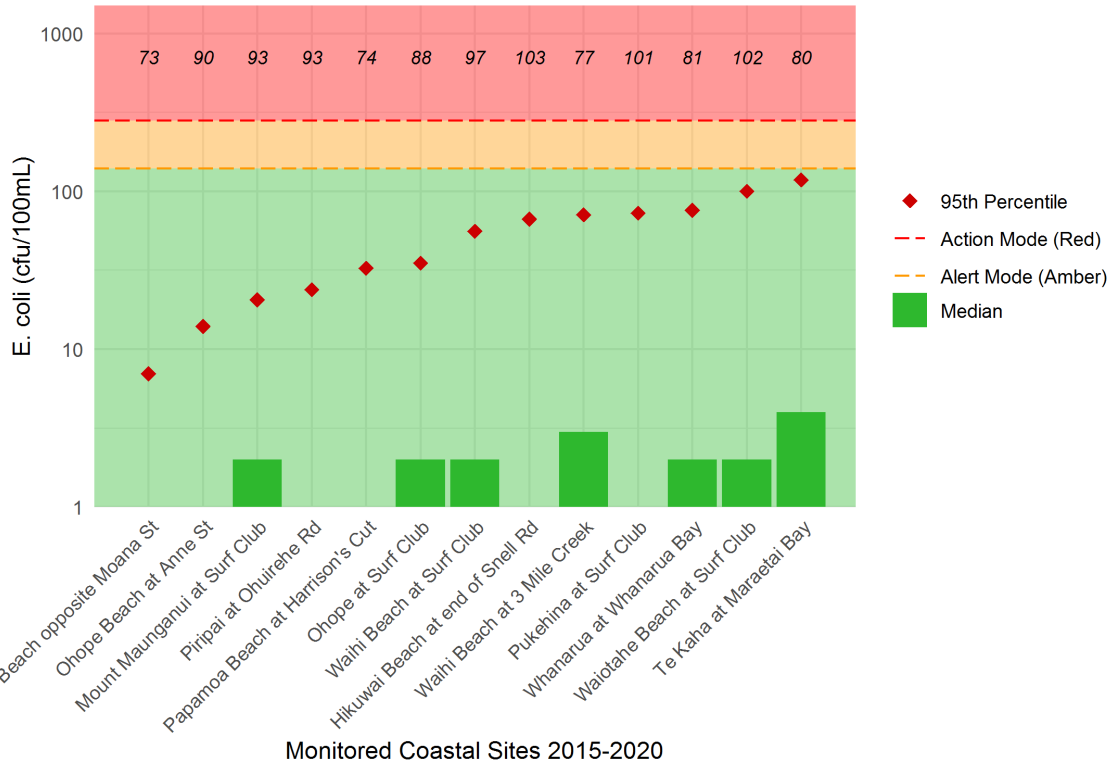


Figure 2.9 *95th Percentile and median Enterococci concentrations for open coastal sites over the past five years. The black numbers represent the number of samples available for the analysis period.*

Estuarine

There were no breaches of the red (action) mode threshold for the 2019/20 season, a reduction from two sites in 2018/19. Eight sites had samples that breached the amber (alert) mode threshold, down from 12 sites in 2019/20. Of the two sites that breached the red (action) mode threshold in 2018/19 (i.e. they had two consecutive samples greater than 280 cfu/100 ml for Enterococci), Tauranga Harbour at Tilby Point returned to 100% green (surveillance) mode compliance, while Tauranga Harbour at Pahoia Beach Road had only one sample (4.5%) over 140 cfu/100 ml.

Only two of the 13 monitored sites had 95th percentile values greater than the red (action) mode threshold; a total of three sites less than the 2018/19 season. The two sites that had 95th percentile values greater than the red (action) mode threshold, Tauranga Harbour at Pahoia Beach Road, and Tauranga Harbour at Waimapu Bridge, both exceeded this in the previous season. The other three sites that exceeded the red (action) mode threshold in 2018/19 (Waihi Estuary at Main Channel, Tauranga Harbour at Tanners Point Beach, and Tauranga Harbour at Ongare Point), all reduced to within the amber (alert) mode. As with the previous season, no site exceeded a median value of
50 cfu/100 ml, which is indicative of reliably safe estuarine swimming conditions throughout the region.

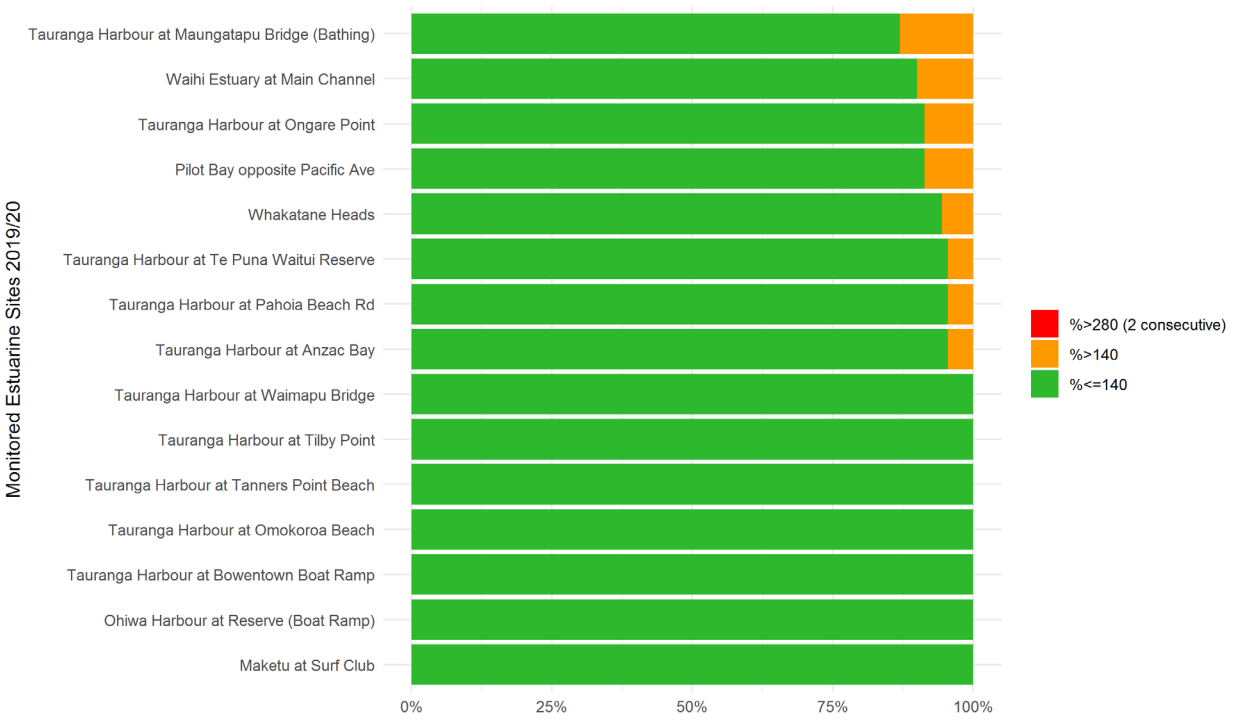


Figure 2.10 *Percentage of samples from estuarine sites with Enterococci concentrations (cfu/100 ml) in each of the levels in the Microbiological Water Quality Guidelines (MfE, 2003), 2019/20 bathing season.*

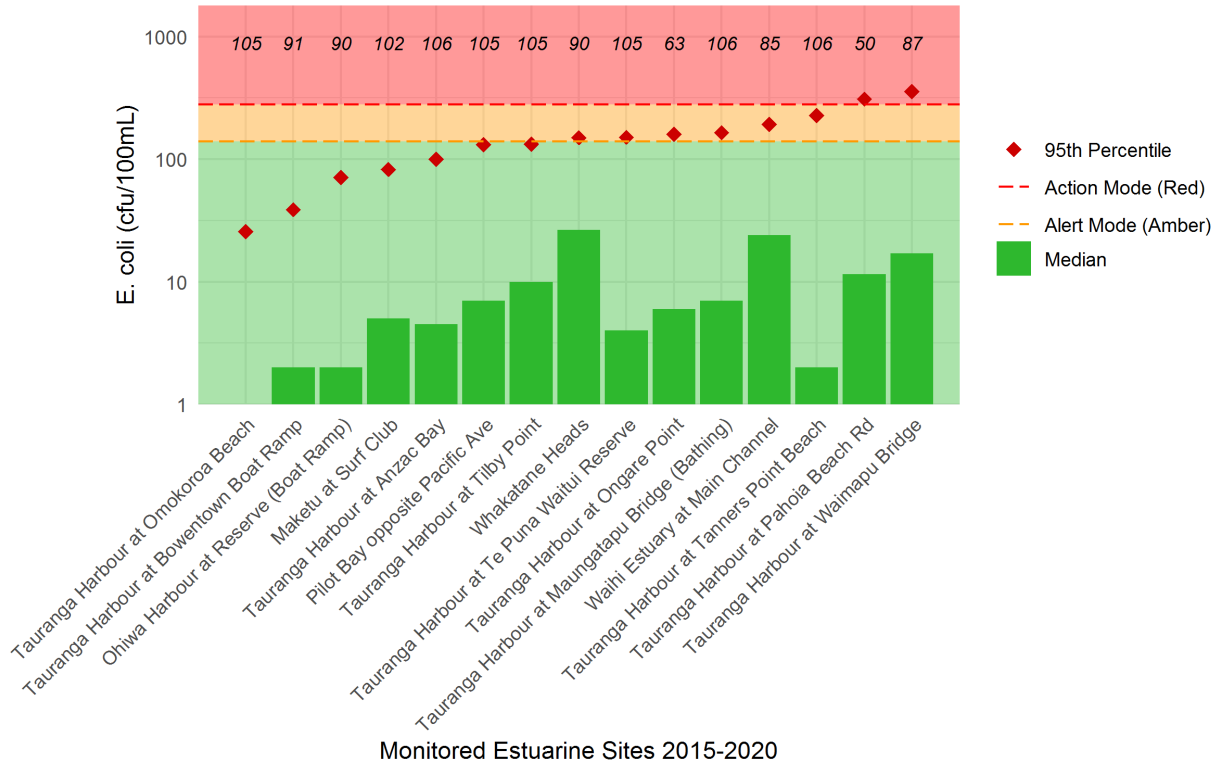


Figure 2.11 *95th Percentile and median Enterococci concentrations for open coastal sites over the past five years. The black numbers represent the number of samples available for the analysis period.*

Part 3:
Shellfish water quality

Introduction and methods

Eleven of the 28 open coastal and estuarine surveillance sites are regarded by communities as desirable shellfish gathering locations. Water samples are collected from these sites on a weekly basis over the summer period, as per bathing sample methods, and analysed for concentrations of Faecal Coliforms (FC). Faecal Coliforms have a stronger correlation with health risks associated with eating shellfish than other indicators such as Enterococci (MfE, 2003), making them an important indicator for shellfish contamination. The FC values specified in the NZMWQG indicate the likely presence of pathogenic bacteria, protozoa and viruses.

Water quality guidelines for safe shellfish consumption are as follows:

- The median FC content should not exceed a Most Probable Number (MPN) of 14/100 ml, and
- No more than 10% of samples should exceed a MPN of 43/100 ml.

Compliance with these guidelines does not ensure that shellfish in the waters will be safe for consumption as they do not account for biotoxins. However, they do provide a useful management tool to assess the risk to human health.

Results

Results for shellfish waters sampled over the 2019/20 season are shown in Figures 3.1 and 3.2. Of the 11 monitored sites, five (45%) breached the median threshold of 14 MPN FC/100 ml. Maketū at Surf Club was the only new addition to median breaches for 2019/20 (with a median value of 23 MPN FC/100 ml), as the other exceeding sites (Waihi Estuary at Main Channel, Waiōtahe at Estuary, Tauranga Harbour at Tilby Point, and Tauranga Harbour at Anzac Bay) also breached in 2018/19. Despite the additional breaching site, median values for 2019/20 were much lower than median values for 2018/19 for breaching sites, with significant reductions for traditionally poor performing sites, Waihī Estuary at Main Channel (2018/19: >75 MPN; 2019/20: 19 MPN) and Waiōtahe at Estuary (2018/19: ~37 MPN; 2019/20: 18 MPN).

Seven of the 11 monitored sites (64%) breached the 10% threshold for exceedances of 43 MPN/100 ml. These were: Waihi Estuary at Main Channel, Tauranga Harbour at Tilby Point, Tauranga Harbour at Anzac Bay, Maketū at Surf Club, Waiōtahe at Estuary, Tauranga Harbour at Te Puna Waitui Reserve, and Ōhope at Surf Club. This is a reduction of two sites from 2018/19, and in contrast to the previous season, Tauranga Harbour at Bowentown Boat Ramp, Ōhiwa Harbour at Reserve, and Waihi Beach at 3 Mile Creek came in below the 10% threshold, although Ōhope Beach at Surf Club slipped above it.

Overall, five sites (45%) breached both thresholds and should be considered unsafe for shellfish consumption. These are: Waihi Estuary at Main Channel, Tauranga Harbour at Tilby Point, Tauranga Harbour at Anzac Bay, Maketū at Surf Club, and Waiōtahe at Estuary. A further two sites (19%) breached only the 10% threshold, indicating that these sites can be affected by short-lived, periodic contamination, and caution should be applied when choosing to harvest, especially after rainfall events. These sites are: Tauranga Harbour at Te Puna Waitui Reserve, and Ōhope at Surf Club. Finally, the remaining four sites (37%) were below the health warning threshold for both statistics, meaning these sites are generally safe to harvest and consume shellfish from, provided no other health warnings are active (e.g. Paralytic Shellfish Poison warnings). These sites are: Waihi Beach at 3 Mile Creek, Tauranga Harbour at Bowentown Boat Ramp, Ōhope Beach Opposite Moana Street, and Ōhiwa Harbour at Reserve.

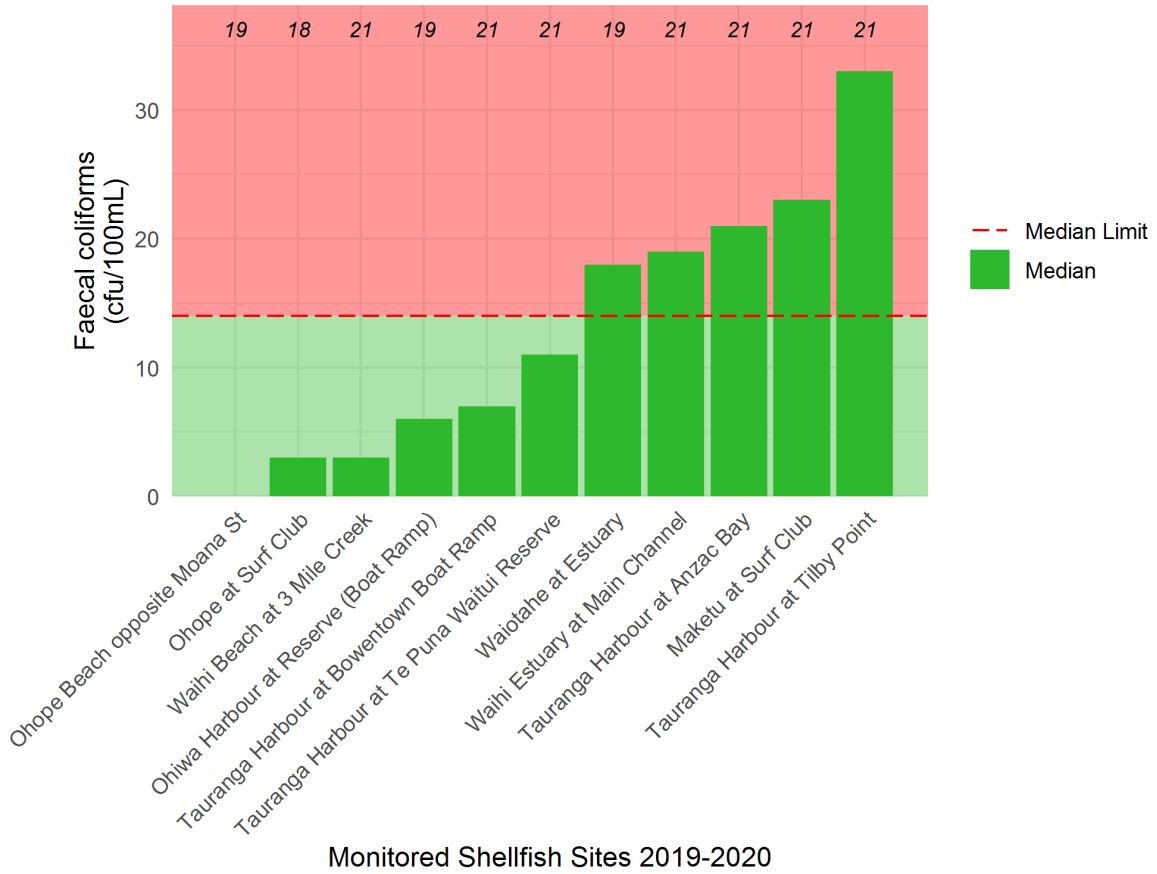


Figure 3.1 *Median faecal coliform concentrations at shellfish gathering locations for the 2019/20 season and guideline median limit for safe shellfish consumption. The black numbers represent the number of samples available for the analysis period.*

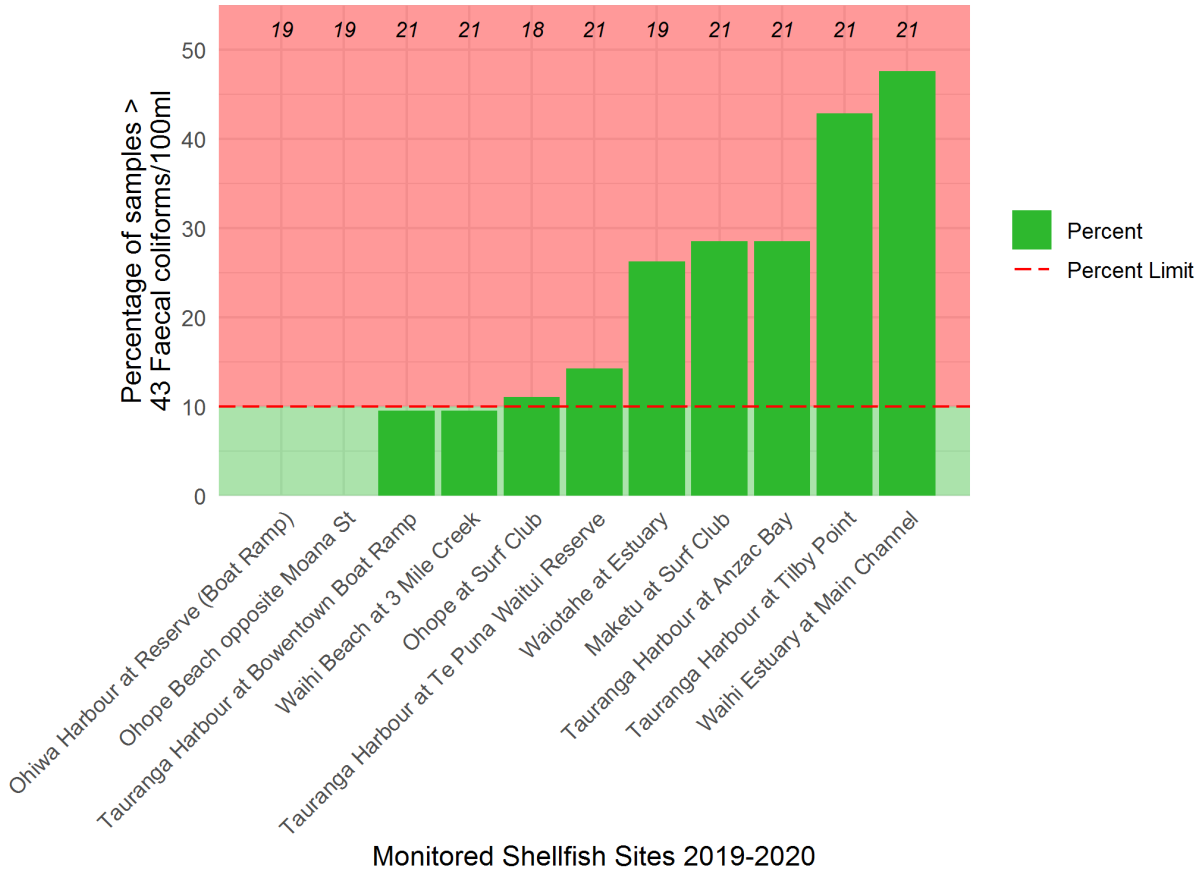


Figure 3.2 *Percentage of samples at shellfish gathering locations in the 2019/20 season exceeding the limit of 43 cfu/100 ml stipulated by the Microbiological Water Quality Guidelines (MFE, 2003). The black numbers represent the number of samples available for the analysis period.*

Part 4:
Cyanobacteria monitoring

Introduction

Blue-green algae are widespread throughout New Zealand. Lakes and rivers in the Bay of Plenty are affected by free living algal blooms at times (leading to soupy looking water or surface scums) or blooms of attached 'benthic' algae (often in the form of mats covering the river bed). These blooms may or may not be toxic.

The presence of toxin-producing blue-green algae species (cyanobacteria) and the occurrence of blooms within the Rotorua Lakes is a natural phenomenon. Blooms can also occur in the 'cleaner' (oligotrophic/lower nutrient) lakes (including Lakes Tarawera and Okataina). Many of the lakes have a history of cyanobacteria blooms that are significantly influenced by artificially elevated nutrient enrichment. The intensity of blooms can be increased by anthropogenic inputs of nutrients when the environmental conditions are favourable (i.e. calm weather, high temperatures, low amount of mixing between the Epilimnion (surface) and Hypolimnion (bottom) layers of the lake, limited out flow, shallow conditions).

The BOPRC cyanobacteria monitoring programme was set up in 1997 after blooms exceeded levels safe for drinking and recreation in four of the Rotorua lakes (Lakes Okaro, Rotoiti, Rotorua, and Rotoehu). Blooms have occurred in these lakes on an almost annual basis since 1997. In addition, at least two other lakes and the Kaituna River are intermittently affected by blooms. The monitoring programme has now been tailored to anticipate and pre-empt periods of heightened bloom activity. In the periods with anticipated bloom activity the frequency of monitoring increases to enable timely health warnings if required. However, during the anticipated bloom periods swimming may still be safe, provided bloom activity remains at low levels.

The cyanobacteria monitoring programme targets areas where the public is likely to have the greatest exposure to cyano-toxins (either through immersion, consumption or inhalation of water affected by cyano-toxins or irritants). The Medical Officer of Health (MO) relies on cell counts provided by BOPRC along with the results of toxicity tests, to determine whether cyanobacteria blooms pose a public health risk. The cell count generates the information to determine whether a sites' sample has exceeded a given cyanobacteria biovolume threshold indicating that a health warning is required. The biovolume thresholds are based on the potential health risk of that amount of cyanobacteria and the warnings indicate it is no longer safe to use the lake water for swimming, drinking, and watersports.

A number of blue-green algae are known to produce cyano-toxins. These include the cyclic peptides (microcystin and nodularin), alkaloids (cylindrospermopsin, anatoxins and saxitoxins) and lipopolysaccharides (LPS) (Wood, 2004). Microcystin and its various analogues are the most prevalent cyano-toxin in the Rotorua Lakes and therefore also potentially the most harmful.

Methods

Cyanobacteria monitoring

Thirteen sites in the Rotorua Lakes region, which have shown historical bloom activity, are sampled on a weekly basis, from November to June. The duration of the sampling season may vary depending on health status of the lakes (i.e. if blooms are persistent).

- Lake Rotoehu - Kennedy Bay, Otautu Bay.
- Lake Rotoiti - Hinehopu, Okawa Bay, Te Weta Bay, Okere Arm, Otaramarae.
- Kaituna River - Trout Pool at Okere Falls.
- Lake Rotorua - Ohau Channel, Hamurana, Ngongotaha, Holdens Bay.
- Lake Okaro - Boat ramp.

Sampling involves taking five integrated samples from different locations around the sampling site (approximately 1 m apart) and subsampling an 80 to 100 ml aliquot from a pooled sample. The sample is fixed with lugols iodine. Visual observations at the site (such as time, water clarity, and wind direction) are also recorded.

Samples are analysed using the Axiovert 100 microscope using whole plate or random colony counts depending on cyanobacteria colonies present. Cell counts are entered to a database and converted to biovolume for reporting purposes.

Guidelines and reporting framework

Results are assessed against the 'New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters' (Table 4.1; MfE, 2009), and reported weekly on the Land Air Water Aotearoa (LAWA) website, and via an email to primary stakeholder groups. The MO at Toi Te Ora Public Health is responsible for issuing any public health warnings, and instructing the relevant territorial authority to post warning signs.

Table 4.1 Alert - level framework for planktonic cyanobacteria (when using biovolume not cell/ml).

Alert Level	Actions
Surveillance (green mode): The biovolume equivalent for the combined total of all cyanobacteria material does not exceed 0.5 mm3/L.	Undertake weekly or fortnightly visual inspection and sampling of water bodies where cyanobacteria are known to proliferate between spring and autumn.
Alert (amber mode): 0.5 to < 10 mm3/L total biovolume of all cyanobacterial material.	Increase sampling frequency to at least weekly.
	Notify the public health unit.
	Multiple sites should be inspected and sampled.

Action (red mode): 10 mm3/L total biovolume of all cyanobacterial material or greater.	Continue monitoring as for alert (amber mode).
	If potentially toxic taxa are present consider testing samples for cyanotoxins.
	Notify the public of a potential risk to health.

NPS-FM Cyanobacteria attribute

The volume of cyanobacteria present in a given lake or freshwater body is one of the attributes within Appendix 2A of the NPS-FM (MfE, 2020). The attribute bands scale lake cyanobacteria levels through a ranking system of A to D, where B band is not applicable (Table 4.2). These bands are based either on biovolume or cell count of cyanobacteria, using the 80th percentile of a site over a three year period to compare with the bands numerical thresholds. The results for this can be found in following sections.

Table 4.2 Cyanobacteria attribute state from NPS-FM (2020).

Value	Attribute state (Cyanobacteria Biovolume (mm3/L)	Attribute state (Cyanobacteria Biovolume (mm3/L))		
	A	**B**	**C**	**D**
Numeric state 80th percentile*.	<= 0.5 mm3/L bio-volume, or 500 cells/mL.	N/A	> 0.5 and less than or equal to 1.8 mm3/L toxic cyanobacteria biovolume, or > 0.5 and >= 10 mm3/L total cyanobacteria.	>1.8 mm3/L toxic cyanobacteria biovolume, OR 10 mm3/L total cyanobacteria.
Human health for secondary contact (annual median).	Risk exposure from cyanobacteria is no different to that in natural conditions (from any contact with fresh water).		Low risk of health effects from exposure to cyanobacteria (from any contact with fresh water).	Potential health risks (e.g. respiratory, irritation and allergy symptoms) exist from exposure to cyanobacteria (from any contact with fresh water).

**80th percentile must be calculated using a minimum of 12 samples collected over three years.*

Results

Lake Okaro

Lake Okaro is monitored at the boat ramp of the Lake Okaro Campsite, on Okaro Road. The 2019/20 cyanobacteria season resulted in moderate cyanobacteria activity within Lake Ōkaro (Figure 4.1), with health warnings issued on two separate occasions.

The first bloom, composed predominantly of *Anabaena circinalis*, occurred in early December 2019, and breached the red (action) threshold for total biovolume, with a total biovolume of 10.1 mm3/l. This had dissipated by the next sample in early January 2020, and the health warnings were lifted soon after. Lake Okaro did not breach the red (action) threshold for 'total biovolume' again in the 2019/20 season, but did breach the amber (alert) threshold on five further occasions, two of which also breached the red (alert) threshold for potentially toxic biovolume (dominant genera: *Planktothrix* and *Oscillatoria,* not shown). The second health warning of the 2019/20 season was issued in June 2020, and remains in place at the time of report writing.

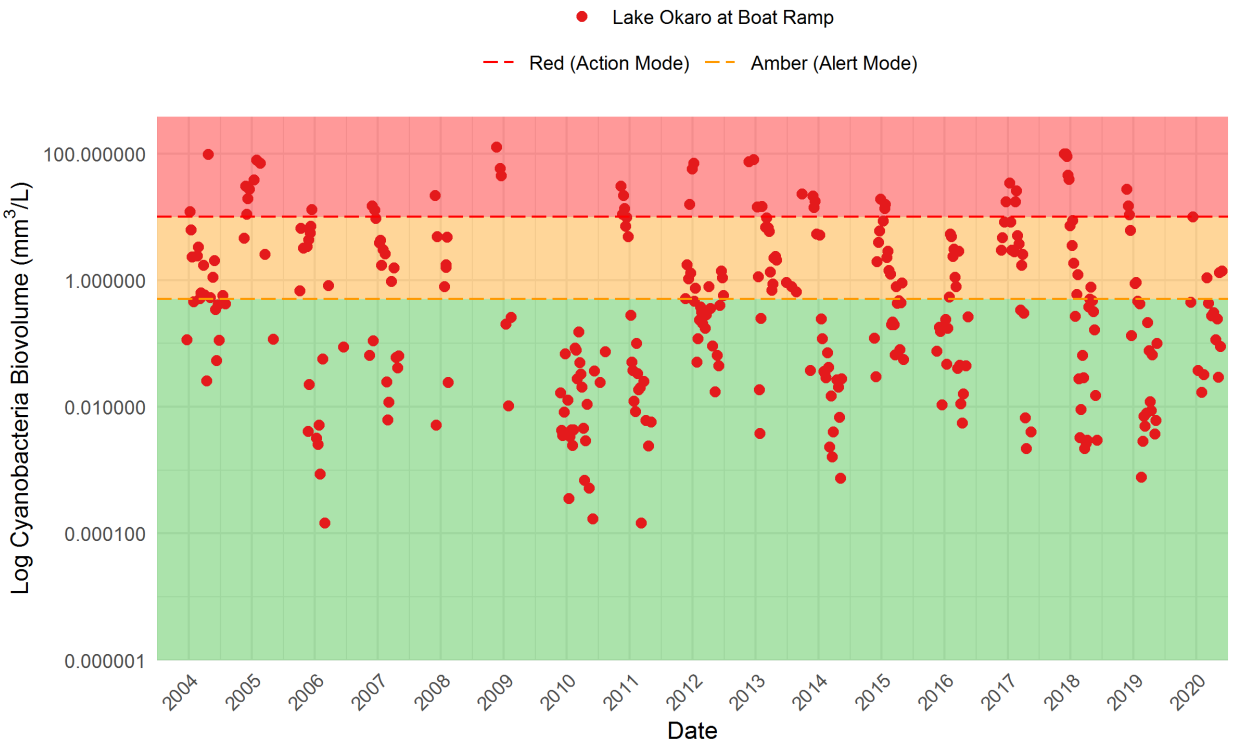


Figure 4.1 Total cyanobacteria biovolume sampled at Lake Okaro boat ramp, 2003 to 2020.

Lake Rotoehu

Lake Rotoehu is monitored at two different sites; Kennedy Bay, and the Otautu Bay Boat Ramp. Both sites were much improved on the 2018/19 season, which was documented as the worst season on record (Dare, 2019), and resulted in a health warning from December 2018 to December 2019.

Both sites exceeded the amber (alert) threshold on five occasions each during the 2019/20 season (Figure 4.2), with Otautu Bay breaching the red (action) threshold for potentially toxic biovolume on 20 April 2020, in a bloom dominated by *Microcystis sp.* and *Anabaena planktonica*. No site exceeded the red (action) threshold for total biovolume over the entire season, which is the first time this has happened since the 2013/14 season, and only the fifth time this has occurred since 2002/2003.

Lake Rotoehu was one of three lakes included in a 'health advisory' issued by Toi Te Ora on 25 April. The advisory was issued in response to increasing bloom activity in lakes Rotoehu, Rotoiti, and Rotorua, during the COVID-19 pandemic lockdown. The advisory acted as a blanket warning of algal bloom activity in these lakes, over a period where monitoring and reporting may be interrupted by logistical problems (such as an essential worker becoming infected). Monitoring over this period did not experience the anticipated problems, however, and results were able to be collected, processed, and reported on schedule. Despite this, and cyanobacteria levels returning to relative normality, Toi Te Ora has not removed the health advisory, which stands to the date of reporting.

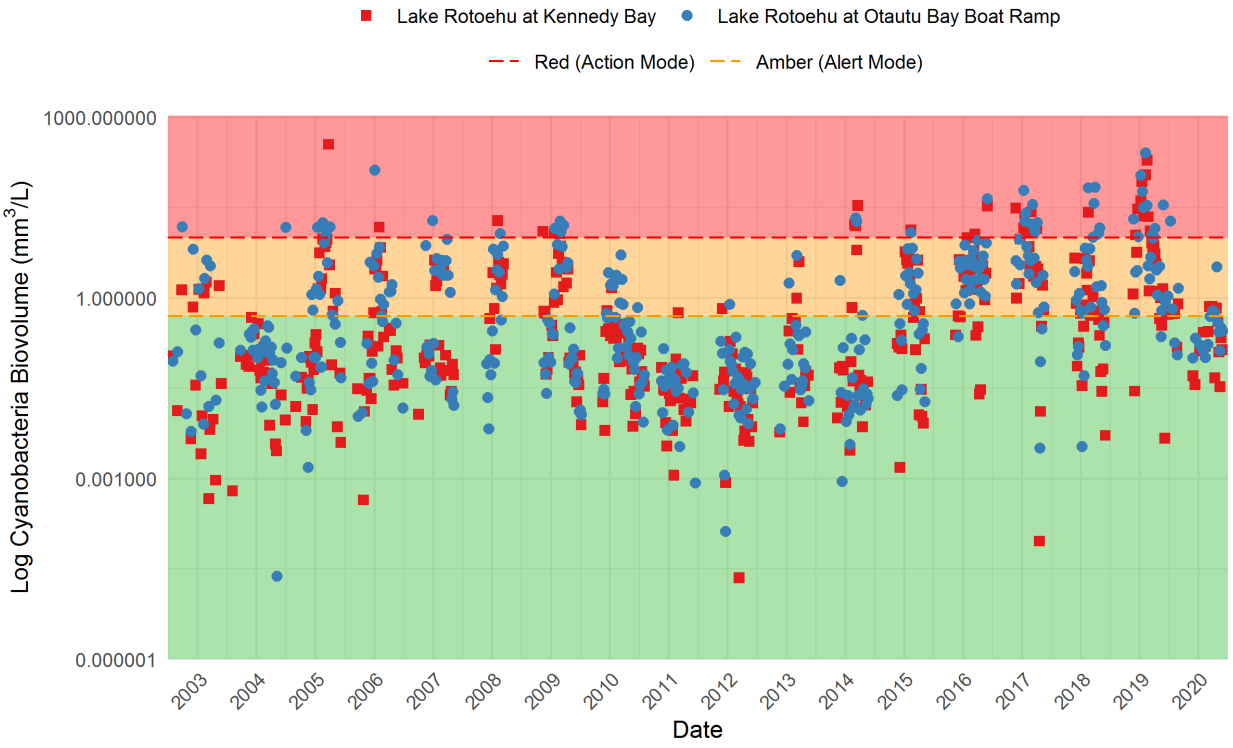


Figure 4.2 *Total cyanobacteria biovolume sampled at Otautu Bay and Kennedy Bay of Lake Rotoehu, 2003 to 2020.*

Lake Rotorua

Lake Rotorua is monitored at four foreshore sites around the lake. There was more algal activity at each site than was recorded during the 2018/19 season, however, only one site, Ohau Channel at Lake Rotorua Outlet, experienced biovolumes high enough to breach the amber (alert) threshold for total biovolume (Figure 4.3). This bloom occurred on the 28 April 2020, and was comprised entirely by *Anabaena ciricinalis,* a toxin-producing species that caused the site to also breach the red (action) mode threshold for potentially toxic species. This bloom was also reported by residents in the Okere Inlet of Lake Rotoiti, and at the monitoring site in the Okere Arm, around the same time. All sites were covered by the health advisory issued by Toi Te Ora, so no official health warning was issued.

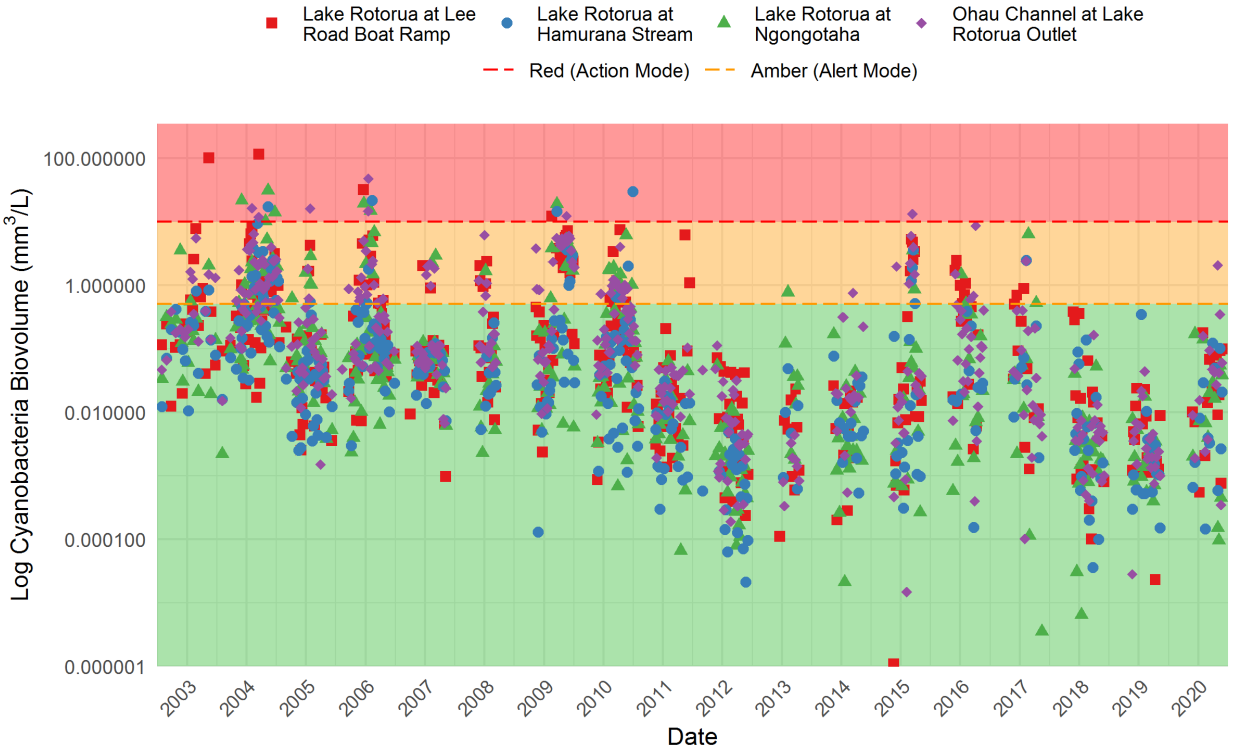


Figure 4.3 *Total cyanobacteria biovolume sampled at Holdens Bay, Ngongotaha, Hamurana, and Ohau Channel, Lake Rotorua, 2003 to 2020.*

Lake Rotoiti

Lake Rotoiti is monitored at five different locations, of which Lake Rotoiti at Okawa Bay was the most active over the 2019/20 season with five samples breaching the amber (alert) threshold over the cyanobacteria monitoring season (Figure 4.4). These results are similar to the 2018/19 season which saw a late bloom in Okawa Bay, however, no other sites expressed any exceedances of the amber (alert) threshold. In contrast, the 2019/20 season saw Lake Rotoiti at Whangamoa Drive Boat Ramp (i.e. Otaramarae), Lake Rotoiti at Walkway 7 Goulding Road (Te Weta Bay), and Kaituna at Rotoiti Outlet (i.e. Okere Arm) each exceed the amber (alert) threshold on at least one occasion throughout the cyanobacteria season.

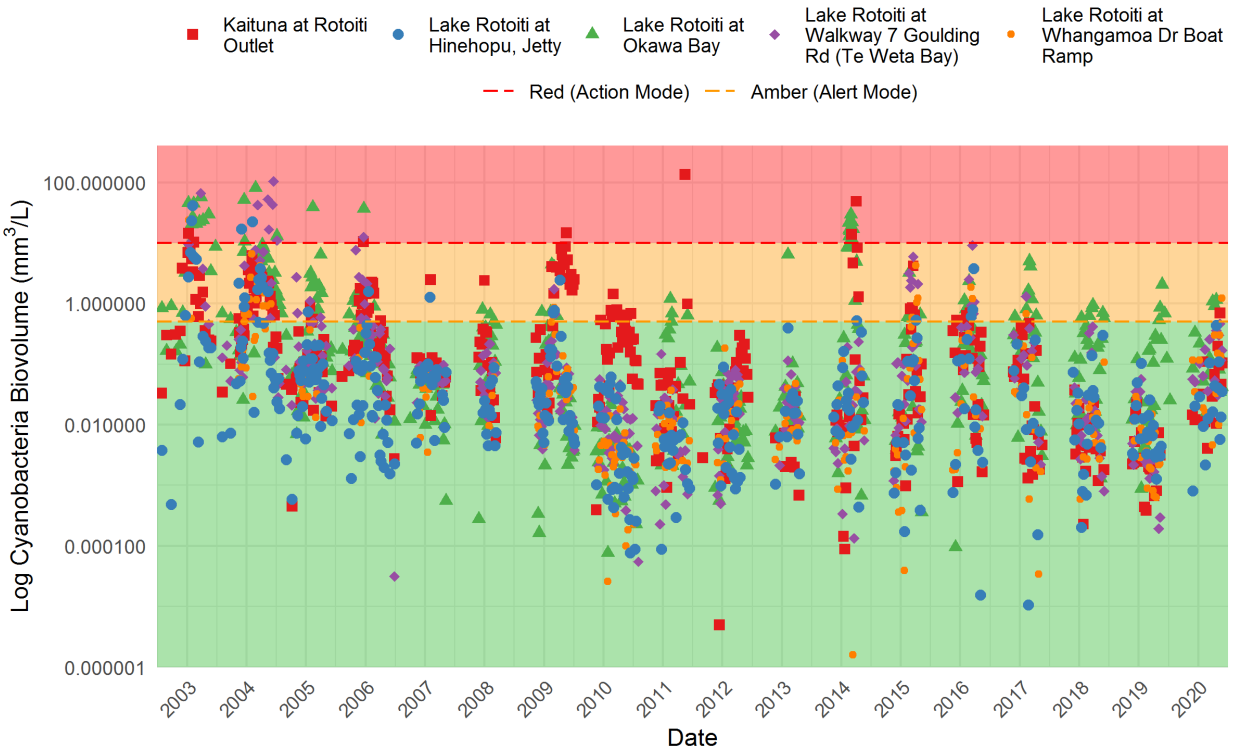


Figure 4.4 *Total cyanobacteria biovolume sampled at Lake Rotoiti at Hinehopu Jetty, Lake Rotoiti at Okawa Bay, Kaituna at Rotoiti Outlet, Lake Rotoiti at Walkway 7 Goulding Road (Te Weta Bay, and Lake Rotoiti at Whangamoa Drive Boat Ramp), 2003 to 2020.*

Comparison with Appendix 2A of the NPS-FM

Updated NPS-FM analysis results are shown in table 4.3. All sites outside of lakes Okaro and Rotoehu scored within the 'A' attribute band for cyanobacteria. The 80th percentile value for each of these sites was lower in comparison with the 2018/19 analysis value, reflecting a season of relatively low cyanobacteria activity. Lake Okaro at Boat Ramp and Lake Rotoehu at Kennedy Bay both scored within the 'C' band, with the latter improving from a 'D' band in the 2018/19 analysis. The only site that scored below the national bottom line was Lake Rotoehu at Otautu Bay Boat Ramp, however, this site also showed a reduction in the 80th percentile biovolume from the 2018/19 analysis (2018/19: 17.09 mm^3/l; 2019/20: 11.96 mm^3/l).

Table 4.3 NOF banding result for Total Cyanobacteria (planktonic) biovolumes in Rotorua lakes, 2017 to 2020

Lake	Site Name	n	80th Percentile	Attribute State Band
Lake Okaro	Lake Okaro at Boat Ramp	65	**2.20**	**C**
Lake Rotoehu	Lake Rotoehu at Kennedy Bay	70	**5.79**	**C**
	Lake Rotoehu at Otautu Bay Boat Ramp	72	**11.96**	**D**
Lake Rotoiti	Kaituna at Rotoiti Outlet	56	**0.01**	**A**
	Lake Rotoiti at Whangamoa Dr Boat Ramp	51	**0.02**	**A**
	Lake Rotoiti at Hinehopu, Jetty	54	**0.03**	**A**
	Lake Rotoiti at Walkway 7 Goulding Rd (Te Weta Bay)	53	**0.04**	**A**
	Lake Rotoiti at Okawa Bay	66	**0.34**	**A**
Lake Rotorua	Lake Rotorua at Ngongotaha	53	**0.01**	**A**
	Lake Rotorua at Hamurana Stream	52	**0.01**	**A**
	Ohau Channel at Lake Rotorua Outlet	61	**0.01**	**A**
	Lake Rotorua at Lee Road Boat Ramp	54	**0.02**	**A**
None	Kaituna at Trout Pool Rd	55	**0.02**	**A**

Part 5:
Focus catchment investigations

The National Environment Regional Monitoring Network or bathing monitoring programmes (such as the basis of this report), have detected deterioration at a number of sites throughout the Bay of Plenty region. These programmes inform BOPRC that deterioration is occurring, or has occurred, but provide no insight into the drivers of decline, such as where within the catchment the contaminant is coming from, or when mobilisation occurs.

To address these questions, BOPRC has undertaken, or is about to commence investigative sampling programs in 12 of the regions' most vulnerable catchments, deemed 'focus catchments' (https://www.boprc.govt.nz/environment/fresh-water/focus-catchments). Each focus catchment has been selected with a water quality indicator (e.g. *E. coli)*, or group of indicators that are the focus for improvement. The investigative process will draw upon existing information, if available, and seek to fill knowledge gaps with relevant monitoring or analyses, that will ultimately help BOPRC staff to better understand and mitigate contaminant sources. A list of the 12 focus catchments, and the associated focus for water quality improvement, can be found in Table 5.1.

Many of the focus catchments are defined as being vulnerable due to problems with faecal contamination, and have been mentioned in previous sections of this report. The aim of this section is to provide information and preliminary results, if available, about focus catchment programmes which are designed to address problems at bathing or shellfish harvesting sites included in the bathing monitoring programme.

If should be noted that focus catchment programmes have, and will continue to commence at different times due to resource constraints, therefore some catchments will have more comprehensive information than others. A comprehensive report of eight focus catchment programmes can be found in Mahon et al. (2020). Further analyses will follow in the near future for the other four focus catchments.

Table 5.1. Focus catchments for Bay of Plenty Regional Council, and the associated water quality improvement focus.

Focus catchment name	Water quality improvement focus
Rotorua Lakes Catchment Area	**Various, including specific TLI targets for each lake and other targets where required.**
Uretara, Katikati	**Reduce *E. coli* bacteria load for swimmability.**
Te Mania, Katikati	**Reduce sediment and *E. coli.***
Kopurererua, Tauranga	**Reduce sediment and *E. coli.***
Waitao, Tauranga	**Reduce *E. coli* and sediment for swimmability.**
Kopuaroa, Te Puke	**Reduce nitrogen (N), phosphorous (P), sediment and *E. coli*.**
Ford Rd/Waitepuia, Maketū	**Reduce N, P, sediment and *E. coli.***
Waihī Estuary, Pongakawa	**Reduce N, P, sediment and *E. coli.***
Awakaponga, Matatā	**Reduce N, P, sediment and *E. coli.***
Upper Rangitāiki, Taupō	**Halt increasing nitrate trend.**
Ōhiwa Harbour, Ōhope	**Reduce sediment (and nutrients in Nukuhou).**
Waiōtahe, Waiōtahe	**Reduce *E. coli* for shellfish gathering.**

Rotorua Lakes Catchment area

Sub-catchment name	Ngongotaha Catchment
Relevant bathing or shellfish sites	*Ngonogtaha at Railway Bridge* *Lake Rotorua at Ngongotaha*
Improvement focus	*E. coli*
Summary of problem	• Ngongotaha at Railway Bridge is graded an 'E' for the *E. coli* attribute in the NPS-FM, and is therefore deemed 'not suitable for primary contact'. Over 25% of samples at this site exceed the red (action) threshold, and more than 50% exceed the amber (alert) threshold. • Outflow from the Ngongotaha River, especially after large rainfall events, is likely to be causing elevated concentrations at the Lake Rotorua at Ngongotaha bathing site. This site is the worst performing lake bathing site, and is currently graded a 'D' for the *E. coli* attribute.
Summary of current monitoring programme	• Ten sites are monitored monthly throughout the catchment. • Sampling sites are aimed at isolating sub-branches of the catchment to determine contaminant contribution. • Samples are analysed for *E. coli*, nutrients, sediment, and field parameters. • *E. coli* results greater than 550 cfu/100 ml are stored for faecal source tracking (FST). • Flow is measured at each site on a number of occasions, and related to continuous flow at the hydrological site (SH 5).
Summary of results to date	• *E. coli* concentrations are elevated throughout the catchment during periods of high, and low, flow. • The Mamaku plateau is highly variable and expresses a surface run-off signature. • Highest *E. coli* concentrations are found in the middle reaches of the main stem of the Ngongotaha, upstream of the Umurua confluence. • FST results show a ruminant source (sheep and cow) during elevated flows. • There is some contamination between SH 5 and SH 36. FST results from these sites show an avian signature, in addition to background ruminant. • Results are reported to the Paradise Valley community group on an annual basis.
Contact person	Baylee.Jackson@boprc.govt.nz

Uretara, Katikati

Catchment name	Uretara Catchment
Relevant Bathing or Shellfish Sites	*Uretara at Henry Road Ford*
Improvement focus	*E. coli*
Summary of problem	• Uretara at Henry Road Ford is graded a 'D' for the *E. coli* attribute in the NPS-FM, and is therefore deemed 'un-swimmable'. • Over 25% of samples at this site exceed the red (action) threshold, and more than 50% exceed the amber (alert) threshold.
Summary of monitoring programme	• Two historical investigations have taken place to date: ▪ The first sampled 13 sites throughout the catchment, on a weekly basis over the 2017/18 summer period. ▪ The second focused on 5 lower catchment sites, sampled on a fortnightly basis, over the summer of 2019/20. • 13 sites are currently monitored quarterly, throughout the catchment. • All samples are analysed for *E. coli*, nutrients, sediment, and field parameters. • *E. coli* results greater than 550 cfu/100 ml are stored for FST. • Flow is measured at each site on a number of occasions, and related to a level logger in the lower catchment.
Summary of results and actions to date	• Boyd Creek has much higher *E. coli* concentrations than the main stem of the Uretara. • FST shows a ruminant signature in the upper catchment, and a strong avian signature in the lower catchment. • A flock of geese were found to be nesting upstream of the swimming site, which was thought to be contributing to elevated *E. coli* concentrations, however, these have since been removed and concentrations remain elevated. • Community discussion raised the possibility of chicken manure, applied as a fertiliser for organic horticulture, being the source of the avian FST signal in the lower catchment. DNA sequencing of water samples, carried out in February 2020, showed no sign of chicken DNA. However, disproportionately high levels of Pūkeko markers were found at a number of sites.
Contact person	braden.rowson@boprc.govt.nz

Kopurererua, Tauranga

Catchment name	Kopurererua Catchment
Relevant Bathing or Shellfish Sites	*Kopurererua at McCord Avenue*
Improvement focus	*E. coli*
Summary of problem	• Kopurererua at McCord Avenue is graded a 'D' for the *E. coli* attribute in the NPS-FM, and is therefore deemed 'un-swimmable'. • Close to 75% of samples from this site exceed the amber (alert) threshold.
Summary of monitoring programme	• Twelve sites are monitored monthly throughout the catchment. • Sampling sites are aimed at isolating sub-branches of the catchment to determine contaminant contribution. • Samples are analysed for *E. coli*, nutrients, sediment, and field parameters. • Sites in the lower catchment are analysed for heavy metals (in water). • *E. coli* results greater than 550 cfu/100 ml are stored for FST. • Flow is measured at each site on a number of occasions, and related to continuous flow at the hydrological site (SH 5).
Summary of results and actions to date	• *E. coli* concentrations downstream of the Tautau confluence are higher than the upper catchment. This pattern was evident in standard sampling, and during a high rainfall event. • There are some highly variable sites that might warrant further investigation, but overall, most sites have reasonably consistent levels of *E. coli*. • FST shows a ruminant signature on the main stem of the Kopurererua, with some avian input in the lower catchment. • Autosampler results collected in June 2020 show that the *E. coli* peak arrives before the flood peak, which implies that most *E. coli* was being derived from within the stream (i.e. bottom sediments) during that time. • BOPRC, TCC, and WBOPDC are working together to further refine the results, and mitigate potential sources.
Contact person	Paul.Greenshields@boprc.govt.nz

Waitao, Tauranga

Catchment name	Waitao Catchment
Relevant Bathing or Shellfish Sites	*Kaiate at Kaiate Falls Road*
Improvement focus	*E. coli*
Summary of problem	• Kaiate Falls at Kaiate Falls Road is the worst performing bathing site monitored by BOPRC. • The site is graded an 'E' for the *E. coli* attribute in the NPS-FM, and is therefore deemed 'not suitable for primary contact'. • Over 90% of samples at this site are above the red (action) threshold, and well over 75% exceed the amber (alert) threshold.
Summary of monitoring programme	• Seven sites were monitored weekly over the 2019/20 summer period, including a 'control' site. • Sites were based on previous monitoring which had indicated which tributary the majority of *E. coli* load was coming from. • Samples are analysed for *E. coli*, and field parameters. • Flow was measured on a fortnightly basis and relationships with the NERMN continuously rated site were developed.
Summary of results and actions to date	• The upper catchment (Otawera and Owairoa tributaries) are the main source of *E. coli* load to the bathing site. • FST has previously identified the main source to be ruminant. • 2019/20 summer monitoring provided baseflow results due to the lack of rain. This showed a significant proportion of the *E. coli* load must be coming from direct deposition rather than runoff. • The control site indicates a reasonable level of 'natural' *E. coli* present, however, this is only a small percentage of the downstream *E. coli* load in the Owairoa Stream.
Contact person	Hayden.Schick@boprc.govt.nz

Waihi Estuary, Pongakawa

Catchment name	Waihi Estuary Catchment
Relevant Bathing or Shellfish Sites	*Waihi Estuary at Main Channel (bathing)* *Waihi Estuary at Main Channel (shellfish)*
Improvement focus	*E. coli*
Summary of problem	• The Waihi Estuary at Main Channel shellfish site breaches both the 10 MPN FC/100 ml median limit, and the 10% limit for samples over 43 MPN FC/100 ml. • The shellfish site is the worst performing site in the region, with more than 45% of samples exceeding the 43 MPN FC/100 ml threshold. This implies that the site is subject to significant variability.
Summary of monitoring programme	• Event and baseline sampling of 13 pump stations in the lower catchment has occurred. Quarterly sampling on seven sites located across the Puanene Sub-catchment occurred including event sampling in 2018-2019. • Current plan to sample all main locations (seven sites) of inputs to estuary post-rainfall event for *E. coli* and FST for any high results. • A community catchment group, with support from BOPRC, MPI, NZ Landcare Trust and the NEXT Foundation has been set up to create a catchment strategy for the catchment, one part of that will be a monitoring plan for the catchment.
Summary of results and actions to date	• Pump station monitoring has informed the requirement for more detailed monitoring of the discharges of pump stations. • Telemetry has recently been set up on all pump stations to help inform a more detailed monitoring plan to estimate contaminant loads from the pump scheme. • A community catchment group, with support from BOPRC, MPI, NZ Landcare Trust and the NEXT Foundation has been set up to create a catchment strategy.
Contact person	Thomas.Grant@boprc.govt.nz

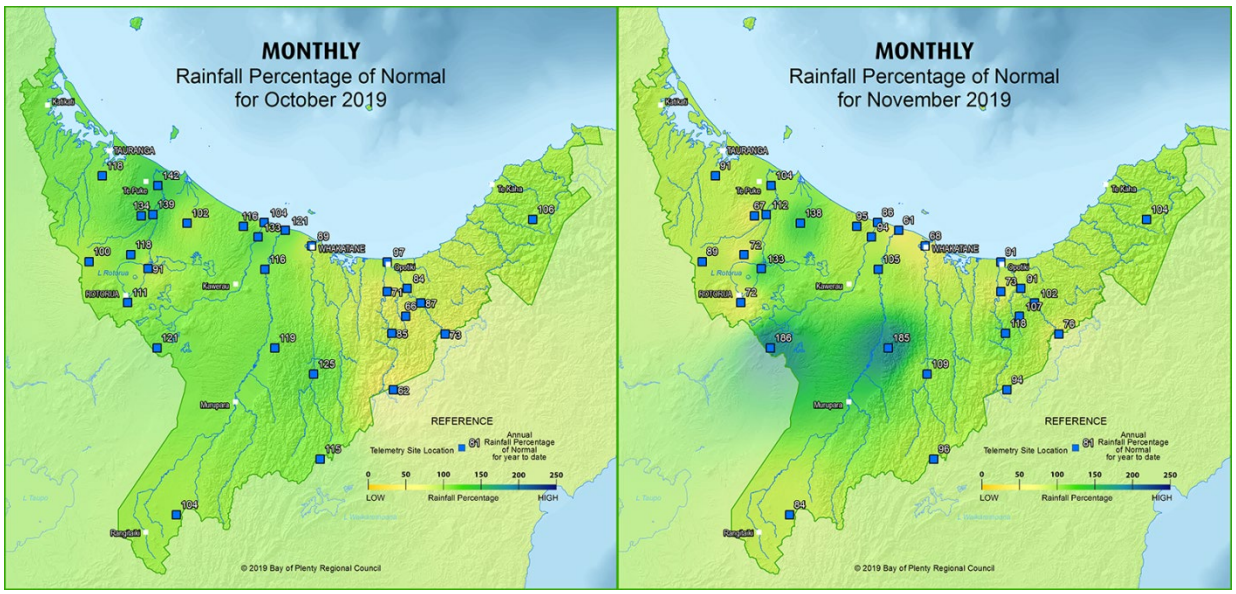
Waiōtahe, Waiōtahe

Catchment name	Waiōtahe Catchment
Relevant Bathing or Shellfish Sites	*Waiōtahe at Estuary*
Improvement focus	Faecal Coliforms for shellfish consumption.
Summary of problem	• The Waiōtahe at Estuary shellfish site breaches both the 10 MPN FC/100 ml median limit, and the 10% limit for the percentage of samples exceeding 43 MPN FC/100 ml. This means that the site is unsuitable for shellfish consumption. • This is a particularly significant problem because the Pipi (*Paphies australis*) beds in Waiōtahe Estuary are a cultural food gathering site.
Summary of monitoring programme	• 25 sites throughout the catchment have been monitored monthly for *E.coli,* since mid-2017. • *E. coli* results greater than 550 cfu/100 ml are stored for FST.
Summary of results and actions to date	• There are no clear patterns in *E. coli* results, although there does seem to be a link with both rainfall and temperature. • FST shows primary *E.coli* source to be cows. • *E. coli* levels are much higher in stream sediments than in the water. The data is currently being analysed by experts with a report expected in August 2020. • A plan is in place that aims to mitigate the movement of *E. coli* into waterways • A group of farmers have set up a catchment group with the support of DairyNZ, Fonterra and BOPRC. They have extra funding from the Red Meat Profit Partnership and are holding field days to learn more about work that needs to be done on farm to address the problem. • Many landowners have already made great strides in ensuring that all streams and drains are fenced and (where appropriate) planted and are working on other ways of mitigating the movement of *E. coli* to waterway.
Contact person	Tim.Senior@boprc.govt.nz

Part 6:
Weather patterns

Figure 6.1 provides a Thiessen interpolation between rain gauge records, for each month during the 2019/20 bathing season. This is intended to provide a broad overview of rainfall patterns, a fundamental driver of faecal mobilisation, throughout the region for the 2019/20 season.

In general, October, November, and December 2019 had rainfall accumulation slightly above normal for the region, with isolated patches of high rainfall accumulation around the Rotorua Lakes, in the upper Rangitāiki, and in the Western Urewera Ranges. January and February 2020 were particularly dry throughout the region, with most rain gauges registering less than 50% of the typical rainfall for each month. March was also drier than normal, particularly in the west, although the upper Rangitāiki, and Urewera Ranges received close to normal rainfall accumulation.



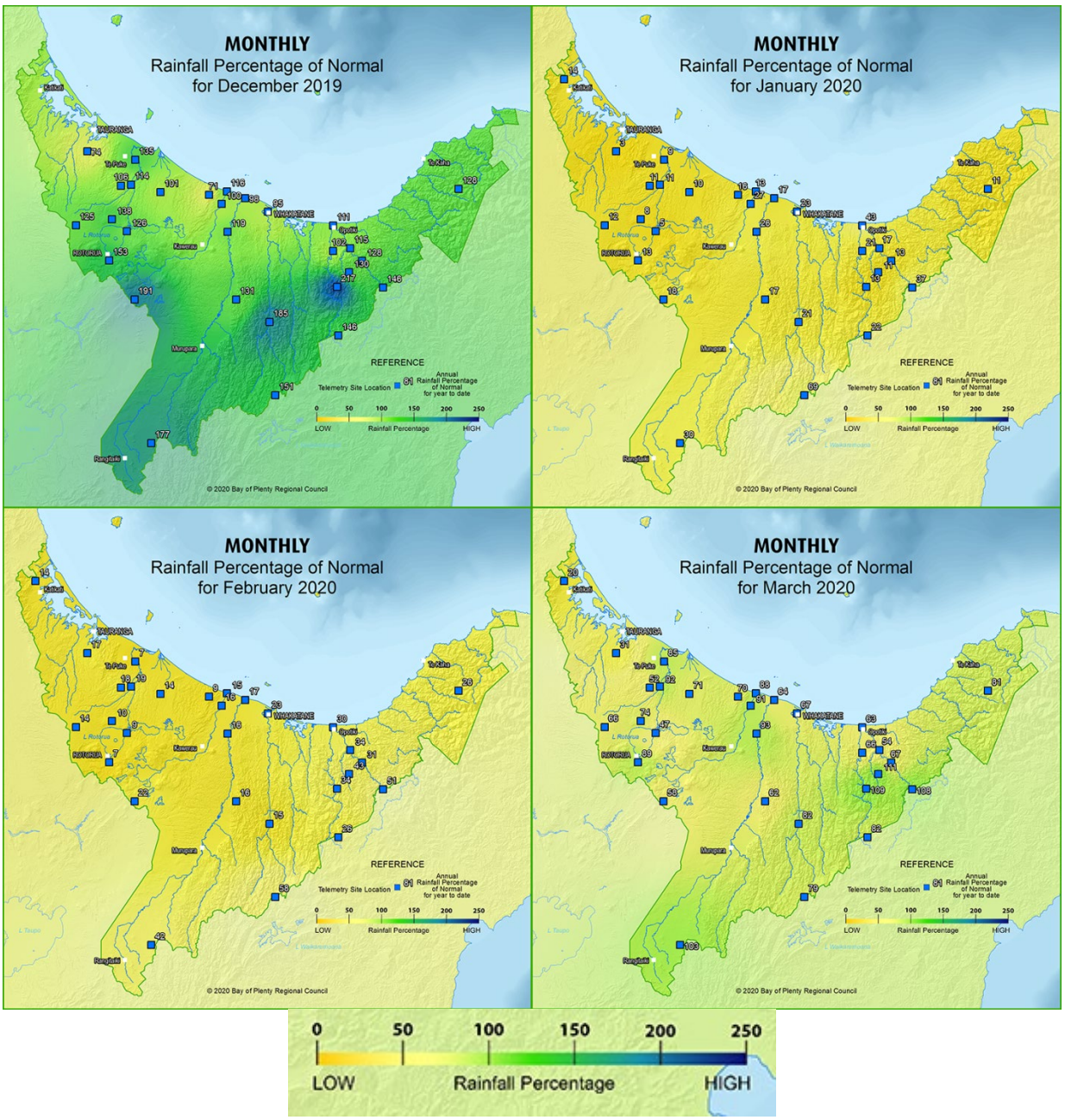


Figure 6.1 *Spatial distribution of rainfall relative to mean rainfall, for each month during the 2019/20 bathing season. These figures are based on Thiessen interpolation between closest rain gages, and should be regarded as indicative only.*

Figures 6.2 and 6.3 show the percentage of samples that fall in green (surveillance), amber (alert), and red (action) modes, for river and lake sites, respectively. These figures are useful in context of Figure 6.1, as they allow comparison of months with high rainfall with categorized *E. coli* results at each site.

Unlike the 2018/19 season, 2019/20 did not have any significant periods of region wide rainfall, the likes of which would typically increase faecal contamination within a number of catchments. Instead, there was a period of region-wide low rainfall accumulation in January and February, which may have temporarily improved some sites (e.g. Lake Rotorua Catchment sites), while coinciding with the highest percentage of amber/red samples at other sites (e.g. Uretara at Henry Road Ford).

Figure 6.2 *Percentage of samples in green (surveillance), amber (alert), and red (action) modes, per month, for each of the 30 river bathing water quality monitoring sites.*

The Lake Rotorua at Ngongotaha Lake site shows a similar, but less contaminated pattern to the Ngongotaha at Railway Bridge site, illustrating the link between the two sites. The same cannot be said between Lake Rotorua at Hamurana, and Hamurana at Hamurana Road sites. In this case, the lake site experiences higher levels of contamination (i.e. greater percentage of samples that breach the red (action) mode threshold) in February and March, than the river site, supporting the theory that avian derived contamination may be elevating results at this site.

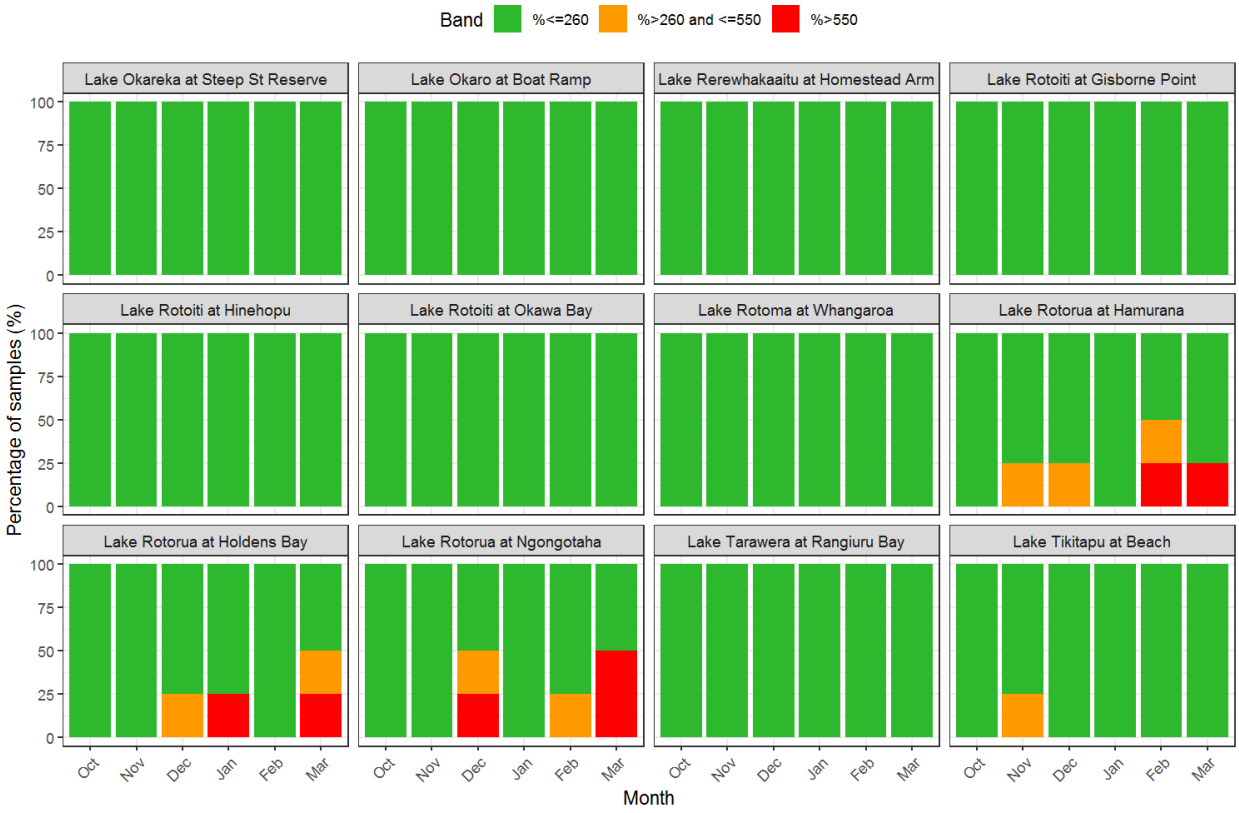


Figure 6.3 *Percentage of samples belonging to green, amber (alert), and red (action) bands, per month, for each of the 12 lake bathing water quality monitoring sites.*

Part 7:
Summary discussion

Bathing water quality

The 2019/20 bathing season was climatically similar to the 2018/19 season, without the region-wide high rainfall events in November and early December 2018. Despite this, a number of river sites, such as Kaiate at Kaiate Falls Road, Utuhina at Lake Road, and Tuapiro at McMillan Road declined in quality, i.e. had a greater proportion of samples in a worse category than the previous season, which suggests that factors other than just rainfall are responsible for faecal contamination in these systems. The worst of these was Kaiate Falls at Kaiate Falls Road, which had over 75% of samples above the red threshold for the 2019/20 season, an increase from around 50% in 2018/19.

Lake Rotorua at Ngongotaha, Lake Rotorua at Holdens Bay, and Lake Rotorua at Hamurana also declined relative to the 2018/19 season. Lake Rotorua at Ngongotaha and Lake Rotorua at Holdens Bay are close to inflows from the Ngongotaha and Waingaehe catchments, respectively.
E. coli concentrations at the Ngongotaha Lake site have previously been shown to elevate in response to high flow events in the Ngongotaha Catchment (Dare, 2019), and results from the current study suggest that the catchment's 95th percentile, i.e. faecal response to high flow events, has increased in recent time, causing the site to move from a 'D' to 'E' grade. No other lake site scored lower than a 'B' grade for recreational suitability (i.e. Table 9 in the NPS-FM), although, all three Lake Rotorua sites ranked 'poor' according to the primary contact *E. coli* attribute (Table 22) in the NPS-FM.

Although there are no recreational bathing sites on the Waingaehe River, it is likely that elevated concentrations at the 'Lake Rotorua at Holdens Bay' site are also related to discharge from the agriculturally dominated Waingaehe Catchment, however, one elevated result that occurred in absence of heavy rainfall suggests that other sources may also contribute to the problem. Finally, field observations from the Lake Rotorua at Hamurana site suggest this season's poor results may be related to abnormally large numbers of geese congregating in the area (A. Spence, personal communication, May 2020).

Of the 30 river sites that were monitored throughout the 2019/20 bathing season, 16 (53%) were deemed suitable for recreational contact (Table 9 in the NPS-FM), a reduction of three sites from the 2018/19 season. Furthermore, only 14 (47%) were above the new primary contact *E. coli* attribute (Table 22 in the NPS-FM) national bottom line according to the NPS-FM (MfE, 2020), emphasising how stringent this new attribute is, especially since many well-performing sites were ranked 'poor' due to one or two large contamination events in the most recent year. Sites that were suitable for recreational contact according to the 2018/19 report, and unsuitable this year include: Utuhina at Pukehangi, Pongakawa at SH 2, and Whakatāne at Landing Road. All of these sites shifted from a 'B' in the previous season, to a 'D' in 2019/20. In the case of Utuhina, this shift was caused by an increase in the 95th percentile value, implying that contamination events have become worse over time, which is consistent with findings from other western catchments of Lake Rotorua (e.g. Ngongotaha, and Waiteti). This may be due to an increase in storm events over this period, or the loss of a comparatively good season of 2014/15 from the five year analysis. Pongakawa at SH 2 and Whakatāne at Landing Road both increased from a 'B' to 'D' grade due to the median value exceeding 130 cfu/100 ml.

Estuarine sites performed much better in 2019/20 than 2018/19, where no site breached the red (action) mode threshold of two consecutive samples over 280 cfu/100 ml. Significant sources of faecal contamination at estuarine sites have three main sources: local input from urban infrastructure (sewage overflows, stormwater) or septic systems, direct input by large congregations of gregarious animals (e.g. ducks, geese), or transport from catchments through river systems. Given the low frequency of contamination events at estuarine sites, and the difference in results from 2018/19, input from damaged infrastructure is less likely to be the source of contamination at these sites, unless remedial action was taken over the 2019 winter period. Aggregations of birdlife are a possibility, and would explain the variable results seen for some sites between seasons. However, the climatic difference between 2018/19 and 2019/20 is arguably the biggest change, and possibly why estuarine sites performed so much better this season.

Open coastal sites are less subject to faecal contamination from contributing catchments, unless they are situated close to river outflows. A comparison of these site between 2018/19 and 2019/20 shows that overall, sites performed worse in 2019/20 than the previous year. However, the only two sites that breached the amber (alert) mode threshold in 2018/19, had a 100% record of green (surveillance) mode sample results for 2019/20. This suggests two things: firstly contamination in these areas is minor, with every site being safe to swim at nearly all of the time; and secondly, any contamination events that occur seem to lack consistency, i.e. they disappear quickly, which suggests that management actions are likely to be limited. One site that may require further investigation if patterns continue is Ōhope at Surf Club. This site also breached the threshold of percentage of samples above 43 cfu/100 ml FC threshold, which supports the observation of high variability at this site. The causes are unknown, but given the characteristics of the area (i.e. a surf-beach with no major inflows), direct input from local infrastructure is a possibility.

Shellfish

Most shellfish sites performed better over the 2019/20 season than the previous season. Notable improvements include Waihi Estuary at Main Channel, which had a median of more than 75 FC CFU/100 ml in 2018/19, and less than 20 FC CFU/100 ml in 2019/20, and Waiōtahe at Estuary where the median reduced from around 37 FC CFU/100 ml in 2018/19 to less than 20 FC CFU/100 ml in 2019/20. Given that most faecal contamination in estuaries comes from contributing watersheds, reduced flow caused by a drier summer period is likely to be the reason for the reprieve. Despite the overall positive news for recreational shellfish fisheries, the same five sites that breached shellfish consumption guidelines in 2018/19, also breached guidelines in 2019/20. This illustrates that although conditions at these sites were generally better over the current bathing season, there is still a risk to human health through consumption.

Ōhope Beach at Surf Club and Tauranga Harbour at Te Puna Waitui Reserve both breached the percentage of samples greater than 43 FC CFU/100 ml threshold, but not the 10 FC CFU/100 ml median threshold. This indicates that the sites are highly variable, and often there are contamination events that could be deemed a health risk to the public, but in general contamination at these sites is low. Regardless, caution is advised when harvesting from these sites.

Cyanobacteria

The 2019/20 cyanobacteria season was comparatively mild, with only two public health warnings, and a public health advisory, issued in total. Furthermore, the severe blooms that occurred in Lake Rotoehu throughout the 2018/19 season did not reappear in 2019/20 season. In contrast, Lake Rotoehu did not breach the red (action) mode threshold for total biovolume at any stage during the 2019/20 season, and only one of the two monitored sites on that lake breached the red (action) threshold for potentially toxic cyanobacteria.

The reasons for the unusually low results in Lake Rotoehu are unknown. Land-use has remained relatively constant, and there has been little change to the reticulation status of many lake-side properties who continue to use septic tanks. In addition, the alum dosing plant on the Waitangi Springs inflow was turned off while a new consent is being developed, resulting in a greater inorganic P supply to the lake. Regardless, monthly hypolimnetic nutrient samples have shown less DRP and NH4-N release from bottom sediments, despite prolonged periods of stratification.

Possible theories for these results in Lake Rotoehu include: increased wind mixing over the summer period preventing deep stratification from occurring, absence of forest harvesting, or possibly removal of N and P from the main lake basin during last year's blooms, i.e. wind-blown accumulation of organic N and P in shallow northern arms. Despite this year's positive results, the major drivers of algal blooms in Lake Rotoehu remain unchanged, which means that these results are most likely a temporary reprieve, rather than a 'new normal'. One management action that may prevent future decline is installation of a new alum diffuser in the centre of the lake basin. This project is currently in the consenting stage, but is expected to be completed within the next few years.

Lake Rotorua and Rotoiti experienced an atypical bloom of *A. ciricinalis* in April 2020, which was detected at the Ohau Channel gates, and Rotoiti Outlet. Biovolumes showed that the bloom reached low amber (alert) levels and was therefore of little risk to the community. Given the uncertainty of the of COVID-19 lockdown, Toi Te Ora decided that it would be sensible to issue a blanket health warning for Lakes Rotorua, Rotoiti, and Rotoehu in anticipation of increased activity and the reduced ability for sample based warnings.

Despite the relatively low biovolumes, the same bloom raised significant concern from locals living on the edge of the Okere Inlet, who reported slicks of green algae accumulating in enclosed bays. The severity of the April bloom was likely exacerbated in this instance by wind direction, and the presence of a high macrophyte biomass that prevented the bloom from dispersing. Bay of Plenty Regional Council tested the main reported site on two occasions, both of which returned low amber (alert) biovolume levels. The bloom dissipated within a month of the initial report, but the health warning has been maintained.

The comparatively mild 2019/20 season resulted in an improved NPS-FM rating for Lake Rotoehu at Kennedy Bay, which moved from a 'D' band to a 'C'. Lake Rotoehu at Otautu Bay and Lake Okaro at Boat Ramp, both maintained the same band as the previous season ('D' and 'C' respectively). All other sites were ranked an 'A'.

Part 8: **References**

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Appendices

Appendix 1a

Suitability for recreation grading - grades for river and stream sites over the previous five years

NPS-FM bands are for Table 9 in Appendix 2A of the NPS-FM.

District	Site Name	Site ID	n	Mean	Median	95th Percentile	MAC	SIC	SFRG	% of Samples < Action/Red Mode	NOF Band
Kawerau	Tarawera at Kawerau Bridge	IK555889	104	164.4	97.3	442.5	C	Very Low	Fair	97.1	A
Opotiki	Haparapara at SH 35	RN123610	64	30.9	10.5	95.0	B	Very Low	Very Good	100.0	A
	Kereu at SH 35	RO629568	84	112.6	7.0	96.3	A	Very Low	Very Good	97.6	A
	Otara at SH 35	NL683503	105	323.9	76.7	476.0	D	Moderate	Poor	95.2	A
	Waioeka at Mouth of Gorge	NK608503	86	188.2	32.5	452.5	C	Moderate	Fair	95.3	A
	Waioeka at SH 2	NL517414	104	372.4	98.3	735.5	D	Moderate	Poor	89.4	C
Rotorua	Hamurana at Hamurana Road	EL613536	87	121.7	86.0	384.0	C	Low	Fair	98.9	A
	Ngongotaha at Railway Bridge	EL192023	105	1048.4	360.0	6560.0	D	Low	Poor	68.6	E
	Ohau Channel at SH 33	FL230406	105	99.8	46.0	290.0	C	Low	Fair	98.1	A
	Puarenga at Whakarewarewa	EK537123	107	508.8	205.0	2480.0	D	Moderate	Poor	82.2	D
	Utuhina at Lake Road	EK405487	105	536.4	280.0	2360.0	D	Moderate	Poor	76.2	D
	Utuhina at Pukehangi Road	EK260170	82	308.3	129.0	1275.0	D	Moderate	Poor	91.5	D
	Waitangi Soda Springs at Bathing Pool	HL149406	85	87.6	26.0	372.0	C	Moderate	Fair	97.6	A
	Waiteti at SH 36	EL143137	103	669.0	190.0	2600.0	D	Moderate	Poor	86.4	D

TCC	Kopurererua at McCord Avenue	DP768284	87	651.9	260.0	1404.0	D	Moderate	Poor	82.8	D
	Wairoa at SH 2	DP281304	102	437.1	106.7	1492.5	D	Moderate	Poor	89.2	D
WBOP	Kaiate at Kaiate Falls Road	EO564565	105	1358.4	580.0	3040.0	D	Moderate	Poor	47.6	E
	Kaituna at Te Matai	FO620177	77	357.3	92.0	1800.0	D	Moderate	Poor	89.6	D
	Pongakawa at SH 2	GN922883	108	337.5	158.3	1002.0	D	Moderate	Poor	88.9	D
	Tuapiro at McMillan Road	BR748451	101	345.4	126.7	960.0	D	Moderate	Poor	90.1	B
	Uretara at Henry Road Ford	BQ723939	100	722.2	310.0	3015.0	D	Moderate	Poor	72.0	D
	Waiari at Te Puke Highway	FO397216	65	388.1	140.0	1460.0	D	Low	Poor	87.7	D
	Wairoa Below McLaren Falls	CO809137	103	645.5	65.0	1680.0	D	Moderate	Poor	89.3	D
Whakatane	Rangitaiki at Boat Ramp	KM083686	101	95.5	49.0	440.0	C	Moderate	Fair	100.0	A
	Rangitaiki at Matahina Dam	JK491452	66	16.4	4.0	72.8	A	Very Low	Very Good	100.0	A
	Rangitaiki at Murupara	IG265664	66	52.6	36.0	177.5	B	Very Low	Very Good	100.0	A
	Rangitaiki at Te Teko Bridge	JL348334	105	71.9	29.0	386.0	C	Low	Fair	98.1	A
	Tauranga at Wardlaw Glade	LK445461	103	248.3	36.0	583.0	D	Moderate	Poor	94.2	B
	Whakatane at Landing Road	KM909138	105	352.4	150.0	970.0	D	High	Very Poor	88.6	D
	Whakatane at Ruatoki	LK082095	85	234.9	18.0	282.0	C	Moderate	Fair	95.3	A

**less than 60 samples but greater than 50*

**less than 50 samples

Suitability for recreation grading - grades for river and stream sites over the most recent bathing season

NPS-FM bands are for Table 22 in Appendix 2B of the NPS-FM.

District	Site Name	Site ID	n	Median	95th Percentile	% of Samples < Action/Red Mode	NOF Band (Table 22)
Kawerau	Tarawera at Kawerau Bridge	IK555889	21	57.0	390.0	100.0	Fair
Opotiki	Haparapara at SH 35	RN123610	19	8.0	46.3	100.0	Excellent
	Kereu at SH 35	RO629568	19	6.0	32.1	100.0	Excellent
	Otara at SH 35	NL683503	21	110.0	400.0	95.2	Fair
	Waioeka at Mouth of Gorge	NK608503	21	20.0	3100.0	90.5	Poor
	Waioeka at SH 2	NL517414	19	80.0	929.0	89.5	Poor
Rotorua	Hamurana at Hamurana Road	EL613536	21	150.0	410.0	100.0	Fair
	Ngongotaha at Railway Bridge	EL192023	21	420.0	7200.0	66.7	Poor
	Ohau Channel at SH 33	FL230406	21	50.0	210.0	100.0	Good
	Puarenga at Whakarewarewa	EK537123	21	240.0	2600.0	71.4	Poor
	Utuhina at Lake Road	EK405487	21	420.0	2600.0	61.9	Poor
	Utuhina at Pukehangi Road	EK260170	21	180.0	1300.0	90.5	Poor
	Waitangi Soda Springs at Bathing Pool	HL149406	20	14.5	60.8	100.0	Excellent
	Waiteti at SH 36	EL143137	21	220.0	2700.0	85.7	Poor
TCC	Kopurererua at McCord Avenue	DP768284	21	430.0	1000.0	76.2	Poor
	Wairoa at SH 2	DP281304	21	190.0	450.0	95.2	Fair
WBOP	Kaiate at Kaiate Falls Road	EO564565	21	860.0	2800.0	14.3	Poor
	Kaituna at Te Matai	FO620177	21	90.0	1400.0	90.5	Poor

District	Site Name	Site ID	n	Median	95th Percentile	% of Samples < Action/Red Mode	NOF Band (Table 22)
	Pongakawa at SH 2	GN922883	21	160.0	1300.0	85.7	Poor
	Tuapiro at McMillan Road	BR748451	21	130.0	2200.0	81.0	Poor
	Uretara at Henry Road Ford	BQ723939	21	380.0	3000.0	61.9	Poor
	Waiari at Te Puke Highway	FO397216	21	210.0	880.0	85.7	Poor
	Wairoa Below McLaren Falls	CO809137	21	78.0	1500.0	90.5	Poor
Whakatane	Rangitaiki at Boat Ramp	KM083686	20	53.0	111.0	100.0	Excellent
	Rangitaiki at Matahina Dam	JK491452	21	2.0	10.0	100.0	Excellent
	Rangitaiki at Murupara	IG265664	21	50.0	78.0	100.0	Excellent
	Rangitaiki at Te Teko Bridge	JL348334	21	16.0	120.0	100.0	Excellent
	Tauranga at Wardlaw Glade	LK445461	21	30.0	230.0	95.2	Good
	Whakatane at Landing Road	KM909138	21	160.0	2000.0	90.5	Poor
	Whakatane at Ruatoki	LK082095	21	8.0	250.0	95.2	Good

Appendix 1b

Suitability for recreation grading - grades for lake sites

NPS-FM bands are for Table 9 in Appendix 2A of the NPS-FM.

Lake	Site Name	Site ID	n	Mean	Median	95th Percentile	MAC	SIC	SFRG	% of Samples < Action/Red Mode	NOF Band
Okareka	Lake Okareka at Steep Street Reserve	FK325034	105	40.1	10.0	158.1	B	Very Low	Very Good	100.0	A
Okaro	Lake Okaro at Boat Ramp	FI660574	95	40.3	13.0	193.0	B	Very Low	Very Good	98.9	A
Rerewhakaaitu	Lake Rerewhakaaitu at Homestead Arm	GI442508	95	49.2	20.0	186.2	B	Very Low	Very Good	98.9	A
Rotoiti	Lake Rotoiti at Gisborne Point	GL314263	105	12.0	3.0	46.8	A	Very Low	Very Good	100.0	A
	Lake Rotoiti at Hinehopu	GL606421	87	17.7	3.0	114.0	A	Very Low	Very Good	100.0	A
	Lake Rotoiti at Okawa Bay	FL289316	106	24.3	11.5	88.2	A	Very Low	Very Good	100.0	A
Rotoma	Lake Rotoma at Whangaroa	HL337241	105	22.9	4.0	117.6	A	Very Low	Very Good	99.0	A
Rotorua	Lake Rotorua at Hamurana	EL438512	105	215.6	25.0	684.0	D	Very Low	Poor	93.3	B
	Lake Rotorua at Holdens Bay	EK935598	106	92.7	12.0	415.0	C	Moderate	Fair	96.2	A
	Lake Rotorua at Ngongotaha	EL224087	107	450.9	40.0	1280.0	D	Moderate	Poor	87.9	D
Tarawera	Lake Tarawera at Rangiuru Bay	FJ737728	105	6.5	2.0	24.6	A	Very Low	Very Good	100.0	A
Tikitapu	Lake Tikitapu at Beach	FJ157807	105	37.0	12.0	192.4	B	Very Low	Very Good	100.0	A

*less than 60 samples but greater than 50
**less than 50 samples

Suitability for recreation grading - grades for lake sites over the most recent bathing season

NPS-FM bands are for Table 22 in Appendix 2B of the NPS-FM.

District	Site Name	Site ID	n	Median	95th Percentile	% of Samples < Action/Red Mode	NOF Band (Table 22)
Okareka	Lake Okareka at Steep Street Reserve	FK325034	21	6	120	100.0	Excellent
Okaro	Lake Okaro at Boat Ramp	FI660574	21	27	190	100.0	Good
Rerewhakaaitu	Lake Rerewhakaaitu at Homestead Arm	GI442508	21	5	21	100.0	Excellent
Rotoiti	Lake Rotoiti at Gisborne Point	GL314263	21	4	140	100.0	Good
	Lake Rotoiti at Hinehopu	GL606421	21	1	130	100.0	Excellent
	Lake Rotoiti at Okawa Bay	FL289316	21	11	45	100.0	Excellent
Rotoma	Lake Rotoma at Whangaroa	HL337241	21	2	24	100.0	Excellent
Rotorua	Lake Rotorua at Hamurana	EL438512	21	24	620	90.5	Poor
	Lake Rotorua at Holdens Bay	EK935598	21	24	1400	90.5	Poor
	Lake Rotorua at Ngongotaha	EL224087	21	28	760	85.7	Poor
Tarawera	Lake Tarawera at Rangiuru Bay	FJ737728	21	1	23	100.0	Excellent
Tikitapu	Lake Tikitapu at Beach	FJ157807	21	17	120	100.0	Excellent

**less than 60 samples but greater than 50*
***less than 50*

Appendix 1c

Suitability for recreation grading - grades for open coastal sites

District	Site Name	Site ID	n	Mean	Median	95th Percentile	MAC	SIC	SFRG	% of Samples < 280 n/100ml
Opotiki	Hikuwai Beach at end of Snell Road	NL713661	103	39.0	1.0	61.9	B	Moderate	Good	99.0
	Te Kaha at Maraetai Bay	RO364396	80	145.3	4.0	110.8	B	Very Low	Very Good	98.8
	Waiotahe Beach at Surf Club	NL243661	102	115.2	2.0	97.6	B	Low	Good	98.0
	Whanarua at Whanarua Bay	SO235884	81	135.0	2.0	76.0	B	Very Low	Very Good	98.8
TCC	Mount Maunganui at Surf Club	EQ065035	93	5.3	2.0	19.2	A	Very Low	Very Good	100.0
	Papamoa Beach at Harrison's Cut	EP886340	74	9.4	1.0	31.7	A	Low	Very Good	100.0
WBOP	Pukehina at Surf Club	GO701513	101	26.2	1.0	72.0	B	Moderate	Good	98.0
	Waihi Beach at 3 Mile Creek	CS131458	77	22.8	3.0	69.0	B	Moderate	Good	98.7
	Waihi Beach at Surf Club	CS010698	97	17.7	2.0	54.6	B	Low	Good	97.9
Whakatane	Ohope at Surf Club	LM474063	88	6.8	2.0	31.8	A	Very Low	Very Good	100.0
	Ohope Beach at Anne Street	ML081849	90	2.6	0.0	14.0	A	Very Low	Very Good	100.0
	Ohope Beach opposite Moana Street	LL770939	73	2.6	1.0	7.0	A	Very Low	Very Good	100.0
	Piripai at Ohuirehe Road	KM969398	93	4.4	1.0	23.4	A	Very Low	Very Good	100.0

Appendix 1d

Suitability for recreation grading - grades for estuarine sites

Estuary	Site Name	Site ID	n	Mean	Median	95th Percentile	MAC	SIC	SFRG	% of Samples < 280 n/100ml
Maketu	Maketu at Surf Club	GO441583	102	37.7	5.0	76.5	B	Moderate	Good	98.0
Ohiwa	Ohiwa Harbour at Reserve (Boat Ramp)	ML251726	90	11.9	2.0	66.0	B	Very Low	Very Good	100.0
Tauranga	Pilot Bay opposite Pacific Avenue	EP057968	105	35.6	7.0	118.4	B	Moderate	Good	97.1
	Tauranga Harbour at Anzac Bay	CR395919	106	23.1	4.5	96.8	B	Very Low	Very Good	99.1
	Tauranga Harbour at Bowentown Boat Ramp	CS292034	91	18.3	2.0	38.0	A	Low	Very Good	98.9
	Tauranga Harbour at Maungatapu Bridge (Bathing)	EP095164	106	35.8	7.0	159.0	B	Low	Good	97.2
	Tauranga Harbour at Omokoroa Beach	CQ940066	105	8.4	0.0	23.8	A	Very Low	Very Good	99.0
	Tauranga Harbour at Ongare Point	CR253528	63	42.8	6.0	135.2	B	Low	Good	96.8
	Tauranga Harbour at Pahoia Beach Road	CQ490084	50	61.3	11.5	263.2	C	Low	Fair	94.0
	Tauranga Harbour at Tanners Point Beach	CR054756	106	38.0	2.0	166.8	C	Low	Fair	95.3
	Tauranga Harbour at Te Puna Waitui Reserve	CP895761	105	26.1	4.0	142.8	B	Low	Good	98.1
	Tauranga Harbour at Tilby Point	DP547739	105	38.6	10.0	131.4	B	Low	Good	97.1
	Tauranga Harbour at Waimapu Bridge	DP896097	87	58.7	17.0	317.0	C	Moderate	Fair	94.3
Waihi	Waihi Estuary at Main Channel	GO661503	85	129.0	24.0	177.6	B	Moderate	Good	96.5
Whakatane	Whakatane Heads	LM237268	90	54.3	26.5	150.0	B	Moderate	Good	98.9

Appendix 2

List of sites

Type	SiteID	Name	Easting	Northing
Coastal	NL713661	Hikuwai Beach at end of Snell Road	1977138	5786616
	EQ065035	Mount Maunganui at Surf Club	1880652	5830352
	LM474063	Ohope at Surf Club	1954743	5790635
	ML081849	Ohope Beach at Anne Street	1960813	5788495
	LL770939	Ohope Beach opposite Moana Street	1957708	5789391
	EP886340	Papamoa Beach at Harrison's Cut	1888867	5823406
	KM969398	Piripai at Ohuirehe Road	1949691	5793985
	GO701513	Pukehina at Surf Club	1907018	5815139
	RO364396	Te Kaha at Maraetai Bay	2013648	5813967
	CS131458	Waihi Beach at 3 Mile Creek	1861312	5854588
	CS010698	Waihi Beach at Surf Club	1860109	5856987
	NL243661	Waiotahe Beach at Surf Club	1972431	5786610
	SO235884	Whanarua at Whanarua Bay	2022352	5818841
Cyanobacteria	FL356693	Kaituna at Rotoiti Outlet	1893562	5786935
	FL344809	Kaituna at Trout Pool Road	1893447	5788095
	FI660574	Lake Okaro at Boat Ramp	1896600	5755748
	HL129560	Lake Rotoehu at Kennedy Bay	1911292	5785607
	HL143688	Lake Rotoehu at Otautu Bay Boat Ramp	1911431	5786889

Type	SiteID	Name	Easting	Northing
	GL604463	Lake Rotoiti at Hinehopu, Jetty	1906043	5784631
	FL289316	Lake Rotoiti at Okawa Bay	1892891	5783164
	FL416536	Lake Rotoiti at Walkway 7 Goulding Road (Te Weta Bay)	1894160	5785365
	FL779744	Lake Rotoiti at Whangamoa Drive Boat Ramp	1895773	5787441
	EL606530	Lake Rotorua at Hamurana Stream	1886066	5785303
	EK984647	Lake Rotorua at Lee Road Boat Ramp	1889850	5776471
	EL224087	Lake Rotorua at Ngongotaha	1882247	5780874
	FL168384	Ohau Channel at Lake Rotorua Outlet	1891686	5783849
Estuarine	GO441583	Maketu at Surf Club	1904414	5815835
	ML251726	Ohiwa Harbour at Reserve (Boat Ramp)	1962517	5787266
	EP057968	Pilot Bay opposite Pacific Ave	1880567	5829686
	CR395919	Tauranga Harbour at Anzac Bay	1863958	5849190
	CS292034	Tauranga Harbour at Bowentown Boat Ramp	1862924	5850349
	EP095164	Tauranga Harbour at Maungatapu Bridge (Bathing)	1880957	5821645
	CQ940066	Tauranga Harbour at Omokoroa Beach	1869400	5830662
	CR253528	Tauranga Harbour at Ongare Point	1862533	5845284
	CQ490084	Tauranga Harbour at Pahoia Beach Road	1864908	5830841
	CR054756	Tauranga Harbour at Tanners Point Beach	1860542	5847565
	CP895761	Tauranga Harbour at Te Puna Waitui Reserve	1868959	5827615
	DP547739	Tauranga Harbour at Tilby Point	1875472	5827396
	DP896097	Tauranga Harbour at Waimapu Bridge	1878968	5820974

Type	SiteID	Name	Easting	Northing
	GO661503	Waihi Estuary at Main Channel	1906617	5815039
	LM237268	Whakatane Heads	1952377	5792687
Lake	FK325034	Lake Okareka at Steep Street Reserve	1893250	5770341
	FI660574	Lake Okaro at Boat Ramp	1896600	5755748
	GI442508	Lake Rerewhakaaitu at Homestead Arm	1904423	5755088
	GL314263	Lake Rotoiti at Gisborne Point	1903140	5782634
	GL606421	Lake Rotoiti at Hinehopu	1906063	5784210
	FL289316	Lake Rotoiti at Okawa Bay	1892891	5783164
	HL337241	Lake Rotoma at Whangaroa	1913370	5782419
	EL438512	Lake Rotorua at Hamurana	1884387	5785126
	EK935598	Lake Rotorua at Holdens Bay	1889359	5775980
	EL224087	Lake Rotorua at Ngongotaha	1882247	5780874
	FJ737728	Lake Tarawera at Rangiuru Bay	1897377	5767284
	FJ157807	Lake Tikitapu at Beach	1891571	5768077
River	EL613536	Hamurana at Hamurana Road	1886132	5785363
	RN123610	Haparapara at SH 35	2011231	5806108
	EO564565	Kaiate at Kaiate Falls Road	1885648	5815655
	RO629568	Kereu at SH 35	2016299	5815685
	DP768284	Kopurererua at McCord Avenue	1877686	5822847
	EL192023	Ngongotaha at Railway Bridge	1881925	5780238
	FL230406	Ohau Channel at SH 33	1892304	5784064

Type	SiteID	Name	Easting	Northing
	NL683503	Otara at SH 35	1976838	5785034
	GN922883	Pongakawa at SH 2	1909225	5808837
	EK537123	Puarenga at Whakarewarewa	1885377	5771236
	KM083686	Rangitaiki at Boat Ramp	1940875	5796975
	JK491452	Rangitaiki at Matahina Dam	1934919	5774526
	IG265664	Rangitaiki at Murupara	1922660	5736647
	JL348334	Rangitaiki at Te Teko Bridge	1933489	5783348
	LK445461	Tauranga at Wardlaw Glade	1954452	5774619
	BR748451	Tuapiro at McMillan Road	1857482	5844516
	BQ723939	Uretara at Henry Road Ford	1857235	5839394
	EK405487	Utuhina at Lake Road	1884052	5774873
	EK260170	Utuhina at Pukehangi Road	1882598	5771708
	FO397216	Waiari at Te Puke Highway	1893975	5812165
	NK608503	Waioeka at Mouth of Gorge	1976081	5775032
	NL517414	Waioeka at 2	1975174	5784146
	DP281304	Wairoa at SH 2	1872819	5823049
	CO809137	Wairoa Below McLaren Falls	1868096	5811374
	HL149406	Waitangi Soda Springs at Bathing Pool	1911491	5784063
	EL143137	Waiteti at SH 36	1881436	5781370
	KM909138	Whakatane at Landing Road	1949094	5791381
	LK082095	Whakatane at Ruatoki	1950830	5770958

Type	SiteID	Name	Easting	Northing
Shellfish	GO441583	Maketu at Surf Club	1904414	5815835
	ML251726	Ohiwa Harbour at Reserve (Boat Ramp)	1962517	5787266
	LM474063	Ohope at Surf Club	1954743	5790635
	LL770939	Ohope Beach opposite Moana St	1957708	5789391
	CR395919	Tauranga Harbour at Anzac Bay	1863958	5849190
	CS292034	Tauranga Harbour at Bowentown Boat Ramp	1862924	5850349
	CP895761	Tauranga Harbour at Te Puna Waitui Reserve	1868959	5827615
	DP547739	Tauranga Harbour at Tilby Point	1875472	5827396
	CS131458	Waihi Beach at 3 Mile Creek	1861312	5854588
	GO661503	Waihi Estuary at Main Channel	1906617	5815039
	ML922670	Waiotahe at Estuary	1969229	5786705