greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Lakes State of the Environment monitoring programme

Annual data report, 2012/13

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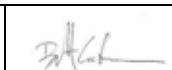
Report prepared by:	B Cockeram	Senior Environmental Monitoring Officer	
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Contents

1. Introduction

This report summarises the key results from the Lakes State of Environment (LSoE) monitoring programme for the period 1 July 2012 to 30 June 2013 inclusive. The LSoE programme involves monthly monitoring of water quality on two lakes and periodic assessments of submerged plant community structure and composition in additional lakes.

Information on lake water levels during 2012/13 is presented in Harkness et al. (2013).

2. Overview of Lakes SoE monitoring programme

Up until recently, Greater Wellington Regional Council (GWRC) routinely monitored water quality in only one lake in the Wellington region, Lake Wairarapa. Monitoring in this lake commenced in 1994 and, up until June 2012, incorporated four principal sampling sites. In August 2009, water quality monitoring programmes were established for two additional lakes, Waitawa and Onoke (Figure 2.1). Monitoring of Lake Onoke is ongoing but monitoring in Lake Waitawa was restricted to a year-long investigation (see Perrie & Milne (2012) for a summary of data collected from Lake Waitawa).

In 2011 assessments of ecological condition, based on submerged plant community structure and composition, were introduced for Lakes Kohangapiripiri, Kohangatera and Pounui (Figure 2.1).

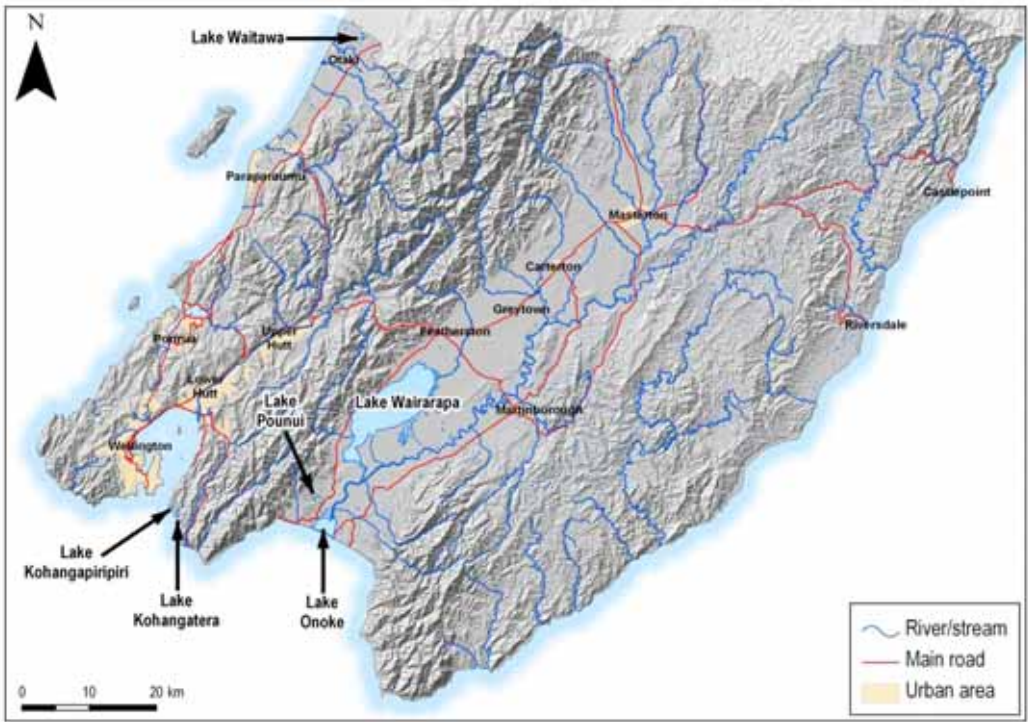

Figure 2.1: Locations of lakes monitored in the Wellington region to date

2.1 Monitoring objectives

The aims of GWRC's Lakes SoE monitoring programme are to:

1. Assist in the detection of spatial and temporal changes in the condition of selected lakes;
2. Contribute to our understanding of freshwater biodiversity in the Wellington region;
3. Determine the suitability of lakes for designated uses;
4. Provide information to assist in targeted investigations where remediation or mitigation of poor water quality or ecosystem health is desired; and
5. Provide information required to determine the effectiveness of regional plans and policies.

2.2 Monitoring sites, variables and protocol

Two types of lake monitoring are undertaken in the Wellington region:

- Monthly analysis of surface water samples for a variety of physico-chemical variables (eg, total and dissolved nutrients, dissolved oxygen, Secchi depth, etc.) in Lakes Wairarapa and Onoke; and

- Periodic assessments of macrophyte community structure and composition (as an indicator of ecological condition) in lakes that support submerged aquatic plant communities (eg, Lake Kohangatera).

2.2.1 Physico-chemical water quality monitoring

Water quality is assessed monthly at three sites on Lake Wairarapa and at one site on Lake Onoke (Figure 2.2, Appendix 1) by measuring a range of physico-chemical variables: dissolved oxygen, water temperature, pH, conductivity, visual clarity (Secchi depth), turbidity, suspended solids, chlorophyll *a* and dissolved and total nutrients. The full list of variables monitored, together with details of field and analytical methods, is provided in Appendix 2.

Note that as the monitoring site in Lake Onoke is located where the Ruamahanga River enters the lake, it is unlikely to be representative of water quality across the whole lake (see Perrie & Milne 2012).

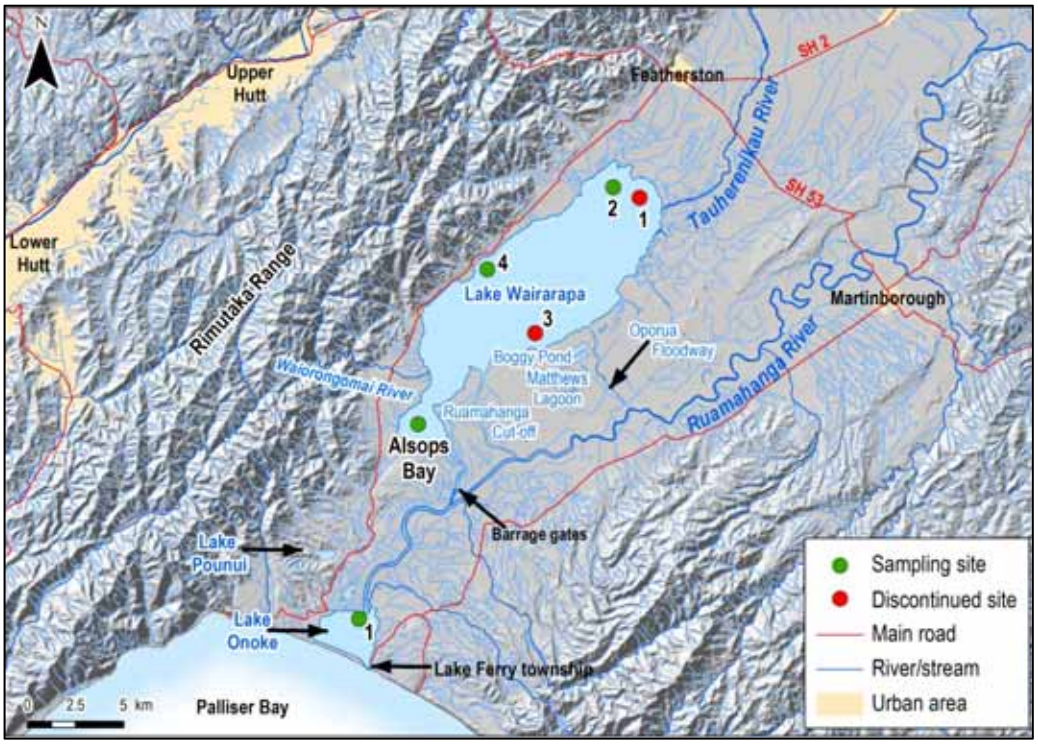

Figure 2.2: Lake Wairarapa and Lake Onoke sites monitored over 2012/13

(a) Changes to the monitoring programme in 2012/13

The following changes took effect from July 2012 following recommendations made in the last report on state and trends in the region's lakes (see Perrie & Milne 2012):

- Monitoring at two of the four sites (sites 1 and 3) on Lake Wairarapa ceased and an additional monitoring site was introduced in Alsops Bay (Figure 2.2);

- The frequency of sampling in Lake Wairarapa increased from quarterly to monthly;

- Absorbance was added to the suite of monitoring variables for both Lake Onoke and Lake Wairarapa, with pheophytin *a* analysis also introduced for Lake Wairarapa water samples; and

- Faecal coliforms and *E. coli* were removed from the suite of variables analysed in water samples collected from both lakes.

(b) Data analysis and reporting

Water quality data collected from Lakes Wairarapa and Onoke for the July 2012 to June 2013 period are summarised and assessed using the trophic level index (TLI). The TLI was developed by Burns et al. (2000) for assessing the water quality status of New Zealand lakes[1]. The TLI is calculated using four key variables of lake water quality (chlorophyll *a*, Secchi depth, total phosphorus and total nitrogen) and is based on the following four regression equations:

1. TLc = 2.22 + 2.54 log(Chlorophyll *a*)
2. $\text{TLs} = 5.10 + 2.27 \log\left(\frac{1}{\text{Secchi depth}} - \frac{1}{40}\right)$
3. TLp = 0.218 + 2.92 log(Total phosphorus)
4. TLn = -3.61 + 3.01 log(Total nitrogen)

An overall TLI score is calculated by averaging the four individual trophic level equation results.[2] Lake water quality is then assigned an overall trophic level status according to its average score (Table 2.1) (see Burns et al. 2000 for full details). Note that TLI results should be interpreted cautiously as Burns et al. (2000) recommend that at least two years of monthly monitoring is undertaken to provide an adequate baseline of current lake status. See Perrie and Milne (2012) for a more comprehensive assessment of water quality from Lakes Wairarapa and Onoke spanning a longer time period.

During data processing, any water quality variables reported as less than or greater than detection limits were replaced by values one half of the detection limit or the detection limit respectively (eg, a value of <2 became 1, a value of >400 became 400). The exceptions are minimum and maximum values presented in the tabulated summaries in Sections 3, 4 and Appendix 3 (eg, if a value was reported as <2 the minimum value presented is <2).

[1] The TLI can be calculated a variety of ways (eg, with or without Secchi depth) and GWRC is currently investigating which calculation method is most appropriate when applying the TLI to Lakes Wairarapa and Onoke.

[2] The mean value for each of the key variables, generated from the entire monitoring period (July 2012 to June 2013 inclusive), was used to calculate each trophic level value using these equations.

Table 2.1: Classification of lake trophic status using the TLI (after Burns et al. 2000) and nutrient enrichment descriptions described in Burns et al. (1999)

Trophic status (nutrient enrichment)	TLI	Chlorophyll *a* (mg/m^3)	Secchi depth (m)	Total phosphorus (mg/L)	Total nitrogen (mg/L)
Ultra-microtrophic (practically pure)	0.0–1.0	0.13–0.33	33–25	0.00084–0.0018	0.016–0.034
Microtrophic (very low)	1.0–2.0	0.33–0.82	25–15	0.0018–0.0041	0.034–0.073
Oligotrophic (low)	2.0–3.0	0.82–2.0	15–7.0	0.0041–0.009	0.073–0.157
Mesotrophic (medium)	3.0–4.0	2.0–5.0	7.0–2.8	0.0090–0.0200	0.157–0.337
Eutrophic (high)	4.0–5.0	5.0–12	2.8–1.1	0.0200–0.0430	0.337–0.725
Supertrophic (very high)	5.0–6.0	12–31	1.1–0.4	0.0430–0.0960	0.725–1.558
Hypertrophic (extremely high)	>6.0	>31	<0.4	>0.0960	>1.558

2.2.2 Submerged aquatic plant community assessments

Submerged aquatic plant communities are assessed using the nationally accepted LakeSPI (Submerged Plant Index) methodology developed by Clayton and Edwards (2006), (refer Appendix 2). The first LakeSPI surveys were carried out in autumn 2011 and are intended to be repeated at five-yearly intervals. However, Lake Kohangatera was re-surveyed during 2012/13, in response to recommendations made after the initial LakeSPI survey in March 2011 (de Winton et al. 2011) recorded *Elodea canadensis*, an invasive aquatic weed[3], in the lake for the first time (see Perrie and Milne 2012 for further details).

(a) Data analysis and reporting

Application of the LakeSPI method results in three indices expressed as a percentage of expected pristine state:

- A native condition index (ie, the diversity and quality of the indigenous flora);
- An invasive condition index (ie, the degree of impact by invasive weed species); and
- An overall LakeSPI index that synthesises components of both the native condition and invasive condition indices to provide an overall indication of lake ecological condition.

The LakeSPI index is used to place the lake vegetation into one of five categories of lake condition (Table 2.2; Verburg et al. 2010).

[3] A second invasive weed, *Egeria densa*, was also found in the lake catchment in 2011 but is limited to the wetland above the lake (Wells et al. 2011).

Table 2.2: Classification of lake ecological condition using the LakeSPI index (from Verburg et al. 2010)

Lake ecological condition	LakeSPI index (% of expected pristine state)
Non-vegetated	0
Poor	>0–20
Moderate	>20–50
High	>50–75
Excellent	>75

3. Lake Wairarapa

Water samples were collected from two sites (sites 2 and 4) on Lake Wairarapa on ten occasions[4] during 2012/13. The site located in Alsops Bay could only be accessed on six occasions[5] and so data from this site have been excluded[6] from the summary and TLI statistics presented in this section. Summary statistics for each individual site are provided in Appendix 3.

A summary of water quality, based on data pooled from sites 2 and 4, is provided in Table 3.1. Trophic level classes based on the mean values of the four key lake water quality variables ranged from eutrophic (total nitrogen and chlorophyll *a*) to supertrophic (Secchi depth and total phosphorus). Overall, based on the year's sampling, the lake can be classed as supertrophic with a TLI score of 5.2 (Table 3.2).

Table 3.1: Summary of water quality in Lake Wairarapa, based on ten sampling occasions between July 2012 and June 2013. All values presented are based on data pooled from two sites (sites 2 and 4) (D.L. = detection limit)

Variable	Mean	Median	Minimum	Maximum	% *n* <D.L.
Water temperature (°C)	15.4	15.0	8.7	21.9	0
Dissolved oxygen (% saturation)	100.8	97.9	89.9	127	0
Dissolved oxygen (mg/L)	10.2	10.2	8.0	13.9	0
pH	7.6	7.7	6.7	8.3	0
Conductivity (µS/cm)	982	1,026	207	2,377	0
Secchi depth (m)	0.43	0.38	0.13	0.95	0
Turbidity (NTU)	44.2	22.0	8.4	210	0
Total suspended solids (mg/L)	46.1	25.0	7.0	220	0
Volatile suspended solids (mg/L)	4.0	3.0	<2.0	14.0	45
Total nitrogen (mg/L)	0.404	0.350	0.210	1.030	0
Total Kjeldahl nitrogen (mg/L)	0.366	0.325	0.180	0.950	0
Nitrite nitrogen (mg/L)	0.001	0.001	<0.002	0.006	85
Nitrite-nitrate nitrogen (mg/L)	0.037	0.008	<0.002	0.125	45
Ammoniacal nitrogen (mg/L)	0.009	0.005	<0.010	0.030	80
Total phosphorus (mg/L)	0.076	0.056	0.013	0.300	0
Dissolved reactive phosphorus (mg/L)	0.002	0.002	<0.004	0.005	95
Chlorophyll *a* (mg/m^3)	11.5	4.0	<3.0	49.0	25
Pheophytin *a* (mg/m^3)	4.0	2.0	<3.0	18.0	80
Absorbance at 340 nm (AU/cm)	0.031	0.025	0.014	0.082	0
Absorbance at 440 nm (AU/cm)	0.008	0.007	<0.002	0.030	10
Absorbance at 740 nm (AU/cm)	0.002	0.001	<0.002	0.007	85

[4] Sampling sites on Lake Wairarapa could not be accessed on two occasions (April and June 2013) because strong winds prevented safe access.

[5] This site cannot currently be accessed during low lake levels.

[6] Including this data would result in little overall change to the summary statistics and TLI score presented except that the site located in Alsops Bay is more likely to be influenced by saline water (ie, higher conductivity) than the other two sites located further north (sites 2 and 4). See Appendix 3 for a summary of data from Alsops Bay.

Table 3.2: Lake Wairarapa mean total nitrogen, total phosphorus, Secchi depth (water clarity) and chlorophyll *a* values. Trophic level (TL) values and classes for each variable as well as an overall TLI score and class are also presented. Values presented are based on data pooled across two sites (sites 2 and 4) from ten sampling occasions between July 2012 and June 2013

Variable	Mean	TL value	TL class
Total nitrogen (mg/L)	0.404	4.2	Eutrophic
Total phosphorus (mg/L)	0.076	5.7	Supertrophic
Secchi depth (m)	0.43	5.9	Supertrophic
Chlorophyll *a* (mg/m^3)	11.5	4.9	Eutrophic
Overall TLI score		5.2	Supertrophic

4. Lake Onoke

Water quality samples were collected from one site on Lake Onoke on 12 occasions during 2012/13 and the results are summarised in Table 4.1. Trophic level classes based on the mean values of the four key lake water quality variables ranged from mesotrophic (chlorophyll *a*) to supertrophic (total phosphorus and Secchi depth). Overall, based on the year's sampling, the lake can be classed as eutrophic with a TLI score of 4.8 (Table 4.2).

Table 4.1: Summary of water quality in Lake Onoke, based on 12 sampling occasions between July 2012 and June 2013 (D.L. = detection limit)

Variable	Mean	Median	Minimum	Maximum	*n* <D.L.
Water temperature (°C)	14.7	14.4	7.3	21.5	0
Dissolved oxygen (% saturation)	104	101	97.7	120	0
Dissolved oxygen (mg/L)	10.4	10.0	8.6	12.9	0
pH	7.5	7.6	6.7	8.0	0
Conductivity (µS/cm)	3,690	2,593	135	12,548	0
Secchi depth (m)	0.57	0.47	0.19	>1.29[1]	0
Turbidity (NTU)	27.8	22.0	3.6	82.0	0
Total suspended solids (mg/L)	36	29	5	97	0
Volatile suspended solids (mg/L)	4.2	3.5	<2.0	9.0	3
Total nitrogen (mg/L)	0.550	0.375	<0.300	1.520	1
Total Kjeldahl nitrogen (mg/L)	0.267	0.215	<0.200	0.610	2
Nitrite nitrogen (mg/L)	0.003	0.002	<0.002	0.007	6
Nitrite-nitrate nitrogen (mg/L)	0.274	0.173	<0.002	0.900	1
Ammoniacal nitrogen (mg/L)	0.016	0.015	<0.010	0.037	5
Total phosphorus (mg/L)	0.049	0.037	0.020	0.120	0
Dissolved reactive phosphorus (mg/L)	0.009	0.006	<0.004	0.025	4
Chlorophyll *a* (mg/m^3)	4.3	3.8	<3.0	12.0	6
Absorbance at 340 nm (AU/cm)	0.032	0.026	0.002	0.098	0
Absorbance at 440 nm (AU/cm)	0.008	0.005	<0.002	0.028	3
Absorbance at 740 nm (AU/cm)	0.001	0.001	< 0.002	0.004	10

[1] On two sampling occasions the Secchi disc was visible on the lake bottom (>1.17 m and >1.29 m).

Table 4.2: Lake Onoke mean total nitrogen, total phosphorus, Secchi depth (water clarity) and chlorophyll *a* values, based on 12 sampling occasions between July 2012 and June 2013. Trophic level (TL) values and classes for each variable as well as an overall TLI score and class are also presented

Variable	Mean	TL value	TL class
Total nitrogen (mg/L)	0.550	4.6	Eutrophic
Total phosphorus (mg/L)	0.049	5.2	Supertrophic
Secchi depth (m)	0.57	5.6	Supertrophic
Chlorophyll *a* (mg/m^3)	4.3	3.8	Mesotrophic
Overall TLI score		4.8	Eutrophic

5. Lake Kohangatera

Table 5.1 summarises the results from the LakeSPI survey undertaken by NIWA in March 2013. The survey is documented in full in de Winton (2013a).[7] An overall LakeSPI score of 87% was calculated for Lake Kohangatera (Table 5.1). This score classifies Lake Kohangatera as having 'excellent' ecological condition. According to de Winton (2013a), out of 242 lakes assessed nationally using LakeSPI, Lake Kohangatera is ranked 9th highest.

Table 5.1: Summary of LakeSPI results for Lake Kohangatera from a survey undertaken in March 2013 (de Winton et al. 2013)

Native condition index (%)	Invasive impact index (%)	LakeSPI index (%)
83	8.1	87

A single set of surface water samples was also collected from one site at the time of the LakeSPI survey and analysed for a range of physico-chemical water quality variables. The analytical results are presented in Appendix 3.

[7] A separate report (de Winton 2013b) addresses the current status of exotic weeds in the lake and recommended management options.

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Juliet Milne reviewed a draft version of this report.

Appendix 1: Lake SoE monitoring sites

Lake	Site no./name	NZTM site coordinates	
		Easting	Northing
Lake Wairarapa	2 (stump)	1791644	5439152
	4 (west)	1785175	5435526
	Alsops Bay	1781568	5427654
Lake Onoke	1	1778829	5417842

Refer to de Winton (2013a) for Lake Kohangatera LakeSPI transect locations. One-off water quality samples were collected from Lake Kohangatera at Easting 1755290 Northing 5981060.

Appendix 2: Monitoring variables and methods

Physico-chemical water quality

All monitoring sites are accessed by boat, except in the case of Lake Onoke, where sampling is carried out by wading from the lake's edge. Water samples are collected in accordance with the sub-surface grab method for sampling isothermal lakes described in Smith et al. (1989) and in the case of Lake Onoke, a 'grabber pole' is used to collect water samples in an effort to minimise the potential effects of re-suspension of lakebed sediments (caused by wading) on the samples. Note that the sub-surface grab method differs from protocols outlined in Burns et al. (2000) for the sampling of isothermal lakes.

Field measurements (conductivity, dissolved oxygen, pH and temperature) are generally taken using a YSI 556 field meter which is calibrated on the day of sampling. Secchi disc measurement methodology is consistent with the procedure outlined in Burns et al. (2000) except that an underwater viewer is not used. Note that all field measurements collected from Lake Onoke are made from a 'wading position', although care is taken to minimise any disturbance of lakebed sediments.

Water samples requiring laboratory analysis are stored on ice upon collection and couriered overnight to RJ Hill Laboratories in Hamilton. The variables monitored and current analytical methods are summarised in Table A2.1. In contrast with river and groundwater samples, all lake water samples for dissolved nutrient analysis are filtered in the laboratory.

Table A2.1: Laboratory analytical methods for lake water samples

Variable	Method	Detection limit
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 21st Ed. 2005	0.05 NTU
Total suspended solids	Filtration using Whatman 934 AH, Advantec GC-50 or 1-2 equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st Ed. 2005	2 mg/L
Volatile suspended solids*	Filtration (GF/C, 1.2 µm). Ashing 550°C, 30 min. Gravimetric. APHA 2540 E 21st Ed. 2005	2 mg/L
Ammoniacal nitrogen	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N) APHA 4500-NH_3 F (modified from manual analysis) 21st Ed. 2005	0.01 mg/L
Total Kjeldahl nitrogen	Kjeldahl digestion, phenol/hyperclorite colorimetry (Discrete Analysis). APHA 4500-N Org C. (modified) 4500- F (modified) 21st Ed. 2005	0.1 mg/L
Nitrate-N + Nitrite-N (NNN)	Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO_3 - I (modified) 21st Ed. 2005	0.002 mg/L
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N	0.002 mg/L
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3 - I (modified) 21st Ed. 2005	0.002 mg/L
Total nitrogen	Calculation: TKN + Nitrate-N +Nitrite-N	0.1 mg/L
Dissolved reactive phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21st Ed. 2005	0.004 mg/L
Total phosphorus	Total Phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21st Ed. 2005	0.004 mg/L
Chlorophyll *a* (mg/m^3)	Acetone extraction. Spectroscopy. APHA 10200 H 21st Ed. 2005	0.003 mg/L
Pheophytin *a* (mg/m^3)	Acetone extraction. Spectroscopy. APHA 10200 H 21st ed. 2005	0.003 mg/L
Absorbance at 340 nm (AU/cm)	Filtered sample. Spectrophotometry, 1cm cell. APHA 5910 B 21st Ed. 2005	0.002 AU/cm
Absorbance at 440 nm (AU/cm)	Filtered sample. Spectrophotometry, 1cm cell. APHA 5910 B 21st Ed. 2005	0.002 AU/cm
Absorbance at 740 nm (AU/cm)	Filtered sample. Spectrophotometry, 1cm cell. APHA 5910 B 21st Ed. 2005	0.002 AU/cm

*Note the detection limit for these variables is not always achieved (ie, is often higher than indicated here).

Submerged aquatic plants

Surveys of submerged aquatic plants follow the nationally accepted LakeSPI (Submerged Plant Index) methdology developed by Clayton and Edwards (2006). This involves scuba divers assessing 11 metrics over a 2 m wide transect from the shore to the deepest vegetation limit at several sites which are representative of the lake. Metrics include measures of diversity from the presence of key of plant communities, the depth of vegetation growth, and the extent that invasive weeds are represented.

Appendix 3: Tabulated water quality monitoring data

Table A3.1: Water quality summary statistics for Lake Wairarapa monitoring sites sampled between July 2012 and June 2013 (D.L. = detection limit)

Variable	Site 2 (*n*=10)					Site 4 (*n*=10)					Alsops Bay (*n*=6)				
	Mean	Median	Minimum	Maximum	*n* <*D.L.*	Mean	Median	Minimum	Maximum	*n* <*D.L.*	Mean	Median	Minimum	Maximum	*n* <*D.L.*
Water temperature (°C)	15.5	16.0	8.9	20.9	0	15.2	14.9	8.7	21.9	0	12.5	11.4	8.4	19.3	0
Dissolved oxygen (% saturation)	102	102	89.9	123	0	99.4	97.5	90.9	127	0	106	100	91.1	128	0
Dissolved oxygen (mg/L)	10.2	10.2	8.5	13.3	0	10.1	10.0	8.0	13.9	0	11.3	10.8	8.8	13.9	0
pH	7.7	7.7	7.2	8.4	0	7.5	7.6	6.7	8.0	0	7.8	7.9	7.1	8.2	0
Conductivity (µS/cm)	951	1,026	207	2,144	0	1,010	975	224	2,377	0	3,306	660	219	9,128	0
Secchi depth (m)	0.40	0.37	0.15	0.95	0	0.45	0.40	0.13	0.90	0	0.66	0.52	0.14	>1.62[1]	0
Turbidity (NTU)	44.5	22.5	9.4	200	0	44.1	22.0	8.4	210	0	43.3	23.1	3.2	150	0
Total suspended solids (mg/L)	48.4	28.0	7.0	220	0	43.7	21.0	7.0	210	0	46.3	24.5	4.0	160	0
Volatile suspended solids (mg/L)	4.1	4.0	<4.0	8.0	4	3.8	1.5	<2.0	14.0	5	4.3	2.8	<2.0	12.0	2
Nitrite nitrogen (mg/L)	0.002	0.001	<0.002	0.006	8	0.001	0.001	<0.002	0.002	9	0.002	0.001	<0.002	0.003	4
Nitrate nitrogen (mg/L)	0.042	0.007	<0.002	0.117	5	0.031	0.008	<0.002	0.124	4	0.023	0.001	<0.002	0.083	4
Nitrite-nitrate nitrogen (mg/L)	0.043	0.007	<0.002	0.120	5	0.032	0.010	<0.002	0.125	4	0.024	0.001	<0.002	0.086	4
Ammoniacal nitrogen (mg/L)	0.008	0.005	<0.010	0.025	8	0.009	0.005	<0.010	0.030	8	0.014	0.008	<0.010	0.033	3
Total Kjeldahl nitrogen (mg/L)	0.379	0.340	0.200	0.950	0	0.353	0.320	0.180	0.930	0	0.383	0.315	0.190	0.860	0
Total nitrogen (mg/L)	0.420	0.340	0.220	1.030	0	0.387	0.355	0.210	0.940	0	0.410	0.315	0.270	0.870	0
Dissolved reactive phosphorus (mg/L)	0.002	0.002	<0.004	0.005	9	0.002	0.002	<0.004	0.002	10	0.002	0.002	<0.004	0.002	6
Total phosphorus (mg/L)	0.078	0.061	0.013	0.300	0	0.075	0.045	0.015	0.290	0	0.074	0.051	0.026	0.220	0
Chlorophyll *a* (mg/m^3)	13.9	7	<3.0	49	1	9.1	3.0	<3.0	39	4	16.7	4.5	3.0	46.0	0
Pheophytin *a* (mg/m^3)	4.0	2.0	<3.0	18	8	3	2.0	<3.0	12	8	6.0	4.0	<3.0	17	3
Absorbance at 340 nm (AU/cm)	0.031	0.024	0.014	0.082	0	0.031	0.026	0.014	0.077	0	0.034	0.028	0.009	0.077	0
Absorbance at 440 nm (AU/cm)	0.008	0.007	<0.002	0.030	1	0.008	0.007	<0.002	0.026	1	0.009	0.006	<0.002	0.027	2
Absorbance at 740 nm (AU/cm)	0.002	0.001	<0.002	0.007	9	0.002	0.001	<0.002	0.005	8	0.002	0.001	<0.002	0.005	4

[1] On one sampling occasion the Secchi disc was visible on the lake bottom (>1.62 m).

Table A3.2: Water quality data for Lake Kohangatera sampled on 20 March 2013

Variable	Result
Water temperature (°C)	15.5
Dissolved oxygen (% saturation)	88.6
Dissolved oxygen (mg/L)	8.8
pH	7.5
Conductivity (µS/cm)	802
Secchi depth (m)	1.32
Turbidity (NTU)	4.1
Total suspended solids (mg/L)	3.0
Nitrite-nitrate nitrogen (mg/L)	0.003
Ammoniacal nitrogen (mg/L)	<0.01
Total Kjeldahl nitrogen (mg/L)	0.410
Total nitrogen (mg/L)	0.410
Dissolved reactive phosphorus (mg/L)	0.013
Total phosphorus (mg/L)	0.05
Chlorophyll *a* (mg/m^3)	<3