





Some aspects of water quality in Lake Tarawera

Deniz Özkundakci - Toihuarewa – Waimāori | The University of Waikato Lake Tarawera Ratepayers' Association AGM - 14 January 2014

Overview

- 1. Water quality information
 - Data sources
 - Long-term trends
- 2. Nutrient budgeting
 - Nutrient loads and variability
- 3. Sewage reticulation study
 - Ongoing MSc research



Water quality information

- Routine monitoring
 - State of the Environment/policy effectiveness
 - Collected within the lake
 - Data is intermittent before 2005
 - Laboratory analysis has changes in 2009
- National Water Quality Network
 - Consistent long-term monitoring
 - Collected at the outflow of the lake
 - Consistent since 1989 (34+ years)
- High frequency monitoring buoy
 - Research/modelling
- Lake and catchment research
- ...and many others



Bay of Plenty

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BOPRC water quality summary

Lake	Trophic Level Index		National Policy Statement for Freshwater Management				10 Year Trends				Contact Recreational Attributes		
			(NPS-FM) Lakes Attributes 2022/23			Very Likely Improving 📁 Likely Improving		Improving 🔲 Inc	oving Indeterminate/Uncertain				
	TLI 2022/23 (TLI Target)	TLI 3 Year Average	Total Nitrogen Median	Total Phosphorus Median	Chl- <i>a</i> Median	Chl- <i>a</i> Max	Total Nitrogen	Total Phosphorus	Chl-a	Water Clarity	Blue-green health warning	Cyano- bacteria Biovolumes 2020-23	Swimming water quality – faecal ¹
Ōkāreka	3.0 (3.0)	3.1	В	А	В	А	-				N/A	N/A	Good
Okaro	4.5 (5.0)	4.6	с	В	С	С	_		-	-	Yes	С	Good
Ōkataina	2.7 (2.6)	2.7	А	А	В	А	_		-	-	N/A	N/A	N/A
Rerewhakaaitu	3.6 (3.6)	3.3	В	А	В	С	-		-	-	N/A	N/A	Good
Rotoehu	4.3 (3.9)	4.3	А	В	В	В	_			-	Yes	С	Fair
Rotoiti	3.8 (3.5)	3.7	B/B	B/B	C/B	B/A	-		-		Yes	В	Good
Rotokakahi*	3.6 (3.1)	3.5	В	В	В	А		-	-	-	N/A	N/A	N/A
Rotomā	2.5 (2.3)	2.5	А	А	А	А	-				N/A	N/A	Excellent
Rotomahana	3.9 (3.9)	3.7	В	В	В	В	-		-	-	N/A	N/A	N/A
Rotorua	4.2 (4.2)	4.3	B/B	B/B	c/c	C/B	-		-	-	Yes	А	Poor
Tarawera	2.9 (2.6)	2.8	А	В	А	А	-	-	-	-	No ⁺	N/A	Excellent
Tikitapu	2.8 (2.7)	2.9	В	А	В	А	-	_	_	-	N/A	N/A	Fair

*Italicised figures are based on Te Wairoa Stream monitoring and a three-parameter TLI (no Secchi disk).

¹ NPS-FM Human contact attribute based on 95 percentile E. coli over the most recent five bathing seasons. The lowest (worst) grade is shown where lakes have more than one bathing site.

+ Lake Tarawera is not routinely monitored, however ad-hoc samples collected in response to public concern, has resulted in health warnings in past seasons.

https://jdboprcscience.shinyapps.io/BoPRC_Lakes_Dashboard/

BOPRC lake health summary

	Lake Submerged Plant Index ¹			Kõura			Kākahi		Catfish			
Lake	LakeSPI	LakeSPI Native Index ²	LakeSPI Invasive Index ²	Invasive Submerged Plants Present	Abundance	Trend	Reason for Change	Abundance	Trend	Abundance	Trend	
Ōkāreka	High	В	В	d	Moderate		N/A	Present	N/A	Absent	N/A	
Okaro	High	С	В	с	Absent	N/A	N/A	Absent	N/A	Absent	N/A	
Ōkataina	High	В	с	d	Abundant	_	N/A	Present	N/A	Absent	N/A	
Rerewhakaaitu	Moderate	с	с	b, d	Present	_	N/A	Present	N/A	Absent	N/A	Trand Koy
Rotoehu	Poor	с	D	a, c, e	Present	-	Declining water quality	Moderate	N/A	Absent	N/A	
Rotoiti	Moderate	с	с	a, b, c, d, e	Moderate	-	Catfish predation	Abundant		Abundant	-	Stable
Rotokakahi*	Moderate	С	С	с	Moderate		N/A	Abundant	N/A	N/A	N/A	
Rotomā	High	В	с	d	Abundant	—	N/A	Abundant	N/A	Absent	N/A	
Rotomahana	Moderate	С	с	a, b	Absent	N/A	N/A	Absent	N/A	Absent	N/A	
Rotorua	Moderate	С	с	b, c, d	Moderate	-	Catfish predation	Abundant		Abundant		
Tarawera	Moderate	С	С	a, b, c, d, f	Abundant		Unknown	Abundant	N/A	Absent	N/A	
Tikitapu	High	В	с	d	Present	-	White Tail Disease	Absent	N/A	Absent	N/A	

¹based on LakeSPI survey data collected between 2018 and 2023; data from Rotokakahi Mar-2018.

² the LakeSPI native and invasive indices refer to tables 11 and 12 in the NPS-FM.

Invasive Submerged Plants: a) Ceratophyllum; b) Egeria; c) Elodea; d) Lagarosiphon; e) Potamogeton crispus; f) Ranunculus trichophyllus

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High frequency monitoring buoy data





Bottom water oxygen demand



BOPRC data



A A

Monthly data consistently collected and analysed since 1989



- Short-term trends (e.g., 10 years) can be difficult to interpret
- Still useful to understand changes on recent time scales



- Long-term changes are generally more certain
- Useful to understand broad scale chages



- Chlorophyll a concentrations are not measured
- TLI calculations not possible

Attribute	Kendall's tau value	p-value	Confidence in trend direction	Percent annual change	Trend direction
Total phosphorus	0.23	<0.05	Highly likely	0.74	Increasing (worsening)
Total nitrogen	0.20	<0.05	Highly likely	0.64	Increasing (worsening)
Black disk (water clarity)	-0.08	0.02	Highly likely	-0.28	Decreasing (worsening)
Dissolved reactive phosphorus	0.14	<0.05	Highly likely	1.00	Increasing (worsening)
Nitrate (+nitrite)	-0.01	0.72	As likely as not	0	-
Ammonium	-0.14		Indetermined	0	-







Black disk measurement (photo:NIWA)

Lake nutrient budget

Lake nutrient budgets account for sources and sinks of nutrients, as well as nutrient cycling and sequestration. Nutrient budgets quantify external loading, outflow rates, and lake nutrient concentrations.





Conceptual model idea: Alastair MacCormick, slide credit: Chris McBride



Water quality of 'connected' lakes

Trophic Level Index	Lake Type
Less than 2	Very good water quality (microtrophic)
2 – 3	Good water quality (oligotrophic)
3 – 4	Average water quality (mesotrophic)
4 – 5	Poor water quality (eutrophic)
Greater than 5	Very poor water quality (supertrophic)



Lake nutrient budget

- Sources of nitrogen and phosphorus to Lake Tarawera from the greater Tarawera catchment
- Wilson (2022) found N load from catchment can vary c. ±30% for any given year (dry vs wet years)

Land use	Surface catchment (ha)	Groundwater catchment (ha)	TN yield (kg ha ⁻¹ y ⁻¹)	TP yield (kg ha ⁻¹ y ⁻¹)	TN load (kg y ⁻¹)	TP load (kg y ⁻¹)	Landuse (%)	TN load (%)	TP load (%)
Agriculture - dry stock	1669.4	1669.4	21.3	3.02	20266	2879.1	11.5	19.0	27.0
Agriculture - lifestyle	288.7	288.7	30.0	2.00	4946	329.7	2.0	4.6	3.1
Forest - exotic	1647.2	1647.2	3.0	0.19	2822	176.4	11.3	2.6	1.7
Forest - native	6481.7	6481.7	3.7	0.15	13586	555.3	44.6	12.7	5.2
Scrub/shrub	43.2	43.2	5.0	1.25	123	30.8	0.3	0.1	0.3
Unknown	96.0	96.0	5.0	1.00	274	54.8	0.7	0.3	0.5
Urban - infrastructure	159.0	159.0	5.9	0.50	536	45.4	1.1	0.5	0.4
Urban - parks	1.9	1.9	25.0	0.14	28	0.2	0.0	0.0	0.0
Water - lake or stream	4159.5	4159.5	6.7	0.34	27869	1414.2	28.6	26.1	13.3
Gorse/broom			38.0	0.00	7583	0.2		7.1	0.0
Wastewater					2844	284.4		2.7	2.7
Connections					23200	2492.1		21.7	23.4
Geothermal					2690	2390.0		2.5	22.4
All sources					106767	10653			

Source: McBride et al. 2021: Estimated catchment loads of nitrogen and phosphorus to the Rotorua Te Arawa Lakes. ERI report 143. The University of Waikato.

Groundwater monitoring bore

Lake edge groundwater inflow monitoring site

The Landing

aromia

Tarawera Sewage Reticulation study



Part 1:

• Shallow groundwater monitoring

Groundwater monitoring bore

Lake edge groundwater inflow monitoring site

Boatshed Bay

Spencer Road

The Landing

aromia

Tarawera Sewage Reticulation study

Part 2:

- Groundwater flux into the lake ٠
- Fate of nutrients at the point of entry ٠



Thank you for listening

