

Bathing Beach Recreational Water Quality
State of the Environment
Monitoring Report
Summer 2014-2015

Technical Report 2015-11

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Executive summary

This report provides an assessment of microbial water quality at 12 bathing beach sites in the Taranaki region, based on routine summer monitoring of faecal indicator bacteria (enterococci, *E. coli* and faecal coliforms) conducted by the Council between 10 November 2014 and 20 March 2015. The report focusses on enterococci results, as this indicator is considered by health authorities to provide the closest correlation with risks of health effects in New Zealand coastal waters. Results have been assessed for compliance with microbiological water quality guidelines prepared by the Ministry for the Environment (MfE) and the Ministry of Health (MfE, 2003).

Thirteen samples were collected at every monitored beach under dry weather conditions for state of the environment monitoring (SEM) purposes. An extra 7 samples were collected regardless of weather conditions at 5 sites, to satisfy MfE grading purposes.

During the 2014-2015 summer season, microbiological water quality was generally good across bathing beaches in the Taranaki region. The highest median enterococci counts were recorded at Oakura Surf Club and Ohawe (57 and 24 enterococci cfu/100 ml respectively). Median enterococci counts at all other beaches were equal to or less than 8 cfu/100 ml. Out of the 191 samples collected for both SEM and for additional monitoring purposes, 96% were below the Alert level. Of the few samples which individually entered the Alert guideline category (4%), over two thirds (5 out of 7) had been influenced by rainfall or freshwater.

The guideline MfE 'Action' mode is reached when enterococci counts in two consecutive samples exceed 280 enterococci cfu/100 ml. No site reached Action mode during the 2014-2015 season and no individual sample exceeded 280 enterococci cfu/100 ml.

Mann-Kendall tests were performed in order to assess long term trends in microbiological water quality. Two sites show a significant decrease in median enterococci counts over the 13-20 years monitored (Fitzroy and Ngamotu), indicating an overall improvement in microbiological water quality. Oakura Surf Club was the only site where there was a significant increase in enterococci medians over the time period monitored i.e. deterioration in water quality. This increase in enterococci counts was significant using the Mann-Kendall test, but not significant after False Discovery Rate application. All other sites showed no significant change.

During the 2014-2015 season, 3 of the 12 beach sites recorded the lowest or equal lowest SEM enterococci median counts in the 20 years of the programme to date (Urenui, Waitara East and Waitara West Beach). At the Oakura Surf Club site the median enterococci count obtained for the 2014-2015 summer season was the highest to date at this site. Interannual variation in median enterococci counts at this site can be largely attributed to the changing location of the small stream mouths relative to the sampling site.

Microbiological water quality results were regularly reported on the Taranaki Regional Council website (www.trc.govt.nz) and there was timely liaison with territorial local authorities and the Health Protection Unit of the Taranaki District Health Board throughout the summer bathing season of 2014-2015.

Through the Council's LTP, the Council's target in respect of the microbiological state of coastal bathing sites is that there is *maintenance or increase in the number of sites from 2003 compliant with 2003 Ministry of Health contact recreational guidelines*. In 2003, 10 of 11 coastal

bathing sites were compliant with the guidelines ('Action' levels). In the season under review, 12 of 12 beaches were compliant with the guidelines. The LTP target was therefore met.

Continuation of the bathing beach SEM programme is recommended in the 2015-2016 year.

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1. Introduction

The coastal waters of New Zealand are used for a broad range of recreational activities, including bathing, surfing, diving, sailing, kayaking, and shellfish gathering. Maintaining the quality of this recreational water is therefore an important resource management and environmental health issue.

1.1 State of the environment monitoring (SEM)

Regional councils have responsibilities under the Resource Management Act (1991) to monitor the state of the environment. The purpose of state of the environment monitoring (SEM) is to collect sufficient data to produce information on the general health of the environment. This information can then be used to measure how well management practices, policies and laws are working, and whether environmental outcomes are being achieved. As part of SEM, environmental performance indicators (EPI's) are used to measure human activities and their effects on the environment. Included amongst these EPI's, faecal indicator bacteria (enterococci, *E. coli* and faecal coliforms) can be monitored to assess the contamination of water by human or animal excreta. Levels of these faecal indicators are of particular interest in coastal waters used for recreational activities due to the potential health risks associated.

The Taranaki Regional Council has monitored faecal indicator bacteria at bathing beaches along the Taranaki coast since 1979, with systematic surveys undertaken from 1987. A more comprehensive annual bathing beach monitoring programme was implemented during the 1995-1996 summer as an on-going component of the SEM programme for the Taranaki region.

The SEM bacteriological bathing water quality programme has three objectives:

- to characterise the bacteriological quality of principal recreation waters in the Taranaki area, and more specifically to determine their suitability for contact recreation;
- to identify changes in contact recreational water quality over time. Therefore the detection of trends is an important component in programme design;
- to assess compliance with recreational water quality guidelines.

[Note: Contact recreation concerns water-based activities involving a high probability of accidental water ingestion. This mainly applies to bathing, but may also include other high-contact water sports e.g. jet-skiing, surfing, kayaking]

2. Contact recreation water quality standards and guidelines

2.1 Microbiological water quality guidelines for marine recreational areas (2003)

Guidelines for microbiological water quality of marine recreational areas have been prepared by the Ministry for the Environment in conjunction with the Ministry of Health (MfE, 2003). The guidelines use a combination of a qualitative risk grading of the catchment, together with direct measurements of appropriate faecal indicators to assess the suitability of a site for recreation (see 2.2).

In addition, 'Alert' and 'Action' guideline levels are used for surveillance throughout the bathing season. These guideline levels are summarized in Table 1 and are based on keeping illness risk associated with recreational water use to less than approximately 2%. Levels are based on enterococci counts as these bacteria are the preferred indicators for marine waters. Research has shown that enterococci are the indicator most closely correlated with health effects in New Zealand marine waters, in common with general findings overseas (New Zealand Marine Bathing Study). In coastal waters, faecal coliforms and *E. coli* are not as well correlated with health risks, but can be used as indicators, in addition to enterococci, where enterococci levels alone may be misleading.

Table 1 Surveillance, Alert and Action levels for marine waters (2003)

| | Mode | | |
|--------------------------|---|--|--|
| | Surveillance | Alert | Action |
| Enterococci (cfu/100 ml) | No single sample >140 | Single sample >140 | Two consecutive single samples >280 |
| Procedure | <ul style="list-style-type: none"> Continue routine monitoring | <ul style="list-style-type: none"> Increase sample to daily Undertake sanitary survey Identify sources of contamination Consult CAC to assist in identifying possible source | <ul style="list-style-type: none"> Increase sample to daily Undertake sanitary survey Identify sources of contamination Consult CAC to assist in identifying possible source Erect warning signs Inform the public through the media that a public health problem exists |

CAC = Catchment Assessment Checklist

2.2 Suitability for recreation grading (SFRG) of sites

The 2003 Microbiological Water Quality Guidelines (MfE, 2003) provide for the grading of recreational water bodies based on two components:

- The Microbiological Assessment Category (MAC)*: this is established on the basis of five years' enterococci data for a particular site, providing a quantitative measurement of the actual water quality over time. Sites are assigned MAC categories ranging from A to D, with definitions provided in Table 2. For the Taranaki region, the Taranaki Regional Council provides the Ministry for the Environment with these data collected as part of the annual bathing beach monitoring programme.

- *The Sanitary Inspection Category (SIC)*: generates a measure of the susceptibility of a water body to faecal contamination. A site is allocated a category of either Very High, High, Moderate, Low or Very Low, and is determined using the SIC flow chart. Information used in the flow chart comes from the Catchment Assessment Checklist (CAC) which provides qualitative risk information on the catchment. Detailed information about SIC, including the SIC flow chart and the CAC can be found in the 2003 Microbiological Water Quality Guidelines (MfE, 2003).

The SIC is combined with the MAC to determine a Suitability for Recreation Grade (SFRG) for each site. The SFRG therefore describes the general condition of a site based on both qualitative risk grading of the catchment and the quantitative measurement of faecal indicators. A grade is established on the basis of the most recent five years' data and recalculation of a grade is typically performed annually.

Table 2 Microbiological Assessment Categories

| MAC | MAC definitions for marine waters |
|-----|--|
| A | Sample 95 percentile \leq 40 enterococci/100ml |
| B | Sample 95 percentile 41 - 200 enterococci/100ml |
| C | Sample 95 percentile 201 - 500 enterococci/100ml |
| D | Sample 95 percentile $>$ 500 enterococci/100ml |

SFRGs, as defined by the Ministry for the Environment, are:

- *Very Good*: considered satisfactory for swimming at all times.
- *Good*: satisfactory for swimming most of the time. Exceptions may include following rainfall.
- *Fair*: generally satisfactory for swimming, though there are many potential sources of faecal material. Caution should be taken during periods of high rainfall, and swimming avoided if water is discoloured.
- *Poor*: generally unsuitable for swimming, as indicated by historical results. Swimming should be avoided, particularly by the very young, the very old and those with compromised immunity.
- *Very Poor*: avoid swimming.

Sixteen of the 19 coastal sites monitored by the Council had sufficient data available to calculate SFRG grades for the period spanning November 2010 to April 2015 (Table 3, Appendix II). Of these 16 sites, 11 were graded 'good', 3 were graded 'fair' and 2 were graded 'poor'. None of the beaches graded 'very poor'. As 14 of the 16 beaches were assigned a SIC of 'moderate' it was not possible for any of these beaches to obtain a 'very good' SFRG grading regardless of the enterococci results used to calculate MAC. This was mainly related to either the agricultural nature of the catchment areas or the presence of nearby streams and rivers which heavily influenced the SIC assessment results.

It must be emphasized that the SFRG grade provides a conservative/precautionary guideline intended for assessing the suitability of beaches for contact recreation from a public health perspective. The grade is of limited use for assessing the state of the environment, as it includes the SIC: a static assessment based on qualitative information. Instead, the remainder of this report will focus on presenting and

interpreting actual faecal indicator data collected during routine monitoring. This quantitative information enables the assessment of general trends in coastal water quality, and can be used to measure how well management practices and policies are working, and whether environmental outcomes are being achieved.

It should be noted that the Ministry itself states that the SFRG 'reflects a precautionary approach to managing public health risks and does not represent an accurate picture of water quality in the catchment. ...The grades reflect a precautionary approach to managing health risk and are not designed to represent health risks on a particular day. They tend to reflect the poorest water quality measured at a site rather than the average water quality. A site may be graded as poor but still be suitable for swimming much of the time....The indicator does not replace the site-specific information available on council websites'¹

Note: Table 3 takes into account data from both standard SEM samples along with extra samples required by MfE (see Section 3).

Table 3 Suitability for recreation grade for the period November 2010 to April 2015

| Site | Sanitary Inspection Category * and primary influence | Microbiological assessment Enterococci (cfu/100ml) | | | SFR Grade | % of all samples in compliance (ie: <280 enterococci) |
|-------------------|--|--|-------------------|----------|-----------|---|
| | | 95 %ile | Number of samples | Category | | |
| Wai-iti | Moderate 13 | 57 | 26 | B | Good | 100 |
| Urenui | Moderate 13 | 29 | 26 | A | Good | 100 |
| Onaero | Low | 240 | 100 | C | Fair | 96 |
| Onaero Settlement | Low 14 | 98 | 26 | B | Good | 100 |
| Waitara (East) | Moderate 13 | 333 | 65 | C | Fair | 93 |
| Waitara (West) | Moderate 13 | 145 | 65 | B | Good | 96 |
| Bell Block | Moderate 3 | 2292 | 26 | D | Poor | 92 |
| Fitzroy | Moderate 3 | 44 | 100 | B | Good | 99 |
| East End | Moderate 3 | 109 | 52 | B | Good | 100 |
| Ngamotu | Moderate 3 | 91 | 100 | B | Good | 98 |
| Oakura (SC) | Moderate 13 | 200 | 100 | B | Good | 96 |
| Oakura (CG) | Moderate 13 | 49 | 65 | B | Good | 100 |
| Opunake | Moderate 3 | 39 | 100 | A | Good | 100 |
| Ohawe | Moderate 13 | 240 | 65 | C | Fair | 96 |
| Patea (Mana Bay) | Moderate 13 | 37 | 45 | A | Good | 100 |
| Back | Low 14 | 616 | 26 | D | Poor | 92 |
| Patea | Moderate 13 | Insufficient data to calculate | | | | |
| Waverley | Moderate 13 | Insufficient data to calculate | | | | |
| Wai-inu | Moderate 13 | Insufficient data to calculate | | | | |

* 13 = River - agricultural activities/birds/feral animals

14 = River - focal points of discharge

3 = Urban stormwater

**Insufficient data – a minimum of 20 samples is needed to calculate MAC

¹ Suitability for swimming: Indicator update July 2013: INFO 690, Ministry for the Environment

3. Monitoring methodology

3.1 SEM sample collection

The monitoring network is designed to assess coastal water quality in terms of its suitability for contact recreation. As such, the network targets the main bathing times and avoids, as far as possible, the localized influence of diffuse sources (i.e. streams and rivers) on coastal water quality. For these reasons the following criteria have been adopted during sampling:

Sample collection, field measurements, transport and analyses were undertaken according to documented Taranaki Regional Council procedures. It was intended that on average, four samples would be collected from each of the sites in each month when hydrological flow conditions permitted, within two hours of high tide. SEM sampling was performed only under dry weather flow conditions (i.e. not within three days of a fresh). Bathing water samples were taken between the hours of 0900 and 1800 hours (NZDT) to reflect the most likely period for swimming usage. Where necessary, a 2 m sampling pole was used for bacteriological sample collection immediately beneath the water surface and at a minimum of knee depth at the sites (Photo 1). Thirteen samples were collected from each site during the season.

Results for the 2014-2015 bathing season were posted on the Taranaki Regional Council website (www.trc.govt.nz) as soon as checking had been completed. Where single results fell in the Action mode, further sampling was performed when necessary i.e. where historical databases and staff expertise indicated this was warranted.

3.2 Sample analysis

Samples were analyzed for enterococci, *E. coli*, faecal coliforms and conductivity. *E. coli* and faecal coliform numbers were obtained using the mTEC agar method #9213-d, Standard Methods for the Examination of Waters and Wastewaters (APHA, 2005). Enterococci were quantified using the EPA modified method #1600 on mEI agar (EPA, 1986).

At each of the sites the following additional information was recorded: time, water temperature, weather condition, wind condition, surf condition, colour/appearance of water, and number of bathers and other users.

3.3 Programme design

The locations of the twelve sites sampled in the 2014-2015 programme are shown in Figure 1 and Table 4.

Table 4 Location of bathing water bacteriological sampling sites 2014-2015

| Beach | Location | GPS | Site code |
|---------|---|-----------------|-----------|
| Wai-iti | 75 m N of Wai-iti Stream | 1727667-5690609 | SEA900060 |
| Urenui | East of Urenui River mouth | 1720582-5683563 | SEA900072 |
| Onaero | Opposite surf lifesaving club | 2628254-6244898 | SEA900085 |
| Onaero | Settlement beach | 1717129-5683099 | SEA900087 |
| Waitara | East Beach | 1706602-5683915 | SEA901033 |
| Waitara | West Beach | 1705951-5683802 | SEA901037 |
| Fitzroy | Opposite surf lifesaving club | 2605036-6239351 | SEA902025 |
| Ngamotu | Centre of beach | 2600022-6237765 | SEA902062 |
| Oakura | Opposite surf lifesaving club, south of Wairau Stream | 2591974-6231726 | SEA903030 |
| Oakura | Opposite motorcamp, south of Waimoku Stream | 2591700-6231600 | SEA903032 |
| Opunake | Centre of beach | 2583775-6193800 | SEA904090 |
| Ohawe | Adjacent to boat ramp, east of Waingongoro River | 2612688-6179169 | SEA906010 |

Primary beach sites are monitored each year (Figure 1). Remaining beach sites are sampled on a three year rotation, with Year 3 beaches sampled during the 2014-2015 monitoring programme (Table 5).

Table 5 Coastal bathing beach sampling programme

| Annually sampled | Year 1 | Year 2 | Year 3 |
|-------------------------|--------------|------------|-------------------|
| Fitzroy | Patea | Bell Block | Wai-iti |
| Ngamotu | Patea Bay ** | East End | Urenui |
| Oakura CG | Waverley | Back Beach | Onaero Settlement |
| Oakura SC | Wai-inu | | |
| Opunake | | | |
| Ohawe * | | | |
| Onaero (opp. surf club) | | | |
| Waitara East | | | |
| Waitara West | | | |

*since 1996-97

** since 2000-01 summer period



Photo 1 Faecal indicator bacteria sampling

3.3.1 Additional monitoring (MfE guidelines)

The revised guidelines (MfE, 2003) generally require weekly surveillance monitoring during the 5-month recreational period, with a minimum of 20 sampling dates, regardless of weather conditions or state of the tide. This is primarily to facilitate the calculation of the Microbiological Assessment Category (See Section 2.2). Following consultation with the territorial local authorities and the Taranaki District Health Board, TRC added seven sampling dates to the SEM protocol at five of the most popular marine recreational sites (Onaero, Fitzroy, Ngamotu, Oakura and Opunake beaches) in the 2002-2003 period. These seven sampling dates were systematically selected (one per week) in weeks not sampled by the SEM programme. Sampling was undertaken regardless of prior weather conditions or tides but adhering to all other SEM programme protocols. [NB: These data will not be used for trend analysis purposes as they do not comply with the format of the originally established SEM programme].

3.4 Long-term trend analysis

For sites with sufficient data (≥ 10 years), non-parametric trend analysis was performed using annual median enterococci data. For each site, a LOWESS (Logically Weighted Scatterplot) line (tension 0.4) was fitted to a temporal scatter plot of the enterococci median data. Statistical significance of the trend was tested using a Mann-Kendall test. The sign (+/-) of the Kendall tau value was used to assess whether the trend was positive or negative and the significance of the trend was determined using the p value ($p < 0.05 = \text{significant}$).

When multiple correlations are undertaken, there is a chance that some will be found to be significant purely by chance. In order to deal with this potential problem, the Benjamini-Hochberg False Discovery Rate (FDR) method was applied to the results of the Mann-Kendall test. Further justification for this statistical approach can be found in Stark and Fowles (2006).



Figure 1 SEM beach bathing bacteriological survey sites

4. Results

From 10 November 2014 to 20 March 2014 a total of 13 samples were collected at each site for the purpose of state of the environment monitoring (SEM). Whenever possible, no SEM sampling was undertaken within three days following significant river freshes. However, occasionally sampling was affected by localized rainfall and elevated river flows. An additional seven samples were taken at five of the beaches (Onaero, Fitzroy, Ngamotu, Oakura and Opunake) regardless of weather conditions for the purpose of MfE categorization (as discussed in Section 3.3.1). All results within this report are presented and discussed on a site-by-site basis for the sampling period. The timing of high tide on the dates sampled is provided in Appendix I.

Sampling was confined to weekdays, with no public holidays included. For these reasons, recreational usage of the waters was generally less intensive, often with no apparent usage at the time of sampling. However, all sites are known to be regularly utilized for bathing and other contact recreational activities, particularly at weekends, dependent on suitable weather conditions.

4.1 Wai-iti Beach

4.1.1 SEM programme

Wai-iti Beach (Photo 2) is located in north Taranaki. The relatively small Wai-iti Stream drains onto the southern end of the beach.



Photo 2 Wai-iti Beach

The data for this site are presented in Table 6 and Figure 2, with a statistical summary provided in Table 7.

Table 6 Bacteriological results for Wai-iti Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|-----------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 10:10 | 4550 | 40 | 4 | 41 | 17.1 |
| 09-Dec-14 | 09:30 | 4730 | 8 | 7 | 8 | 18.3 |
| 05-Jan-15 | 09:45 | 4740 | 8 | 4 | 8 | 21.2 |
| 08-Jan-15 | 10:50 | 4780 | 8 | 8 | 8 | 20.5 |
| 12-Jan-15 | 12:15 | 4770 | 65 | 19 | 65 | 20.9 |
| 20-Jan-15 | - | 4720 | 11 | 23 | 11 | 20.1 |
| 23-Jan-15 | 10:45 | 4690 | 15 | <1 | 15 | 20.2 |
| 26-Jan-15 | 12:15 | 4730 | 4 | 8 | 4 | 20.9 |
| 09-Feb-15 | 11:05 | 4640 | 8 | 21 | 8 | 20.3 |
| 19-Feb-15 | 09:35 | 4620 | 41 | 43 | 41 | 19.8 |
| 04-Mar-15 | 08:00 | 4680 | 17 | 13 | 17 | 20.7 |
| 12-Mar-15 | 11:45 | 4720 | 8 | 6 | 8 | 22 |
| 20-Mar-15 | 10:30 | 4740 | 11 | 15 | 11 | 19 |

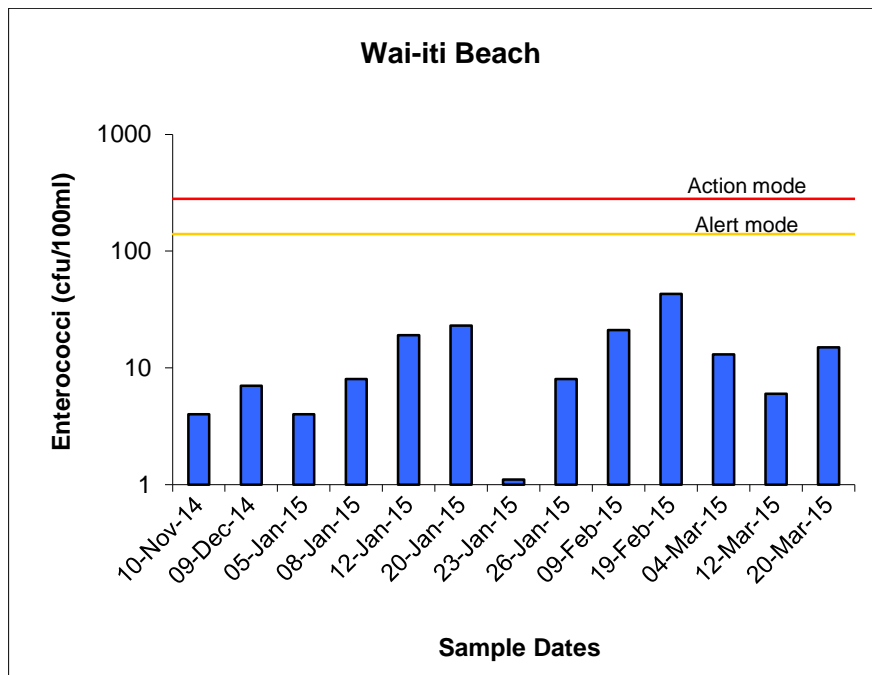
**Figure 2** Enterococci numbers for the 13 SEM samples taken at Wai-iti Beach

Table 7 Statistical summary for Wai-iti Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4550 | 4780 | 4720 |
| <i>E. coli</i> | cfu/100 ml | 13 | 4 | 65 | 11 |
| Enterococci | cfu/100 ml | 13 | 1 | 43 | 8 |
| Faecal coliforms | cfu/100 ml | 13 | 4 | 65 | 11 |
| Temperature | °C | 13 | 17.1 | 22.0 | 20.3 |

Bacteriological water quality at Wai-iti Beach remained high throughout the season, with low median and maximum values for all faecal indicator bacteria (Table 7).

4.1.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 8. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 8 Bacterial guidelines performance at Wai-iti Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|-------------------------------------|----|
| | ALERT | | ACTION | |
| | Single sample >140/100ml | | Two consecutive samples >280/100 ml | |
| Enterococci | 0/13 | 0% | 0/13 | 0% |

4.1.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Wai-iti Beach over 7 summer seasons are presented in Table 9 and Figure 3.

Table 9 Summary of enterococci data (cfu/100 ml) for summer surveys at Wai-iti Beach

| Summer | 1996-97 | 1999-00 | 2002-03 | 2005-06 | 2008-09 | 2011-12 | 2014-15 |
|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | 3 | 3 | 1 | 4 | <1 | <1 | 1 |
| Maximum | 92 | 80 | 87 | 95 | 140 | 80 | 43 |
| Median | 16 | 15 | 7 | 15 | 21 | 9 | 8 |

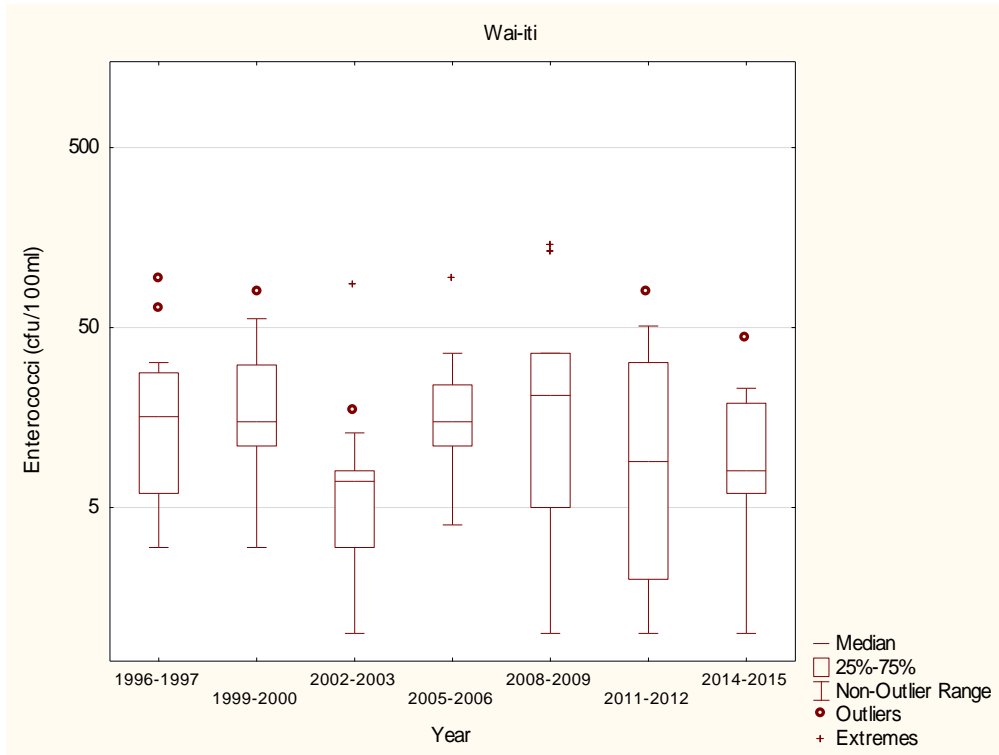


Figure 3 Box and whisker plots of enterococci counts for all summer SEM surveys at Wai-iti Beach

The median and maximum enterococci data obtained for the 2014-2015 summer season at Wai-iti Beach were at the lower end of the range of values previously recorded at this site (Table 9, Figure 3).

4.1.4 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.2 Urenui Beach

4.2.1 SEM programme

Urenui Beach (Photo 3), in north Taranaki, is a relatively popular bathing beach, especially over the Christmas holiday period. Draining through predominantly agricultural land, the Urenui River enters at the western end of the beach and makes a significant contribution to bacteria counts subsequent to rainfall events.



Photo 3 Urenui Beach

The data for this site are presented in Table 10 and Figure 4, with a statistical summary provided in Table 11.

Table 10 Bacteriological results for Urenui Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 10:40 | 4700 | 4 | <1 | 4 | 16.4 |
| 09-Dec-14 | 10:05 | 4590 | 5 | 1 | 5 | 18.3 |
| 05-Jan-15 | 10:20 | 4700 | 3 | 31 | 3 | 22 |
| 08-Jan-15 | 09:40 | 4600 | <1 | 8 | <1 | 21.2 |
| 12-Jan-15 | 12:50 | 4720 | 1 | <1 | 1 | 22 |
| 20-Jan-15 | 08:24 | 4720 | 13 | 19 | 16 | 20.3 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 23-Jan-15 | 11:15 | 4690 | 16 | 4 | 16 | 20.7 |
| 26-Jan-15 | 12:45 | 4680 | <1 | <1 | <1 | 21.5 |
| 09-Feb-15 | 11:35 | 4510 | 1 | 4 | 1 | 20.1 |
| 19-Feb-15 | 09:15 | 4660 | <1 | 1 | <1 | 19.6 |
| 04-Mar-15 | 08:30 | 4710 | 7 | 3 | 7 | 21 |
| 12-Mar-15 | 12:20 | 4510 | 14 | 2 | 14 | 21.7 |
| 20-Mar-15 | - | 4750 | 6 | 28 | 6 | 18.6 |

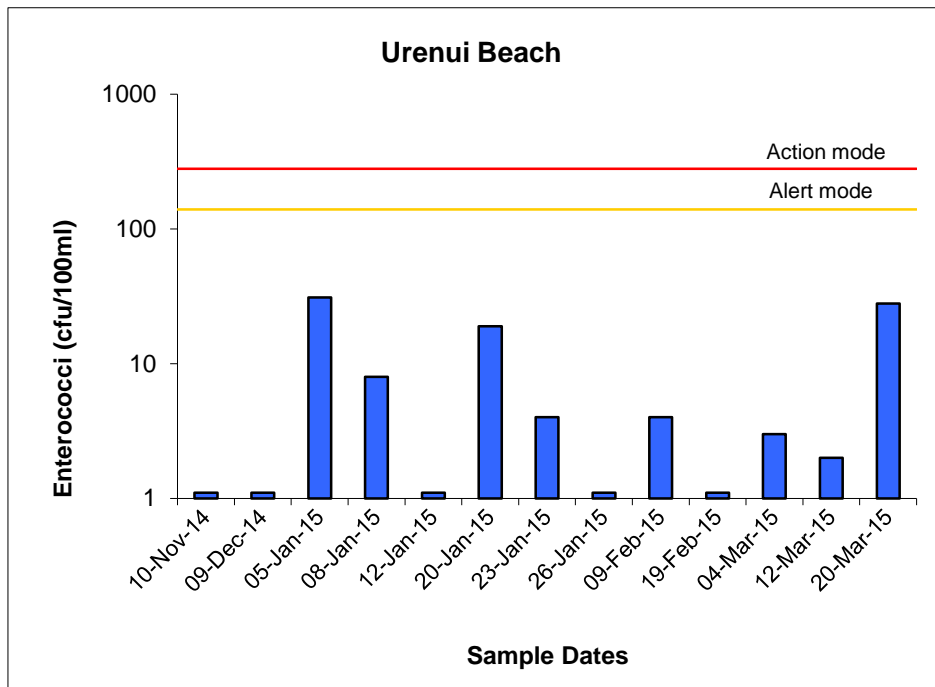


Figure 4 Enterococci numbers for the 13 SEM samples taken from Urenui Beach

Table 11 Statistical summary for Urenui Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4510 | 4750 | 4690 |
| <i>E. coli</i> | cfu/100 ml | 13 | <1 | 16 | 4 |
| Enterococci | cfu/100 ml | 13 | <1 | 31 | 3 |
| Faecal coliforms | cfu/100 ml | 13 | <1 | 16 | 4 |
| Temperature | °C | 13 | 16.4 | 22 | 20.7 |

Water quality at Urenui Beach remained high throughout the season, with low median and maximum values for all bacteriological faecal indicators.

4.2.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 12. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 12 Bacterial guidelines performance at Urenui Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140/100ml | | ACTION Two consecutive samples >280/100 ml | |
| Enterococci | 0/13 | 0% | 0/13 | 0% |

4.2.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Urenui Beach over 7 summers are presented in Table 13 and Figure 5.

Table 13 Summary of enterococci data (cfu/100 ml) for summer surveys at Urenui Beach

| Summer | 1996-97 | 1999-00 | 2002-03 | 2005-06 | 2008-09 | 2011-12 | 2014-15 |
|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | <1 | <1 | <1 | 1 | <1 | <1 | <1 |
| Maximum | 20 | 25 | 53 | 160 | 33 | 21 | 31 |
| Median | 4 | 12 | 3 | 3 | 3 | 3 | 3 |

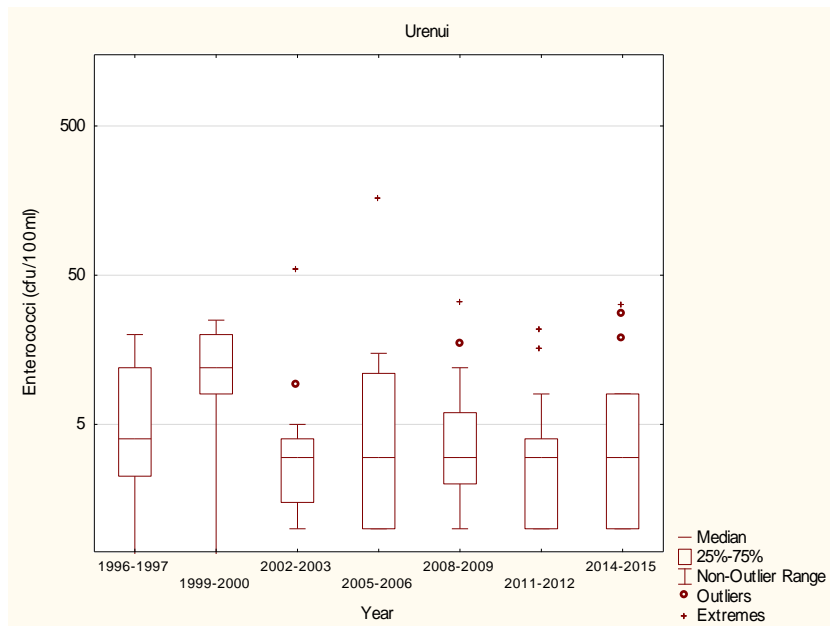


Figure 5 Box and whisker plots of enterococci for all summer SEM surveys at Urenui Beach

Continued low median and maximum enterococci data obtained for Urenui Beach during the 2014-2015 summer continues the trend of excellent water quality at this site (Table 13, Figure 5).

4.2.4 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.3 Onaero Beach

4.3.1 SEM programme

Onaero Beach (Photo 4), located in north Taranaki, is a relatively popular bathing beach, particularly over the Christmas holiday period. The Onaero River drains to the southern end of the beach, making a significant contribution to bacteria counts following rainfall events.



Photo 4 Onaero Beach

The data for this site are presented in Table 14 and Figure 6, with a statistical summary provided in Table 15.

Table 14 Bacteriological results for Onaero Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 11:00 | 4690 | 1 | <1 | 1 | 16.2 |
| 09-Dec-14 | 10:20 | 4650 | 17 | 9 | 19 | 18.4 |
| 05-Jan-15 | 09:15 | 4690 | 5 | 7 | 5 | 20.9 |
| 08-Jan-15 | 09:50 | 4660 | 17 | 12 | 17 | 20.2 |
| 12-Jan-15 | 13:05 | 4810 | <1 | 7 | <1 | 21.4 |
| 20-Jan-15 | 08:45 | 4720 | 210 | 24 | 220 | 20.3 |
| 23-Jan-15 | 10:15 | 4640 | 7 | 3 | 7 | 20.6 |
| 26-Jan-15 | 13:00 | 4710 | 3 | <1 | 3 | 21.3 |
| 09-Feb-15 | 11:45 | 4570 | 3 | 11 | 3 | 20.1 |
| 19-Feb-15 | 08:50 | 4660 | 3 | 3 | 3 | 19.7 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|-----------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 04-Mar-15 | 08:45 | 4680 | 8 | 15 | 8 | 20.7 |
| 12-Mar-15 | 12:40 | 4590 | 26 | 12 | 26 | 22 |
| 20-Mar-15 | 09:40 | 4730 | 4 | 4 | 4 | 18.9 |

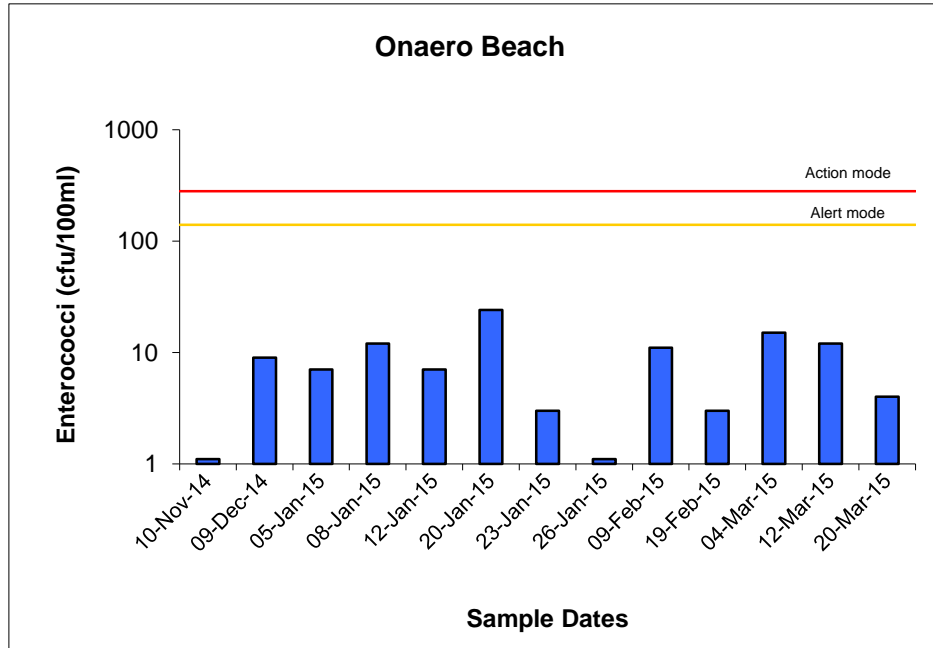


Figure 6 Enterococci numbers for the 13 SEM samples taken from Onaero Beach

Table 15 Statistical summary for Onaero Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4570 | 4810 | 4680 |
| <i>E. coli</i> | cfu/100 ml | 13 | <1 | 210 | 5 |
| Enterococci | cfu/100 ml | 13 | <1 | 24 | 7 |
| Faecal coliforms | cfu/100 ml | 13 | <1 | 220 | 5 |
| Temperature | °C | 13 | 16.2 | 22 | 20.3 |

No high individual enterococci counts were recorded throughout the season (all counts ≤ 24 cfu/100 ml) and the median enterococci count was low (Table 15).

4.3.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 16. Enterococci counts in all SEM samples were below both Alert and Action guideline levels.

Table 16 Bacterial guidelines performance at Onaero Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140 cfu/100 ml | | ACTION Two consecutive samples >280 cfu/100 ml | |
| Enterococci | 0/13 | 0% | 0/13 | 0% |

4.3.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Onaero Beach over 16 summers are presented in Table 17 and Figure 7.

Table 17 Summary enterococci data (cfu/100 ml) for summer surveys at Onaero Beach

| Summer | 96/97 | 99/00 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Minimum | 1 | 4 | 5 | < 1 | <1 | <1 | <1 | 2 |
| Maximum | 26 | 40 | 140 | 4200 | 52 | 1000 | 46 | 560 |
| Median | 13 | 12 | 17 | 9 | 5 | 15 | 4 | 7 |
| Summer | 07/08 | 08/09 | 09/10 | 10/11 | 11/12 | 12/13 | 13/14 | 14/15 |
| Minimum | <1 | 2 | 3 | <1 | 1 | <1 | 1 | <1 |
| Maximum | 59 | 64 | 27 | 96 | 42 | 32 | 25 | 24 |
| Median | 4 | 13 | 13 | 11 | 4 | 15 | 5 | 7 |

The median enterococci count obtained for the 2014-2015 summer (7 cfu/100 ml) (Table 17, Figure 7) was towards the lower end of the range previously recorded at this site. The maximum enterococci count (24 cfu/100 ml) was the lowest recorded at Onaero Beach to date (Table 17).

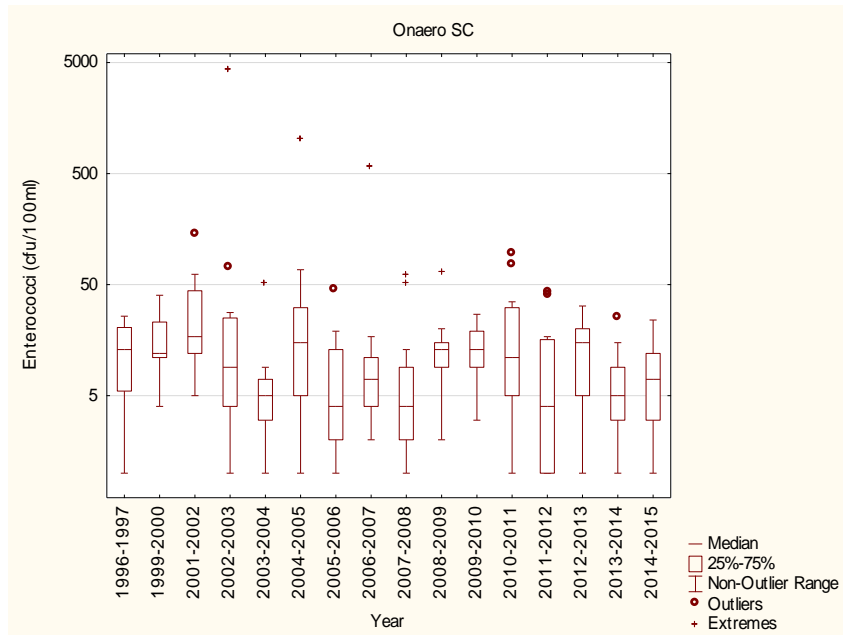


Figure 7 Box and whisker plots of enterococci for all summer SEM surveys at Onaero Beach

4.3.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 13 summer seasons (Figure 4) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

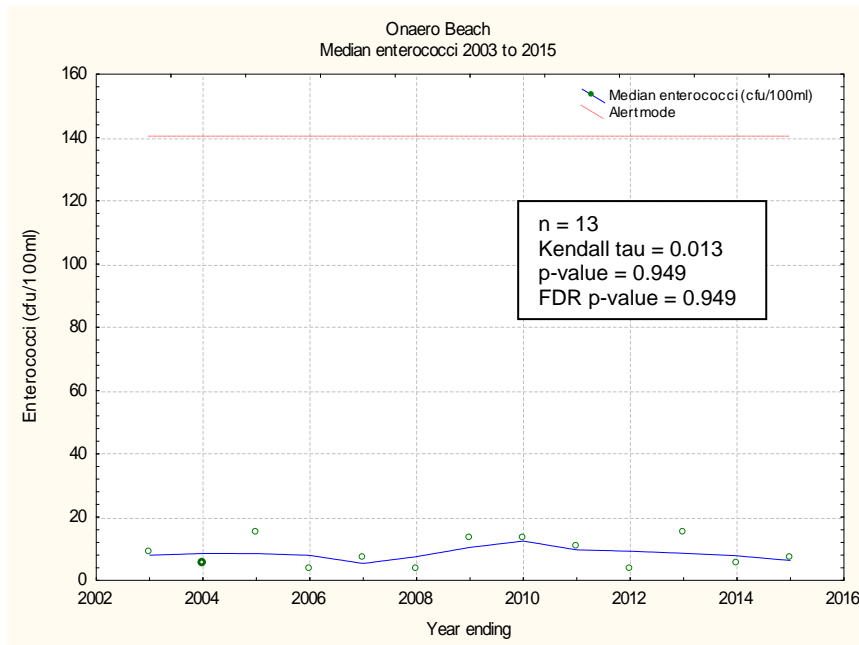


Figure 8 LOWESS trend analysis of median enterococci data at Onaero Beach

Over the 12 seasons monitored, there was a positive trend in median enterococci counts (Kendall tau = 0.013) that was not significant at the 5% level ($p = 0.949$).

4.3.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 18 and Figure 9, with a statistical summary provided in Table 19.

Table 18 Bacteriological results for MfE samples at Onaero Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|-------------|-------------|----------------------------|----------------------------|-------------------------|------------------------------|------------------|
| | | | <i>E. coli</i> (cfu/100ml) | Enterococci (cfu/100ml) | Faecal coliforms (cfu/100ml) | |
| 18 Nov 2014 | 08:55 | 3020 | 980 | 220 | 980 | 14.5 |
| 02 Dec 2014 | 08:45 | 4670 | 17 | 3 | 17 | 15.4 |
| 15 Jan 2015 | 09:00 | 4150 | 20 | 8 | 20 | 20.5 |
| 29 Jan 2015 | 09:30 | 4360 | 71 | 48 | 71 | 21.3 |
| 13 Feb 2015 | 10:30 | 4360 | 29 | 29 | 31 | 20.8 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|-------------|-------------|----------------------------|----------------------------|-------------------------|------------------------------|------------------|
| | | | <i>E. coli</i> (cfu/100ml) | Enterococci (cfu/100ml) | Faecal coliforms (cfu/100ml) | |
| 26 Feb 2015 | 11:40 | 4290 | 51 | 68 | 57 | 22.4 |
| 17 Mar 2015 | 09:05 | 4580 | 62 | 52 | 62 | 19.6 |

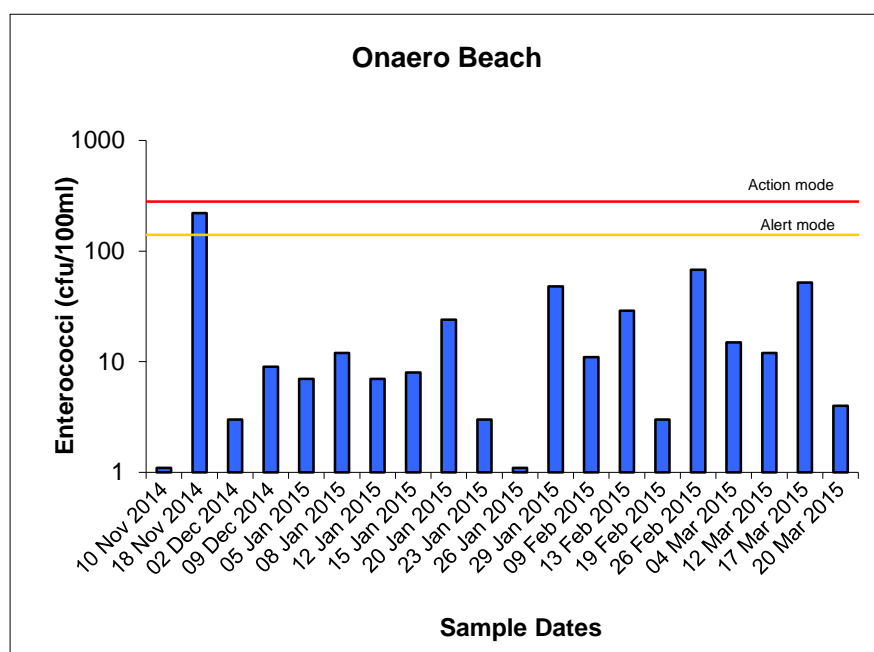


Figure 9 Enterococci numbers for the 20 sample extended survey at Onaero Beach

Table 19 Summary statistics for SEM and MfE samples at Onaero Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 20 | 3020 | 4810 | 4655 |
| <i>E. coli</i> | cfu/100 ml | 20 | <1 | 980 | 17 |
| Enterococci | cfu/100 ml | 20 | <1 | 220 | 10 |
| Faecal coliforms | cfu/100 ml | 20 | <1 | 980 | 17 |
| Temperature | °C | 20 | 14.5 | 22.4 | 20.4 |

Elevated enterococci counts obtained on MfE sampling dates were associated with lower conductivity (Table 18, N.B. typical conductivity of seawater is 4750 mS/m). The Onaero River which drains to the southern end of the beach is likely to have made a significant contribution to the higher bacteria counts e.g 18 November 2014, Table 18. Although slightly elevated, only one enterococci count obtained MfE Alert level.

4.5.3.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 20. At Onaero Beach, one sample entered the Alert category.

Table 20 Bacterial guidelines performance at Onaero Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|-------------------------------------|----|
| | ALERT | | ACTION | |
| | Single sample >140/100ml | | Two consecutive samples >280/100 ml | |
| Enterococci | 1/20 | 5% | 0/20 | 0% |

4.4 Onaero Beach Settlement

4.4.1 SEM programme

Onaero Beach Settlement (Photo 5) is located approximately 1 km west of the Onaero River.



Photo 5 Onaero Beach Settlement

The data for this site are presented in Table 21 and Figure 10, with a statistical summary provided in Table 22.

Table 21 Bacteriological results for Onaero Beach Settlement

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-------------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10 Nov 2014 | 11:15 | 4680 | 1 | <1 | 1 | 16.3 |
| 09 Dec 2014 | 10:35 | 4690 | 68 | 11 | 68 | 18.1 |
| 05 Jan 2015 | 10:35 | 4730 | 120 | 55 | 120 | 21.5 |
| 08 Jan 2015 | 09:40 | 4800 | 48 | 7 | 49 | 19.8 |
| 12 Jan 2015 | 13:20 | 4770 | 4 | 8 | 4 | 21.2 |
| 20 Jan 2015 | 08:50 | 4700 | 200 | 88 | 200 | 20.5 |
| 23 Jan 2015 | 11:30 | 4620 | 460 | 140 | 460 | 20.6 |
| 26 Jan 2015 | 13:15 | 4670 | 29 | 3 | 29 | 21.4 |
| 09 Feb 2015 | 12:10 | 4630 | 43 | 4 | 43 | 20.0 |
| 19 Feb 2015 | 09:55 | 4680 | 21 | 24 | 21 | 19.9 |
| 04 Mar 2015 | 09:00 | 4710 | 9 | 7 | 9 | 21.0 |
| 12 Mar 2015 | 12:50 | 4720 | 4 | 4 | 4 | 22.0 |
| 20 Mar 2015 | 09:25 | 4760 | 8 | 4 | 8 | 18.9 |

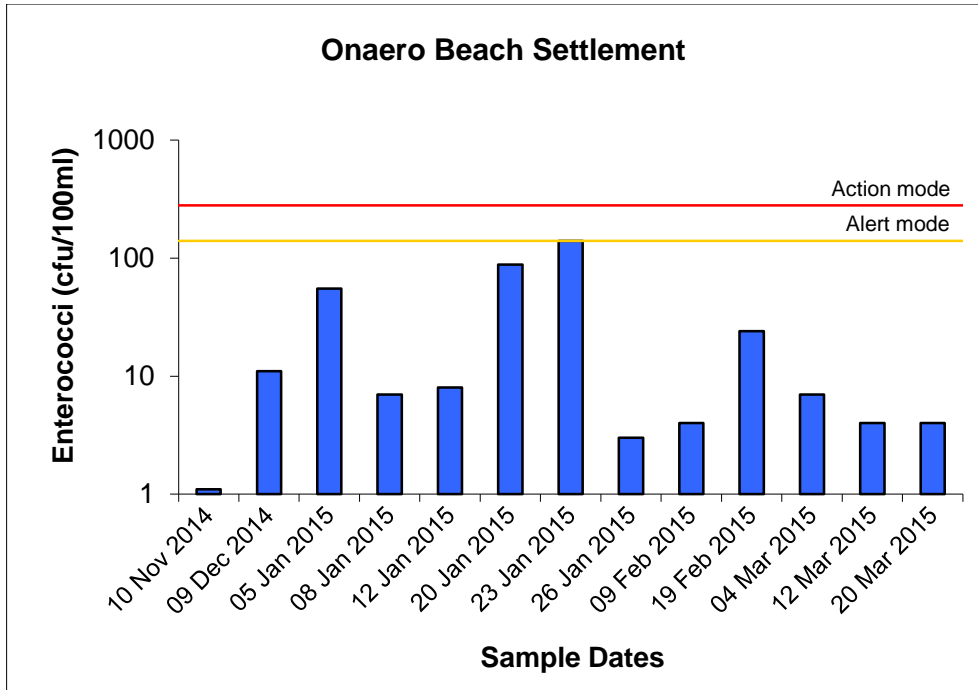


Figure 10 Enterococci numbers for the 13 SEM samples taken from Onaero Beach Settlement

Table 22 Statistical results summary for Onaero Beach Settlement

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4620 | 4800 | 4700 |
| <i>E. coli</i> | cfu/100 ml | 13 | 1 | 460 | 29 |
| Enterococci | cfu/100 ml | 13 | <1 | 140 | 7 |
| Faecal coliforms | cfu/100 ml | 13 | 1 | 460 | 29 |
| Temperature | °C | 13 | 16.3 | 22.0 | 20.5 |

Water quality was good at this site with a low enterococci median (7 cfu/100 ml). (Table 22).

4.4.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 23. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 23 Bacterial guidelines performance at Onaero Beach Settlement

| Parameter | Number of exceedances of enterococci guidelines [% of 13 samples] | |
|-------------|--|---|
| | ALERT Single sample >140/100 ml | ACTION Two consecutive samples >280/100 ml |
| Enterococci | 0 [0] | 0 [0] |

4.4.4 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Onaero Beach Settlement over 7 summers are presented in Table 24 and Figure 11.

Table 24 Summary enterococci data (cfu/100 ml) for summer surveys at Onaero Beach Settlement

| Summer | 1996-97 | 1999-00 | 2002-03 | 2005-06 | 2008-09 | 2011-12 | 2014-15 |
|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | 1 | 1 | <1 | 2 | 1 | <1 | <1 |
| Maximum | 200 | 120 | 64 | 70 | 71 | 50 | 140 |
| Median | 12 | 16 | 5 | 10 | 9 | 1 | 7 |

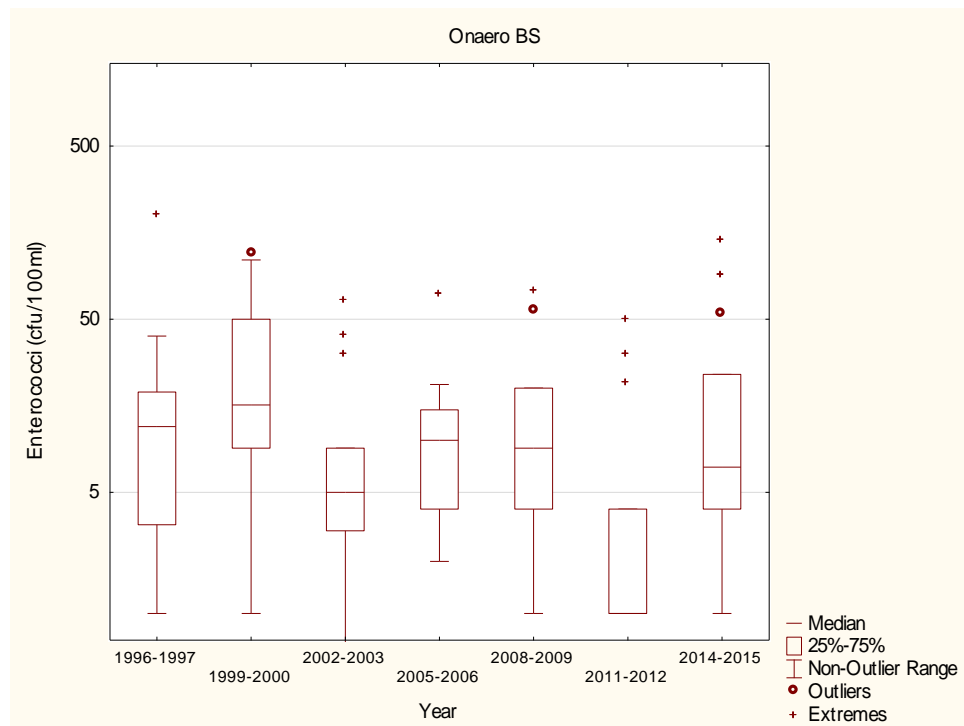


Figure 11 Box and whisker plots for all summer SEM surveys of enterococci numbers at Onaero Beach Settlement

The median enterococci count obtained for the 2014-2015 summer (7 cfu/100 ml) (Table 24, Figure 11) was towards the lower end of the range previously recorded at this site.

4.4.5 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.5 Waitara East Beach

4.5.1 SEM programme

Waitara East Beach is located to the east of the Waitara River mouth (Photo 6). Results at this site are influenced by the Waitara River which drains a large agricultural catchment and often contains high levels of bacteria.

Prior to October 2014, municipal wastewater from the Waitara township was discharged through the Waitara Marine Outfall approximately 1.8 km out to sea. Since October 2014, New Plymouth District Council has pumped municipal wastewater from the Waitara township to the New Plymouth Wastewater Treatment Plant and sewage is no longer discharged through the Waitara Marine Outfall during normal operation of the wastewater system.



Photo 6 Waitara East Beach

The data for this site are presented in Table 25 and Figure 12, with a statistical summary provided in Table 26.

Table 25 Bacteriological results for Waitara East Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|---------------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 12:00 | 4570 | 11 | <1 | 11 | 16.4 |
| 09-Dec-14 | 11:00 | 4130 | 7 | <1 | 7 | 18.3 |
| 05-Jan-15 | 11:05 | 4510 | 4 | 3 | 4 | 21.1 |
| 08-Jan-15 | 10:25 | 4690 | 1 | <1 | 1 | 20.1 |
| 12-Jan-15 | 13:35 | 4400 | <1 | 1 | <1 | 21.7 |
| 20-Jan-15 | 09:25 | 4690 | 510 | 94 | 530 | 20.3 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|------------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 23-Jan-15 | 11:50 | 4640 | <2 | 10 | <2 | 20.9 |
| 26-Jan-15 | 13:35 | 4570 | <1 | <1 | <1 | 21.1 |
| 09-Feb-15 | 12:30 | 4370 | 1 | <1 | 1 | 19.6 |
| 19-Feb-15 | 10:25 | 4660 | 240 | 250 | 240 | 19.6 |
| 04-Mar-15 | 09:30 | 4690 | 9 | 9 | 9 | 21.4 |
| 12-Mar-15 | 13:20 | 4640 | 4 | <1 | 4 | 21.1 |
| 20-Mar-15 | 08:55 | 4700 | <2 | 6 | 2 | 17.2 |

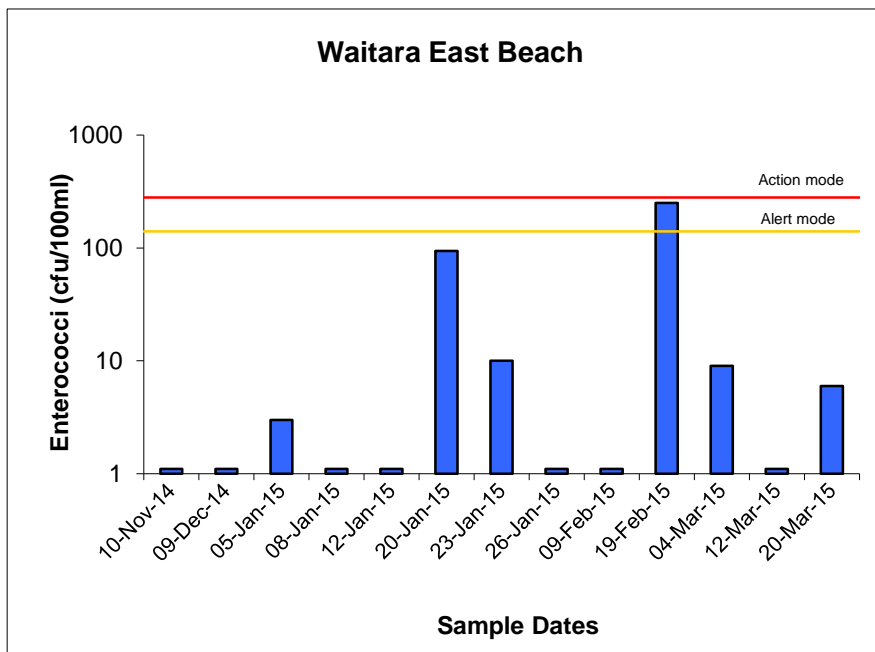


Figure 12 Enterococci numbers for the 13 SEM samples taken from Waitara East Beach

Table 26 Statistical summary for Waitara East Beach

| Parameter | Unit | Number | Minimum | Maximum | Median |
|---------------------|------------|--------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4130 | 4700 | 4640 |
| <i>E. coli</i> | cfu/100 ml | 13 | <1 | 510 | 4 |
| Enterococci | cfu/100 ml | 13 | <1 | 250 | 1 |
| Faecal coliforms | cfu/100 ml | 13 | <1 | 530 | 4 |
| Temperature | °C | 13 | 16.4 | 21.7 | 20.3 |

All median faecal indicator bacteria counts (≤ 4 cfu/100 ml) were low for this site. The highest enterococci count (250 cfu/100 ml) was recorded on 19 February 2015. There was only a minor influence from freshwater input on this day (4660 mS/m, Table 25) and the elevated count remains largely unexplained.

4.5.3 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 27. One SEM sample (19 February 2015) reached Alert level (>140 enterococci cfu/100 ml) at this site during summer 2014-2015.

Table 27 Bacterial guidelines performance at Waitara East Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140/100ml | | ACTION Two consecutive samples >280/100 ml | |
| Enterococci | 1/13 | 8% | 0/13 | 0% |

4.5.4 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Waitara East Beach over 20 summers are presented in Table 28 and Figure 13. The median enterococci count (1 cfu/100 ml) was the lowest to date for this site and the lowest for Taranaki beach bathing sites during the 2014-2015 summer season. The maximum enterococci count was also low relative to previous years at this site. Maxima at this site are historically high due to the influence of the Waitara River (Table 28).

Table 28 Summary enterococci data (cfu/100 ml) for summer surveys at Waitara East Beach

| Summer | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | 1 | 1 | 1 | 3 | 3 | 1 | 4 | <1 | <1 | 1 |
| Maximum | 950 | 960 | 230 | 250 | 230 | 520 | 290 | 410 | 840 | 310 |
| Median | 14 | 11 | 17 | 20 | 40 | 9 | 21 | 13 | 17 | 9 |
| Summer | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
| Minimum | <1 | 1 | 1 | <1 | <1 | <1 | 1 | <1 | <1 | <1 |
| Maximum | 88 | 91 | 120 | 2400 | 210 | 1000 | 190 | 400 | 220 | 250 |
| Median | 9 | 27 | 12 | 41 | 15 | 3 | 6 | 37 | 7 | 1 |

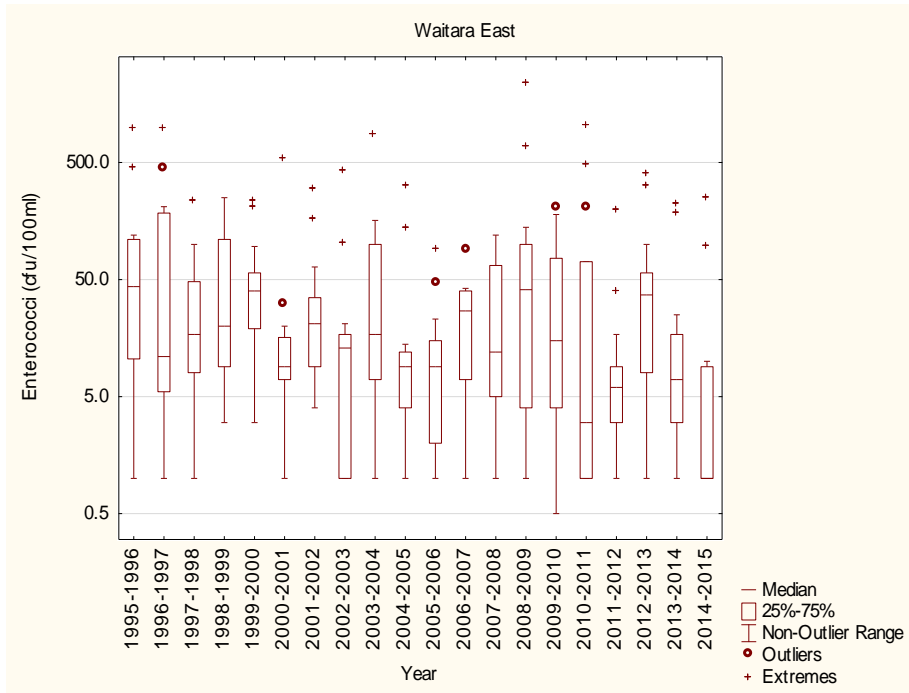


Figure 13 Box and whisker plots of enterococci for all summer surveys at Waitara East Beach

4.5.5 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 19 summer seasons (Figure 14) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

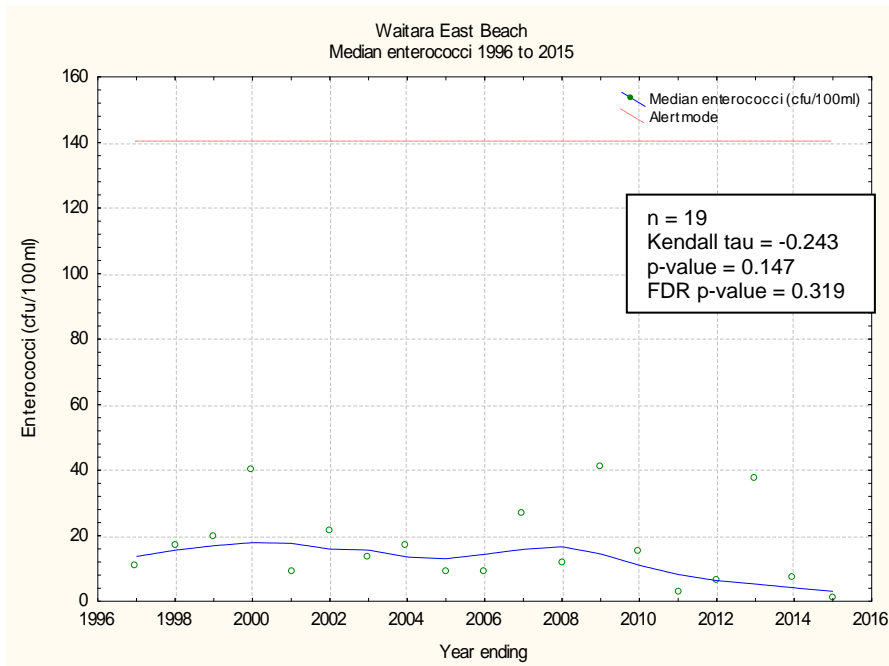


Figure 14 LOWESS trend analysis of median enterococci data at Waitara East Beach

Over the 19 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.243) that was not significant at the 5% level ($p = 0.147$).

4.6 Waitara West Beach

4.6.1 SEM programme

Waitara West Beach is located to the west of the Waitara River mouth (Photo 7). As with Waitara East Beach, the results at this site can be influenced by the Waitara River. Since October 2014, municipal wastewater from the Waitara Township has been directed to the New Plymouth Wastewater Treatment Plant and is no longer discharged through the Waitara Marine Outfall during normal operation of the wastewater system.



Photo 7 Waitara West Beach

The data for this site are presented in Table 29 and Figure 15, with a statistical summary provided in Table 30.

Table 29 Bacteriological results for Waitara West Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|---------------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 12:30 | 4540 | 3 | <1 | 3 | 17.5 |
| 09-Dec-14 | 11:30 | 3970 | 3 | 1 | 3 | 18.5 |
| 05-Jan-15 | 11:30 | 4650 | <1 | 1 | <1 | 21.3 |
| 08-Jan-15 | 13:00 | 4320 | 37 | <1 | 39 | 20.9 |
| 12-Jan-15 | 14:00 | 4730 | 4 | 11 | 4 | 23.0 |
| 20-Jan-15 | 19:45 | 4700 | 32 | 100 | 33 | 19.9 |
| 23-Jan-15 | 12:15 | 4630 | 1 | 4 | 1 | 21.7 |
| 26-Jan-15 | 14:50 | 4570 | 8 | 29 | 8 | 22.4 |
| 09-Feb-15 | 12:55 | 4600 | 1 | 6 | 1 | 20.4 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|------------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 19-Feb-15 | 11:15 | 4670 | 49 | 15 | 49 | 20.3 |
| 04-Mar-15 | 10:05 | 4710 | 27 | 13 | 27 | 21.9 |
| 12-Mar-15 | 13:35 | 4450 | 8 | 4 | 8 | 21.2 |
| 20-Mar-15 | 08:30 | 4680 | 5 | 1 | 5 | 18.4 |

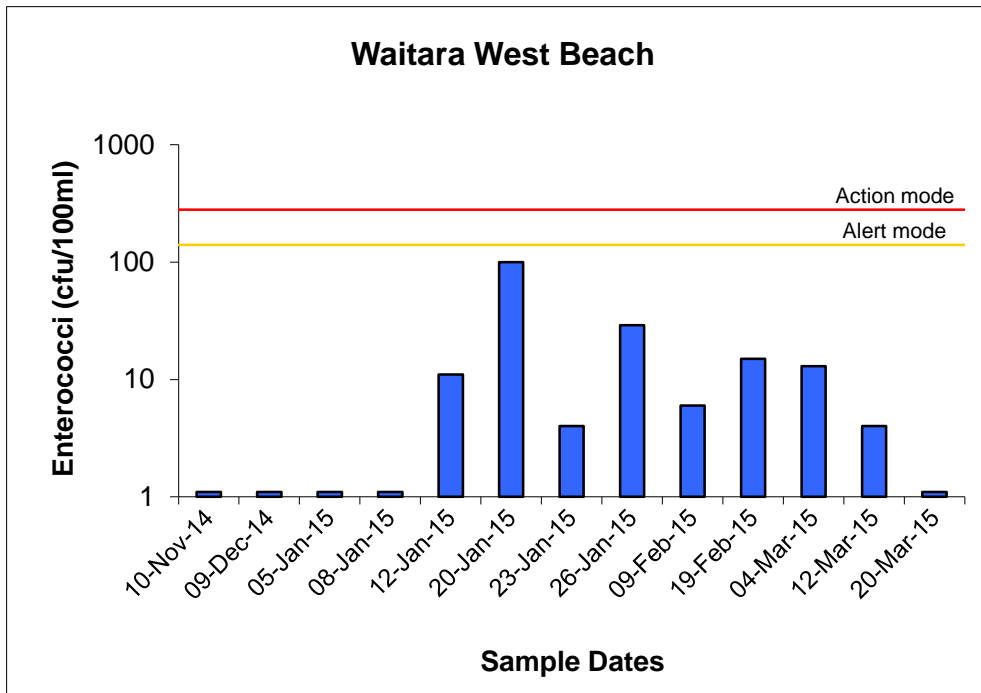


Figure 15 Enterococci numbers for the 13 SEM samples taken from Waitara West Beach

Table 30 Statistical summary for Waitara West Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 3970 | 4730 | 4630 |
| <i>E. coli</i> | cfu/100 ml | 13 | <1 | 49 | 5 |
| Enterococci | cfu/100 ml | 13 | <1 | 100 | 4 |
| Faecal coliforms | cfu/100 ml | 13 | <1 | 49 | 5 |
| Temperature | °C | 13 | 17.5 | 23.0 | 20.9 |

Water quality at Waitara West Beach remained high throughout the season, with low median and maximum values for all faecal indicator bacteria.

4.6.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 19. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 31 Bacterial guidelines performance at Waitara West Beach

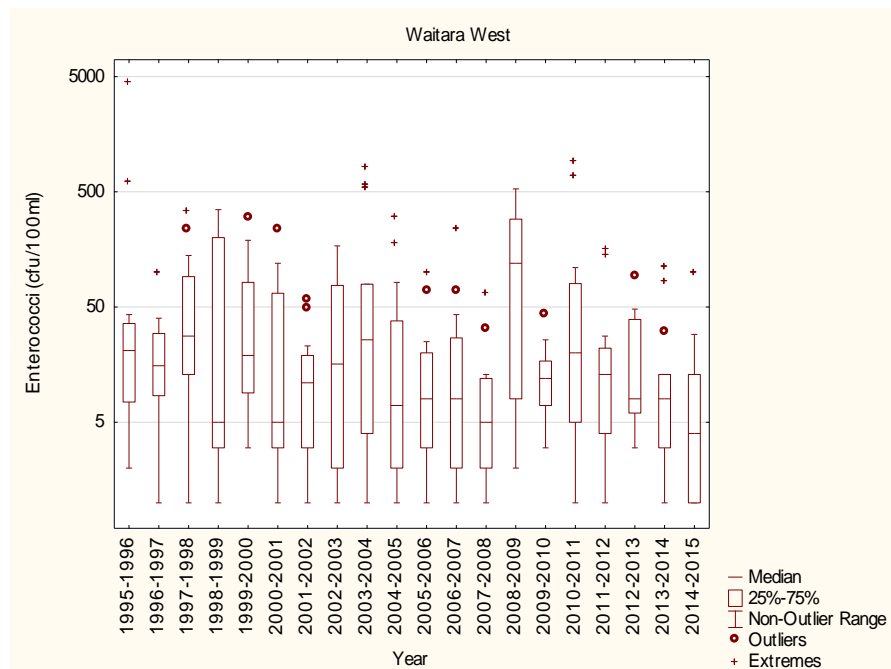
| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|-------------------------------------|----|
| | ALERT | | ACTION | |
| | Single sample >140/100ml | | Two consecutive samples >280/100 ml | |
| Enterococci | 0/13 | 0% | 0/13 | 0% |

4.6.3 Comparison with previous summer surveys

Summary statistics for enterococci survey data collected at Waitara West Beach over 20 summers are presented in Table 32 and Figure 16.

Table 32 Summary enterococci data (cfu/100 ml) for summer surveys at Waitara West Beach

| Summer | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | 2 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 |
| Maximum | 4300 | 100 | 340 | 350 | 290 | 240 | 57 | 170 | 800 | 300 |
| Median | 21 | 16 | 28 | 5 | 19 | 5 | 11 | 16 | 26 | 7 |
| Summer | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
| Minimum | 1 | 1 | 1 | 2 | 3 | 1 | <1 | 3 | <1 | <1 |
| Maximum | 100 | 240 | 67 | 530 | 42 | 910 | 160 | 90 | 110 | 100 |
| Median | 8 | 8 | 5 | 120 | 12 | 20 | 13 | 8 | 8 | 4 |

**Figure 16** Box and whisker plots of enterococci for all summer SEM surveys at Waitara West Beach

The median enterococci count (4 cfu/100 ml) recorded for the 2014-2015 summer season was the lowest to date for this site. The maximum enterococci count was also low relative to previous years at this site.

4.6.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 19 summer seasons (Figure 17) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

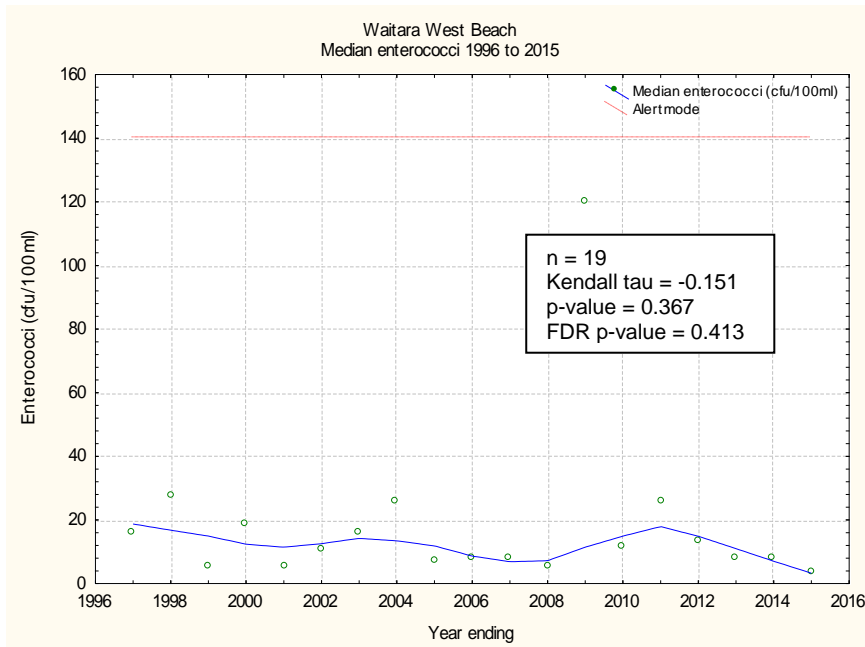


Figure 17 LOWESS trend analysis of median enterococci data at Waitara West Beach

Over the 19 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.151) that was not significant at the 5% level ($p = 0.367$).

4.7 Fitzroy Beach

4.7.1 SEM programme

Fitzroy Beach is situated in New Plymouth and is one of the most popular bathing beaches in Taranaki. It is also a very popular surfing beach due to its central location and high quality waves (Photo 8).

The mouth of the Waiwhakaiho River enters the sea at the eastern end of the beach, approximately 800 m from the sample site, which on rare occasions can contribute significant amounts of freshwater during floods. Draining from a highly modified agricultural and industrial catchment, this can have a significant impact on bacteriological water quality subsequent to heavy rainfall. The river typically has a high level of contamination from birdlife.



Photo 8 Surfer at Fitzroy Beach

The data for this site are presented in Table 33 and Figure 18, with a statistical summary provided in Table 34.

Table 33 Bacteriological results for Fitzroy Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 11:50 | 4540 | 11 | 11 | 11 | 16.6 |
| 09-Dec-14 | 09:30 | 4650 | 3 | 3 | 3 | 17.3 |
| 05-Jan-15 | 11:25 | 4640 | <1 | 1 | <1 | 19.8 |
| 08-Jan-15 | 13:05 | 4860 | <1 | <1 | <1 | 18.2 |
| 12-Jan-15 | 15:15 | 4710 | <1 | 1 | <1 | 20.5 |
| 20-Jan-15 | 08:45 | 4710 | 24 | 9 | 24 | 19.4 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|-----------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 23-Jan-15 | 10:10 | 4700 | 3 | 3 | 3 | 19.1 |
| 26-Jan-15 | 12:35 | 4610 | <1 | 5 | <1 | 21.1 |
| 09-Feb-15 | 10:55 | 4540 | 1 | 5 | 1 | 18.3 |
| 19-Feb-15 | 08:40 | 4700 | <1 | 1 | <1 | 18.7 |
| 04-Mar-15 | 08:35 | 4720 | 5 | 3 | 5 | 21.1 |
| 12-Mar-15 | 11:45 | 4710 | 3 | 5 | 3 | 20.9 |
| 20-Mar-15 | 08:15 | 4750 | <1 | 1 | <1 | 17.3 |

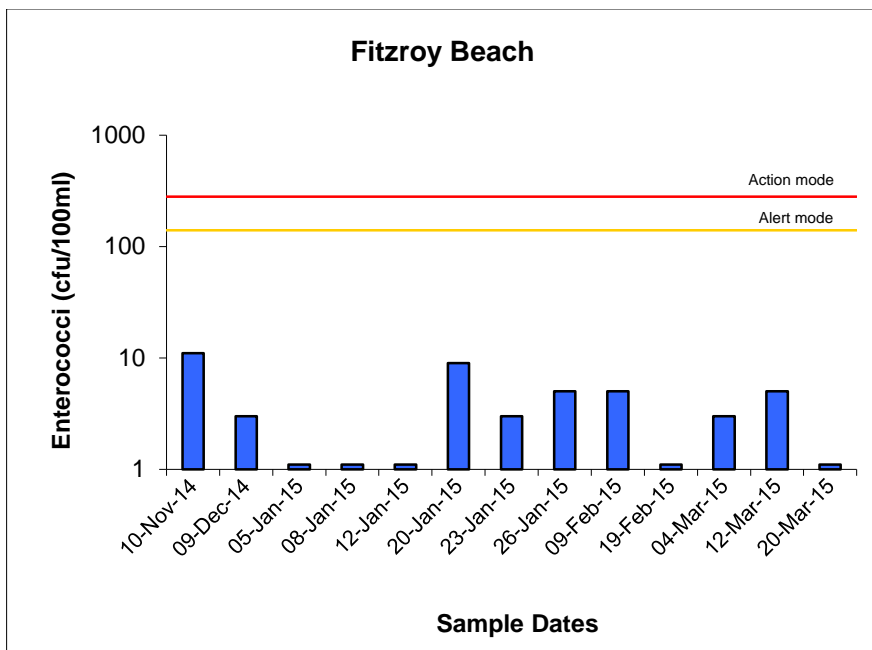


Figure 18 Enterococci numbers for the 13 SEM samples taken from Fitzroy Beach

Table 34 Statistical summary for Fitzroy Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4540 | 4860 | 4700 |
| <i>E. coli</i> | cfu/100 ml | 13 | 0.5 | 24 | 1 |
| Enterococci | cfu/100 ml | 13 | 0.5 | 11 | 3 |
| Faecal coliforms | cfu/100 ml | 13 | 0.5 | 24 | 1 |
| Temperature | °C | 13 | 16.6 | 21.1 | 19.1 |

Bacteriological water quality at Fitzroy Beach was high throughout the season, with low median and maximum values for all faecal indicator bacteria.

4.7.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 35. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 35 Bacterial guidelines performance at Fitzroy Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140/100ml | | ACTION Two consecutive samples >280/100 ml | |
| Enterococci | 0/13 | 0% | 0/13 | 0% |

4.7.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Fitzroy Beach over 20 summers are presented in Table 36 and Figure 19.

Table 36 Summary enterococci data (cfu/100 ml) for summer surveys at Fitzroy Beach

| Summer | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | 3 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Maximum | 46 | 280 | 40 | 79 | 17 | 98 | 350 | 580 | 98 | 52 |
| Median | 10 | 15 | 7 | 7 | 4 | 7 | 9 | 5 | 3 | 4 |
| Summer | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
| Minimum | <1 | <1 | <1 | <1 | 1 | <1 | <1 | <1 | <1 | <1 |
| Maximum | 85 | 33 | 44 | 110 | 60 | 43 | 930 | 36 | 45 | 11 |
| Median | 6 | 3 | 3 | 10 | 8 | 4 | 3 | 3 | <1 | 3 |

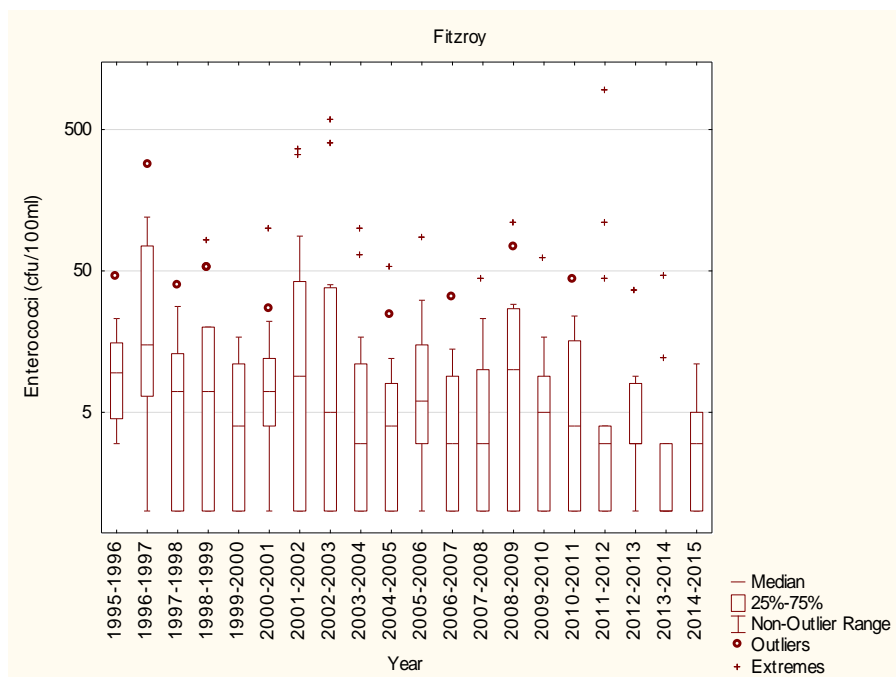


Figure 19 Box and whisker plots of enterococci for all summer SEM surveys at Fitzroy Beach

The maximum enterococci count (11 cfu/100 ml) at Fitzroy Beach was the lowest to date for this site. The median enterococci count (3 cfu/100 ml) was also low relative to other years and sites.

4.7.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 20 summer seasons (Figure 20) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

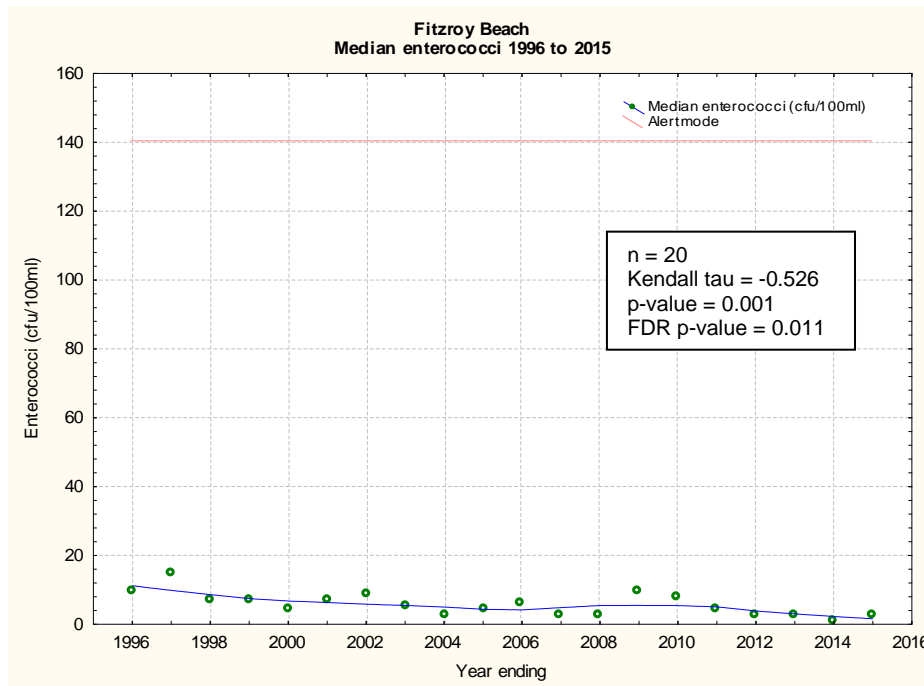


Figure 20 LOWESS trend analysis of median enterococci data at Fitzroy Beach

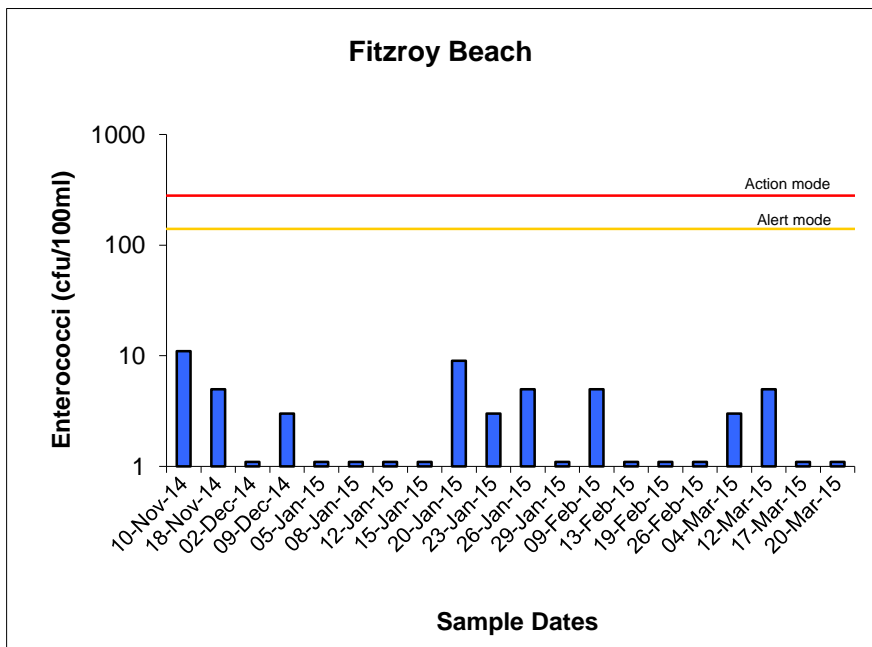
Over the 20 seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.526). This negative trend was significant using the Mann-Kendall test ($p = 0.001$) and after FDR application ($p = 0.011$).

4.7.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 37 and Figure 21, with a statistical summary provided in Table 38.

Table 37 Bacteriological results for MfE samples at Fitzroy Beach

| Date | Time | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|-------------|--------|----------------------------------|--------------------------------|-----------------------------|----------------------------------|---------------------|
| | (NZST) | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 18 Nov 2014 | 10:10 | 4600 | 110 | 5 | 110 | 15.5 |
| 02 Dec 2014 | 09:35 | 4810 | <1 | <1 | <1 | 15.3 |
| 15 Jan 2015 | 09:55 | 4830 | <1 | <1 | <1 | 19 |
| 29 Jan 2015 | 10:20 | 4680 | <1 | 1 | <1 | 20.8 |
| 13 Feb 2015 | 11:25 | 4630 | <1 | <1 | <1 | 21.3 |
| 26 Feb 2015 | 10:05 | 4720 | <1 | 1 | <1 | 21.6 |
| 17 Mar 2015 | 10:05 | 4790 | <2 | 1 | <2 | 19.8 |

**Figure 21** Enterococci numbers for the 20 sample extended survey at Fitzroy Beach**Table 38** Summary statistics for SEM and MfE samples at Fitzroy Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 20 | 4540 | 4860 | 4705 |
| <i>E. coli</i> | cfu/100 ml | 20 | <1 | 110 | <1 |
| Enterococci | cfu/100 ml | 20 | <1 | 11 | 1 |
| Faecal coliforms | cfu/100 ml | 20 | <1 | 110 | <1 |
| Temperature | °C | 20 | 15.3 | 21.6 | 19.5 |

Additional sampling resulted in a slight decrease to the overall seasonal median for enterococci (Table 38), with water quality remaining high throughout the season.

4.5.7.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 39. No samples reached the Alert mode during the 2014-2015 season.

Table 39 Bacterial guidelines performance at Fitzroy Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140 cfu/100 ml | | ACTION Two consecutive samples >280 cfu/100 ml | |
| Enterococci | 0/20 | 0% | 0/20 | 0% |

4.8 Ngamotu Beach

4.8.1 SEM programme

Ngamotu Beach (Photo 9) is situated within Port Taranaki, in close proximity to boat traffic and Port activities. It receives urban stormwater and a piped stream. Due to its sheltered location, situated between two breakwaters, this beach is very popular with young children and school groups and is often used for sports events.



Photo 9 Ngamotu Beach

Data for this site are presented in Table 40 and Figure 22, with a statistical summary provided in Table 41.

Table 40 Bacteriological results for Ngamotu Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 11:00 | 4780 | <1 | 1 | <1 | 17.4 |
| 09-Dec-14 | 09:50 | 4720 | 4 | <1 | 4 | 17.5 |
| 05-Jan-15 | 10:25 | 4760 | <1 | 3 | <1 | 21.2 |
| 08-Jan-15 | 12:00 | 4870 | <1 | <1 | <1 | 19.3 |
| 12-Jan-15 | 14:20 | 4860 | <1 | <1 | <1 | 19.0 |
| 20-Jan-15 | 09:35 | 4710 | 25 | 110 | 25 | 19.7 |
| 23-Jan-15 | 10:30 | 4670 | 7 | 7 | 7 | 20.4 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|-----------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 26-Jan-15 | 13:06 | 4710 | 19 | 48 | 20 | 20.8 |
| 09-Feb-15 | 11:15 | 4610 | 1 | 100 | 1 | 18.7 |
| 19-Feb-15 | 09:40 | 4610 | 8 | 49 | 8 | 19.8 |
| 04-Mar-15 | 09:20 | 4690 | 4 | 16 | 4 | 21.2 |
| 12-Mar-15 | 12:35 | 4660 | 38 | 30 | 38 | 21.3 |
| 20-Mar-15 | 09:40 | 4770 | 1 | 3 | 1 | 17.9 |

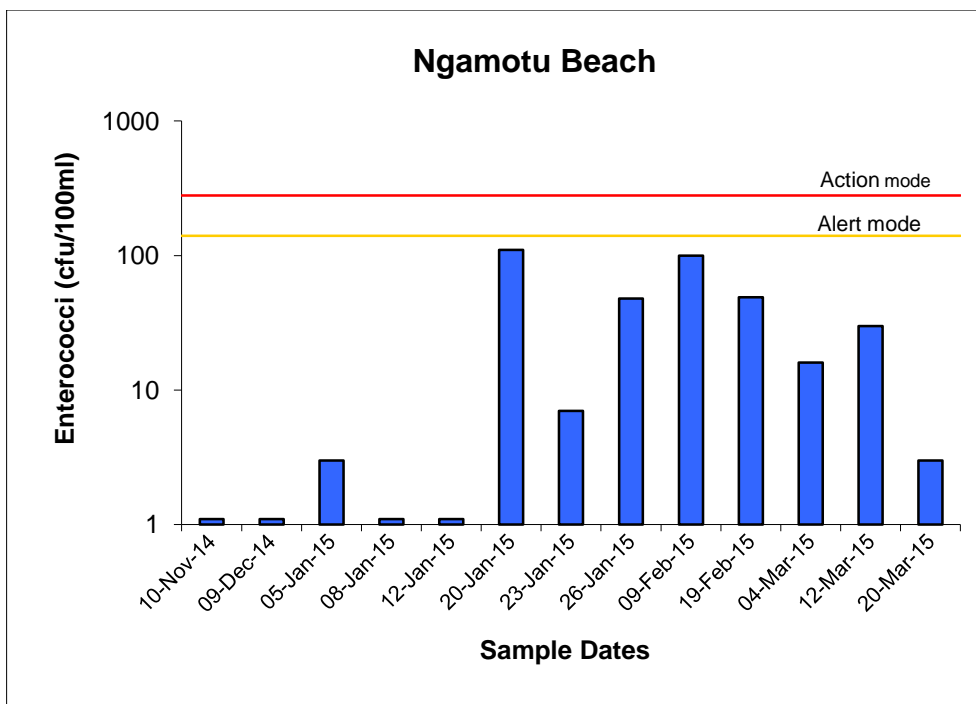


Figure 22 Enterococci numbers for the 13 SEM samples taken from Ngamotu Beach

Table 41 Statistical summary for Ngamotu Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4610 | 4870 | 4710 |
| <i>E. coli</i> | cfu/100 ml | 13 | <1 | 38 | 4 |
| Enterococci | cfu/100 ml | 13 | <1 | 110 | 7 |
| Faecal coliforms | cfu/100 ml | 13 | <1 | 38 | 4 |
| Temperature | °C | 13 | 17.4 | 21.3 | 19.7 |

Relatively low counts were obtained for all SEM faecal indicator bacteria samples through the season (Tables 40 and 41, Figure 22).

4.8.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 42. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 42 Bacterial guidelines performance at Ngamotu Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140/100ml | | ACTION Two consecutive samples >280/100 ml | |
| Enterococci | 0/13 | 0% | 0/13 | 0% |

4.8.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ngamotu Beach over 20 summers are presented in Table 41 and Figure 23.

Table 43 Summary enterococci data (cfu/100 ml) for summer surveys at Ngamotu Beach

| Summer | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | < 1 | 1 | < 1 | < 1 | < 1 | < 1 | 1 | < 1 | < 1 | < 1 |
| Maximum | 160 | 600 | 310 | 72 | 85 | 240 | 630 | 140 | 60 | 230 |
| Median | 16 | 13 | 5 | 20 | 11 | 10 | 44 | 27 | 5 | 14 |
| Summer | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
| Minimum | 1 | 1 | 1 | 1 | <1 | <1 | 1 | <1 | <1 | <1 |
| Maximum | 90 | 48 | 350 | 55 | 23 | 180 | 1000 | 29 | 51 | 110 |
| Median | 13 | 12 | 4 | 9 | 4 | 8 | 8 | 4 | 4 | 7 |

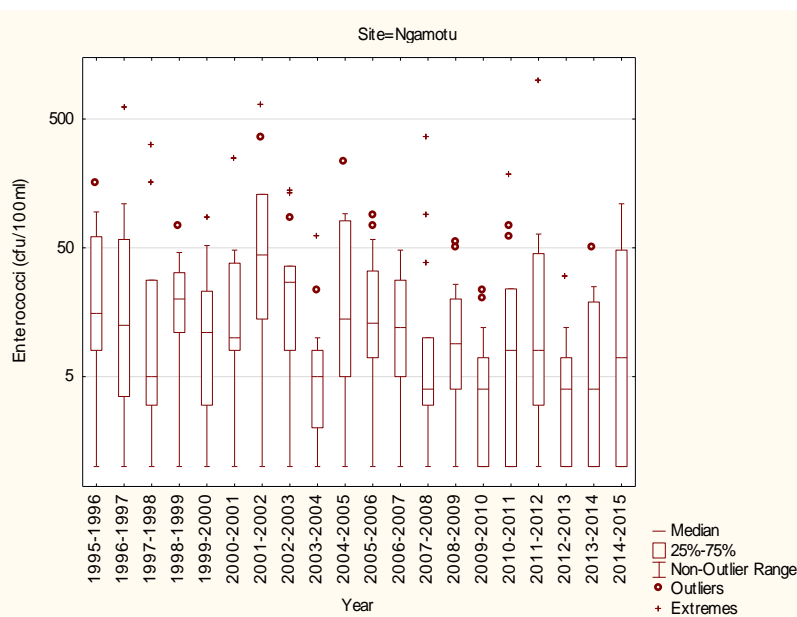


Figure 23 Box & whisker plots of enterococci for all summer SEM surveys at Ngamotu Beach

The median and maximum enterococci counts obtained for the 2014-2015 summer season were within the lower range recorded at this site.

4.8.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 20 summer seasons (Figure 24) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

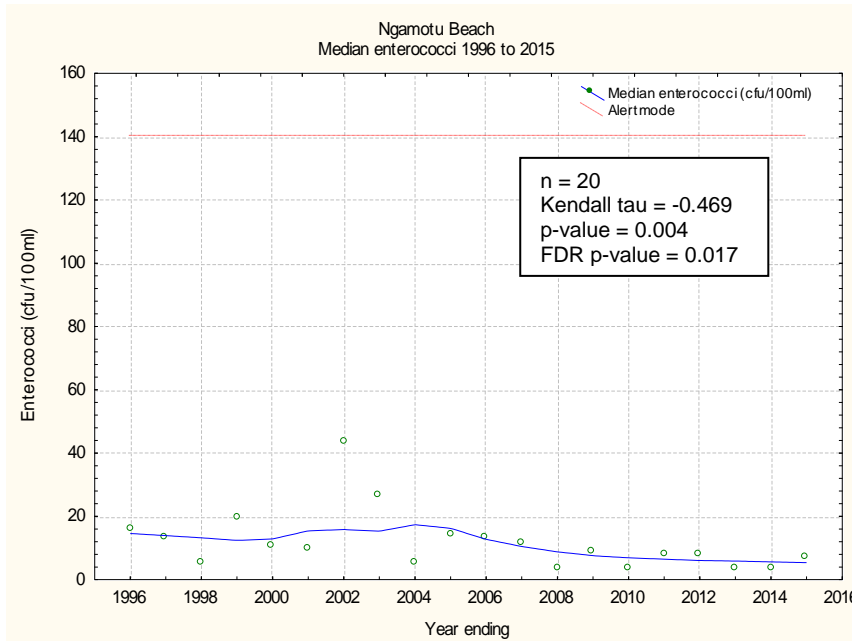


Figure 24 LOWESS trend analysis of median enterococci data at Ngamotu Beach

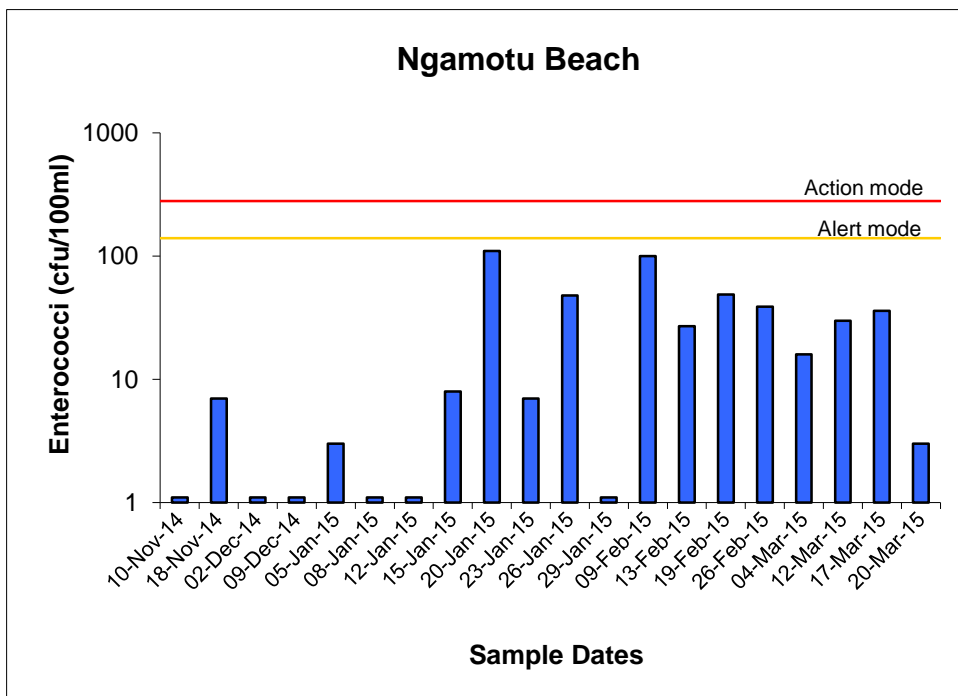
Over the 20 seasons monitored, there was a decrease in median enterococci count (Kendall tau = -0.469). This negative trend was significant using the Mann-Kendall test ($p = 0.004$) and after FDR application ($p = 0.017$).

4.8.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 44 and Figure 25, with a statistical summary provided in Table 45.

Table 44 Bacteriological results for MfE samples at Ngamotu Beach

| Date | Time | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature |
|-------------|--------|-------------------------------|--------------------------------|-----------------------------|----------------------------------|-------------|
| | (NZST) | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | (°C) |
| 18 Nov 2014 | 11:30 | 4790 | 3 | 7 | 3 | 15.4 |
| 02 Dec 2014 | 11:30 | 4770 | <1 | <1 | <1 | 16.4 |
| 15 Jan 2015 | 10:40 | 4730 | 3 | 8 | 3 | 20.8 |
| 29 Jan 2015 | 11:25 | 4630 | 3 | <1 | 3 | 21.5 |
| 13 Feb 2015 | 12:25 | 4630 | <1 | 27 | <1 | 21.7 |
| 26 Feb 2015 | 09:40 | 4610 | 3 | 39 | 5 | 21.1 |
| 17 Mar 2015 | 11:30 | 4740 | 24 | 36 | 24 | 19.6 |

**Figure 25** Enterococci counts for the 20 sample extended survey at Ngamotu Beach**Table 45** Summary statistics for SEM and additional samples at Ngamotu Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 20 | 4610 | 4870 | 4715 |
| <i>E. coli</i> | cfu/100 ml | 20 | <1 | 38 | 3 |
| Enterococci | cfu/100 ml | 20 | <1 | 110 | 8 |
| Faecal coliforms | cfu/100 ml | 20 | <1 | 38 | 3 |
| Temperature | °C | 20 | 15.4 | 21.7 | 19.8 |

Additional sampling resulted in a slight decrease to the seasonal medians for all faecal indicator bacteria (Table 45).

4.5.8.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 46. No samples reached the Alert mode during the 2013-2014 season.

Table 46 Bacterial guidelines performance at Ngamotu Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140/100ml | | ACTION Two consecutive samples >280/100 ml | |
| Enterococci | 0/20 | 0% | 0/13 | 0% |

4.9 Oakura Beach SC (opposite surf lifesaving club)

4.9.1 SEM programme

Oakura Beach (Photo 10) is popular with beach bathers during summer, and frequented by surfers all year-round. Two small lowland streams (Waimoku and Wairau) enter the beach on either side of the site, and as a consequence concentrations of faecal indicator bacteria can increase significantly during periods of high rainfall.



Photo 10 Oakura Beach

The data from this site are presented in Table 47 and Figure 26, with a statistical summary provided in Table 48.

Table 47 Bacteriological results for Oakura Beach SC

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 10:35 | 4650 | 19 | 5 | 27 | 16.1 |
| 09-Dec-14 | 10:30 | 4710 | 8 | 4 | 9 | 16.6 |
| 05-Jan-15 | 09:35 | 4400 | 52 | 57 | 52 | 19.2 |
| 08-Jan-15 | 11:05 | 4300 | 16 | 64 | 16 | 19.5 |
| 12-Jan-15 | 13:45 | 4500 | 65 | 160 | 67 | 20.3 |
| 20-Jan-15 | 10:15 | 4660 | 23 | 55 | 23 | 20.2 |
| 23-Jan-15 | 11:05 | 4470 | 47 | 83 | 47 | 20.2 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|-----------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 26-Jan-15 | 13:40 | 4590 | 32 | 75 | 32 | 20 |
| 09-Feb-15 | 11:45 | 4500 | 4 | 4 | 4 | 16.9 |
| 19-Feb-15 | 10:20 | 4630 | 25 | 83 | 25 | 19.5 |
| 04-Mar-15 | 09:55 | 4470 | 61 | 180 | 61 | 21.1 |
| 12-Mar-15 | 13:05 | 4670 | 26 | 34 | 32 | 20.9 |
| 20-Mar-15 | 10:15 | 4750 | 7 | 9 | 7 | 19 |

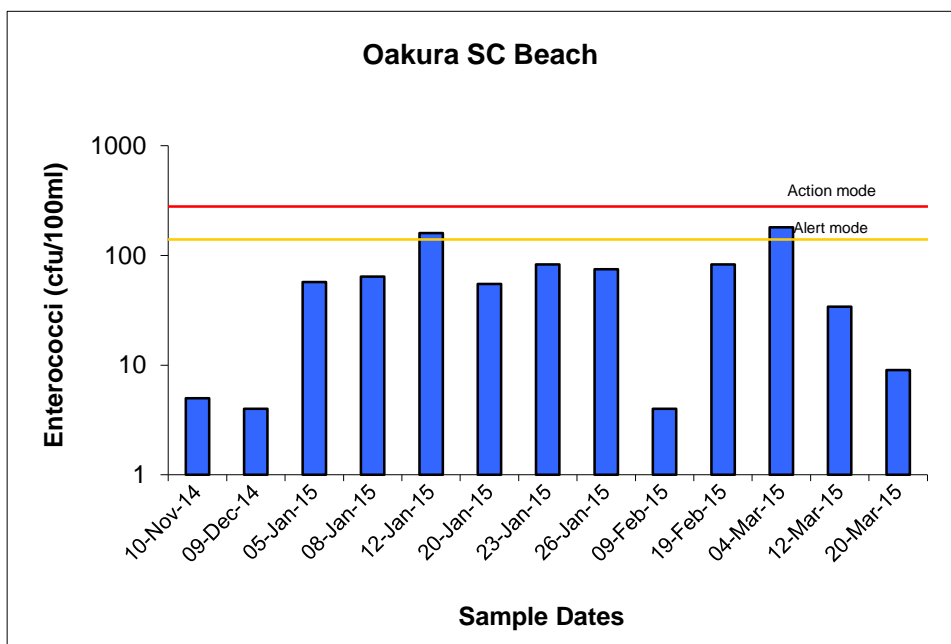


Figure 26 Enterococci numbers for the 13 SEM samples taken from Oakura Beach SC

Table 48 Statistical summary for Oakura Beach SC

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4300 | 4750 | 4590 |
| <i>E. coli</i> | cfu/100 ml | 13 | 4 | 65 | 25 |
| Enterococci | cfu/100 ml | 13 | 4 | 180 | 57 |
| Faecal coliforms | cfu/100 ml | 13 | 4 | 67 | 27 |
| Temperature | °C | 13 | 16.1 | 21.1 | 19.5 |

Compared to other beach bathing sites around the region, the median enterococci count at this site was relatively high (57 cfu/100 ml).

The location of the Waimoku and Wairau stream mouths can influence water quality at this site. Microbial source tracking has shown that resident wildfowl are the principal contributors to elevated faecal indicator bacteria counts within these streams,

particularly in the case of the Waimoku Stream (TRC 2011-01).

The Waimoku Stream (site WMK000298) was sampled on 13 occasions during the 2013-2014 summer season and faecal indicator bacteria counts were found to be consistently high (430-3300 *E. coli* cfu/100 ml, 120-2900 enterococci cfu/100 ml).

Throughout the 2014-2015 summer season the Waimoku Stream continued to cut east across Oakura Beach due to the build up of sand at the stream mouth (Photo 11). This resulted in the Waimoku and Wairau stream mouths moving closer together. The close proximity of the streams to the beach sampling site is likely to have contributed to elevated enterococci counts obtained at this site. The Waimoku Stream was straightened (digging a channel through sand bank) by New Plymouth District Council but not until after all beach bathing monitoring had been completed for the 2014-2015 summer season.



Photo 11 Waimoku Stream (5 January 2015) cutting east across Oakura Beach due to the build up of sand at the stream mouth

4.9.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 49. Two SEM samples (1 January and 4 March 2015) reached Alert level (>140 enterococci cfu/100 ml) at this site during summer 2014-2015. Neither of these samples exceeded 280 cfu/100 ml.

Table 49 Bacterial guidelines performance at Oakura Beach SC

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|-----|---|----|
| | ALERT Single sample >140 cfu/100 ml | | ACTION Two consecutive samples >280 cfu/100 ml | |
| Enterococci | 2/13 | 15% | 0/13 | 0% |

4.9.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Oakura Beach opposite the surf lifesaving club over 20 summers are presented in Table 50 and Figure 27.

Table 50 Summary enterococci data (cfu/100 ml) for summer surveys at Oakura SC

| Summer | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | <3 | <3 | <1 | 5 | <1 | 1 | 4 | 1 | <1 | 2 |
| Maximum | 800 | 56 | 60 | 56 | 880 | 16 | 120 | 180 | 94 | 250 |
| Median | 31 | 8 | 21 | 16 | 7 | 5 | 25 | 8 | 8 | 25 |
| Summer | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
| Minimum | 1 | <1 | 4 | 5 | 5 | 2 | 1 | 7 | 4 | 4 |
| Maximum | 300 | 230 | 160 | 250 | 800 | 100 | 130 | 460 | 650 | 180 |
| Median | 12 | 11 | 32 | 20 | 45 | 17 | 36 | 17 | 29 | 57 |

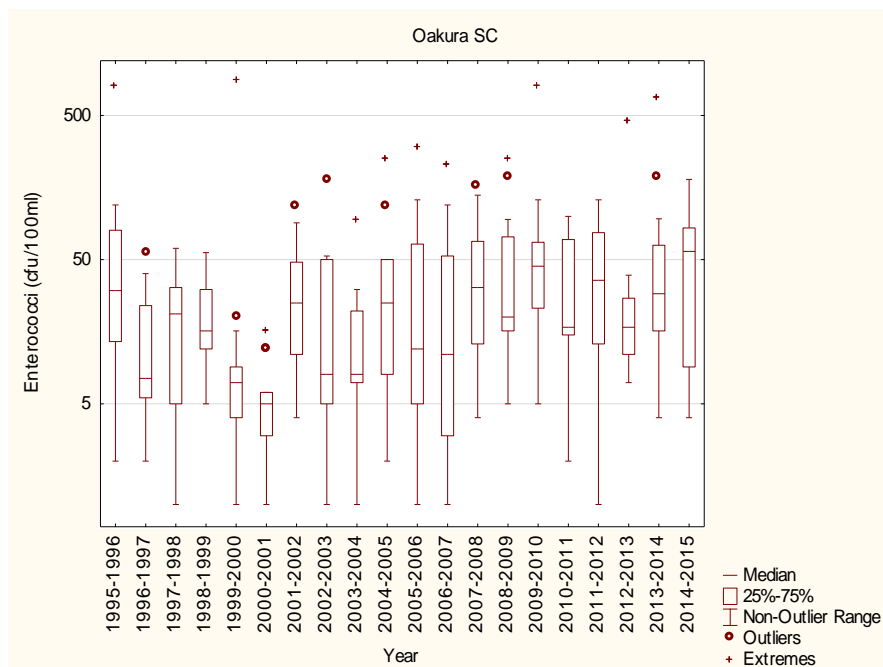


Figure 27 Box & whisker plots of enterococci for all summer SEM surveys at Oakura SC

The median enterococci count (57 cfu/100 ml) obtained for the 2014-2015 summer season was the highest to date at this site (Table 50, Figure 27). Interannual variation in median enterococci counts at this site can be largely attributed to the changing location of the small stream mouths relative to the sampling site.

4.9.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 20 summer seasons (Figure 28) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

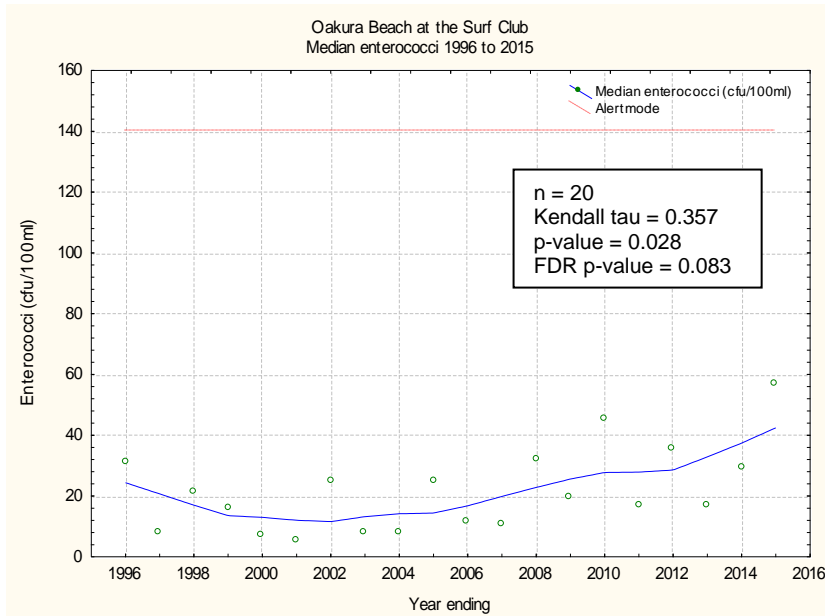


Figure 28 LOWESS trend analysis of median enterococci data at Oakura Beach SC

Over the 20 seasons monitored, there was a positive trend (i.e. an increase) in median enterococci counts (Kendall tau = 0.357). This positive trend was significant using the Mann-Kendall test ($p = 0.028$), but not significant after FDR application ($p = 0.083$).

4.9.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at irregular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 51 and Figure 29, with a statistical summary provided in Table 52.

Table 51 Bacteriological results for MfE samples at Oakura Beach SC

| Date | Time | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|-------------|--------|----------------------------------|--------------------------------|-----------------------------|----------------------------------|---------------------|
| | (NZST) | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 18 Nov 2014 | 12:05 | 4260 | 11 | 11 | 11 | 15.8 |
| 02 Dec 2014 | 11:00 | 4760 | 1 | 1 | 1 | 15.4 |
| 15 Jan 2015 | 11:00 | 4820 | <1 | <1 | <1 | 18.5 |
| 29 Jan 2015 | 12:15 | 4520 | 19 | 51 | 19 | 23.4 |
| 13 Feb 2015 | 12:45 | 4080 | 56 | 150 | 60 | 20.7 |
| 26 Feb 2015 | 09:15 | 4470 | 32 | 96 | 33 | 20.5 |
| 17 Mar 2015 | 12:00 | 4750 | 2 | 8 | 2 | 20.5 |

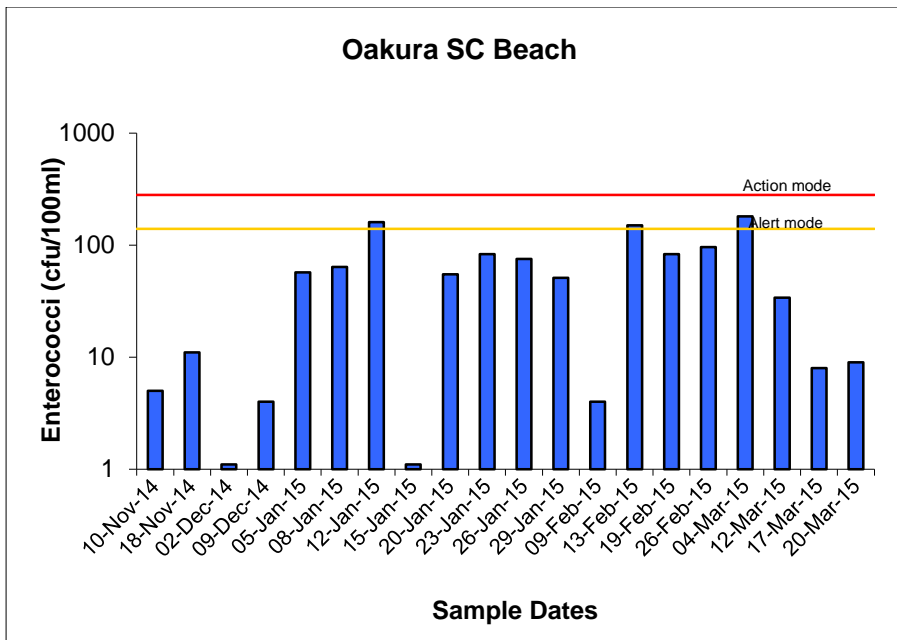


Figure 29 Enterococci numbers for the 20 sample extended survey at Oakura Beach SC

Table 52 Summary statistics for SEM and MfE samples at Oakura Beach SC

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 20 | 4080 | 4820 | 4555 |
| <i>E. coli</i> | cfu/100 ml | 20 | <1 | 65 | 21 |
| Enterococci | cfu/100 ml | 20 | <1 | 180 | 53 |
| Faecal coliforms | cfu/100 ml | 20 | <1 | 67 | 24 |
| Temperature | °C | 20 | 15.4 | 23.4 | 19.8 |

Additional sampling had little effect on the seasonal medians for all faecal indicator bacteria (Tables 48 and 52).

4.5.9.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 53. Three samples (12 January, 13 February and 4 March 2015) reached Alert level (>140 enterococci cfu/100 ml) at this site during summer 2014-2015. None of these samples exceeded 280 cfu/100 ml.

Table 53 Bacterial guidelines performance at Oakura Beach SC

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|-----|---|----|
| | ALERT Single sample 141-280/100ml | | ACTION Two consecutive samples >280/100 ml | |
| Enterococci | 3/20 | 15% | 0/20 | 0% |

4.10 Oakura Beach CG (opposite camp ground)

4.10.1 SEM programme

This site, situated at the west end of Oakura Beach in front of the campground, is a popular site with bathers and surfers (Photo 12).



Photo 12 Oakura Beach in front of the campground

The data for this site are presented in Table 54 and Figure 30, with a statistical summary provided in Table 55.

Table 54 Bacteriological results for Oakura Beach CG

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 10:15 | 4710 | <1 | 4 | <1 | 16.6 |
| 09-Dec-14 | 10:35 | 4730 | <1 | <1 | <1 | 16.6 |
| 05-Jan-15 | 09:20 | 4780 | <1 | 12 | <1 | 18.8 |
| 08-Jan-15 | 10:55 | 4850 | <1 | <1 | <1 | 18.8 |
| 12-Jan-15 | 13:40 | 4790 | <1 | 15 | <1 | 20.1 |
| 20-Jan-15 | 10:20 | 4690 | 28 | 39 | 28 | 20.1 |
| 23-Jan-15 | 11:10 | 4700 | 48 | 3 | 48 | 20.3 |
| 26-Jan-15 | 13:45 | 4700 | 4 | 5 | 4 | 20 |
| 09-Feb-15 | 11:55 | 4670 | <1 | 5 | 1 | 16.8 |
| 19-Feb-15 | 10:25 | 4680 | 130 | 160 | 130 | 19.3 |

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|-----------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 04-Mar-15 | 10:00 | 4720 | 1 | 4 | 1 | 21.3 |
| 12-Mar-15 | 13:15 | 4720 | <1 | <1 | <1 | 20.8 |
| 20-Mar-15 | 10:25 | 4780 | <1 | <1 | <1 | 19.1 |

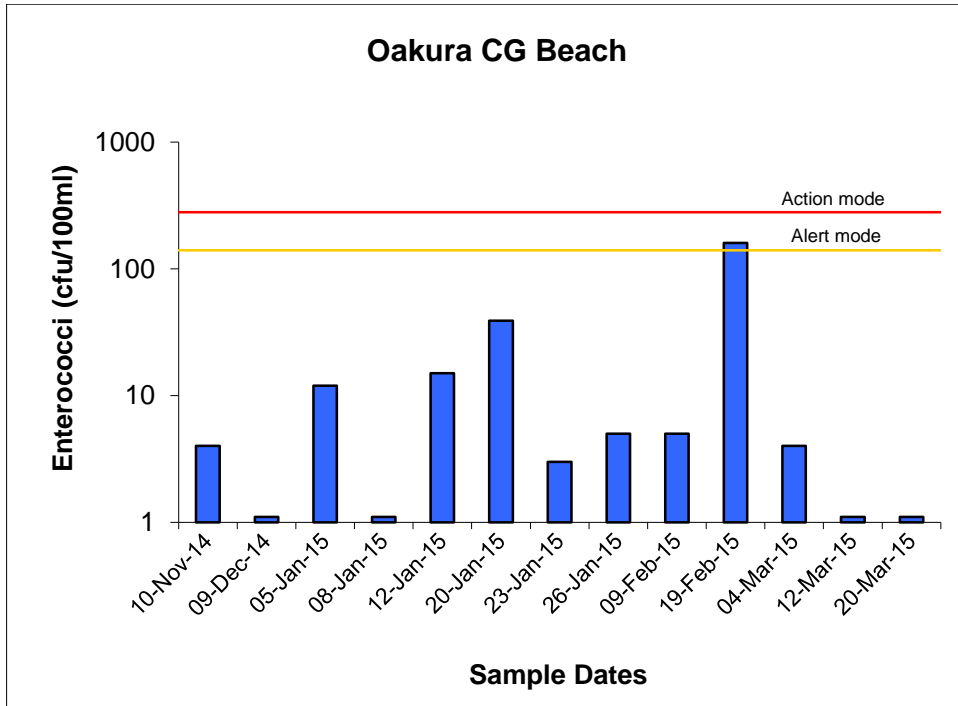


Figure 30 Enterococci counts for the 13 SEM samples taken from Oakura Beach CG

Table 55 Statistical results for Oakura Beach CG

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4670 | 4850 | 4720 |
| <i>E. coli</i> | cfu/100 ml | 13 | <1 | 130 | <1 |
| Enterococci | cfu/100 ml | 13 | <1 | 160 | 4 |
| Faecal coliforms | cfu/100 ml | 13 | <1 | 130 | <1 |
| Temperature | °C | 13 | 16.6 | 21.3 | 19.3 |

Water quality was good at this site with low medians for all faecal indicator bacteria (≤ 4 cfu/100 ml). The highest enterococci count (160 cfu/100 ml) was recorded on 19 February 2015. There was only a minor influence from freshwater input on this day (4680 mS/m, Table 25) and the elevated count remains largely unexplained.

4.10.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 56. One sample reached Alert level (>140 enterococci cfu/100 ml) at this site during summer 2014-2015.

Table 56 Bacterial guidelines performance at Oakura Beach CG

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140 cfu/100 ml | | ACTION Two consecutive samples $>280/100$ ml | |
| Enterococci | 1/13 | 8% | 0/13 | 0% |

4.10.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Oakura Beach opposite the campground over 20 summer surveys are presented in Table 57 and Figure 31.

Table 57 Summary enterococci data (cfu/100 ml) for summer surveys at Oakura Beach opposite the campground

| Summer | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | 2 | 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Maximum | 280 | 150 | 24 | 16 | 48 | 240 | 31 | 17 | 24 | 90 |
| Median | 9 | 5 | 2 | 4 | 3 | 3 | 7 | 3 | 3 | 6 |
| Summer | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
| Minimum | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Maximum | 8 | 260 | 18 | 30 | 25 | 33 | 79 | 260 | 37 | 160 |
| Median | 1 | 3 | 7 | 6 | 1 | <1 | 4 | 3 | 3 | 4 |

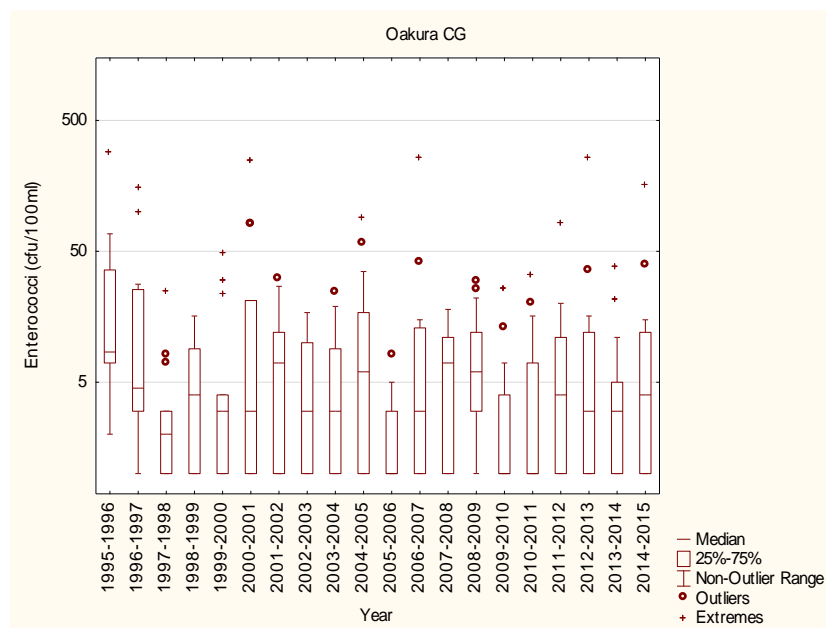


Figure 31 Box and whisker plots of enterococci for all summer SEM surveys at Oakura Beach opposite the campground

The median enterococci count for the 2014-2015 season was within the low range previously recorded at this site (4 cfu/100 ml). Over the past 20 summers water quality has remained consistently high at this site (Table 57).

4.10.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 20 summer seasons (Figure 32) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

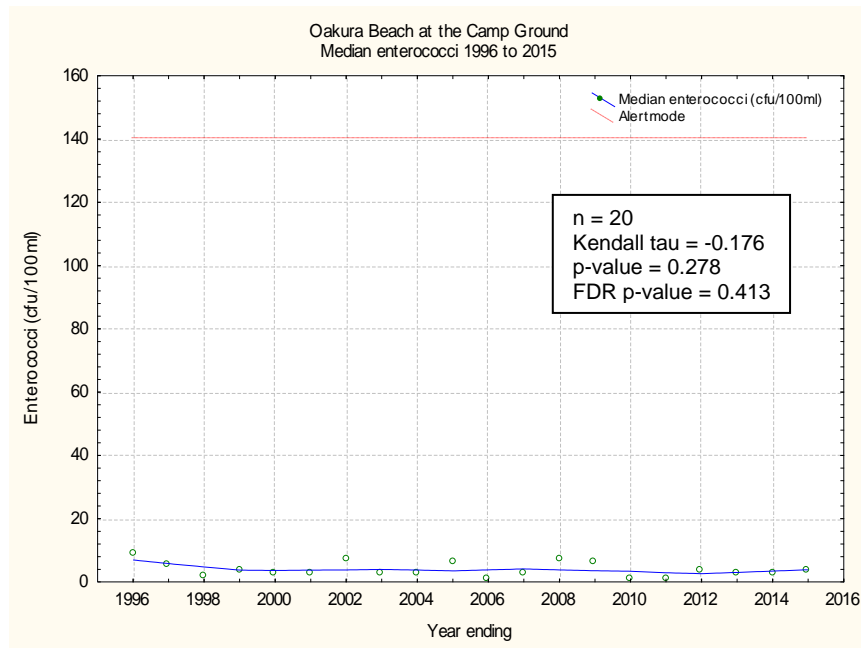


Figure 32 LOWESS trend analysis of median enterococci data at Oakura Beach Camp Ground

Over the 20 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.176) that was not significant at the 5% level ($p = 0.278$).

4.11 Opunake Beach

4.11.1 SEM programme

Opunake Beach (Photo 13) is a very popular swimming beach in south Taranaki. There are no large rivers in the vicinity. However, the outlet of a freshwater stream from the Opunake Power Station enters at the southern end of the beach.



Photo 13 Opunake Beach and motor camp

The data for this site are presented in Table 58 and Figure 33, with a statistical summary provided in Table 59.

Table 58 Bacteriological results for Opunake Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-----------|-------------|----------------------------|-----------------------------|--------------------------|-------------------------------|-----------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10-Nov-14 | 11:55 | 4720 | <1 | 3 | 1 | 16.6 |
| 09-Dec-14 | 11:35 | 4800 | 1 | 1 | 1 | 15.7 |
| 05-Jan-15 | 10:50 | 4780 | 33 | <1 | 40 | 20.2 |
| 08-Jan-15 | 12:45 | 4790 | <1 | 1 | <1 | 20.3 |
| 12-Jan-15 | 14:45 | 4820 | 3 | 4 | 4 | 20.7 |
| 20-Jan-15 | 10:15 | 4690 | 75 | 28 | 76 | 20.3 |
| 23-Jan-15 | 12:40 | 4660 | <1 | 3 | <1 | 19.7 |
| 26-Jan-15 | 14:55 | 4700 | 7 | 4 | 7 | 21.4 |
| 09-Feb-15 | 13:40 | 4670 | 7 | 9 | 7 | 20.5 |
| 19-Feb-15 | 10:30 | 4720 | 7 | 9 | 8 | 19.6 |
| 04-Mar-15 | 08:20 | 4710 | 3 | <1 | 3 | 20.7 |
| 12-Mar-15 | 14:15 | 4690 | 8 | 23 | 8 | 19.9 |
| 20-Mar-15 | 10:25 | 4720 | <1 | 4 | <1 | 15.8 |

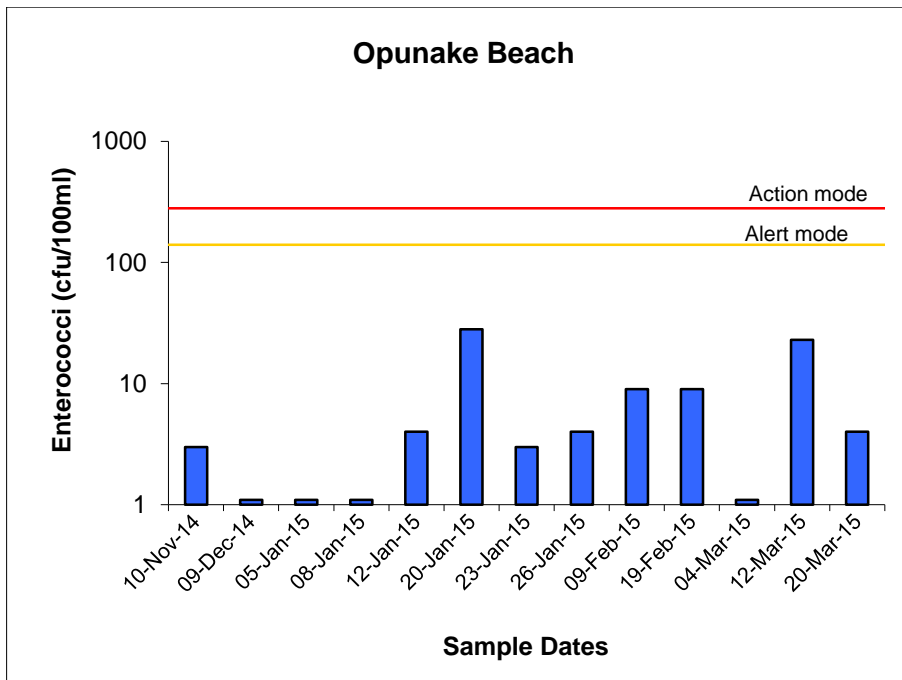


Figure 33 Enterococci numbers for the 13 SEM samples at Opunake Beach

Table 59 Statistical summary for Opunake Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4660 | 4820 | 4720 |
| <i>E. coli</i> | cfu/100 ml | 13 | <1 | 75 | 3 |
| Enterococci | cfu/100 ml | 13 | <1 | 28 | 4 |
| Faecal coliforms | cfu/100 ml | 13 | <1 | 76 | 4 |
| Temperature | °C | 13 | 15.7 | 21.4 | 20.2 |

Concentrations were low for all faecal indicator bacteria, with medians of ≤ 4 cfu/100 ml, indicating excellent water quality at this site.

4.11.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 60. Water quality was considered suitable for contact recreation throughout the season, with all samples well below Alert guideline levels.

Table 60 Bacterial guidelines performance at Opunake Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140 cfu/100 ml | | ACTION Two consecutive samples >280 cfu/100 ml | |
| Enterococci | 0/13 | 0% | 0/13 | 0% |

4.11.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Opunake Beach over 20 summers are presented in Table 61 and Figure 34.

Table 61 Summary enterococci data (cfu/100 ml) for summer surveys at Opunake Beach

| Summer | 1995-96 | 1996-97 | 1999-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Minimum | <1 | <1 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Maximum | 74 | 60 | 73 | 7 | 41 | 69 | 140 | 20 | 9 | 10 |
| Median | 9 | <1 | 5 | <1 | 1 | 2 | 4 | 1 | 1 | 1 |
| Summer | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
| Minimum | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Maximum | 19 | 8 | 11 | 25 | 4 | 100 | 17 | 7 | 49 | 28 |
| Median | 2 | 1 | <1 | 2 | <1 | <1 | 3 | <1 | 1 | 4 |

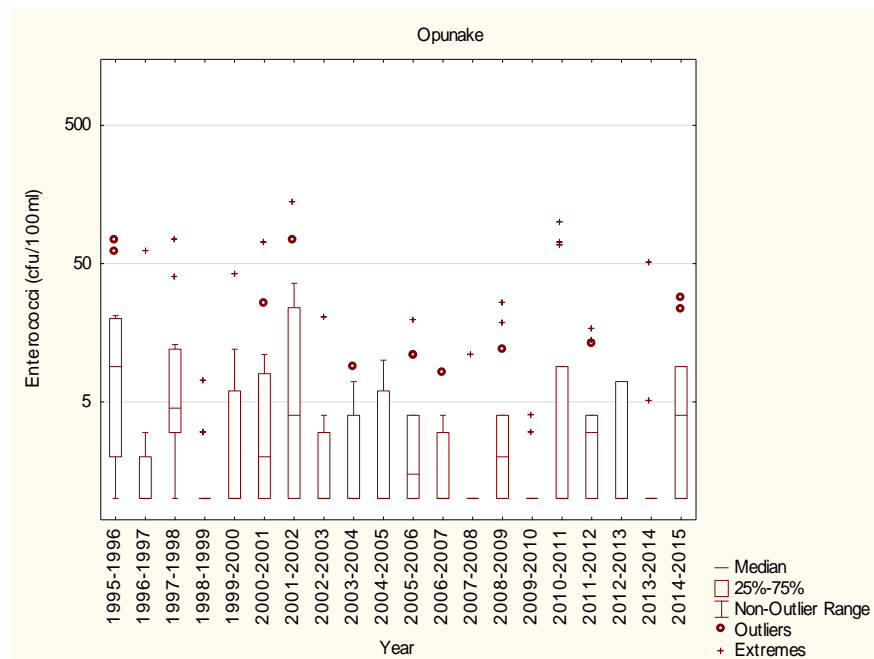


Figure 34 Box and whisker plots of enterococci for all summer SEM surveys at Opunake Beach

The low enterococci data obtained for Opunake Beach during the 2014-2015 summer continues the trend of excellent water quality at this site (Table 61, Figure 34).

4.11.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 20 summer seasons (Figure 35) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

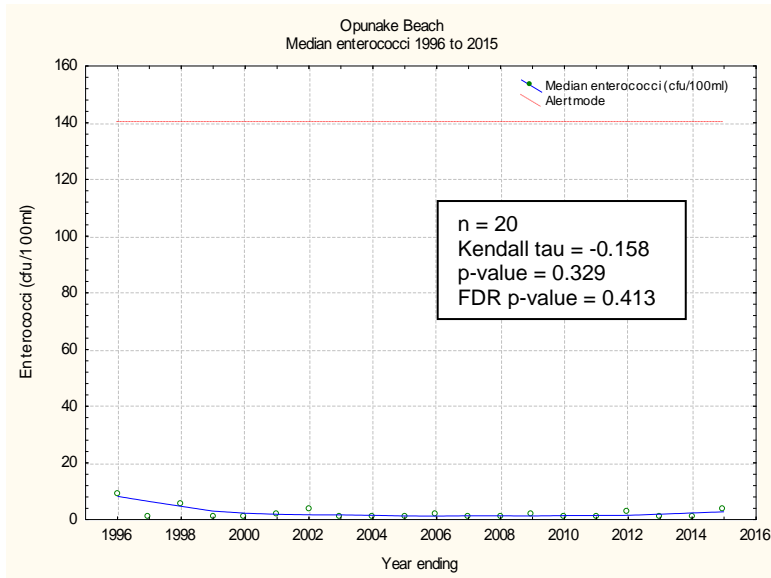


Figure 35 LOWESS trend analysis of median enterococci data at Opunake Beach

Over the 20 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.158) that was not significant at the 5% level ($p = 0.329$).

4.11.5 MfE guidelines additional sampling

For the purpose of MfE monitoring seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples are presented in Table 62 and Figure 36, with a statistical summary in Table 63.

Table 62 Bacteriological results for MfE samples at Opunake Beach

| Date | Time | Conductivity @ 20°C (mS/m) | Bacteria | | | Temperature (°C) |
|--------|--------|----------------------------------|--------------------------------|-----------------------------|----------------------------------|---------------------|
| | (NZST) | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 18 Nov | 12:55 | 4760 | 1 | <1 | 1 | 15.9 |
| 02 Dec | 12:30 | 4730 | <1 | <1 | <1 | 16.3 |
| 15 Jan | 12:15 | 4820 | <1 | <1 | <1 | 20.9 |
| 29 Jan | 14:00 | 4700 | <1 | <1 | <1 | 21.2 |
| 13 Feb | 13:40 | 4700 | <1 | <1 | <1 | 20.5 |
| 26 Feb | 08:10 | 4630 | <1 | 8 | <1 | 19.5 |
| 17 Mar | 12:55 | 4760 | 10 | 8 | 10 | 17.7 |

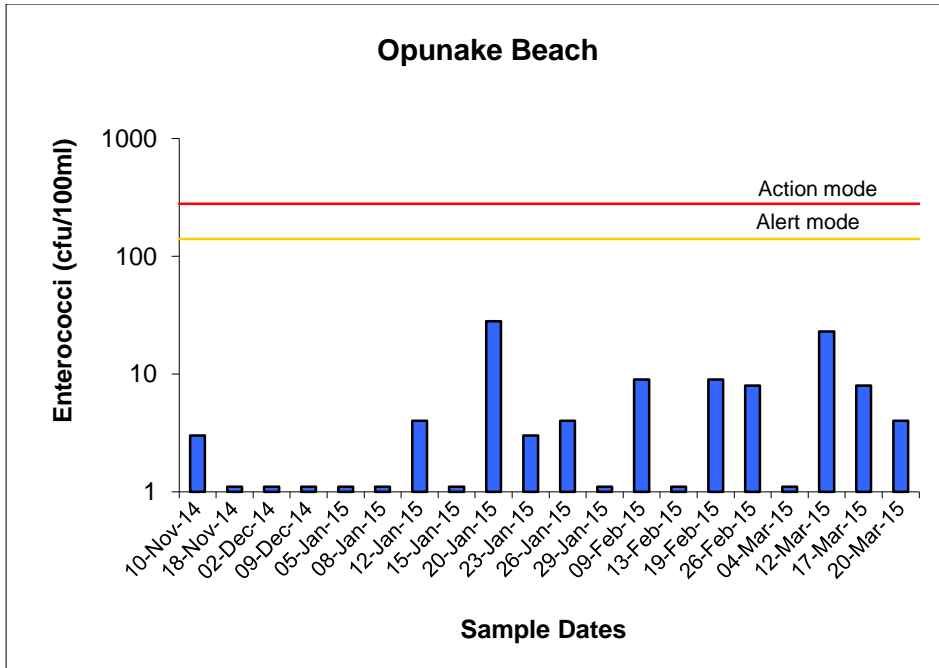


Figure 36 Enterococci numbers for the 20 sample extended survey at Opunake Beach

Table 63 Summary statistics for SEM and MfE samples at Opunake Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 20 | 4630 | 4820 | 4720 |
| <i>E. coli</i> | cfu/100 ml | 20 | <1 | 75 | 1 |
| Enterococci | cfu/100 ml | 20 | <1 | 28 | 3 |
| Faecal coliforms | cfu/100 ml | 20 | <1 | 76 | 1 |
| Temperature | °C | 20 | 15.7 | 21.4 | 20.1 |

The additional MfE samples made little difference to the medians for all faecal indicator bacteria, reflecting consistently high water quality at this site.

4.11.6 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 64. No samples exceeded Alert level.

Table 64 Bacterial guidelines performance at Opunake Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140 cfu/100 ml | | ACTION Two consecutive samples >280 cfu/100 ml | |
| Enterococci | 0/20 | 0% | 0/20 | 0% |

4.12 Ohawe Beach

4.12.1 SEM programme

Ohawe Beach (Photo 14) is located close to the large Waingongoro River in South Taranaki. The river catchment drains highly modified agricultural land.



Photo 14 Ohawe Beach

Data from this site are presented in Table 65 and Figure 37, with a statistical summary provided in Table 66.

Table 65 Bacteriological results for Ohawe Beach

| Date | Time (NZST) | Conductivity @ 20°C (mS/m) | Bacteria | | | Temp (°C) |
|-------------|----------------|----------------------------------|--------------------------------|-----------------------------|-------------------------------------|--------------|
| | | | <i>E. coli</i> (cfu/100 ml) | Enterococci (cfu/100 ml) | Faecal coliforms (cfu/100 ml) | |
| 10 Nov 2014 | 10:50 | 4150 | 21 | 24 | 21 | 16.2 |
| 09 Dec 2014 | 10:15 | 4540 | 7 | 30 | 7 | 17.3 |
| 05 Jan 2015 | 09:20 | 4280 | 24 | 14 | 24 | 20.5 |
| 08 Jan 2015 | 11:20 | 4790 | 3 | 7 | 3 | 20.3 |
| 12 Jan 2015 | 13:20 | 4360 | 2 | 78 | 2 | 22.2 |
| 20 Jan 2015 | 08:30 | 4340 | 43 | 48 | 43 | 20.2 |
| 23 Jan 2015 | 10:40 | 4450 | 350 | 92 | 350 | 21.2 |
| 26 Jan 2015 | 13:30 | 4240 | 4 | 15 | 4 | 23.1 |
| 09 Feb 2015 | 11:50 | 4180 | 40 | 20 | 40 | 19.9 |
| 19 Feb 2015 | 09:00 | 4670 | 8 | 12 | 8 | 17.8 |
| 04 Mar 2015 | 09:45 | 4410 | 480 | 270 | 480 | 21.4 |
| 01 Apr 2015 | 08:15 | 4400 | 27 | 48 | 28 | 17.2 |
| 20 Mar 2015 | 09:10 | 4710 | 4 | 4 | 4 | 17.1 |

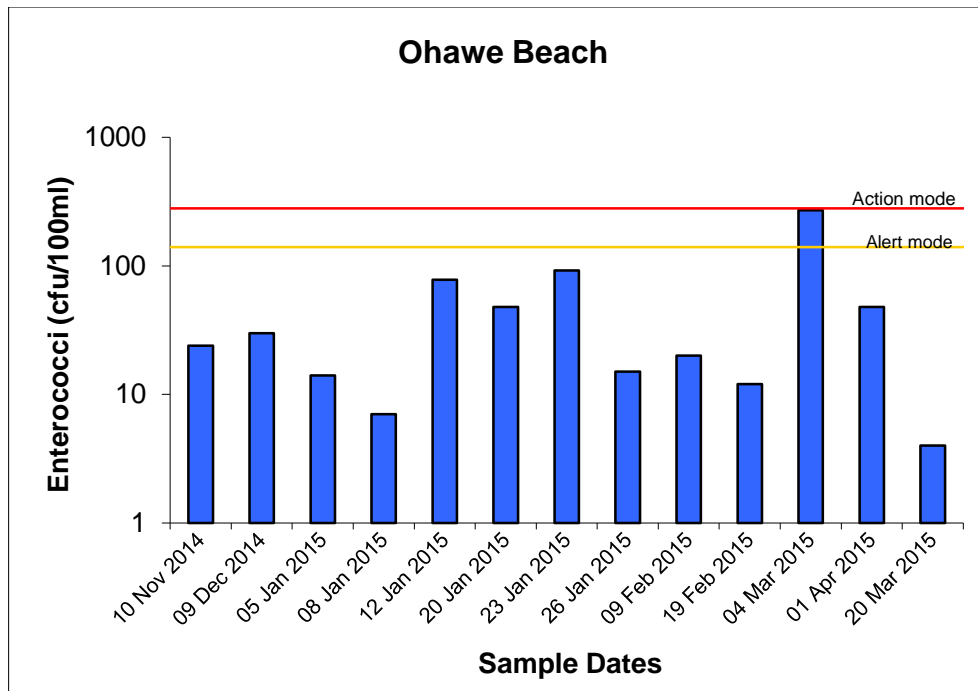


Figure 37 Enterococci numbers for the 13 SEM samples at Ohawe Beach

Table 66 Statistical summary for Ohawe Beach

| Parameter | Unit | Number of samples | Minimum | Maximum | Median |
|---------------------|------------|-------------------|---------|---------|--------|
| Conductivity @ 20°C | mS/m | 13 | 4150 | 4790 | 4400 |
| <i>E. coli</i> | cfu/100 ml | 13 | 2 | 480 | 21 |
| Enterococci | cfu/100 ml | 13 | 4 | 270 | 24 |
| Faecal coliforms | cfu/100 ml | 13 | 2 | 480 | 21 |
| Temperature | °C | 13 | 16.2 | 23.1 | 20.2 |

The site can be influenced by the Waingongoro River (see relatively low conductivities recorded throughout the season, Table 65). Microbial source tracking from samples taken at the river mouth and just upstream of the Ohawe settlement indicate that the main source of faecal contamination in the river is from ruminants and wildfowl (TRC 2013-01).

4.12.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 67. One sample (4 March 2015) reached Alert level (>140 enterococci cfu/100 ml) at this site during summer 2014-2015. This sample did not exceed 280 cfu/100 ml.

Table 67 Bacterial guidelines performance at Ohawe Beach

| Parameter | Number of exceedances of enterococci guidelines | | | |
|-------------|---|----|---|----|
| | ALERT Single sample >140 cfu/100 ml | | ACTION Two consecutive samples >280 cfu/100 ml | |
| Enterococci | 1/13 | 8% | 0/13 | 0% |

4.12.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ohawe Beach over 19 summers are presented in Table 68 and Figure 38.

Table 68 Summary enterococci data (cfu/100 ml) for summer surveys at Ohawe Beach

| Summer | 1996-97 | 1997-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------|---------|
| Minimum | 15 | 7 | <1 | 1 | 3 | 3 | 5 | 3 | <1 | 1 |
| Maximum | 72 | 650 | 280 | 68 | 450 | 1600 | 180 | 11000 | 330 | 1600 |
| Median | 21 | 40 | 17 | 23 | 48 | 48 | 16 | 29 | 23 | 13 |
| Summer | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-2015 | |
| Minimum | <1 | <1 | 2 | 3 | <1 | 2 | <1 | <1 | 4 | |
| Maximum | 80 | 1800 | 280 | 350 | 83 | 160 | 630 | 400 | 270 | |
| Median | 7 | 5 | 20 | 16 | 7 | 34 | 37 | 5 | 24 | |

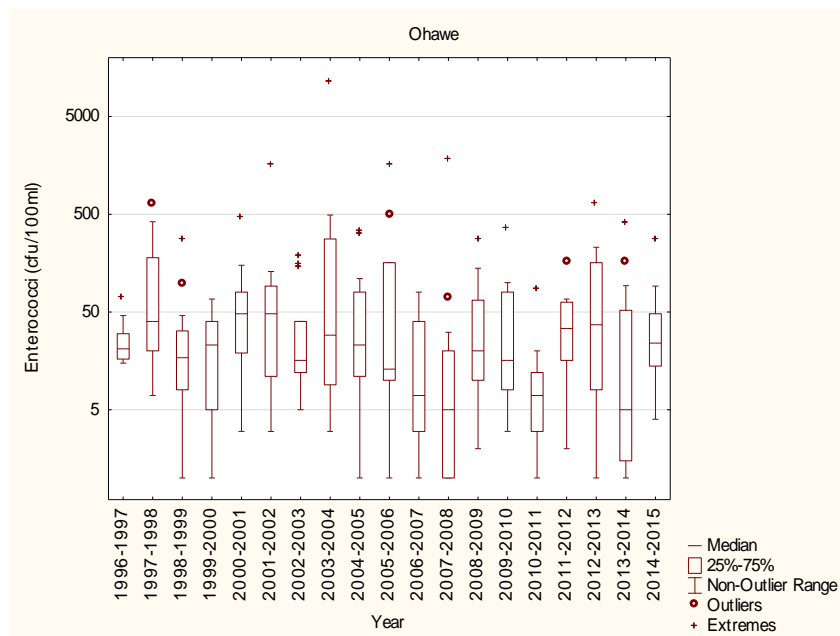


Figure 38 Box and whisker plots of enterococci for all summer surveys at Ohawe Beach

The median enterococci count (24 cfu/100 ml) obtained for the 2014-2015 summer season was within the range recorded at this site previously. Maxima and medians at this site are historically variable due to the influence of the Waingongoro River (Table 68).

4.12.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 19 summer seasons (Figure 39) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

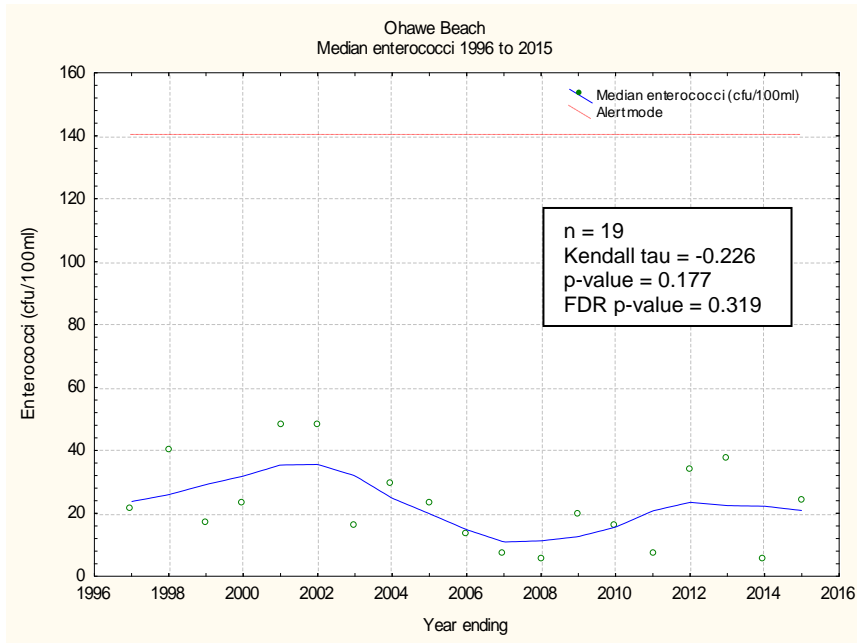


Figure 39 LOWESS trend analysis of median enterococci data at Ohawe Beach

Over the 19 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.226) that was not significant at the 5% level ($p = 0.177$).

5. General summary

5.1 Regional overview

During the 2014-2015 summer season, microbiological water quality was generally good across bathing beaches in the Taranaki region (Table 69). Median enterococci values were equal to or less than 8 cfu/100 ml for ten of the twelve beaches monitored. At the two beach sites with elevated median enterococci counts (Ohawe 24 cfu/100 ml and Oakura Surf Club 57 cfu/100 ml) no individual sample exceeded 280 enterococci cfu/100 ml. Out of the 191 samples collected at 12 beach sites, 96% were below guideline Alert levels (140 enterococci cfu/100 ml). No site reached Action mode (two consecutive samples >280 enterococci cfu/100 ml) during the 2014-2015 season and no individual sample exceeded 280 enterococci cfu/100 ml. Of the few samples which individually entered the Alert guideline category (4% i.e. 7 samples), over two thirds (5 out of 7) had been influenced by rainfall or freshwater. All sites surveyed during the 2014-2015 monitoring period obtained a Suitability for Recreation Grade of either 'good' (9/12) or 'fair' (3/12). These grades reflect qualitative risk grading of the catchment in addition to quantitative enterococci results (see Section 2.2).

Table 69 Summary results for the TRC beach bathing monitoring programme 2014-2015

| Beach sites ¹ | Enterococci median (cfu/100 ml) | | Number of samples above Alert mode (>140 cfu/100 ml) | | Trend analysis ⁴ | | | Suitability for recreation grade (SFRG) ⁷ |
|--------------------------|---------------------------------|----------------------|--|----------------------|-----------------------------|-----------------------------------|------------------------------|--|
| | SEM ² | SEM+MfE ³ | SEM ² | SEM+MfE ³ | Kendall tau ⁵ | Mann-Kendall p value ⁶ | False Discovery Rate p value | |
| Waitara East | 1 | - | 1 | - | -0.243 | 0.147 | 0.319 | Fair |
| Fitzroy | 3 | 1 | 0 | 0 | -0.526 | 0.001 | 0.011 | Good |
| Urenui | 3 | - | 0 | - | - | - | - | Good |
| Opunake | 4 | 3 | 0 | 0 | -0.158 | 0.329 | 0.413 | Good |
| Waitara West | 4 | - | 0 | - | -0.151 | 0.367 | 0.413 | Good |
| Oakura CG | 4 | - | 1 | - | -0.176 | 0.228 | 0.413 | Good |
| Ngamotu | 7 | 8 | 0 | 0 | -0.469 | 0.004 | 0.017 | Good |
| Onaero | 7 | 10 | 0 | 1 | 0.013 | 0.949 | 0.949 | Fair |
| Onaero BS | 7 | - | 0 | - | - | - | - | Good |
| Wai-iti | 8 | - | 0 | - | - | - | - | Good |
| Ohawe | 24 | - | 1 | - | -0.226 | 0.177 | 0.319 | Fair |
| Oakura SC | 57 | 53 | 2 | 3 | 0.357 | 0.028 | 0.083 | Good |

¹Sites ordered in ascending order of SEM median enterococci

²SEM results based on 13 samples

³SEM+MfE results based on 20 samples (MfE data available for selected sites only)

⁴Trend analysis performed on SEM data only (Section 3.4)

⁵A negative/positive Kendall tau indicates a decreasing/increasing temporal trend in median enterococci respectively

⁶A green/red shaded p value = significant (5%) decreasing/increasing temporal trend in median enterococci respectively

⁷The Suitability for Recreational Grade is calculated using the Microbial Assessment Category (based on five years enterococci data) and the Sanitary Inspection Category (a qualitative risk assessment based on the catchment) as explained in Section 2.2

- = insufficient data

During the 2014-2015 season Waitara East Beach had the region's lowest median enterococci count of 1 cfu/100 ml (Table 69, Figure 40). Since October 2014, municipal wastewater from the Waitara Township has been directed to the New Plymouth Wastewater Treatment Plant and is no longer discharged through the Waitara Marine Outfall during normal operation of the wastewater system.

Over the long term, Fitzroy and Opunake are amongst the region's cleanest bathing beaches (Figure 41). Water quality at these two sites has remained consistently high since the Council beach monitoring programme began in 1995-1996 (Figure 41).

Oakura Surf Club recorded the highest enterococci median of the 2014-2015 season (57 cfu/100 ml). Bacteriological water quality at this site has been historically variable due to the influence of nearby streams. During the 2014-2015 season, the Waimoku Stream cut east across the beach due to a build up of sand at the stream mouth. The close proximity of the stream mouth to the sampling site is likely to have contributed to the elevated counts obtained at this site.

Long term trend analysis (13-20 years data) showed a significant (at the 5% level) decrease in enterococci medians at 2 of the 12 sites monitored (Fitzroy and Ngamotu). Oakura Surf Club was the only site where there was a significant increase in enterococci medians over the time period monitored i.e. deterioration in water quality. This increase in enterococci counts was significant using the Mann-Kendall test, but not significant after FDR application (Table 69). All other sites showed no significant change (Table 69, Kendall tau and Mann-Kendall p values).

The site at Fitzroy Beach showed the greatest improvement in microbiological water quality since 1995 (Table 69, Kendall tau -0.526, Mann-Kendall p value 0.001). Improvements in water quality might have arisen due to work undertaken by the New Plymouth District Council as part of the Stormwater Upgrade Project at Fitzroy. As a result of this project there is now less flow of stormwater to the stormwater infiltration galleries located in the Fitzroy beach car park.

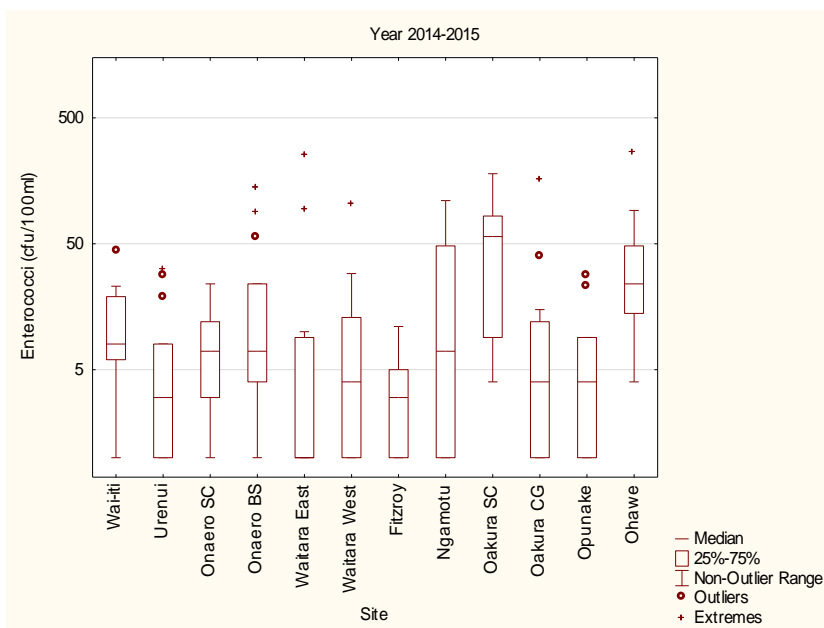


Figure 40 Box and whisker plots of enterococci at all sites during the 2014-2015 season (SEM data only)

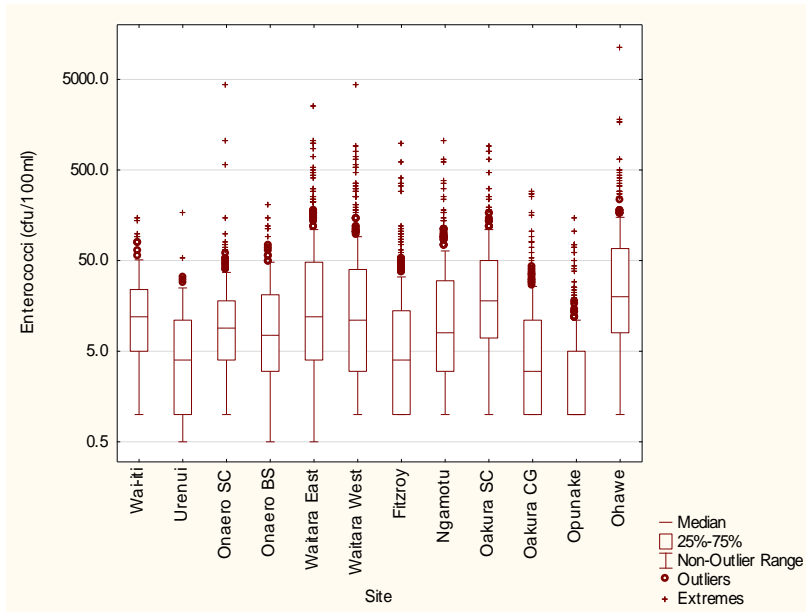


Figure 41 Box and whisker plots of long term enterococci data from 1995/implementation of monitoring to 2015 (SEM data only)

5.2 Conclusion

During the 2014-2015 summer season, water quality across the Taranaki region was generally high with 96% of samples below guideline Alert levels (<141 enterococci cfu/100 ml) and no site reaching Action mode (two consecutive samples >280 enterococci cfu/100 ml). At seven of the twelve sites, no sample entered the alert mode. Sites in Taranaki compared favorably to national results, with 88% of Taranaki sites considered generally satisfactory for swimming based on SFRG grades ('very good', 'good' and 'fair'). In Taranaki, of the few samples which individually entered the Alert guideline category (4%), over two thirds (5 out of 7) had been influenced by rainfall or freshwater. Many of the beach sites monitored in Taranaki are located close to stream or river mouths which can act as a source of contamination during heavy rainfall. The majority of these rivers and streams drain catchments with intensive agricultural land use, including dairying. Microbial source tracking has revealed that in addition to ruminants, birds (wildfowl and gulls) can also act as a key source of contamination in Taranaki freshwater environments (TRC 2015). In order to minimize potential health risks, the Council recommends reducing coastal recreational activities for two-three days following heavy rainfall (when other water quality parameters such as discolouration and high turbidity are not conducive to bathing in any case).

6. Recommendations

As a result of the 2014-2015 summer marine contact recreation bacteriological survey it is recommended:

1. THAT the 2015-2016 summer survey be performed at 13 sites continuing with the existing sampling protocol (annual, plus Year 1 sites).
2. THAT the 2015-2016 summer survey also includes an additional 7 samples collected at the five principal usage sites (Onaero, Fitzroy, Ngamotu, Oakura SC, and Opunake) in accordance with MfE, 2003 guidelines.
3. THAT follow-up sampling be performed as deemed necessary by Council staff. This should include follow-up samples within 24 hours of any samples exceeding 280 cfu/100 ml in order to assess if Action level has been reached.
4. THAT reporting of results be performed as appropriate during the season, and in an Annual Report upon completion of the season's programme.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

| | |
|---|--|
| 'Action' mode | Two consecutive single samples greater than 280 enterococci cfu/100 ml. |
| 'Alert' mode | Single sample greater than 140 enterococci cfu/100 ml. |
| Bathers | Those who enter the water, and either partially or fully immerse themselves. |
| Bathing season | Generally the bathing season extends between 1 November and 31 March. |
| Beach | The shore or any access point to the sea. |
| cfu | Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 ml sample. |
| Condy | Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m. |
| Contact recreation | Recreation activities that bring people physically in contact with water, involving a risk of involuntary ingestion or inhalation of water. |
| <i>E.coli</i> | <i>Escherichia coli</i> , member of the Enterobacteriaceae, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample. |
| Enterococci | Members of the Streptococcus group of bacteria characterised as faecal in origin. Enterococci provide an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample. |
| Faecal coliform | An indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample. |
| Faecal Indicator Bacteria (FIB) | Micro-organisms selected as indicators of faecal contamination. |
| False Discovery Rate (FDR) | The expected proportion of true hypothesis rejected out of the total number of rejections. |
| Follow-up sample | Second sample taken to confirm an initial high result; usually within 24-72 hours depending on accessibility/sample turnaround time, etc. |
| Median | Central value when values are arranged in order of magnitude. |
| Microbiological Assessment RMA | A measurement of water quality over time as provided by historical (five years) microbiological results – A, B, C or D Category (MAC). Resource Management Act 1991 and subsequent amendments. |
| Sanitary Inspection Category (SIC) | A measure of the susceptibility of a water body to faecal contamination – Very High, High, Moderate, Low or Very Low. |
| Suitability for Recreation Grade (SFRG) | A combination of Sanitary Inspection Category (SIC) and Microbiological Assessment Category (MAC), describes the general condition of a site at any given time, based on both risk and indicator bacteria counts. |
| Temp | Temperature, measured in °C (degrees Celsius). |

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Appendix I

High tide times

High tide times (NZST) at New Plymouth for 2014-2015 sampling dates

| Date | | Time of HT |
|-----------|------------------|------------|
| Monday | 10 November 2014 | 1144 |
| Tuesday | 9 December 2014 | 1123 |
| Monday | 5 January 2015 | 0952 |
| Thursday | 8 January 2015 | 1138 |
| Monday | 12 January 2015 | 1411 |
| Tuesday | 20 January 2015 | 0923 |
| Friday | 23 January 2015 | 1142 |
| Monday | 26 January 2015 | 1412 |
| Monday | 9 February 2015 | 1252 |
| Thursday | 19 February 2015 | 0951 |
| Wednesday | 4 March 2015 | 0910 |
| Thursday | 12 March 2015* | 1344 |
| Friday | 20 March 2015 | 0929 |
| Wednesday | 1 April 2015 | 0759 |

Appendix II

MAC assessments 2010-2015

Wai-iti

Marine MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file:

MAC Data Summary

| Sampling Station | Sample Size | Median (E. coli / 100 mL) | Number of exceedances (Enterococci / 100 mL) (140 to 200) (>200) | Days in Compliance (Days < 200 / year) | |
|------------------|-------------|---------------------------|--|--|------|
| 2014 | 13 | 0.0 | 0 | 0 | 100% |
| 2013 | 0 | 0.0 | 0 | 0 | 0% |
| 2012 | 0 | 0.0 | 0 | 0 | 0% |
| 2011 | 13 | 0.0 | 0 | 0 | 100% |
| 2010 | 0 | 0.0 | 0 | 0 | 0% |
| Total | 26 | 0.0 | 0 | 0 | 100% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: **B** **550ae (100 mL)** **50.0**
Median Result? **Median Data Set (< 5 years, or < 100 samples used)**

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: **B**
Median Assessment? **Median Data Set (< 5 years, or < 100 samples used)**

SC Assessment Results
SC Assessment: **Moderate**
Priority SC Input? **T3 River - agricultural activities/bed/dunal animals**

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

SFRG Assessment Results
Site name: **Wai-iti**
SFRG Assessment: **Good**

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SC assessments and the MAC and SC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file
 Print the column labels to the file "ColumnLabelsMarine.txt"

Urenui

Marine MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file:

MAC Data Summary

| Sampling Station | Sample Size | Median (E. coli / 100 mL) | Number of exceedances (Enterococci / 100 mL) (140 to 200) (>200) | Days in Compliance (Days < 200 / year) | |
|------------------|-------------|---------------------------|--|--|------|
| 2014 | 13 | 3.0 | 0 | 0 | 100% |
| 2013 | 0 | 0.0 | 0 | 0 | 0% |
| 2012 | 0 | 0.0 | 0 | 0 | 0% |
| 2011 | 13 | 3.0 | 0 | 0 | 100% |
| 2010 | 0 | 0.0 | 0 | 0 | 0% |
| Total | 26 | 3.0 | 0 | 0 | 100% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: **A** **550ae (100 mL)** **20.0**
Median Result? **Median Data Set (< 5 years, or < 100 samples used)**

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: **A**
Median Assessment? **Median Data Set (< 5 years, or < 100 samples used)**

SC Assessment Results
SC Assessment: **Moderate**
Priority SC Input? **T3 River - agricultural activities/bed/dunal animals**

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

SFRG Assessment Results
Site name: **Urenui**
SFRG Assessment: **Good**

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SC assessments and the MAC and SC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file
 Print the column labels to the file "ColumnLabelsMarine.txt"

Onaero

Marine MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Onaero

MAC Data Summary

| Sampling Season | Sample Size | Median (E. coli / 100 mL) | Number of exceedances (Enterococci / 100 mL) | | Days in Compliance (Days < 200 / year) |
|-----------------|-------------|---------------------------|--|------|--|
| | | | 140 to 200 | >200 | |
| 2014 | 20 | 10.0 | 1 | 0 | 100% |
| 2013 | 20 | 10.5 | 0 | 0 | 100% |
| 2012 | 20 | 7.5 | 0 | 1 | 95% |
| 2011 | 20 | 14.5 | 2 | 2 | 80% |
| 2010 | 20 | 14.0 | 1 | 1 | 95% |
| Total | 100 | 12.0 | 4 | 4 | 96% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: C 35%ile (7100 mL) 2800
Interim Result? Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment? Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Low
Priority SIC Impact: 14 River - local points of discharge

Calculate Marine SPRG
Press "Calculate SPRG" to determine a SPRG assessment

SPRG Assessment Results
Site name: Onaero
SPRG Assessment: Fail

Save this SPRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SPRG, MAC, and SIC assessment and the MAC and SIC data in one file

Save SPRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data to one row in a comma-delimited file

Print the column labels to the file "ColumnLabelsMarine.txt"

OK

Onaero Settlement

Marine MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Onaero settlement

MAC Data Summary

| Sampling Season | Sample Size | Median (E. coli / 100 mL) | Number of exceedances (Enterococci / 100 mL) | | Days in Compliance (Days < 200 / year) |
|-----------------|-------------|---------------------------|--|------|--|
| | | | 140 to 200 | >200 | |
| 2014 | 13 | 7.0 | 0 | 0 | 100% |
| 2013 | 0 | 0.0 | 0 | 0 | 0% |
| 2012 | 0 | 0.0 | 0 | 0 | 0% |
| 2011 | 13 | 2.0 | 0 | 0 | 100% |
| 2010 | 0 | 0.0 | 0 | 0 | 0% |
| Total | 26 | 4.0 | 0 | 0 | 100% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: B 35%ile (7100 mL) 354
Interim Result? Interim Data Set (<5 years or <100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment? Interim Data Set (<5 years or <100 samples used)

SIC Assessment Results
SIC Assessment: Low
Priority SIC Impact: 14 River - local points of discharge

Calculate Marine SPRG
Press "Calculate SPRG" to determine a SPRG assessment

SPRG Assessment Results
Site name: Onaero settlement
SPRG Assessment: Good

Save this SPRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SPRG, MAC, and SIC assessment and the MAC and SIC data in one file

Save SPRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data to one row in a comma-delimited file

Print the column labels to the file "ColumnLabelsMarine.txt"

OK

Waitara (East)

Marine MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Waitara East

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedances (Exceedance / 100 mL) 140 to 200 >200 | Days in Compliance (Days / 200 / year) | |
|-----------------|-------------|---------------------------|---|--|------|
| 2014 | 13 | 1.0 | 1 | 0 | 100% |
| 2013 | 13 | 2.0 | 2 | 0 | 100% |
| 2012 | 13 | 37.0 | 0 | 2 | 84% |
| 2011 | 13 | 5.0 | 1 | 0 | 100% |
| 2010 | 13 | 3.0 | 1 | 2 | 84% |
| Total | 65 | 7.0 | 5 | 4 | 81% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: **C** 95th (100 mL) 302.5
Interim Result? Interim Data Set (5 years, or 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: **C**
Interim Assessment? Interim Data Set (5 years, or 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13 flow - agricultural activities/beach/hot air seal

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.

SFRG Assessment Results
Site name: Waitara East
SFRG Assessment: Fair

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessment and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.

Print the column labels to the file "ColumnLabelsMolres.txt"

Waitara (West)

Marine MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Waitara West

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedances (Exceedance / 100 mL) 140 to 200 >200 | Days in Compliance (Days / 200 / year) | |
|-----------------|-------------|---------------------------|---|--|------|
| 2014 | 13 | 4.0 | 0 | 0 | 100% |
| 2013 | 13 | 5.0 | 0 | 0 | 100% |
| 2012 | 13 | 0.0 | 0 | 0 | 100% |
| 2011 | 13 | 13.0 | 1 | 0 | 100% |
| 2010 | 13 | 20.0 | 0 | 2 | 84% |
| Total | 65 | 5.0 | 1 | 2 | 96% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: **B** 95th (100 mL) 145.0
Interim Result? Interim Data Set (5 years, or 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: **B**
Interim Assessment? Interim Data Set (5 years, or 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13 flow - agricultural activities/beach/hot air seal

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.

SFRG Assessment Results
Site name: Waitara West
SFRG Assessment: Good

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessment, and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.

Print the column labels to the file "ColumnLabelsMolres.txt"

Bell block

Marine MAC Assessment

Input MAC Data
Press "Input Data" to activate a new MAC data set

Site Name
Name of site from the MAC file: Bell Block

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedences (Exceedence / 100 mL) | | Days in Compliance (Days / year) |
|-----------------|-------------|---------------------------|---|----------|----------------------------------|
| | | | 140 to 200 | >200 | |
| 2013 | 13 | 11.0 | 0 | 1 | 92.3% |
| 2012 | 0 | 0.0 | 0 | 0 | 0.0% |
| 2011 | 0 | 0.0 | 0 | 0 | 0.0% |
| 2010 | 13 | 5.0 | 1 | 1 | 10.0% |
| 2009 | 0 | 0.0 | 0 | 0 | 0.0% |
| Total | 26 | 0.0 | 1 | 2 | 92.3% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: II
Median (100 mL): 0.0
Interim Result: Interim Data Set (5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Input: 3 Urban stormwater

Calculate Marine SFRS
Press "Calculate SFRS" to determine a SFRS assessment

SFRS Assessment Results
Site Name: Bell Block
SFRS Assessment: Poor

Save the SFRS Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRS, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRS Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file

Print the column labels to the file "ColumnLabelsMarine.txt"

OK

Fitzroy

Marine MAC Assessment

Input MAC Data
Press "Input Data" to activate a new MAC data set

Site Name
Name of site from the MAC file: Fitzroy

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedences (Exceedence / 100 mL) | | Days in Compliance (Days / year) |
|-----------------|-------------|---------------------------|---|----------|----------------------------------|
| | | | 140 to 200 | >200 | |
| 2014 | 20 | 1.5 | 0 | 0 | 100.0% |
| 2013 | 20 | 1.0 | 0 | 0 | 100.0% |
| 2012 | 20 | 3.0 | 0 | 0 | 100.0% |
| 2011 | 20 | 2.0 | 0 | 1 | 95.0% |
| 2010 | 20 | 2.0 | 0 | 0 | 100.0% |
| Total | 100 | 1.0 | 0 | 1 | 99.0% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: E
Median (100 mL): 0.0
Interim Result: Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: E
Interim Assessment? Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Input: 3 Urban stormwater

Calculate Marine SFRS
Press "Calculate SFRS" to determine a SFRS assessment

SFRS Assessment Results
Site Name: Fitzroy
SFRS Assessment: Good

Save the SFRS Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRS, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRS Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file

Print the column labels to the file "ColumnLabelsMarine.txt"

OK

East End

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: East End

MAC Data Summary

| Sampling Season | Sample Size | Median (E. coli / 100 mL) | Number of exceedences (Enterococci / 100 mL) | | Days in Compliance (S499 / 280 / year) |
|-----------------|-------------|---------------------------|--|------|--|
| | | | 140 to 200 | >200 | |
| 2014 | 13 | 1.0 | 0 | 0 | 100% |
| 2013 | 10 | 3.0 | 0 | 0 | 100% |
| 2012 | 12 | 13.0 | 1 | 0 | 100% |
| 2011 | 9 | 9.0 | 0 | 0 | 93% |
| 2010 | 13 | 11.0 | 0 | 0 | 100% |
| Total | 52 | 4.6 | 1 | 0 | 100% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Result
MAC category: B SF54e (/100 mL) 100%
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment.

Marine Sustainability for Recreational Grade

MAC Assessment Result
MAC Assessment: B
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SC Assessment Result
SC Assessment: Moderate
Primary SC Input: 3 Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.

SFRG Assessment Result
Site name: East End
SFRG Assessment: Good

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SC assessments and the MAC and SC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.

Print the column labels to the file "ColumnLabels.txt"

Ngamotu

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Ngamotu

MAC Data Summary

| Sampling Season | Sample Size | Median (E. coli / 100 mL) | Number of exceedences (Enterococci / 100 mL) | | Days in Compliance (Total / 280 / year) |
|-----------------|-------------|---------------------------|--|------|---|
| | | | 140 to 200 | >200 | |
| 2014 | 20 | 7.5 | 0 | 0 | 100% |
| 2013 | 20 | 4.5 | 0 | 0 | 100% |
| 2012 | 20 | 4.0 | 0 | 0 | 100% |
| 2011 | 20 | 3.0 | 0 | 1 | 95% |
| 2010 | 20 | 8.0 | 1 | 1 | 95% |
| Total | 100 | 7.0 | 1 | 2 | 98% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Result
MAC category: B SF54e (/100 mL) 98%
Interim Result? Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment.

Marine Sustainability for Recreational Grade

MAC Assessment Result
MAC Assessment: B
Interim Assessment? Complete Data Set (5 years with at least 100 samples)

SC Assessment Result
SC Assessment: Moderate
Primary SC Input: 3 Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.

SFRG Assessment Result
Site name: Ngamotu
SFRG Assessment: Good

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SC assessments and the MAC and SC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.

Print the column labels to the file "ColumnLabels.txt"

Oakura (SC)

Marine MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file:

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedances (E. coli / 100 mL) | | Days in Compliance (Days / 201 / year) |
|-----------------|-------------|---------------------------|--|------|--|
| | | | 140 to 200 | >200 | |
| 2014 | 20 | 53.0 | 3 | 0 | 100% |
| 2013 | 20 | 36.5 | 1 | 1 | 95% |
| 2012 | 20 | 18.5 | 0 | 1 | 95% |
| 2011 | 20 | 36.5 | 1 | 1 | 95% |
| 2010 | 20 | 18.5 | 0 | 1 | 95% |
| Total | 100 | 36.0 | 5 | 4 | 95% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: **B** (5000e⁵/100 mL) **2010**
Interim Result? Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: **B**
Interim Assessment? Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: **Moderate**
Priority SIC Impact: T3 River - agricultural activities/bedload removal

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

SFRG Assessment Results
Site name: **Dakusa SC**
SFRG Assessment: **Good**

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessment, and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file

Print the column labels to the file "ColumnLabelsMarine.txt"

Oakura (CG)

Marine MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file:

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedances (E. coli / 100 mL) | | Days in Compliance (Days / 201 / year) |
|-----------------|-------------|---------------------------|--|------|--|
| | | | 140 to 200 | >200 | |
| 2014 | 13 | 4.0 | 1 | 0 | 100% |
| 2013 | 13 | 3.0 | 0 | 0 | 100% |
| 2012 | 13 | 3.0 | 1 | 0 | 100% |
| 2011 | 13 | 4.0 | 0 | 0 | 100% |
| 2010 | 13 | 3.0 | 0 | 0 | 100% |
| Total | 65 | 3.0 | 2 | 0 | 100% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: **B** (9500e⁵/100 mL) **490**
Interim Result? Interim Data Set (1-5 years with at least 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: **B**
Interim Assessment? Interim Data Set (1-5 years with at least 100 samples used)

SIC Assessment Results
SIC Assessment: **Moderate**
Priority SIC Impact: T3 River - agricultural activities/bedload removal

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

SFRG Assessment Results
Site name: **Dakusa CG**
SFRG Assessment: **Good**

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessment, and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file

Print the column labels to the file "ColumnLabelsMarine.txt"

Opunake

Marine MAC Assessment

Input MAC Data
Press "Input Data" to activate a new MAC data set

Input Data

Site Name
Name of site from the MAC file: Opunake

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedances (Enterococci / 100 mL) | | Days in Compliance (Days / 2017 year) |
|-----------------|-------------|---------------------------|--|------|---------------------------------------|
| | | | 140 to 280 | >280 | |
| 2014 | 20 | 3.0 | 0 | 0 | 100% |
| 2013 | 20 | 1.0 | 0 | 0 | 100% |
| 2012 | 20 | 1.0 | 0 | 0 | 100% |
| 2011 | 20 | 1.0 | 0 | 0 | 100% |
| 2010 | 20 | 1.0 | 0 | 0 | 100% |
| Total | 100 | 1.0 | 0 | 0 | 100% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

Calculate MAC

MAC Result
MAC category: B
Median (100 mL): 1.0
Intens Result?: Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Save MAC Report

DF

Marine Sustainability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Intens Assessment?: Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3 Urban stormwater

Calculate Marine SPRG
Press "Calculate SPRG" to determine a SPRG assessment

Calculate SPRG

SPRG Assessment Results
Site name: Opunake
SPRG Assessment: Good

Save the SPRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SPRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SPRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data to one row in a comma-delimited file

Press the column labels in the file "Column_Labels.html"

DF

Ohawe

Marine MAC Assessment

Input MAC Data
Press "Input Data" to activate a new MAC data set

Input Data

Site Name
Name of site from the MAC file: Ohawe

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedances (Enterococci / 100 mL) | | Days in Compliance (Days / 2017 year) |
|-----------------|-------------|---------------------------|--|------|---------------------------------------|
| | | | 140 to 280 | >280 | |
| 2014 | 13 | 24.0 | 1 | 0 | 100% |
| 2013 | 13 | 5.0 | 1 | 1 | 92% |
| 2012 | 13 | 20.0 | 3 | 1 | 92% |
| 2011 | 13 | 34.0 | 1 | 0 | 100% |
| 2010 | 13 | 7.0 | 0 | 0 | 100% |
| Total | 65 | 16.0 | 6 | 2 | 96% |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

Calculate MAC

MAC Result
MAC category: C
Median (100 mL): 16.0
Intens Result?: Intens Data Set (5 years, or 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Save MAC Report

DF

Marine Sustainability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Intens Assessment?: Intens Data Set (5 years, or 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13 River - agricultural (urban/industrial/animal)

Calculate Marine SPRG
Press "Calculate SPRG" to determine a SPRG assessment

Calculate SPRG

SPRG Assessment Results
Site name: Ohawe
SPRG Assessment: Fair

Save the SPRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SPRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SPRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data to one row in a comma-delimited file

Press the column labels in the file "Column_Labels.html"

DF

Pate (Mana Bay)

Marine MAC Assessment

Input MAC Data
Press "Report Data" to retrieve a new MAC data set. Input data

Site Name
Name of site from the MAC file: Pate/Mana Bay

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedances (Enterococci / 100 mL) | Days in Compliance (Days < 200 / year) |
|-----------------|-------------|---------------------------|--|--|
| 2012 | 13 | 3.0 | 0 | 0 |
| 2011 | 13 | 5.0 | 0 | 0 |
| 2010 | 13 | 3.0 | 0 | 0 |
| 2009 | 0 | 0.0 | 0 | 0 |
| 2008 | 0 | 0.0 | 0 | 0 |
| Total | 45 | 4.0 | 0 | 0 |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment. Calculate MAC

MAC Results
MAC category: 4 95%ile (100 mL) 37.0
Interim Result? Interim Data Set (≤ 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment. Save MAC Report

OK

Marine Suitability for Recreational Grade

MAC Assessment Result
MAC Assessment: 4
Interim Assessment? Interim Data Set (≤ 5 years, or < 100 samples used)

SIC Assessment Result
SIC Assessment: Moderate
Priority SIC Impact: 13 River - agricultural activities/beef feed stores

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment. Calculate SFRG

SFRG Assessment Result
Site name: Pate/Mana Bay
SFRG Assessment: Good

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessment, and the MAC and SIC data in one file. Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data in one row in a comma delimited file. Save to a Database Format File

Print the column labels to the file "ColumnLabelsMarine.txt"

OK

Back Beach

Marine MAC Assessment

Input MAC Data
Press "Report Data" to retrieve a new MAC data set. Input data

Site Name
Name of site from the MAC file: Back Beach

MAC Data Summary

| Sampling Season | Sample size | Median (E. coli / 100 mL) | Number of exceedances (Enterococci / 100 mL) | Days in Compliance (Days < 200 / year) |
|-----------------|-------------|---------------------------|--|--|
| 2013 | 13 | 37.0 | 1 | 2 |
| 2012 | 0 | 0.0 | 0 | 0 |
| 2011 | 0 | 0.0 | 0 | 0 |
| 2010 | 13 | 32.0 | 1 | 0 |
| 2009 | 0 | 0.0 | 0 | 0 |
| Total | 26 | 31.5 | 2 | 2 |

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment. Calculate MAC

MAC Results
MAC category: D 95%ile (100 mL) 67.0
Interim Result? Interim Data Set (≤ 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment. Save MAC Report

OK

Marine Suitability for Recreational Grade

MAC Assessment Result
MAC Assessment: D
Interim Assessment? Interim Data Set (≤ 5 years, or < 100 samples used)

SIC Assessment Result
SIC Assessment: Low
Priority SIC Impact: 18 River - local ponds of drainage

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment. Calculate SFRG

SFRG Assessment Result
Site name: Back Beach
SFRG Assessment: Poor

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessment, and the MAC and SIC data in one file. Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data in one row in a comma delimited file. Save to a Database Format File

Print the column labels to the file "ColumnLabelsMarine.txt"

OK