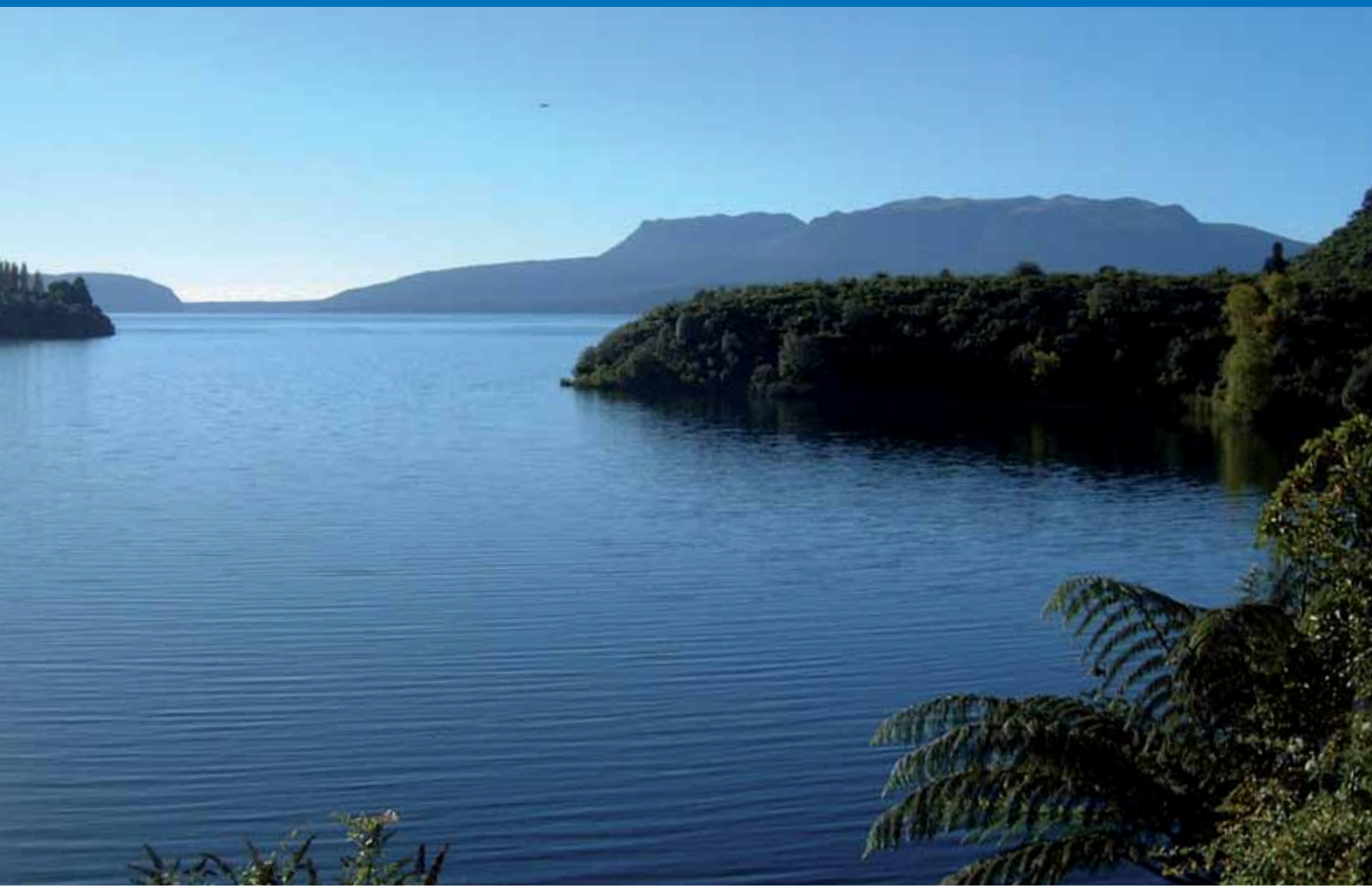
State of the Rotorua/Te Arawa Lakes 2009-2010

An update on the current state of the Rotorua/Te Arawa Lakes and what actions are being taken to protect and restore them



THE ROTORUA LAKES

Protection and Restoration Action Programme

A **Bay of Plenty Regional Council**, **Rotorua District Council** and **Te Arawa Lakes Trust** joint project

Contents

He mihi

Tukua mai te wai karere kia piri, tukua mai te waiora kia tata, kia eke ai te oranga hiranga ki runga i ō tātau moana, i ō tātau roto o Te Arawa. Kati, tēnei te mihi uruhau ki a koutou katoa e whai wahi nei ki te tiaki, manaaki, nanaa i ō tātau moana, i ō tātau roto o Te Arawa. Hei aha? Hei oranga mō te tangata, mō te whānau, mō te hapū, mō te iwi. Ko tēnei ripoata he wherawhera i te oranga pai, oranga kino rānei o ō tātau roto o Te Arawa. No reira, ka mihi nei ra ki a tātau katoa.

Let the scared waters be close, let the life giving waters be close, so that our Te Arawa Lakes find vitality. A sincere and warm greeting to you that have found time to care about the health of our lakes. For what? So that our present and future generations can live healthy lives. This report investigates the good or bad health of our Te Arawa Lakes. Therefore greetings to us all.

Introduction

This booklet contains a general introduction to the water quality issues of the Rotorua/Te Arawa lakes and contains a series of 12 “Report Cards” for each of the Rotorua/Te Arawa lakes.

The report cards give a ‘snapshot’ of each lake. They include background information on the naming, size and physical characteristics of each lake but the main focus is to show the health status of each lake and the measures that are being taken to protect or improve water quality.

The Rotorua Te Arawa Lakes Strategy Group, consisting of Te Arawa Lakes Trust, Bay of Plenty Regional Council and Rotorua District Council have been concerned about declining water quality in our lakes for many years. This has resulted in the development of a community vision - *Strategy for the Lakes of the Rotorua District (2000):*

> “The lakes of the Rotorua district and their catchments are preserved and protected for the use and enjoyment of present and future generations, while recognising and providing for the traditional relationship of Te Arawa with their ancestral lakes.”
>
> *Strategy for the Lakes of the Rotorua District (2000)*

The Rotorua Lakes Protection and Restoration Action Programme was established to identify issues and propose courses of action to address the water quality problems.

The Programme works with a number of stakeholders, such as scientists, researchers and ratepayers to improve the lakes and is producing Lake Action Plans for each of the lakes, which are detailed reports containing objectives for improved water quality and methods to achieve these goals.

In April 2007, a Memorandum of Understanding was signed between the Crown and the Rotorua Te Arawa Lakes Strategy Group to consider co-funding of Rotorua lakes restoration.

The first set of report cards was produced in 2008, listing the proposed improvement works identified in the Rotorua Lakes Protection and Restoration Action Programme. Since then, a large number of projects and initiatives have been completed, and these are updated within this new version. Te Arawa names have been added, along with a brief historical meaning of each lake, which recognises Te Arawa’s cultural, traditional, spiritual and historical relationship with their lakes.

Photo: Yvonne Vincent

Parties involved in improving lake water quality

Most of the Rotorua/Te Arawa lakes need urgent attention to protect water quality. There are no 'easy fix solutions' and changes will not occur overnight but the long and short-term initiatives proposed by the Rotorua Lakes Protection and Restoration Action Programme will have a positive effect.

The understanding of residents and lake users about the issues and the individual measures that we can all take will greatly assist in helping to reach long-term goals in protecting the quality of our lakes.

The **Rotorua Te Arawa Lakes Strategy Group** is the overarching governance group made up of representatives from Bay of Plenty Regional Council, Te Arawa Lakes Trust and Rotorua District Council. It coordinates policy and actions to improve the Rotorua Te Arawa lakes. The committee was established in law in 2006 as part of the Te Arawa Lakes Settlement Act.

The community has been involved in developing action plans, working with the Trust and councils and with input from the Department of Conservation, Fish & Game, landowners and interest groups.

Water quality action plans have been completed for another two Rotorua lakes during the 2009-2010 financial year (as required by the current Ten Year Plan). They are the Lake Rotomā Action Plan and the Lake Rotorua and Rotoiti Action Plan.

The **Water Quality Technical Advisory Group** (WQTAG) looks at options for improving a lake from a scientific perspective. Results from their work and recommendations are incorporated into the action plans.

The **Land Use Futures Board** (LUFB) provides advice to the Rotorua Te Arawa Lakes Strategy Group on how to implement changes in land use management practice and in land use in the Rotorua lakes catchments to achieve the land based component of nutrient reduction targets defined through the various action plans.

The **Rotorua Lakes Recreation Strategy Forum** meets twice per year, before and after the lake recreation peak summer period, where agency representatives discuss lakes recreation management – the issues and the actions – at a practical level. The Forum also acts to further develop effective working relationships between the various groups responsible for Rotorua Lakes' recreation management.

The purpose of the **Aquatic Pest Technical Advisory Group** (APTAG) is for agencies with a role in the management of aquatic pests to effectively network, pool resources and share information to achieve integrated planning and management of aquatic pests in the Rotorua Lakes.

Funding

In March 2008 the Prime Minister announced a $72.1 million funding package to help improve the health of Lakes Rotorua, Rotoiti, Rotoehu and Ōkareka over the next ten years. This is half of the projected restoration programme cost ($144.2 million) for the four lakes over the next decade. The remainder will be paid through Rotorua District Council and Bay of Plenty Regional Council.

Te Arawa Lakes Trust – Chairman Toby Curtis

"As kaitaki for and on behalf of Te Arawa, we have been fully engaged and participating in the lakes programme for the benefit of the Rotorua/Te Arawa lakes. We remain committed to achieving the best outcomes for the lakes and to date all indications show that the various projects of the programme appear to be providing us with more confidence that respective strategies and options will produce the best outcomes for the lakes."

Bay of Plenty Regional Council – Chairman John Cronin

"We are fortunate to have such a treasure as the Rotorua lakes on our doorstep. Protecting and restoring the Rotorua/Te Arawa lakes is the responsibility of each and every one of us. Together – Bay of Plenty Regional Council, Rotorua District Council, Te Arawa Lakes Trust, landowners and the community as a whole, with support from central government, are working to improve the water quality of our lakes and ensure they continue to remain a source of joy, recreation and cultural significance for generations to come. We are making progress with the programmes and action plans that we have developed, however the challenge is there for us all to help make a positive contribution."

Rotorua District Council – Mayor Kevin Winters

"I have had the privilege of being the Chair of the Rotorua Te Arawa Lakes Strategy Group for five years now. This group was innovative when first conceived as part of the statutory requirement under the Deed of Settlement for lakebeds to be returned to Te Arawa.

The tripartite membership has combined very well to provide governance and management for our lakes. Our kaupapa is to restore water quality in 12 lakes. We have produced action plans for most of the lakes to address water quality issues. Our pace is steady, as we need to include all sectors of our community with us, as all together we have the answers. The science is well documented; the solutions are expensive, yet achievable.

The Crown is assisting us by way of grants for a number of initiatives and this is a huge endorsement of the work we do."

Background to the Issues

The Rotorua/Te Arawa lakes are the jewels of the Central North Island but many of the lakes have too many nutrients. Nutrient loads to the lakes have increased markedly over the past few decades. The main causes are:

- Land use activities, particularly intensive farming.
- Sewage from lakeside communities.
- Large amounts of nutrients stored in the bottom sediments of some lakes derived from historical practices such as the discharge of treated sewage into Lake Rotorua.
- Groundwater aquifers that are being progressively enriched with nutrients from historical farming practices that will continue to feed into the lakes over coming decades.

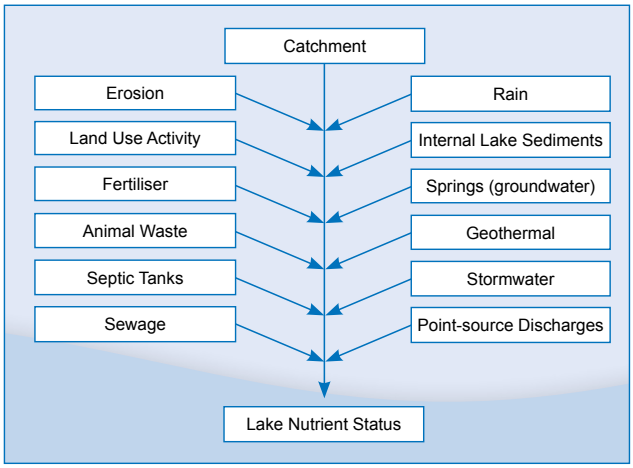
There are a number of other factors that must be considered in restoration actions to improve lake health:

- Most of the water entering the Rotorua lakes has spent considerable time underground and because of this, restoring water quality will take a prolonged effort.
- Our understanding of the issues and appropriate treatment methods to restore water quality continues to evolve with the monitoring and restoration actions taken.
- Long-term actions to reduce nutrient loads from lake catchments are essential but may be supplemented by immediate actions, such as the Ōhau Channel diversion wall, to bring about rapid improvements in water quality.
- As water quality improves and light reaching the lakebed increases, weed growth is likely to increase.

To improve water quality, nutrient levels in our groundwater need to be reduced. Better land management practices and changes in land use are two ways to counteract the degradation of the lakes. In order to achieve better water quality we are using a range of mechanical, chemical and biological methods. Many of these methods, such as changes in land management practices will take years or decades to have an effect, but some of the methods such as phosphorus locking will show more rapid results. There is no single quick solution to improving the water quality across all of the lakes.

Nutrient Inputs

Algal growth in the Rotorua lakes is dependent on a variety of essential elements (nutrients). The two most common nutrients that promote algal growth are nitrogen and phosphorus. Levels of these nutrients in many of the lakes are too high and need to decrease in order to reduce algae concentrations and blooms. To do this it is important to know where these nutrients come from. The diagram below lists the main nutrient sources.



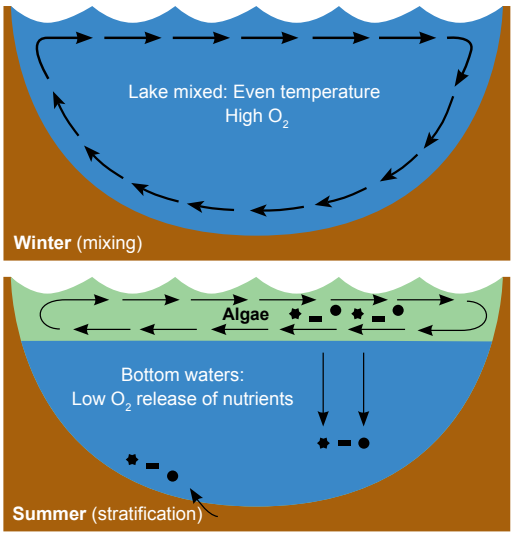
Main nutrient input sources

Lake Dynamics

Water quality in the Rotorua lakes is governed by complex interactions between physical, chemical and biological processes.

Waters in the deeper lakes such as Tarawera, Rotoiti and Rotomā mix fully from top to bottom in winter when the surface waters cool and warmer water below then rises. Dissolved oxygen levels in surface waters of lakes usually remain relatively stable because oxygen losses from respiration are replenished by gains from the atmosphere or photosynthesis of aquatic plants.

However, during warm calm periods in summer and autumn, the lake waters stratify, with dense, cold bottom waters trapped beneath warmer surface waters. In shallow lakes such as Rotorua, Rotoehu and Rerewhakaaitu, stratification occurs temporarily, for only a few days at a time.



Seasonal differences in temperature, light, plant growth and nutrient availability may result in stratification of lake waters.

When lake stratification occurs, oxygen in bottom waters is not replenished adequately because atmospheric inputs are cut off and there is insufficient light for photosynthesis. In low-oxygen conditions, nutrients such as phosphorus can be released from the lake sediments. Remixing of the waters in autumn can bring these nutrients to the surface where they can stimulate algal blooms. Increased algal growth in the surface waters results in further deposition of algae on the lake bed, further fuelling the cycle.

Bay of Plenty Regional Council uses the rate of decline of oxygen in bottom waters of deep lakes as an indication of water quality trends, amongst lakes and within individual lakes, to complement other water quality indices.

Algae in the Rotorua Lakes

Algae are a vital component of lake ecology, producing food for higher levels of the food chain as well as oxygen to sustain life in the lake. Algae contain chlorophyll-*a*, a green pigment which enable them to use the sun's energy to build up biomass and sustain the food chain.

Blue-green algae (cyanobacteria) are a group of bacteria, rather than true algae that have acquired chlorophyll and behave like plants. Blue-green algae are present naturally in lakes but may congregate into surface blooms when the water is calm. Some blue-green algae can fix atmospheric nitrogen which increases their growth rates.

Restricting nutrient supply to the lakes is the key to reduce the frequency of algal blooms. Nitrogen and phosphorus are especially important nutrients in the Rotorua lakes. They are present naturally at levels below optimal for the growth of algae. If you live in one of the Rotorua lakes catchments your activities will have a bearing on nutrients draining into a lake which affects algal growth and water quality.

Bay of Plenty Regional Council conducts regular monitoring of algae in Rotorua lakes as part of its blue-green algae monitoring programme. The monitoring programme provides information to the public to ensure lakes are safe for water-based activities and do not have high levels of toxins that are produced by some cyanobacteria.

The results are reported to the Medical Officer of Health at the Toi te Ora - Public Health Service, who will decide on whether a public health warning is required.

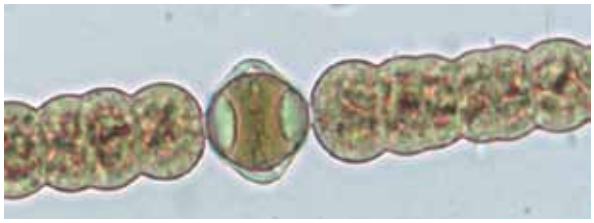


Photo of Anabaena planktonica, one of the blue-green algae responsible for past algal blooms in Lake Rotoiti (magnified x 400 times). The clear cell in the middle of the filament is an heterocycst, a specialised cell used for nitrogen fixation. Photo by Barry O'Brien.

Bloom of blue-green algae at entrance to Ohau Channel, Lake Rotorua (January 2006)

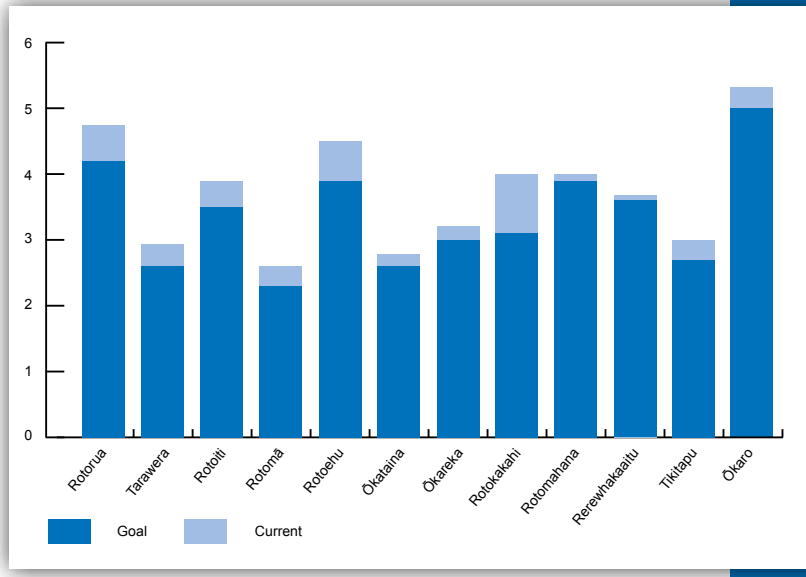
Trophic Level Index (TLI)

The Trophic Level Index (TLI) is a tool used to provide an integrated assessment of water quality in lakes. Several parameters such as water clarity, algae biomass (as chlorophyll-*a* concentration) and nutrients (total nitrogen and total phosphorus) are combined to produce a TLI for a lake. The TLI has been formulated for New Zealand lakes and is rated from zero (ultra-microtrophic) to 7.0 (hypertrophic), with a lower value indicating good water quality. The TLI can be used to measure changes over time or to make comparisons between different lakes.
Bay of Plenty Regional Council uses the TLI in the Regional Water and Land Plan as a benchmark to guide decisions and manage trends in lake water quality.

Trophic Level	Lake Type	Perceived Lake Quality
6.1–7.0	Hypertrophic	Very poor
5.1–6.0	Supertrophic	
4.1–5.0	Eutrophic	
3.1–4.0	Mesotrophic	
2.1–3.0	Oligotrophic	
1.1–2.0	Microtrophic	
0.1–1.0	Ultra-microtrophic	Excellent

Lake Trophic levels and lake types

Current TLI Values for all lakes



Trophic Level Index (TLI) is an overall indication of the lake health based on a number of different criteria, values represent a three-yearly average.

LAKES FACTS SUMMARY

Three-yearly average TLI values for the Rotorua District lakes in comparison to the TLI values set in the Regional Water and Land Plan, and LakeSPI condition.

Lake Regional Water and Land Plan TLI units	Goal TLI	3 yearly average TLI to 2005 TLI units	3 yearly average TLI to 2006 TLI units	3 yearly average TLI to 2007 TLI units	3 yearly average TLI to 2008 TLI units	3 yearly average TLI to 2009 TLI units	Lake Type based on Trophic Level	LakeSPI Condition 2008/2009
Rotorua	**4.2**	4.9	4.9	4.8	4.8	4.7	Eutrophic	Moderate
Tarawera	**2.6**	2.8	2.9	2.9	2.9	2.9	Oligotrophic	Moderate
Rotoiti	**3.5**	4.5	4.3	4.1	4.0	3.9	Mesotrophic	Poor
Rotomā	**2.3**	2.5	2.5	2.5	2.6	2.6	Oligotrophic	High
Rotoehu	**3.9**	4.6	4.5	4.6	4.5	4.5	Eutrophic	Poor
Ōkataina	**2.6**	2.9	2.9	2.8	2.8	2.8	Oligotrophic	Moderate
Ōkareka	**3.0**	3.2	3.3	3.3	3.3	3.3	Mesotrophic	Moderate
Rotokakahi	**3.1**	3.4	3.4	3.5	3.8	4.0	Mesotrophic	Moderate
Rotomahana	**3.9**	3.8	3.9	3.9	3.9	4.0	Mesotrophic	High
Rerewhakaaitu	**3.6**	3.4	3.4	3.5	3.6	3.7	Mesotrophic	Moderate
Tikitapu	**2.7**	3.1	3.1	3.0	3.0	3.0	Mesotrophic	Moderate
Ōkaro	**5.0**	5.5	5.5	5.5	5.3	5.3	Supertrophic	Poor

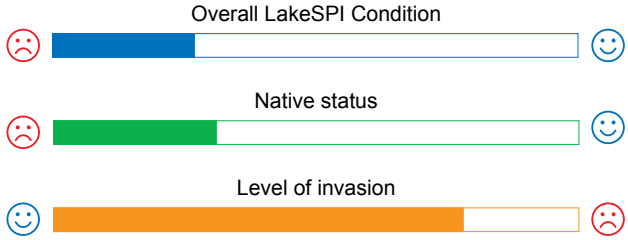
Other ecological indicators - LakeSPI (Submerged Plant Indicators)

The LakeSPI (submerged plant indicators) provide a measure of how the distribution of submerged lake plant communities change over time and how the percentage cover of native submerged plants alters in the presence of invasive submerged plants. Bay of Plenty Regional Council, working in tandem with NIWA, uses standardised LakeSPI (pronounced “Lake SPY”) indices for measuring the health of submerged plant communities.

Samples are taken from Rotorua lakes over a staggered two-year period (six lakes each year). The resulting LakeSPI index shows the overall measure of each lake’s native and invasive condition. This methodology focuses on the littoral margins (edges) of lakes where public access and interaction is greatest.

By examining the distribution of submerged plants, LakeSPI also provides us with additional information on a lake’s long-term water quality trends. Trials have been conducted with incorporating a faunal component into LakeSPI, where the distribution and abundance of koura (freshwater crayfish) and kakahi (freshwater mussels) are monitored in the lakes over time.

LakeSPI Summary



Example of a LakeSPI summary. These results are based on samples taken from Lake Rotorua during 2009. In this example the overall condition is poor, with a low level of native plant species and a high level of invasive pest plant species.

Research

Bay of Plenty Regional Council funds a chair in Lakes Management and Restoration at Waikato University. Professor David Hamilton's work focuses on the Rotorua lakes. Several other research organisations are also involved in the programme including;

- The Institute of Geological and Nuclear Sciences (GNS)
- The National Institute of Water and Atmospheric Research (NIWA)
- AgResearch
- SCION
- Lake Ecosystem Restoration New Zealand (LERNZ)

The research includes;

- Groundwater flows
- Lake dynamics
- Economic evaluation of landuse changes
- Nutrient management options
- Surface water flows

Regulation

Some activities are regulated by the Regional Water and Land Plan (Rule 11) and the On-site Effluent Treatment Plan. These plans set out rules which aim to reduce nutrient inputs to some lakes.

Regional Water and Land Plan

Due to the decline of quality in many Rotorua lakes, land use management is seen as a key strand of the Rotorua Lakes Protection and Restoration Action Programme. Bay of Plenty Regional Council's Regional Water and Land Plan assesses issues and includes actions that will stop any further increases in the amount of nitrogen and phosphorus leaching into the lakes.

Rule 11 is a series of rules in section 9.4 of the Plan and aims to prevent increasing nitrogen and phosphorus loss from land use activities in the catchments of Lakes Rotorua, Rotoiti, Rotoehu, Ōkaro and Ōkareka.

For further information and advice on Rule 11 and how it may affect you please contact your local Lakes Restoration Officer at Bay of Plenty Regional Council.

On Site Effluent Treatment (OSET)

There are thousands of OSET systems (septic tanks) in the Bay of Plenty and many of those within the Rotorua lakes catchments are rudimentary, causing serious pollution problems. Nutrients such as nitrogen and phosphorus from poorly maintained septic tanks in a lake catchment will boost the production of algae and reduce water quality over time.

Bay of Plenty Regional Council is reviewing the OSET Regional Plan. Current rules limit the nutrient entering waterways from septic tanks.

Current Actions

Current actions include initiatives that focus on land management practices and changes in land use, building of filtering wetlands and restricting nutrient outflow. More short-term solutions include sewerage reticulation, structures to detain storm water flows and using mineral products to lock up nutrients.

A number of initiatives are already being undertaken and are detailed in the individual Report cards.

Lakes Facts

The Rotorua Lakes Protection and Restoration Action Programme has produced the following series of Lakes Fact Sheets which give detailed explanations of points covered above and other related issues:

1. Algae in the Rotorua Lakes
2. Lake Dynamics
3. Lake Trophic Level
4. Nutrient Inputs
5. Riparian Protection
6. Wetlands
7. Rule 11
8. Frequently Asked Questions
9. Pine Pollen
10. OSET: Rotorua Lakes Catchments
11. Mesocosms (old trial programme)
12. Saving the Lakes

These fact-sheets are available on the Bay of Plenty Regional Council website **www.envbop.govt.nz/Knowledge-Centre/Lakes-factsheets.aspx.** The website also contains information on many other issues that affect lake water quality, including, but not limited to, dairy effluent management, land management and stream crossings.

A DAY OUT AT THE LAKES

Photo: Kevin Connole

Photo: Bruce Webber, Morefun Company

Photo: Eric Cameron

Lake Rotorua

Te Rotorua nui ā Kahu-matamomoe

AT A GLANCE

Lake size: 8060 ha
Catchment area: 50060 ha
Elevation: 280 m
Average depth: 11 m
Deepest point: 45 m
Formed: 140,000 years ago
Has geothermal input

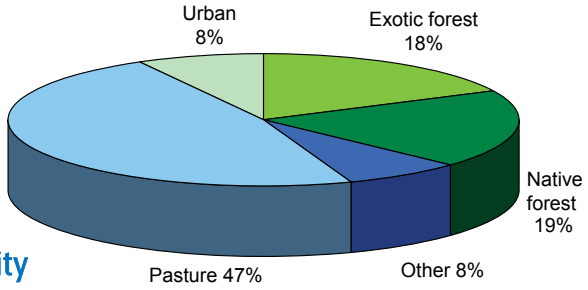
"Lake in a basin". A number of the Rotorua lakes were named by Ihenga - a grandson of the captain of the Arawa canoe Tamatekapua. He named the largest lake, Rotorua nui ā Kahu-matamomoe, in honour of his father-in-law and uncle, Kahumatamomoe. "Rotorua nui" refers to the large basin-like lake.

Lake Rotorua is the largest lake in the district and the most productive trout fishery in New Zealand. With the city of Rotorua on its shores, it is much valued and used by locals and tourists alike. The quality of the water in Lake Rotorua also affects Lake Rotoiti as the two lakes are linked by the Ohau Channel.

In July 2008 a diversion wall was constructed that prevents the high nutrient water from flowing directly into Lake Rotoiti. As a result over 70% of the nutrients that were flowing into Lake Rotoiti have now been diverted down the Kaituna River.

Land cover

The land cover in the Rotorua catchment is predominantly pasture and exotic forest.



Swimming water quality

The lake has five monitored sites for faecal indicator bacteria with overall grades ranging from poor to very good. Health warnings are put in place if algae levels are elevated above recreational standards.

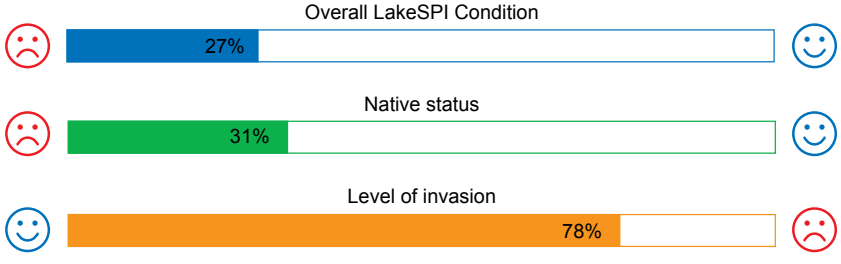
This lake is tested for faecal indicator bacteria and toxin forming algae.
Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

LakeSPI rank: Ranked 9th out of the 12 Rotorua lakes
Current condition: Poor
Long-term trend: Stable

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

The lake's 'native condition' remains low but stable. The invasive condition has improved slightly only because egeria (an invasive aquatic weed) underwent a major decline in Lake Rotorua in the late 1980's and did not recover. Future water quality improvements in this lake will cause aquatic pest plant species to proliferate however, increasing the risk for large weed strandings. Because Rotorua contains three of the region's worst aquatic pest plant species it poses a risk to neighbouring lakes that are free of weeds.



(Rotorua 2009 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

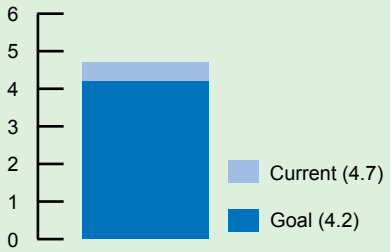
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

In the 2008-2009 season, sustained bloom activity was recorded for up to 12 weeks, beginning late in the season (March) and ending in June.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The three-yearly average TLI results have shown a reduction since 2004, with annual TLI results fluctuating around 4.7 to 4.9 units. This is above the target TLI of 4.5.



Lake Rotorua TLI

A local's perspective

"It is gratifying to have witnessed completion of the first actions necessary to return the water quality of Rotorua's iconic lakes to the desired state. But much more needs to be done and we must now address the difficult catchment issues to achieve the requisite nutrient reduction targets to restore our lakes assets. Future generations expect no less from us"

Brentleigh Bond, Chair of the Rotorua Lakes Community Board

STRATEGY AND ACTIONS

An action plan has been developed for Lake Rotorua / Lake Rotoiti by the community and working parties. This is a long-term plan to improve water quality, through changes such as sewage reticulation, diversion structures, improved farm nutrient management, in-lake treatment and the creation of wetlands. The Action Plan estimates the sustainable nutrient inputs needed to achieve the target TLI are 435 tonnes nitrogen per year and 37 tonnes phosphorus per year. Details of how we are doing so far for Lake Rotorua are set out below.

The proposed action and who is responsible for seeing it through:	How we are doing:
Wastewater treatment: To upgrade the Rotorua wastewater treatment plant. (Who: Rotorua District Council)	▪ Sewage processing equipment has been expanded and methanol dosing added to remove more nitrogen. ▪ Further improvements are planned to maintain low nutrient levels in the increased volume of treated wastewater which is irrigated in Whakarewarewa Forest.
Reticulation: To reticulate and treat sewage from the communities of Mourea, Brunswick Park, Rotokawa and Hamurana – or to upgrade to advanced onsite effluent treatment systems. An estimated reduction of 10.84 tonnes of nitrogen per year and 0.25 tonnes of phosphorus per year is expected. (Who: Rotorua District Council)	▪ Brunswick and Rotokawa sewage reticulation was completed in November 2009. ▪ Construction is due to begin on the Hamurana scheme in 2011. ▪ Sections smaller than 2 ha or within 200 m of the lake that are not scheduled to be reticulated will need to upgrade to advanced individual systems.
Stormwater: To upgrade urban stormwater treatment systems to remove more nutrients. An estimated reduction of 3.0 tonnes of nitrogen per year and 0.5 tonnes of phosphorus per year is expected. (Who: Rotorua District Council)	▪ These upgrades are budgeted to take place progressively up until 2016.
Geothermal flow: To remove and treat the discharge from the Tikitere geothermal field. An estimated reduction of 30 tonnes of nitrogen per year is expected. (Who: Bay of Plenty Regional Council)	▪ Resource consent to treat this flow has been granted and construction was begun on two pilot plants in early 2010.
Stream treatment: To add a low dose of alum to the Utuhina Stream to remove the dissolved phosphorus; and to investigate the viability of similar treatment for other streams entering the lake. (Who: Bay of Plenty Regional Council)	▪ An alum-dosing plant for the Utuhina Stream is operational and removing two tonnes of phosphorus a year with no adverse environmental effects. ▪ A second dosing site for the Puarenga Stream was commissioned in December 2009. ▪ A third dosing site is being investigated.
Wetlands: To investigate potential sites for new or enhanced wetlands. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ Some potential wetland sites have been mapped and feasibility will be investigated in conjunction with private land owners.
Biomass: To investigate the use of biomass to remove nitrogen and phosphorus e.g. harvesting algae or stream-watercress; and using freshwater mussels to filter algae. (Who: Bay of Plenty Regional Council)	▪ Bay of Plenty Regional Council has partnered with Aquaflow Ltd and New Zealand Trade and Enterprise to trial an algae harvesting plant at Ohau channel. ▪ Some hornwort weed areas could be included in a harvesting programme similar to the one at Lake Rotoehu.
Lakebed treatment: To treat the sediment on the lakebed in order to reduce the amounts of nutrients recycling into the lake. An estimated reduction of up to 25 tonnes of phosphorus per year is expected. (Who: Bay of Plenty Regional Council / Te Arawa Lakes Trust)	▪ Lab trials assessing a range of agents have been undertaken and field trials are planned for November 2010. ▪ Investigation into artificial mixing of lake water using aeration has commenced. This aims to prevent nutrient releases from sediments during periods of lake water stratification.
Stream diversion: To further investigate diverting the Hamurana Stream to the Ōhau Channel. An estimated reduction of 53 tonnes of nitrogen per year is expected. (Who: Bay of Plenty Regional Council, Rotorua District Council, Te Arawa Lakes Trust)	▪ Lake modelling work is underway to determine the effectiveness of the potential diversion.
Land use change: To change the way land is managed and used in order to reduce nutrient loss from the catchment area. (Who: Bay of Plenty Regional Council, Rotorua District Council, Te Arawa Lakes Trust)	▪ The Bay of Plenty Regional Council is investigating a range of non-regulatory tools to encourage both changes in land management practice and changes in land use to less nutrient intensive uses. ▪ By August 2010, 28 ha of land under high nitrogen leaching gorse was subject to agreements for conversion to pine trees.
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.
Incentives: Provide incentives for land owners to change land use to lower nutrient loss practices. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ In 2009 several options were assessed to determine cost effective mechanisms to support land owners to reduce nutrient loss from their properties. ▪ In 2010 Bay of Plenty Regional Council will put systems in place to implement incentive schemes for land owners. ▪ Rotorua District Council is looking at incentivising land use change through the District Plan.
Nutrient budget: To commission work to develop a nutrient budget for Lake Rotorua. This measures the input and output of nitrogen and phosphorus in an area and shows how much is entering the lake. It is to be implemented through regional and district plans. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ This was completed and has now been advanced to include catchment and lake computer models. ▪ Benchmarking of farm properties around Lake Rotorua has commenced. ▪ The land use catchment model is now completed and is being used to help predict possible options for lake water improvement.

Lake Tarawera

AT A GLANCE

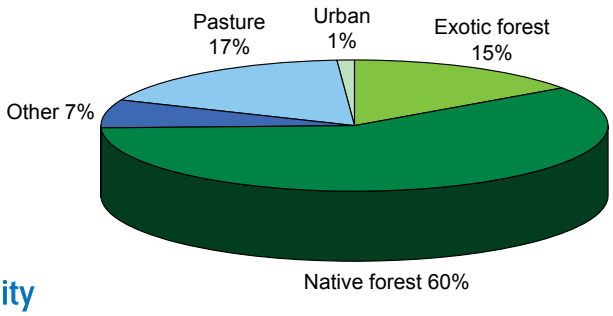
Lake size: 4130 ha
Catchment area: 14520 ha
Elevation 298 m
Average depth: 50 m
Deepest point: 87.5 m
Formed: 5000 years ago
Surface outflow via the Tarawera river

Lake Tarawera, meaning 'Burnt Spear' is one of the largest lakes in New Zealand. The lake was home to many small Māori villages and mission settlements, until the Tarawera eruption in 1886. Legend has it that a "waka wairua" (phantom canoe) appeared on the lake as a portent of death a few days prior to the eruption.

Lake Tarawera is a picturesque lake, famous for the size and condition of its rainbow trout. Several lakes in the area drain into it directly or via groundwater, along with geothermal springs on the southern and northern shores. Lake Tarawera is a deep lake; any water flowing in to it stays there for around ten years.

Land cover

The land cover in the Tarawera catchment is predominantly native and exotic forest.



Swimming water quality

The lake has two monitoring sites for faecal indicator bacteria and toxic forming algae. Both sites have an overall very good grade for recreational bathing. Health warnings are put in place if algae levels are elevated above recreational standards.

Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

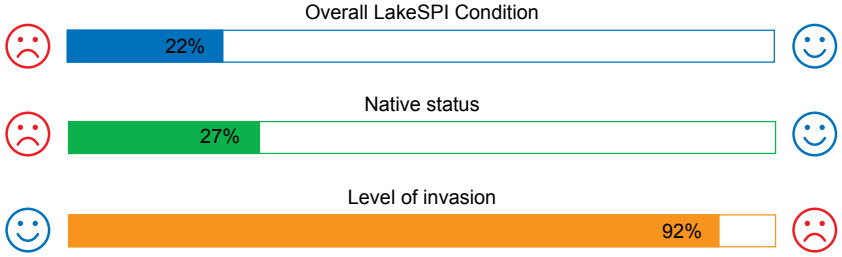
LakeSPI rank: Ranked 8th out of the 12 Rotorua lakes

Current condition: Poor

Long-term trend: Stable

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

A 92% invasive index score, the highest of any of the Rotorua lakes, was due in part to the introduction and spread of hornwort in this lake. The introduction of hornwort doubled the depth range of invasive species. This resulted in the displacement of even the deepest occurring native charophyte meadows and the native condition index has remained low since. The presence of hornwort in Tarawera increases the risk of its spread to nearby, presently unaffected lakes (Tikitapu, Rotokakahi and Ōkareka).



(Tarawera 2008 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

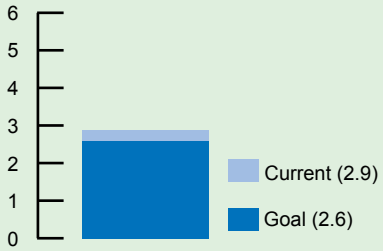
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

In Lake Tarawera, there have been occasional blooms in localised parts of the lake during summer months. Tarawera has experienced several clear years where there has been no sustained activity.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The TLI for Lake Tarawera is 0.3 units above the target TLI and has been steady at this level for the last four years.



Lake Tarawera TLI

A draft Action Plan is currently being developed for Lake Tarawera – this indicates that annual nutrient reductions of 13.7 tonnes of nitrogen and 1.86 tonnes of phosphorus are needed to achieve the target TLI. The details of how we are doing for Lake Tarawera so far are set out below.

The proposed action and who is responsible for seeing it through:	How we are doing:
Action Plan: The Bay of Plenty Regional Council Ten Year Plan 2009-2019 states that we will develop water quality action plans for two Rotorua lakes per financial year. The process of completing an Action Plan for Lake Tarawera is currently scheduled for July 2011. (Who: Bay of Plenty Regional Council)	▪ A working group has been established and has met to define its issues. Draft material for an Action Plan has also started.
District Plan: To ensure that the District Plan recognises the landscape values and the natural hazard risks associated with the Tarawera catchment. (Who: Rotorua District Council)	▪ The 'Lakes A Zone' in the District Plan has clear objectives and rules recognising these matters.
Sewerage scheme: To consider the future impact of septic tanks on Lake Tarawera as part of the Tarawera Action Plan and consider the reticulation of sewage from the catchment in conjunction with the Ōkareka Sewage reticulation. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ All septic tanks on properties within 200 m of the lake edge, or in the maintenance zone, must either join up to a sewerage scheme, gain resource consent or upgrade to advanced individual treatment systems by December 2014. If / when a sewerage scheme is constructed all properties will be required to connect. For new on-site wastewater systems, Bay of Plenty Regional Council will issue a resource consent for a standard septic tank system, provided on-site conditions are suitable, to be used only until the sewerage scheme is installed. ▪ Sewerage reticulation of the Tarawera community is scheduled to occur in 2014-2015. The District Council will undertake a feasibility investigation in 2012, looking at the service area and the options for reticulation. The reticulation network will be connected into the lakes sewer trunk main running from Tarawera to Ōkareka, then along Tarawera Road through to the Hona Road pump station and the city wastewater treatment plant.
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.

A local's perspective

"Many of our overseas tourists use the water taxi service to visit Hot Water Beach or to access many of the well known bush and lake walks. The geothermal activity combined with pristine water quality and stunning views make Lake Tarawera a 'must visit' location for our foreign visitors"

Graham Van Praagh, Owner of Lake Tarawera Water Taxi

Lake Rotoiti

Te Roto kite ā Ihenga I Ariki ai Kahu

AT A GLANCE

Lake size: 3400 ha
Catchment area: 12160 ha
Elevation: 279 m
Average depth: 31 m
Deepest point: 93.5 m
Formed: 8500 years ago
Drains to the Kaituna River; and to Lakes Rotoehu and Rotomā via subsurface flow

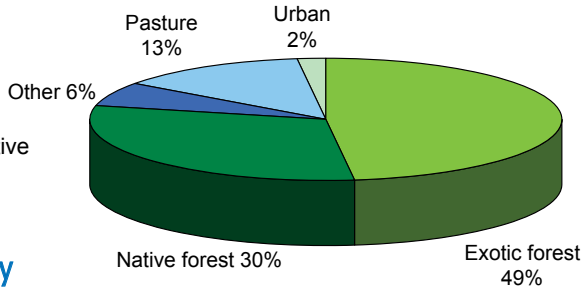
Ihenga came inland to explore the area. His dog Potakatawhiti disappeared for some time and on return, vomited up whitebait. Ihenga then realised he was near water. He landed on the shores of the lake which he, because of the size of the particular bay, was deceived into thinking the lake was a small lake. He called it Lake Rotoiti, or Te Roto-Whaiti-i-kite-ai-a-Ihenga-i-Ariki-ai-a Kahumatamomoe.

Lake Rotoiti is a relatively large lake and a popular location for boating and fishing. It is linked to Lake Rotorua via the Ohau Channel. This means that the quality of the water in Lake Rotorua has a significant effect on Lake Rotoiti – much of the work being done to improve Lake Rotorua is also aimed at improving water quality in Lake Rotoiti.

In July 2008 a diversion wall was constructed that prevents water that has a high nutrient content from flowing directly into Lake Rotoiti. As a result over 70% of the nutrients that were flowing into Lake Rotoiti have now been diverted down the Kaituna River.

Land cover

The land cover in the Rotoiti catchment is predominantly native and exotic forest.



Swimming water quality

The lake has six monitored sites for faecal indicator bacteria. All sites have an overall very good grade for recreational bathing. Health warnings are put in place if algae levels are elevated above recreational standards.

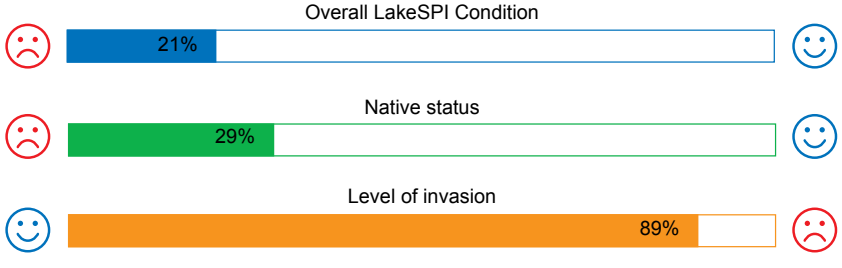
This lake is tested for faecal indicator bacteria and toxin forming algae. Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

LakeSPI rank: Ranked 12th (lowest) out of the 12 Rotorua lakes
Current condition: Poor
Long-term trend: Stable

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

Lake Rotoiti has both the second highest ranked invasive condition and the lowest ranked LakeSPI index. While the LakeSPI index is stable, several embayments such as Okawa, Te Weta and Wairau Bays have shown signs of further deterioration with filamentous algae (single algae cells that form long visible threads) and blue green algae mats replacing true plants in some areas. The LakeSPI scores indicate poor water quality in this lake.



(Rotoiti 2009 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

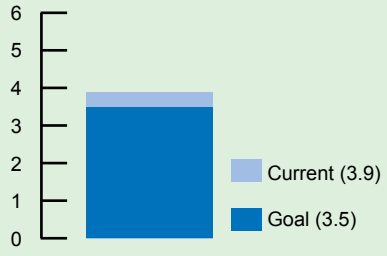
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

After three consecutive bloom-free years, late blooms affected Ōkere Arm at the western end of Lake Rotoiti from April to June 2009. These closely mirrored the timing and intensity of blooms in Lake Rotorua, particularly bloom activity closer to Ōhau Channel. Areas east of the Ōhau Channel diversion remained bloom free. While Okawa Bay (traditionally one of the hardest hit sites in Lake Rotoiti for blooms) registered a short spike in bloom activity in February 2009, the lake lasted the entire 2008-2009 season without a health warning.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The Lake Rotoiti TLI continues to improve, with the three yearly average under 4.0 for the past two years. Because of this the lake has now moved from an eutrophic classification to mesotrophic. Continued improvement is required if the lakes is to meet its target TLI of 3.5 units.



Lake Rotoiti TLI

STRATEGY AND ACTIONS

An action plan has been developed for Lake Rotorua / Lake Rotoiti by the community and working parties. This is a long-term plan to improve water quality, through changes such as sewage reticulation, diversion structures, improved farm nutrient management, in-lake chemical treatment and the creation of wetlands. Details of how we are doing so far for Lake Rotoiti are set out below.

Reductions in lake nutrients needed to achieve the TLI target are 130 tonnes of nitrogen per year and 19 tonnes of phosphorus per year.

The proposed action and who is responsible for seeing it through:	How we are doing:
Ohau Channel diversion: To divert the flow of water from Lake Rotorua to the Kaituna River, preventing it from mixing with the main body of Lake Rotoiti. (Who: Bay of Plenty Regional Council)	▪ The completion of the $10 million diversion wall was officially launched on 20 October 2008. ▪ Ongoing monitoring is undertaken to determine effects on water quality, fisheries, algae and bird life.
Reticulation: To reticulate and treat sewage from the communities of Mourea, Okawa Bay, Ōkere Falls, Otaramarae, Whangamarino, and Rotoiti from Cutis Road to Hinehopu. (Who: Rotorua District Council)	▪ Mourea and Okawa reticulation was completed in 2008. ▪ Construction is due to commence in 2013. Ōkere Falls and Otaramarae in 2011. Rotoiti construction is due to commence in 2013. ▪ All sections smaller than 2 ha or within 200 m of the lake that are not reticulated are required to upgrade to advanced individual systems or obtain resource consent.
Lakebed cap: To create a phosphorus-absorbing 'cap,' or mineral layer, on the lakebed to limit the release of phosphorus from the sediment. (Who: Bay of Plenty Regional Council)	▪ The need for this cap will be assessed in 2013, when the diversion wall has been in place for five years, using the results of monitoring, and lake modelling.
Water-edge protection: To work with landowners to keep stock away from the water's edge and to create vegetation buffers. (Who: Bay of Plenty Regional Council)	▪ The northern margins of the lake are now fully stock-fenced with vegetation buffers.
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.

A local's perspective

"We love and respect our lakes. Our community is committed to ensuring that responsible action on behalf of all parties contributing to the state of health of the Rotorua lakes is paramount. Rotorua is a big draw-card to national tourism. For this to continue, the health of the lakes is critical."

Hilary Prior, Lake Rotoiti Community Association

Local action

The Lake Rotoiti Classic & Wooden Boat Association has almost completed building four new eco-toilets as part of an Environmental Enhancement Fund project. The toilets are located at popular boat-only access points around the lake.

"Tau Koura" - Traditional fishing method used as a monitoring tool. *Photo taken by Dr Chris Hickey, NIWA*

"With the assistance of Ngati Pikiao, traditional methods of collecting kōura using submerged bracken fern bundles are being used in Lake Rotoiti to monitor the possible effects of the new diversion wall on kōura populations. Early results indicate that the wall has not affected the size or quantity of kōura when comparing the different sample sites."

Willie Emery, Ngati Pikiao and Ian Kusabs, Te Arawa Lakes Trust consultant

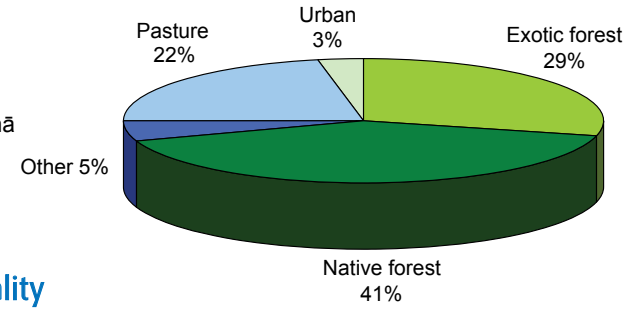
Lake Rotomā

Lake Rotomā means lake of exceptionally "clear water". The lake currently has the best water quality of all the Rotorua lakes.

Lake Rotomā is the cleanest of all the Rotorua lakes with water clarity of around 11 metres and no invasive lake weeds. The clarity makes fly fishing more challenging. There is a high risk of lakeweed infestation from nearby Lake Rotoehu or other lakes. Four buoys near the centre of the lake mark a submerged Māori pa site.

Land cover

The land cover in the Rotomā catchment is predominantly native and exotic forest.



Swimming water quality

The lake has two monitored sites and all have an overall very good grading for recreational bathing. Health warnings are put in place if algae levels are elevated above recreational standards.

This lake is tested for faecal indicator bacteria. Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

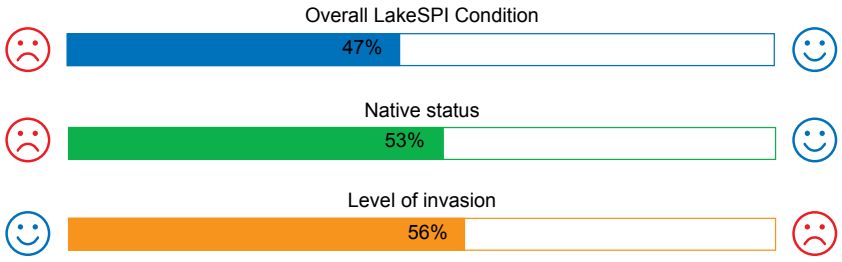
LakeSPI rank: Ranked 2nd out of the 12 Rotorua lakes

Current condition: Good

Long-term trend: Stable

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

The deepest occurring plants in this lake have not altered their position since records began 35 years ago suggesting that this lake continues to enjoy stable water quality/ clarity. Lake Rotomā presently contains the most intact native plant community of all the Rotorua lakes. However this lake remains highly vulnerable to pest plant invasion particularly now that hornwort has established in neighbouring lakes.



(Rotomā 2009 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

AT A GLANCE

Lake size: 1110 ha
Catchment area: 2810 ha
Elevation: 316 m
Average depth: 37 m
Deepest point: 83 m
Formed: 8500 years ago
Drains by subsurface outflow

Lake health indicators

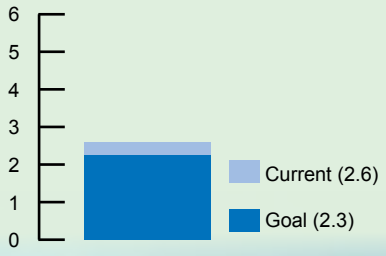
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

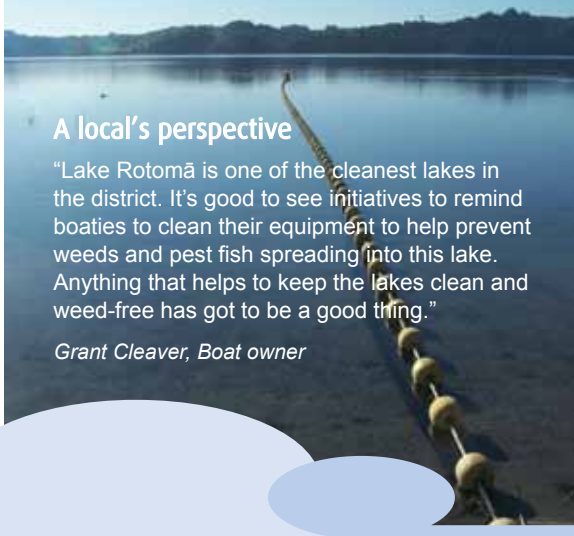
No algal blooms have been recorded in Lake Rotomā and this lake is not routinely monitored for blue-green algae.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The TLI for Lake Rotomā remains stable at around 2.5 units, above its target TLI of 2.3 units. The annual average total nitrogen concentration is lower than previous years.



Lake Rotomā TLI



A local's perspective

"Lake Rotomā is one of the cleanest lakes in the district. It's good to see initiatives to remind boaties to clean their equipment to help prevent weeds and pest fish spreading into this lake. Anything that helps to keep the lakes clean and weed-free has got to be a good thing."

Grant Cleaver, Boat owner

STRATEGY AND ACTIONS

An action plan has been developed for Lake Rotomā – this indicates that annual nutrient reductions of 1320 kg nitrogen and 250 kg phosphorus are needed to achieve the target TLI of 2.3. The details of how we are doing so far are set out below.

The proposed action and who is responsible for seeing it through:	How we are doing:
Reticulate along southern shore and upgrade on-site effluent treatment systems by 2015: Action in Rotorua Long Term Council Community Plan (LTCCP), 2009-2019. The remaining septic tanks in the catchment will need to be upgraded to advanced on-site effluent treatment systems, or apply for resource consent, in line with the On-Site Effluent Treatment Regional Plan by 2015. (Who: Rotorua District Council / Bay of Plenty Regional Council)	▪ Sewage reticulation scheme in feasibility study stage. ▪ Project to consider feasibility of reticulation of reticulation of Pangopangoa Bay to Okopua Point (Doctors Point on the western shore).
Rotorua District Council review the adequacy of the existing public toilet facilities: Develop a strategy for the consistent provision of appropriate facilities taking into account any anticipated increase to visitor numbers. (Who: Rotorua District Council)	▪ Strategy to be developed.
Adopt stewardship approach to farm land management: Reduce the amount of nutrients lost to the lake, with reductions of up to 190 kg per year phosphorus, and ensure the amount of nutrients currently lost to Lake Rotomā as a result of farming activities does not increase. (Who: Landowners)	▪ Memorandum of Understanding (MoU) in place with two farming landowners in Rotomā catchment. Farm nutrient losses have been assessed and nutrient management plans are being developed.
Investigate and monitor the use of innovative technologies: New technologies are adopted, where appropriate, to reduce the amount of nutrients entering Lake Rotomā. (Who: Bay of Plenty Regional Council / landowners)	▪ On-going.
Continue lakeside wetland planting programme and explore enhancements: Bay of Plenty Regional Council and Rotorua District Council will explore the suitability of enhancing the existing Planting Programme. (Who: Bay of Plenty Regional Council, Rotorua District Council, community and iwi)	▪ The lake and lagoons are fully stock-fenced and planted. ▪ Bay of Plenty Regional Council is investigating the effectiveness of existing lagoons in protecting the lake from farm nutrients.
Adopt stewardship approach to forestry management: Landowners and Bay of Plenty Regional Council staff will monitor the emergence of new technologies and can adopt these if found to be suitable for reducing nutrient inputs into Lake Rotomā. (Who: Bay of Plenty Regional Council / landowners)	▪ Bay of Plenty Regional Council is exploring Memorandum of Understanding (MoU) with the main forestry landowner in Rotomā catchment.
Investigating alternative land uses: Councils will continue investigating alternative land uses that have low-nutrient impact and help meet the landowners' economic and social goals, and that they are consistent with the regional and district planning documents. (Who: Rotorua District Council and Bay of Plenty Regional Council)	▪ On-going.
Support research on phosphorus loss via groundwater and subsurface water flows and sample waterbodies in catchment for phosphorus levels: Bay of Plenty Regional Council will sample the lagoons, springs and ephemeral flow-paths on land around Lake Rotomā to quantify the amount of phosphorus leached from pastoral land in comparison to forestry and native bush cover. (Who: Bay of Plenty Regional Council)	▪ On-going lake water quality monitoring programme.
Review and develop regulatory rules: Bay of Plenty Regional Council will investigate developing a Rule to manage nutrient discharges from land use. This will include an analysis to assess the feasibility and appropriateness of a Rule 11 type regulation for the Rotomā catchment. (Who: Bay of Plenty Regional Council)	▪ Policy on managing and reducing nutrient discharges (from land use) relating to the Rotorua lakes, including Lake Rotomā, is being considered in the second generation Regional Policy Statement. The proposed Policy statement is due to be publicly notified in late 2010.

Lake Rotoehu

AT A GLANCE

Lake size: 800 ha
Catchment area: 4710 ha
Elevation: 295 m
Average depth: 8 m
Deepest point: 13 m
Formed: 8500 years ago
No surface outlet but drains via northwards groundwater flow to springs

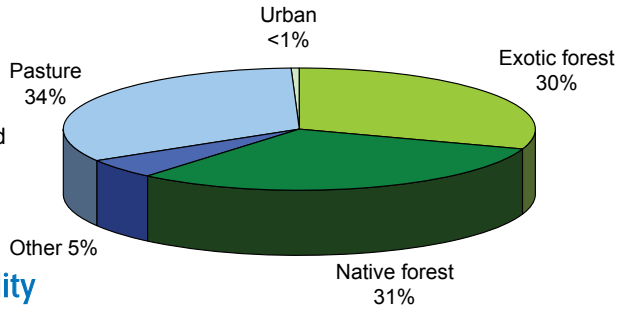
Rotoehu means "turbid" or discoloured waters. In former times, Lake Rotoehu was heavily populated with many pa sites located around its shores. The lake is very shallow and hides an island underneath its waters.

The historical meaning of Rotoehu, "turbid or murky" water, implies that the lake may never have been clear. The water quality remained fairly stable until 1993 when the level of nutrients and algae rose dramatically. This was attributed to a drop in the water level and a warm summer. It is a shallow lake with geothermal inputs and nutrient levels remain high.

Lake Rotoehu is included in the four Rotorua lakes that have received government funding assistance for restoration projects.

Land cover

The land cover in the Rotoehu catchment is divided fairly evenly into pasture and exotic and native forests.



Swimming water quality

Two sites are monitored for cyanobacteria; health warnings are put in place if algae levels are elevated above recreational standards.

This lake is tested for toxin forming algae. Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

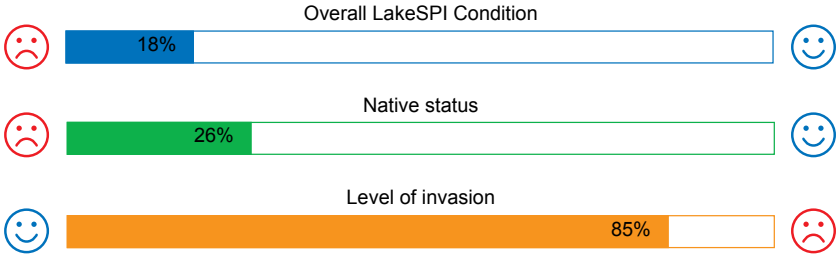
LakeSPI rank: Ranked 11th out of the 12 Rotorua lakes

Current condition: Poor

Long-term trend: Declining

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

Recent LakeSPI results highlight the ongoing negative impact hornwort, an invasive species that was accidentally introduced into the lake in 2004, is having in the lake. Hornwort is at times now surface-reaching in all but the deepest parts of this lake. The mechanical removal of hornwort and consequently also nutrients held in the plants, helps to strip nutrients from the lake, reducing its nutrient budget. This lake is categorised as being in poor condition.



(Rotoehu 2008 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

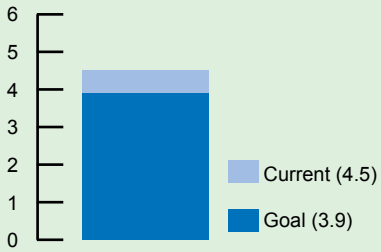
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

Blooms in 2008-2009 ran more or less consistently from the end of January in Lake Rotoehu to the beginning of April, continuing the pattern of persistent blooms in this lake.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. A low 2008-2009 TLI result for Lake Rotoehu has impacted on the three-yearly average TLI moving marginally. This indicates that the TLI remains relatively stable.



Lake Rotoehu TLI

STRATEGY AND ACTIONS

The Lake Rotoehu Action Plan was finalised in late 2007. This is a long-term plan to improve the lake's water quality, through changes such as better farming practices, weed harvesting and the creation of wetlands. The details of how we are doing so far are set out below. The Action Plan estimates the reductions in lake nutrients needed to achieve the TLI target are 8880 kg of nitrogen per year and 708 kg of phosphorus per year.

The proposed action and who is responsible for seeing it through:	How we are doing:
Land management: To work with Māori land trustees to implement protection works, particularly the edges of streams and the lake, by stock fencing and planting. (Who: Bay of Plenty Regional Council)	▪ The lake-edge protection works have been completed. ▪ Funding is available to assist land use change to meet action plan targets. ▪ Negotiations with Māori trustees were underway in August 2010 for an agreement to convert existing areas of pasture and grazing land to forestry.
Hornwort harvesting: To co-ordinate harvesting the hornwort weed for ten years. Test results have shown that harvesting removes nutrients. Harvesting could be extended if a commercial interest wanted to purchase hornwort biomass. (Who: Bay of Plenty Regional Council)	▪ A commercial operator was employed to harvest hornwort in autumn 2008, 2009 and 2010. In 2009 there were 3000 tonnes of harvested weed taken out of the catchment for disposal and in 2010 there were 2744 tonnes removed, achieving the nutrient reduction target for the lake for each year.
Wetlands: To construct a wetland to remove dissolved nitrogen from the Te Maero stream or to install sufficient floating wetlands to remove nitrogen directly from the lake, subject to cost-effectiveness investigations and legal requirements. (Who: Bay of Plenty Regional Council)	▪ Two floating wetlands are being trialled in Ōtautū Bay and tests in trial tanks are being conducted by NIWA to test the wetland's nutrient removal efficiency. ▪ Bay of Plenty Regional Council is conducting a full season trial to use floating wetlands as an effective nitrogen removal option; due for completion in August 2010. ▪ Bay of Plenty Regional Council has obtained consent for floating wetlands on 11 lakes, including Rotoehu.
Phosphorus removal: To work with the owners of Waitangi Soda Springs on options to remove phosphorus. (Who: Bay of Plenty Regional Council)	▪ Bay of Plenty Regional Council commenced the construction of the phosphorus locking plant at Waitangi Soda Springs in mid-2010.
Farm nutrient reduction: To help landowners reduce the quantity of farming nutrients entering the lake by changing the way the land is used or managed. (Who: Rotorua District Council, Bay of Plenty Regional Council, Te Arawa Lakes Trust, landowners)	▪ Nutrient benchmarks have been completed for all properties. Regional Council staff are now working with landowners in developing agreements to achieve and lock in the nutrient reduction targets.
Other nutrient removal: To continue to investigate other means of farm nutrient removal; based on cost and results. (Who: Bay of Plenty Regional Council)	▪ Other options investigated so far include a nitrate stream-treatment box, UV/Ozone treatment, the application of minerals (e.g. zeolite or alum), biological treatment and using grass carp or silver carp. Investigation is on-going.
Research: To continue to promote research into Lake Rotoehu and the catchment area, in order to understand better how the lake works and to manage it more effectively. (Who: Bay of Plenty Regional Council, Rotorua District Council, Te Arawa Lakes Trust)	▪ The University of Waikato is developing a computer model for Lake Rotoehu which will predict how a particular action will affect water quality. ▪ The Water Quality Technical Advisory Group is investigating the possibility of controlling nutrient releases from sediment to assist lake restoration. This includes investigations into artificial mixing of water in the lake using aeration as a means of preventing nutrient release from sediments during periods of lake stratification. This is being assessed as a potential trial for use of this technique in Lake Rotorua. ▪ Bay of Plenty Regional Council is investigating the application of a real-time monitoring buoy on Rotoehu for on-going water quality monitoring.
Sewerage reticulation: Addressing septic tank nutrients seeping to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ Sewerage treatement is proposed for Lake Rotoehu as part of the Lake Rotomā sewage scheme. Technical design work began in 2009 and construction is scheduled to commence in 2011. ▪ Recent changes to the rules under the OSET plan mean that by 2017 conventional septic tanks will either have to be consented by Bay of Plenty Regional Council, or be replaced with an advanced system where reticulation is not available.
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.

A local's perspective

"The waters and surrounding land of Te Rotoehu sustained the people of Ngati Pikiao after our ancestors settled on the shores of Rotoehu. Their migration inland from the coast began shortly after the landing of the Te Arawa canoe. It goes without saying that the well being of the lake is as important to us as it is for the community living around the lake.
The Waitangi 3 Trust, as descendents of those ancestors, is pleased to be working with Bay of Plenty Regional Council to construct a P locking plant that will improve water quality of Te Rotoehu."

Davey Gardiner, Chairman of Waitangi 3 Trust

Hornwort harvesting is carried out on Lake Rotoehu as part of the lake nutrient management plan. Harvesting is budgeted to be carried out each season over ten years. Nutrient removed in this way is dependent on the lake weed growth available for harvesting each season. In 2009, more than 3000 tonnes of hornwort was removed, equating to eight tonnes of nitrogen from the catchment.

Lake Ōkataina

Te Moana i kataina ā Te Rangitakaroro

AT A GLANCE

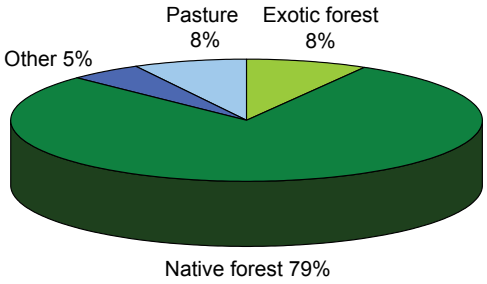
Lake size: 1080 ha
Catchment area: 6290 ha
Elevation: 311 m
Average depth: 39 m
Deepest point: 79 m
Formed: about 7000 yrs ago
Drains to Lake Tarawera via subsurface flow

The name Ōkataina means "The lake of laughter", a shortened form of the original name Te Moana-i-kataina-ā-Te Rangitakaroro, which means "The ocean where Te Rangitakaroro laughed". Te Rangitakaroro and his warriors were resting when one member of his group referred to the lake as an ocean and this was seen as a great joke by the rest of the group. Their laughter echoed around the lake and now remains enshrined in its name.

Lake Ōkataina was an important link in pre-European travel routes, when canoes were carried from Lake Tarawera to Lake Ōkataina. The lake and surrounding scenic reserve is remote and beautiful, with native bush down to the water's edge containing fine examples of rimu, totara, rata and kahikatea.

Land cover

The land cover in the Ōkataina catchment is predominantly native forest.



Swimming water quality

The lake has one monitoring site with an overall very good grade for recreational bathing.

This lake is tested for faecal indicator bacteria. Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

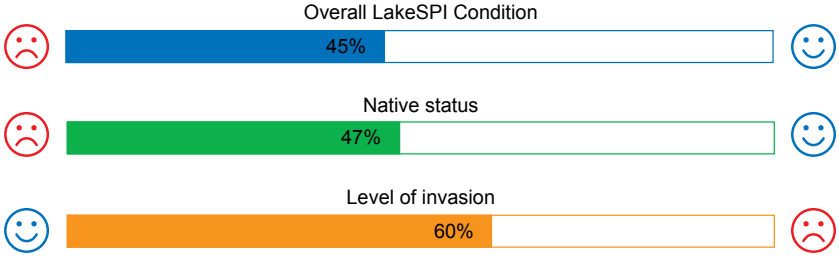
LakeSPI rank: Ranked 3rd out of the 12 Rotorua lakes

Current condition: Good

Long-term trend: Stable

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

All three indices (native, invasive and LakeSPI condition) have remained relatively stable since records began. However, there is a high risk of hornwort and egeria becoming established – both species pose a significant threat to Lake Ōkataina. There have been two recent hornwort incursions; one in 2007, which was neutralised and another in 2009. The recent incursion has been found in a restricted arm of the lake and appears to have come in via an anchor chain. An eradication programme has been put in place but it is too early to predict whether it can be effectively controlled.



(Ōkataina 2009 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

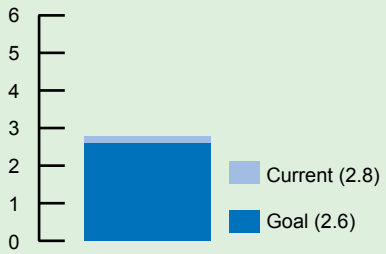
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

Lake Ōkataina has sustained infrequent and short-lived blooms in the past, but none have been recorded for several years.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The TLI for Lake Ōkataina remains above the target, but has decreased compared the previous year. A downward trend of the three-yearly average TLI has occurred over the last five years.



Lake Ōkataina TLI

STRATEGY AND ACTIONS

Recommendations in the Strategy for the Lakes of the Rotorua District include putting covenants on unreserved land at Lake Ōkataina, limiting certain recreational activities and working on pest control. The details of how we are doing so far are set out below.

The proposed action and who is responsible for seeing it through:	How we are doing:
Action Plan: The Bay of Plenty Regional Council Ten Year Plan 2009-2019 states that we will develop water quality action plans for two Rotorua lakes per financial year. There are currently six Rotorua lakes which require water quality action plans that need to be developed. The process of creating an official Action Plan for the lake Ōkataina is currently scheduled for 2011. (Who: Bay of Plenty Regional Council)	▪ The Action Plan process is currently scheduled to start in 2011.
Recreational ban: To consider changing district legislation to ban powerboats and diving on the lake. (Who: Rotorua District Council)	▪ Jet-skis, helicopters, aircraft and hovercraft are not permitted on or over the lake. Nor is recreational towing e.g. water-skiing. Other boats must travel at under 5 knots within 200 m of the shore. Responsibility for managing and enforcing this ban has been transferred to Bay of Plenty Regional Council as it has the resources to monitor the lake. ▪ There is no ban on diving.
Land covenants: To work with landowners on covenanting the non-reserved private land in the Ōkataina catchment. (Who: Rotorua District Council / Bay of Plenty Regional Council)	▪ No specific actions so far although covenanting will be considered if opportunities arise.
Pest control: To work with Land Information New Zealand (LINZ) and the Department of Conservation on plant and animal pest control around the catchment. Aquatic pests, including hornwort, pose a real threat to the biodiversity of Lake Ōkataina. (Who: Bay of Plenty Regional Council)	▪ Agencies continue to work together on pest control efforts. ▪ A hornwort incursion Response Plan has been formulated in response to a 2010 hornwort incursion in the south-western end of the lake. The plan involves spraying, isolation of the infestation from the main body of the lakes by a weed cordon and extensive monitoring and surveillance. Extensive public education is being undertaken and the status of hornwort is planned to be elevated in the next Regional Pest Management Strategy (RPMS).
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.

A local's perspective

"Only 20 minutes from the Rotorua International Airport, Lake Ōkataina is a stunningly spectacular and serene setting whose environment is something special to be looked after. Now it is classified as a passive lake it is the perfect place to relax and find peace of mind…"

Nick Berryman, Ōkataina Lodge

Lake Ōkareka

AT A GLANCE

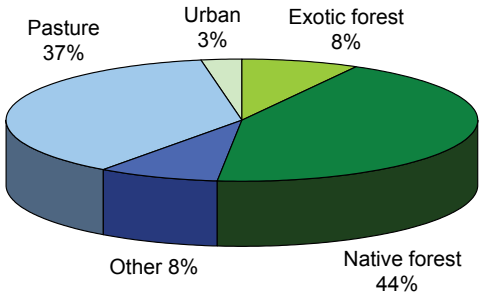
Lake size: 340 ha
Catchment area: 1980 ha
Elevation: 355 m
Average depth: 20 m
Deepest point: 34 m
Formed: 19,000 years ago
Drains to Lake Tarawera via Waitangi Springs and an artificial surface channel

The lake of "sweet food". In the days of old, Māori grew sweet potatoes or Kumara around the outside of the lake. The lake is now a very popular recreational resource and residential area.

Lake Ōkareka has reasonably clear, clean water and is used extensively for recreation such as boating, swimming and fishing. However, the quality of the water has been declining over recent years due to excess levels of nitrogen and phosphorus. These nutrients come from surrounding farmland, residential septic tanks and from the release of existing and accumulated nutrients from sediments on the lake bed.

Land cover

The land cover in the Ōkareka catchment is predominantly pasture and native forest.



Swimming water quality

The lake has two monitored sites – these have an overall very good grade for recreational bathing. Health warnings are put in place if algae levels are elevated above recreational standards.

The lakes are tested for faecal indicator bacteria and toxin forming algae. Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

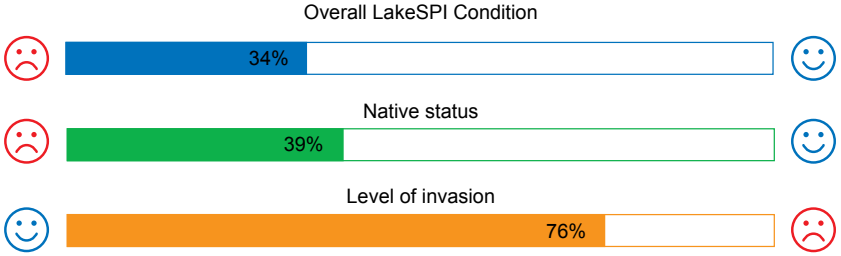
LakeSPI rank: Ranked 5th out of the 12 Rotorua lakes

Current condition: Average

Long-term trend: Declining

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

Egeria weed was first reported in Lake Ōkareka in 2000 and continues to spread around the lake occupying deeper water than the longer established pest weed lagarosiphon. Currently the lake is still free of hornwort, the region's worst aquatic weed; however if accidentally introduced, it would be expected to eliminate all remaining deep water native charophyte meadows.



(Ōkareka 2009 – source NIWA)

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Lake health indicators

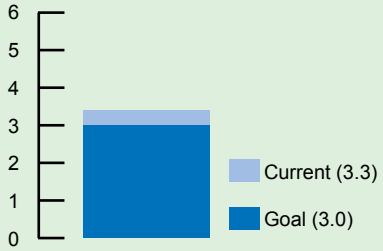
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

Over the last two to three seasons, potentially toxic cyanobacteria species have twice been recorded in Lake Ōkareka. Although the blooms have been short-lived, Ōkareka has shown similar effects to a number of other occasionally monitored lakes in the region.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The three-yearly average for Ōkareka indicates little change over the last five years.



Lake Ōkareka TLI

STRATEGY AND ACTIONS

The Lake Ōkareka Catchment Management Plan was developed in 2004. This is a long-term plan to improve the water quality of the lake, through changes like sewage reticulation, in-lake chemical treatment and farm nutrient management. It has been calculated that the load nutrients needed to reach the target TLI of 3.0 are 2.5 tonnes per year of nitrogen and 0.08 tonnes per year of phosphorus. Details of how we are doing so far are set out below.

The proposed action and who is responsible for seeing it through:	How we are doing:
Sewerage: To proceed urgently with a full reticulated sewerage scheme for the Lake Ōkareka area. This will extend to public facilities at the nearby Lake Tikitapu (Blue Lake). (Who: Rotorua District Council)	▪ A construction contract has now been let for reticulation to Lake Tikitapu, with completion expected by October 2010. ▪ In March 2008 the Government announced funding assistance which includes a 50 percent share of reticulation costs.
Wetlands: Build wetlands to reduce the amount of nitrogen and phosphorus entering the lake. Two sites were to be investigated: Millar Road and along the southern lake edge. (Who: Bay of Plenty Regional Council)	▪ Investigations found the Millar Road wetlands site was not technically feasible. ▪ Wetland planting has taken place at points along the southern lake edge. ▪ No action on establishing wetlands for stormwater treatment or reviewing stormwater infrastructure.
Nutrient reduction: Discuss ways of reducing the level of farming nutrients entering the lake with individual rural landowners. These include fencing streams to exclude stock from waterways and retiring steep erosion-prone land to bush or forestry. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ All lake shore now protected/fenced from stock access.
Land-use change: To make provision for changing the way 200 ha of land is used. This includes changing council land plans, investigating the concept of a regional park and exploring the possibility of setting up a 'large-land owners' group to discuss land-use changes. This would reduce the nitrogen loads by up to 0.9 tonnes per year and 0.05 tonnes of total phosphorus. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ 50 percent (approximately 100 ha) of the target land-use change has been secured. ▪ Forestry information workshops have been held for landowners. ▪ Currently negotiating agreements with landowners for land-use change. ▪ Initiated project to target phosphorus run off with land owners for 2010-2011.
Lake treatment: To continue to evaluate engineering and treatment options. Methods include: siphoning off and treating the nutrient-rich bottom water before discharging to Lake Tarawera, a groundwater treatment wall and phosphorus locking treatment. (Who: Bay of Plenty Regional Council)	▪ The siphon discharge option was discarded as it would be too costly to remove the phosphorus before the water entered Lake Tarawera. ▪ Phoslock, a clay-based phosphorus-removing product, was applied to the lake yearly over the period 2005-2007. ▪ Current projects are expected to meet the Lake Ōkareka TLI target.
Monitoring: To monitor the ongoing levels of nutrients in the water and to assess the effectiveness of various actions. (Who: Bay of Plenty Regional Council)	▪ Monthly water quality monitoring takes place with more intensive checks following Phoslock applications. ▪ Since 2006, phosphorus levels have been decreasing in the hypoliminion (bottom waters) due to Phoslock applications reducing phosphorus-release from the sediment. Nitrogen levels have stayed fairly constant. ▪ There are indications that more phosphorus is entering the lake from septic tank sources than previously thought.
Regulation: Lake Ōkareka is regulated under the Bay of Plenty Regional Water and Land Plan. (Who: Bay of Plenty Regional Council)	▪ Proposed Rule 14 to manage nutrients going into the Lake from land-use was withdrawn by Bay of Plenty Regional Council on 17 September 2009. This was in response to legal advice that the plan change was unworkable in its notified form. It is considered that the nutrient reduction targets can be reached through other methods including land-use change. ▪ Further intensification of land use in the Ōkareka catchment is currently prevented by Rule 11.

A local's perspective

"The fencing of the Lake Ōkareka margins adjacent to the farm land has kept the animals out of the lake. This fencing had also allowed some regeneration of wetland plant species, supplemented by additional plantings by Landcare Ōkareka volunteers. This has provided important habitat for a diverse range of birdlife all year round. This in turn has provided an attractive recreational area for walkers, birdwatchers and picnickers along the Lake Ōkareka public walkway."

Sandra Goodwin, Lake Ōkareka resident and Secretary Landcare Ōkareka

Lake Rotokakahi

Green Lake

AT A GLANCE

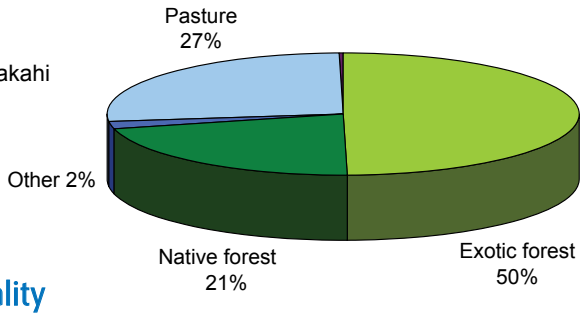
Lake size: 440 ha
Catchment area: 1860 ha
Elevation: 394 m
Average depth: 17.5 m
Deepest point: 32 m
Formed: 13,300 years ago
Drains to Lake Tarawera via Te Wairoa Stream

Rotokakahi means the lake of the shellfish "kakahi". While the Green Lake is now deserted and tapu, in days gone by it was heavily populated. The lake was known for its kakahi, an edible shellfish found in the lake's sandy bed. It is also famous for its island named Motutawa, the burial ground of many Māori ancestors.

Rotokakahi is privately owned by local iwi and considered tapu or sacred; with no swimming or boating permitted on the lake. A small island on the lake is also of historical significance, and many people are buried there.

Land cover

The land cover in the Rotokakahi catchment is predominantly exotic forestry with the remainder being pasture and native forest.



Swimming water quality

No swimming water quality is carried out on Lake Rotokakahi because it is a privately owned lake and not available for public swimming access.

LakeSPI (Submerged Plant Indicators)

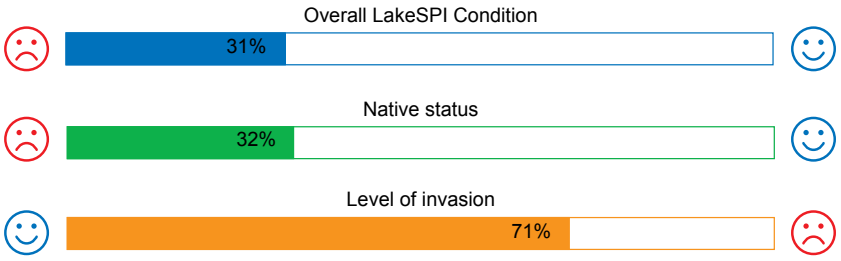
LakeSPI rank: Ranked 7th out of the 12 Rotorua lakes

Current condition: Average

Long-term trend: Declining

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

Plant growth is now restricted to a significantly shallower depth range indicating that there has been a decline in water quality. Deep occurring native charophyte meadows have all but disappeared from deeper parts of the lake, having being replaced by blue-green algal mats, a probable sign of declining lake health. Rotokakahi does not have any of the worst aquatic pest plants but is vulnerable to plant invasion from nearby lakes.



(Rotokakahi 2008 – source NIWA)

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Lake health indicators

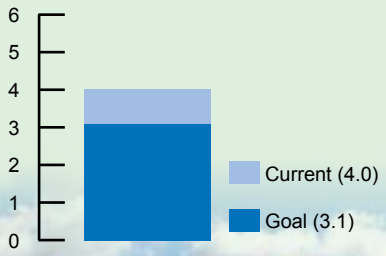
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

The lake is not required to be monitored for algal blooms and no blooms have been reported in recent years.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The TLI's calculated from 1999 to 2009 are based on only three TLI parameters, rather than four. Secchi depth can not be taken at the outlet stream and so a three parameter TLI is calculated. The annual average TLI for Lake Rotokakahi remains elevated for the second consecutive year at just above 4.0 units.



Lake Rotokakahi TLI

STRATEGY AND ACTIONS

The Strategy for the Lakes of the Rotorua District (2000) is a long-term strategy to improve the water quality of the lakes in the region. While there is no specific "action plan" yet for Lake Rotokakahi, the Strategy refers to co-operation with the Māori owners and the Lake Rotokakahi Trust towards how to protect the natural character of the lake.

The proposed action and who is responsible for seeing it through:	How we are doing:
Cooperation on goals: To work with the Lake Rotokakahi Trust, the Department of Conservation and landowners to achieve the Board of Control's goals for maintaining and enhancing the lake and its catchment area. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ Bay of Plenty Regional Council respects the request of the lake owners not to go onto the lake for monitoring. Regular monitoring has now been established with the assistance of one of the beneficiaries. ▪ Aside from some initial contact, the planned discussion has yet to take place. ▪ The southern edge of the lake is now planted and fenced off from livestock.
Action plan: The Bay of Plenty Regional Council Ten Year Plan 2009-2019 states that we will develop water quality action plans for two Rotorua lakes per financial year. There are currently six Rotorua lakes which require water quality action plans that need to be developed. The process of creating an official Action Plan for the Lake Rotokakahi is currently scheduled for 2011. (Who: Bay of Plenty Regional Council)	▪ Starting the Action Plan process is currently scheduled for 2011.
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.

Local action

Joe Butterworth, from Ngāti Tumatawera / Ngāti Wahiao – Tūhourangi, obtained special tribal permission to carry out research on this private lake.

The outcomes of this study suggest that the lake has undergone further water quality degradation as indicated by a lengthened period of anoxia in the bottom waters of the lake during summer, increased algal biomass and reduced water clarity.

The thermocline (water layer that prevents mixing of oxygen rich surface waters with oxygen depleted bottom waters during summer) corresponds to the lower distributional limit of the kakahi. In lakes that stratify the thermocline could be a major limiting factor for kakahi colonising deeper areas. Of particular concern is the ability of kakahi to survive prolonged periods of depleted oxygen in lakes with degrading water quality.

Joe Butterworth surveying the kakahi Echyridella menziesii population in Lake Rotokakahi. A University of Waikato M.Sc. research study looking at lake water quality trends and key environmental determinants of the kakahi or freshwater mussel.

Lake Rotomahana

AT A GLANCE

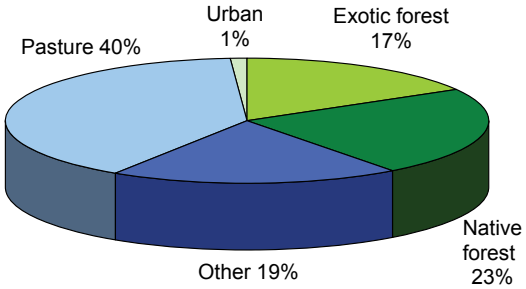
Lake size: 900 ha
Catchment area: 8370 ha
Elevation: 339 m
Average depth: 60 m
Deepest point: 125 m
Modified and enlarged in 1886 Tarawera eruption
Drains probably to Lake Tarawera by subsurface flow

Rotomahana means "Warm lake". Prior to the Tarawera eruption, this lake comprised two smaller lakes – Lake Rotomahana (warm) and Lake Makariri (cold). Rotomahana was the site of the famous Pink and White Terraces, destroyed by the Tarawera eruption.

Lake Rotomahana was the site of the geothermal "Pink and White Terraces", once considered the eighth wonder of the natural world. The terraces were destroyed in the 1886 Tarawera eruption, which also substantially altered the lake. Today, it is the deepest of the Rotorua lakes and is said to contain the purest strain of rainbow trout in the world.

Land cover

The land cover in the Rotomahana catchment is predominantly pasture and exotic forest.



Swimming water quality

No testing done - there is limited public access to this lake.

LakeSPI (Submerged Plant Indicators)

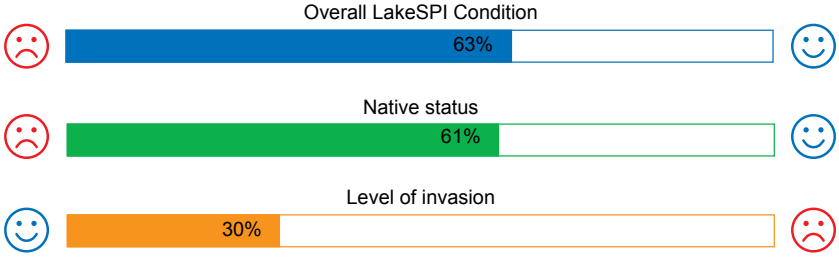
LakeSPI rank: Ranked 1st (highest) out of the 12 Rotorua lakes

Current condition: Good

Long-term trend: Stable but with signs of decline

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

Lake Rotomahana has until recently had the highest native condition index score and the lowest invasive index score out of all the Rotorua lakes. With the introduction of hornwort and egeria into Lake Rotomahana in 2006-2007, the once intact native plant communities are expected to decline in the short term. Egeria in particular has shown early signs of spread and in 2009 was found to have established at two of the five monitored LakeSPI sites.



(Rotomahana 2009 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

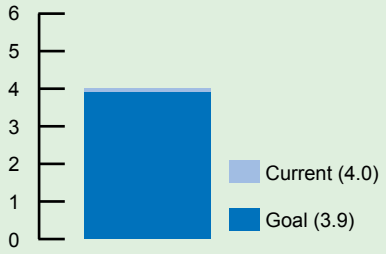
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

Algal blooms are not uncommon in Lake Rotomahana, but this lake is not required to be monitored on a routine basis.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The TLI for Lake Rotomahana continues to show a steady increase over the past five years. However, the annual average TLI for the last two years has been at 4.0 units, just above the target TLI of 3.9.



Lake Rotomahana TLI

STRATEGY AND ACTIONS

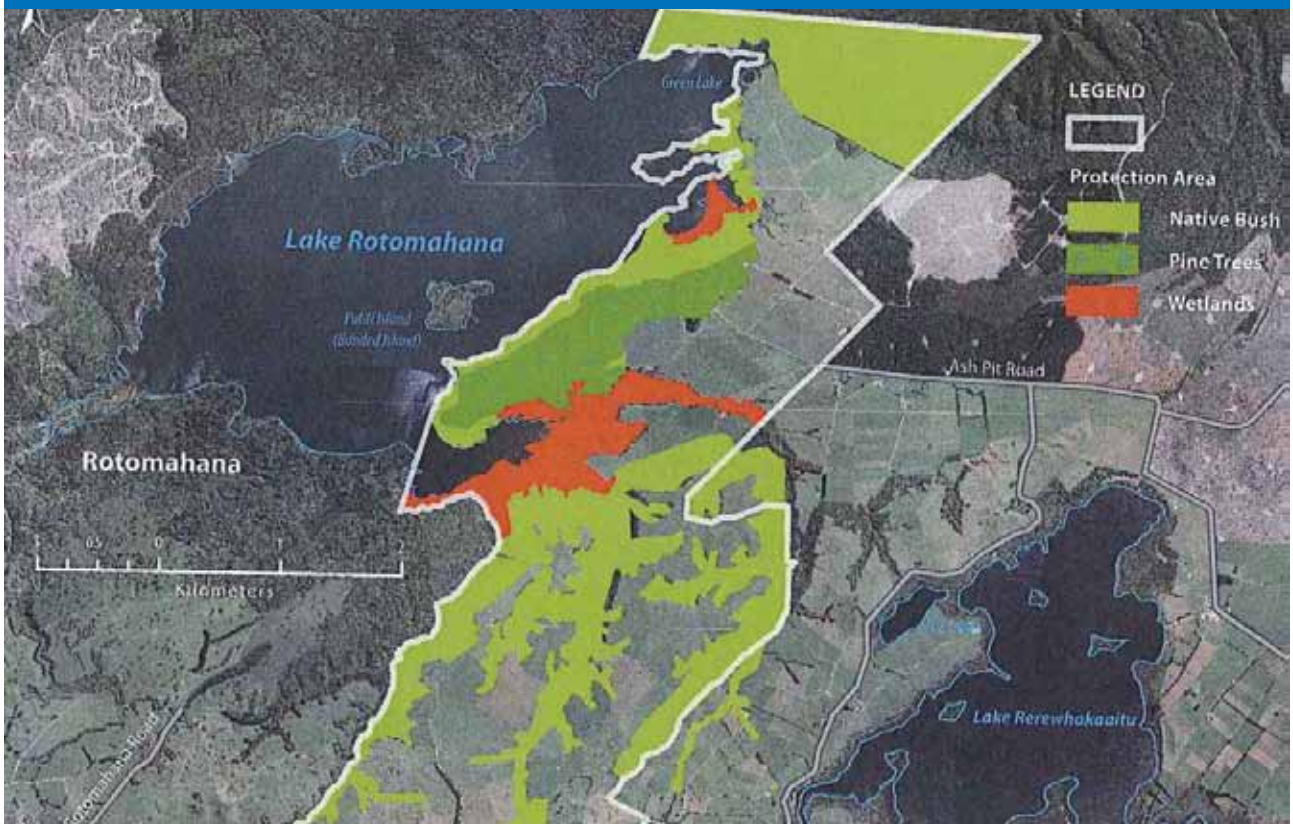
The Strategy for the Lakes of the Rotorua District (2000) is a long-term strategy to improve the water quality of the lakes in the region. While there is no action plan yet Lake Rotomahana, progress is still being made. The details of how we are doing so far are set out below.

The proposed action and who is responsible for seeing it through:	How we are doing:
Action Plan: The Bay of Plenty Regional Council Ten Year Plan 2009-2019 states that we will develop water quality action plans for two Rotorua lakes per financial year. There are currently six Rotorua lakes which require water quality action plans that need to be developed. The process of starting an official Action Plan for the Lake Rotomahana is currently scheduled for July 2012. (Who: Bay of Plenty Regional Council)	▪ Starting the Action Plan process is currently scheduled for July 2012.
Weed action: To work with conservation and research agencies on the threats to indigenous plants and animals in the lake. (Who: Bay of Plenty Regional Council / Department of Conservation)	▪ New incursions of the invasive weeds Egeria and Hornwort have been found in the lake and the option of weed cordons will be looked at to try and limit the spread of these weeds.
Boat-washing facilities: To consider installing boat-washing facilities at launch points around the lake. (Who: Bay of Plenty Regional Council)	▪ A mobile washdown facility has been constructed and will be operated at selected areas by Department of Conservation and Bay of Plenty Regional Council.
Lake-edge buffer-zones: To work with landowners on increasing stock fencing and plant buffer-zones in the catchment area. (Who: Bay of Plenty Regional Council)	▪ All the lake margins are now fully protected from livestock with vegetation buffer-zones.
Geothermal protection: To investigate the need to protect the natural geothermal features of the lake. (Who: Bay of Plenty Regional Council)	▪ The Rotomahana geothermal resources now have complete preservation status in the Regional Water and Land Plan.
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.

A local's perspective

"Onuku Māori Lands Trust has shown a very strong commitment towards environmental planning and protecting the quality of lake water. In total, more than 700 ha have been retired, including lake shore fencing of streams and the re-generation of native bush. An extensive programme of land care has seen the removal of stock access from and protection of all gullies draining into Lake Rotomahana."

Barnett Vercoe, Onuku Māori Lands Trust



Lake Rerewhakaaitu

AT A GLANCE

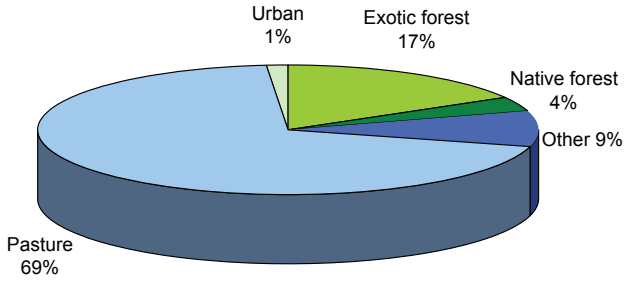
Lake size: 530 ha
Catchment area: 5290 ha
Elevation: 435 m
Average depth: 7 m
Deepest point: 15 m
Formed: 700 years ago
Groundwater links with Lake Rotomahana plus some overflow to the Mangaharakeke Stream and Rangitaiki River during high lakes levels.

Rerewhakaaitu means the lake of "wandering spirits." The land surrounding this lake, rich with the volcanic soils from the Tarawera eruption, was the last of the developed farming areas of the Rotorua District.

Lake Rerewhakaaitu lies at the base of the southern slopes of Mount Tarawera. It is a relatively shallow lake, with unusual catchment groundwater drainage. Most of the farmland groundwater does not enter the lake but drains into other catchments. The area around the lake is of special wildlife interest, with the largest breeding population of banded dotterel in the Rotorua district.

Land cover

The land cover in the Rerewhakaaitu catchment is predominantly pasture and exotic forest.



Swimming water quality

The lake has one monitored site with an overall very good grade for recreational bathing.

This lake is tested for faecal indicator bacteria. Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

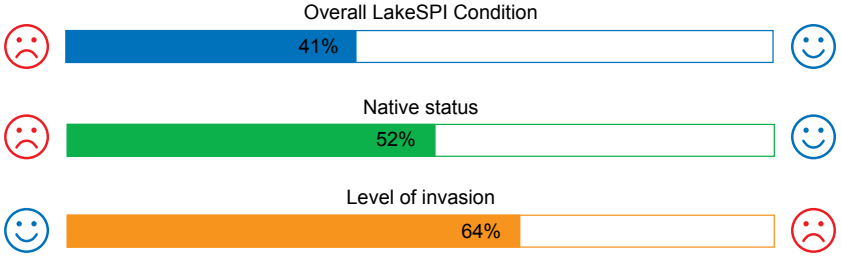
LakeSPI rank: Ranked 4th out of the 12 Rotorua lakes

Current condition: Good

Long-term trend: Stable

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

There have been some improvement in the ecological health of the lake since the 1970's, due to improved water quality and subsequent extension of the bottom plant boundary. However, negative effects have resulted from the accidental introduction of lagarosiphon and more recently egeria. This lake is presently free of hornwort, the worst aquatic pest plant in the region.



(Rerewhakaaitu 2008 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

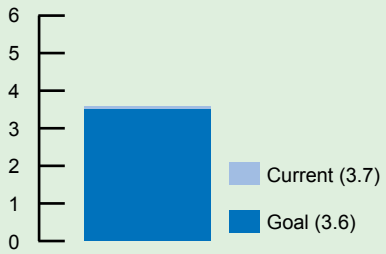
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

Rerewhakaaitu is not monitored for cyanobacteria blooms.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. Lake Rerewhakaaitu is mesotrophic and has had an increasing TLI trend since 2002. If the increasing trend continues, this will trigger Method 35 of the Regional Water and Land Plan.



Lake Rerewhakaaitu TLI

Photo: Alison Marshall

STRATEGY AND ACTIONS

The Strategy for the Lakes of the Rotorua District (2000) is a long-term strategy to improve the water quality of the lakes in the region. Further actions specific to Lake Rerewhakaaitu were identified by Bay of Plenty Regional Council in 2001 and by local farmers in subsequent Sustainable Farming Fund projects. These projects were designed to identify nutrient losses and propose mitigations. Landowners are in the process of developing their catchment plan to manage nutrient losses from their properties to a level that meets the target TLI.

The proposed action and who is responsible for seeing it through:	How we are doing:
Action plan: The Bay of Plenty Regional Council Ten Year Plan 2009-2019 states that we will develop water quality action plans for two Rotorua lakes per financial year. There are currently six Rotorua lakes which require water quality action plans that need to be developed. The process of starting an official Action Plan for the Lake Rerewhakaitu is currently scheduled for July 2012. (Who: Bay of Plenty Regional Council)	▪ Starting of a formal Action Plan process is currently scheduled for July 2012.
Stream-edge protection: To fence along the Awaroa and Mangakino streams and their main tributaries, along with the Mangaharakeke tributary channel. This will exclude stock, stabilise the land and help reduce nitrogen and phosphorus levels in the lake. (Who: Landowners)	▪ The Awaroa Stream is largely unfenced and unplanted, aside from some protection along a minor eastern tributary. ▪ The fencing of the Mangakino streams is 90 percent completed; remaining areas have been identified by the Farm Environmental walks and will be fenced.
Groundwater investigation: To investigate below ground in order to determine the groundwater catchment boundaries. This will tell us how much groundwater is draining into the lake. (Who: Bay of Plenty Regional Council)	▪ Bay of Plenty Regional Council has a programme of study in place to evaluate all the groundwater catchments for the Rotorua lakes area. The groundwater catchment for Lake Rerewhakaaitu was the first lake area to be evaluated. This work has been completed and published. Most groundwater in the catchment does not flow to the lake. ▪ At this time no further groundwater study is planned for Lake Rerewhakaaitu, however surface water quality monitoring surveys are continuing.
Nutrient management: Proposed project to assess current farm nutrient practices on individual farms and recommend improvements those farmers can implement voluntarily. (Who: Landowners assisted by Bay of Plenty Regional Council and other agencies)	▪ Farmers have commenced individual farm nutrient management plans. This is the first stage of a recently commenced Sustainable Farming Fund (SFF) project. ▪ The Rerewhakaaitu community is taking the initiative to create their own collective catchment management plan, supported by the Sustainable Farming Fund and the Bay of Plenty Regional Council.
Monitoring: To continue lake level, rainfall and aquatic plant monitoring. (Who: Bay of Plenty Regional Council)	▪ Monitoring is continuing, with annual reports on lake and rainfall levels, and biannual reports on aquatic plants
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.

A local's perspective

"Our family has farmed here since 1967 and the lake has been an integral part of our family life. Now that we have grandchildren, we want them to enjoy the lake as our children did. We are amending our farming and land-use practices and, along with other residents, undertaking lakeside planting. We are also developing an environmental management strategy for our property and the lake catchment. We see this as our contribution to help to improve the water quality for generations to come."

Anne Koopal, Lake Rerewhakaaitu restoration group

Lake Tikitapu

Blue Lake

AT A GLANCE

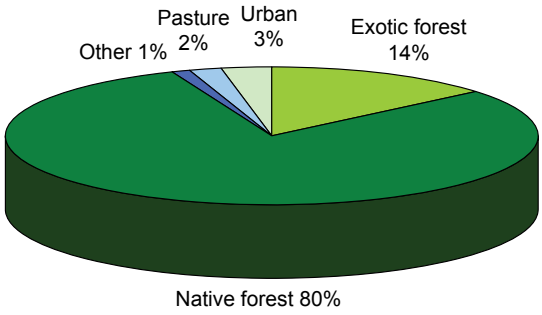
Lake size: 150 ha
Catchment area: 570 ha
Elevation: 415 m
Average depth: 18 m
Deepest point: 27.5 m
Formed: 13,500 years ago
No surface outlet but probably drains via groundwater to Lake Rotokakahi

In ancient times, the daughter of a high born chief was bathing in its crystal waters and wore the Tikitapu (sacred greenstone neck ornament). The piece dislodged itself while she swam and the blue waters of the lake are believed to still be hiding the tikitapu.

Lake Tikitapu is a small, circular lake framed by pretty native bush and forestry. Famous for its striking colour, it is commonly known as the Blue Lake and is adjacent to the slate-green coloured "Green Lake" / Lake Rotokakahi. With a water slide and an easy walking track around the lake, it is a popular location for family outings.

Land Cover

The land cover in the Tikitapu catchment is predominantly native forest.



Swimming water quality

The lake has one monitored site with an overall very good grade for recreational bathing. Health warnings are put in place if algae levels are elevated above recreational standards.

The lakes are tested for faecal indicator bacteria and toxin forming algae. Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

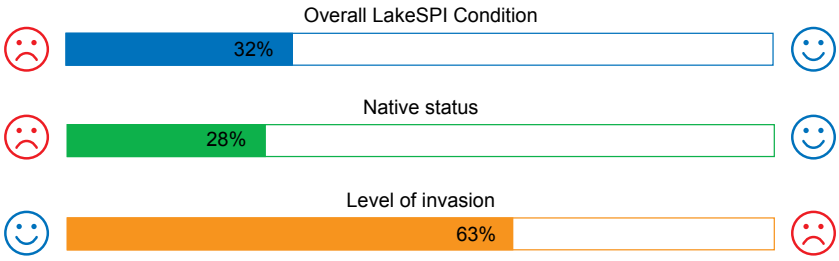
LakeSPI (Submerged Plant Indicators)

LakeSPI rank: Ranked 6th out of the 12 Rotorua lakes
Current condition: Average
Long-term trend: Declining

LakeSPI (Submerged Plant Indicators) provides an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

Since records began, Lake Tikitapu has experienced a 31% reduction in LakeSPI condition, the largest drop of any of the Rotorua Lakes over the same 1988-2008 period. The reduction in native condition has not been caused so much by the competitive impacts of invasive pest plant species as by the contracted depth range and condition of submerged native plant species. Where previously the bottom plant boundary extended to a depth of almost 13 metres, the deepest plants recorded in 2008 were in depths of less than nine metres.

Lake Tikitapu is presently free of two of the worst aquatic pest weeds, hornwort and egeria. It is however, surrounded by lakes containing these pests and is extremely vulnerable to infestation.



(Tikitapu 2008 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

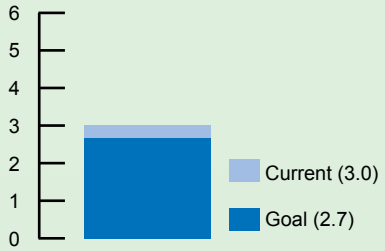
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

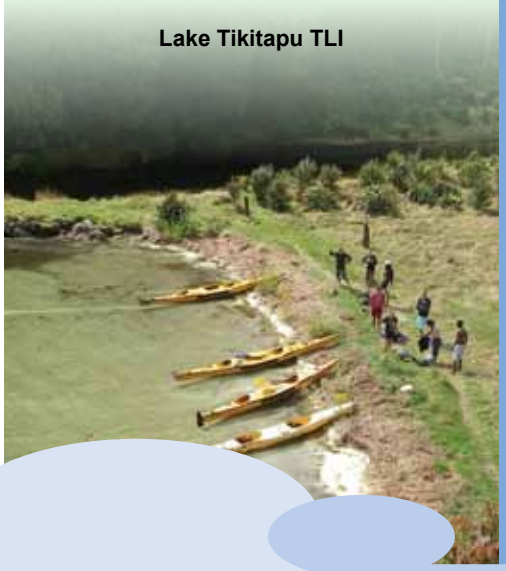
Frequent and persistent blue green algae blooms are not a feature of Lake Tikitapu and this lake is not currently monitored for blue-green algae.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. The three yearly average TLI for Lake Tikitapu increased slightly, by 0.01 unit. The increase puts the lake on the cusp of the mesotrophic classification and further away from the target TLI of 2.7 units.



Lake Tikitapu TLI



STRATEGY AND ACTIONS

The Strategy for the Lakes of the Rotorua District (2000) is a long-term strategy to improve the water quality of the lakes in the region. Sewage from the Tikitapu catchment will be reticulated for treatment along with Ōkareka sewage by October 2010. The details of how we are doing for Lake Tikitapu so far are set out below.

The proposed action and who is responsible for seeing it through:	How we are doing:
Action plan: The Bay of Plenty Regional Council Ten Year Plan 2009-2019 states that we will develop water quality action plans for two Rotorua lakes per financial year. There are currently six Rotorua lakes which require water quality action plans that need to be developed. (Who: Bay of Plenty Regional Council)	▪ Science to help define the water quality problem has been completed. ▪ The process of starting an official Action Plan for the Lake Tikitapu is currently scheduled for 2011.
Bush covenant: To work with landowners to covenant the bush around the lake. (Who: Rotorua District Council)	▪ Rotorua District Council works with individual owners to protect native bush as opportunities arise.
Recreational facilities: Consult with regular users of the lake on a programme to develop additional recreational facilities. (Who: Rotorua District Council)	▪ The Blue Lake Reserve foreshore and adjacent reserve has recently been upgraded after extensive consultation with users. One of the boat ramps is being renewed to meet the needs of lake users. Signage is being replaced and updated.
Sewerage reticulation: Consider linking with any future Ōkareka sewage reticulation scheme. (Who: Rotorua District Council)	▪ Rotorua District Council has let the contract the Ōkareka sewage reticulation scheme, which includes the camping ground and toilet facilities at Lake Tikitapu. The sewage scheme is programmed to be completed by October 2010.
Regulation: Review existing regulation aimed at reducing nutrient loss to the lake. (Who: Bay of Plenty Regional Council / Rotorua District Council)	▪ The second Bay of Plenty Regional Policy Statement has been prepared. A draft Regional Policy Statement was released for public comment early in 2010. The second Regional Policy Statement will provide high level direction on regulatory measures required to reduce nutrient inputs to the lake. A Proposed Bay of Plenty Regional Policy Statement is expected to be publicly notified for submissions in November 2010. ▪ The next Rotorua District Plan is being drafted and is due to be notified in February 2011.

A local's perspective

"The Blue Lake is well-known to be the most popular swimming lake in the area and thousands of locals and tourists love coming here every year expecting a clean, green environment. We have to keep it this way for now and the future, it's too important not to."

Jack Timmer, Blue Lake Top 10 Holiday Park

"Blue Lake is an essential part for our activities as a triathlon club. During summer we run weekly open water swim sessions, a fortnightly aquathon series, have a run/bike training session there and our Club Champs race is based at Blue Lake as well – it is the perfect setting for swim/paddle/bike and run activities."

Katrin Walbert, President Rotorua Association of Triathletes and Multisport (RATS)

Photo: Rotorua Duck Tours

Lake Ōkaro

Ngakaro

The meaning and origin of the name has been lost over time, but Lake Ōkaro is considered to be of significant taonga to Ngati Whaoa / Ngati Tahu.

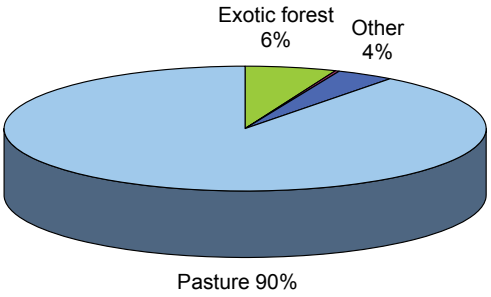
AT A GLANCE

Lake size: 31 ha
Catchment area: 367 ha
Elevation: 419 m
Average depth: 12.5 m
Deepest point: 18 m
Formed: 800 years ago
Drains to Lake Rotomahana via Haumi Stream

Lake Ōkaro/Ngakaro is the smallest of the Rotorua lakes under public management. Appreciated for its quiet rural setting, it is surrounded by farms and is also a popular water-skiing spot. The lake has had a significant algae problem due to the levels of nitrogen and phosphorus nutrients which have increased over several decades. The nutrient-rich deposits over the catchment from the 1886 Tarawera eruption, have an ongoing effect on the lake's water quality.

Land cover

The land cover in the Ōkaro catchment is predominantly pasture.



Swimming water quality

The lake has one monitored site with an overall very good grade for recreational bathing. However health warnings are often in place over summer due to the presence of toxin-forming algae. Health warnings are put in place if algae levels are elevated above recreational standards.

The lakes are tested for faecal indicator bacteria and toxin forming algae. Check **www.envbop.govt.nz** for up to date information on recreational water quality monitoring.

LakeSPI (Submerged Plant Indicators)

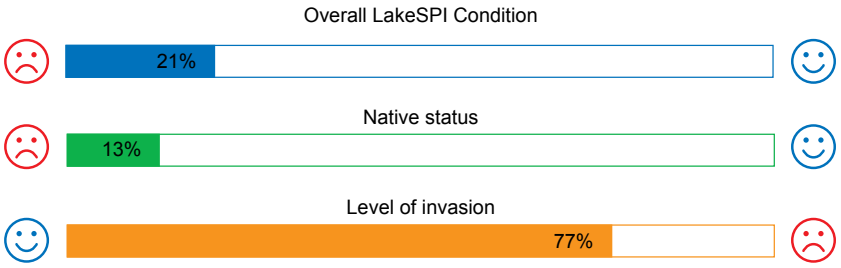
LakeSPI rank: Ranked 10th out of the 12 Rotorua lakes

Current condition: Poor

Long-term trend: Stable

LakeSPI (Submerged Plant Indicators) provide an additional lake health indicator by measuring how native submerged plant communities (native condition) alter in the presence of invasive submerged plants (invasive condition).

Poor water clarity in Lake Ōkaro restricts plant growth to the lake's shallow margins. The super-eutrophic conditions in the lake provide poor conditions for the invasive species elodea, the only introduced weed in this lake. Despite its minimal invasive weed species, the native condition index is the lowest (worst) of the 12 lakes and subsequently the LakeSPI score is one of the lowest recorded.



(Ōkaro 2009 – source NIWA)

For more detailed information on water quality trends refer to Environmental Publication 2009/12 "Rotorua Lakes Water Quality Report 2009", via the website Knowledge Centre on www.envbop.govt.nz.

Lake health indicators

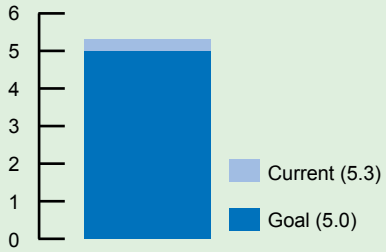
Blue-green algae

Blue-green algae (also referred to as cyanobacteria) are naturally occurring microscopic plants that can reach high concentrations (called blooms) in nutrient enriched lakes. Frequent and sustained algal blooms can signal a decline in lake condition. Because they produce harmful toxins, blue-green algae are also monitored to minimise the potential for human and animal health impacts.

Between 2000 and 2007, the lake had blooms for an average of 28 weeks each year, but has had predominantly summer blooms since 2008. While significant efforts are being made to reduce the nutrient burden/budget, blue-green algae blooms will remain a feature in this lake during the early summer months for some time to come.

Trophic Level Index (TLI)

The Trophic Level Index (TLI) is an overall indication of lake health based on a number of different criteria, values represent a three-yearly average. Better quality sites have a lower TLI. Lake Ōkaro's three-yearly average TLI continues to remain stable at 0.3 TLI units above the target of 5.0 units. Total nitrogen has remained reasonably constant over the past seven years. The sediment capping intervention applied to Lake Ōkaro has caused a marked improvement in phosphorus concentrations in the lake.



Lake Ōkaro TLI

STRATEGY AND ACTIONS

Bay of Plenty Regional Council, Rotorua District Council, Te Arawa, iwi and community representatives agreed upon the Lake Ōkaro Action Plan in 2006. This is a long-term plan to improve the lake's water quality, through changes such as better farming practices, in-lake treatment and the creation of wetlands. The Action Plan estimates the reductions in lake nutrients needed to achieve the TLI target are 910 kg of nitrogen per year and 20 kg of phosphorus per year.

The local community has created the Ōkaro Community Lake Restoration Group (OCLRG) to further improve land management and investigate a system of environmental accountability for the catchment. The OCLRG has succeeded in gaining funds from the Sustainable Farming Fund to continue their efforts to reduce nitrogen and phosphorus entering the lake.

The details of how we are doing so far are set out below.

The proposed action and who is responsible for seeing it through:	How we are doing:
Lakebed cap: To create a phosphorus-absorbing 'cap,' or mineral layer, on the lakebed to limit the release of phosphorus from the sediment. (Who: Bay of Plenty Regional Council)	▪ A modified zeolite compound was applied onto the lake by barge in September 2007. A second capping was undertaken in August 2009 and monitoring is ongoing to determine successes in locking up phosphorus from lake bed sediment.
Wetlands: To build a wetland area on council land and adjacent private farmland. This removes some of the nitrogen and phosphorus from the two main streams entering the lake. (Who: Bay of Plenty Regional Council)	▪ The wetland is performing well and is reducing nutrient inputs to the lake. Over a period of one year, nitrogen and phosphorus inputs were reduced by 47 percent and 50 percent respectively. Monitoring of nutrient, sediment and bacteria retention continued through 2009.
Buffer zones: To create riparian strips by planting and fencing along streams in the catchment. This excludes stock, stabilises land and helps reduce nitrogen and phosphorus levels. (Who: Bay of Plenty Regional Council / landowners)	▪ Stock-proof fencing is complete, and planting is 90 percent completed. ▪ An existing dam has been modified to buffer peak flows and other sites for detention dams are being investigated to further modify flows and reduce storm bypass of the existing constructed wetland.
Nutrient reduction: To investigate the adoption of better land-management practices to reduce storm water bypass of constructed through the wetlands. (Who: Bay of Plenty Regional Council / landowners)	▪ Two completed 'Herdhomes®' are being monitored. ▪ Allophane has been applied to the main stream feeding into lake Ōkaro to absorb phosphorus in the stream. ▪ Farmers are engaged in a Sustainable Farming Fund (SFF), supported by Bay of Plenty Regional Council, to account for and minimise nutrients losses.
Monitoring: To monitor the level of nutrients in the lake and assess the effectiveness of actions taken to improve water quality. (Who: Bay of Plenty Regional Council)	▪ Comprehensive water quality monitoring takes place monthly, with weekly algae level monitoring in summer and autumn. ▪ Daily monitoring occurs after zeolite applications. ▪ The actions taken are being investigated for their effectiveness. ▪ University of Waikato has undertaken ongoing monitoring and modelling as part of a PhD study around sediment capping.
Regulation: Lake Ōkaro is regulated under the Bay of Plenty Regional Water and Land Plan. The second Regional Policy Statement has been drafted; one significant issue it will address is that of water quality in the Rotorua Lakes. (Who: Bay of Plenty Regional Council)	▪ The proposed Rule 15, to manage nutrients going into the lake from land-use, was withdrawn by Council on 17 September 2009. This was in response to legal advice that the plan change was unworkable. ▪ Lake Ōkaro remains regulated under Rule 11. ▪ The next Regional Policy Statement has been drafted and this draft was released to the public for comment early in 2010. ▪ Public comment on the draft Regional Policy Statement closed on 1 April 2010.

Lake action snapshot

"I grew up waterskiing on the lake and every morning when I wake I see the lake. It's important that we as a local community take responsibility and work to improve the lake for future generations."

Megan Birchall – Third generation dairy farmer

Photo left: Tom Bruere plants a native tree on Rotorua District Council reserve at Lake Ōkaro as part of Ōkaro Community Lake Restoration Group's project.

What Can You Do?

Everyone can play a part in maintaining and improving lake quality.

As a lakeside resident or lake user, you can do many small things to help keep our lakes clean and healthy:

- Watch your nutrients
- Avoid draining poisons
- Clean your boat – check, clean and dry
- Look after lake edges
- Consider other lake users
- Join a care group

Watch your nutrients

We know that nitrogen and phosphorus have a major effect on water quality. These nutrients feed the algae and this can lead to algal and cyanobacterial blooms that prompt health warnings. So – what can you do?

Look after your septic tank

Septic tanks need to be pumped out every two years irrespective of usage. The build up of sewage solids in the base of the tank reduces the efficiency of the tank to settle any new solids and prevent them from clogging the disposal drains. Where disposal drains become clogged, water will seep to the surface and result in odours and a public health risk from bacteria. Should this occur you will need to get a drainlayer to install a new disposal field. One method of reducing the potential of failure of the disposal field is to install an effluent solids filter inside your septic tank.

For advanced effluent treatment systems, the operation of the unit should be in accordance with the manufacturer's instructions. These systems will also require pumping out in order to maintain efficient operation.

Buy the right detergent

Some detergent powders and liquids used for washing clothes, dishes and cars have high phosphate levels. Buy detergents with an "Environmental Choice New Zealand", "low P", or "no P" label, and don't use more than you need.

Buy biodegradable

Check that your cleaning products are biodegradable. Some cleaning products are not okay to use with septic tanks or advanced on-site systems.

Compost green waste

If you have a septic tank or a more advanced nutrient-removing on-site system, avoid using a sink-grinder to get rid of green waste; compost it instead.

Use fertiliser sparingly

Compost, blood and bone, "organic" and slow-release mixtures are best as they release nutrients into the soil more slowly.

Avoid draining poisons

Poisons pollute the lakes. They can harm plant and animal species in the lake and make lake ecosystems sick. Around the Rotorua lakes, the most common way that poisons enter streams and lakes is through stormwater drains and channels.

Residues from cars (oil, rubber, heavy metals), cleaning products (bleaches, chemical detergents), household products (rinsed paint, herbicides) and grit and dirt wash off solid surfaces, like driveways and roofs and eventually flow into the lake. So what can you do?

Wash your car on the grass

Wash your car, boat and bike on the lawn or at a car wash, not on the driveway or street where chemicals can wash directly into waterways.

Recycle chemicals

Don't tip out oil, paint, pesticides or other chemicals where they can flow into drains, streams or lakes. Instead, take them to an approved Hazmobile or contact your District Council for disposal advice; some councils offer a free hazardous waste disposal facility at the district landfill.

Grow a lawn

Minimise "hard" surfaces that don't absorb runoff, like tar-seal, concrete or paving. If you do have them design a way to capture some of the runoff, like grass buffers, small soak trenches filled with stones or bark, or leave spaces between hard surfaces so the soil can absorb the stormwater.

Clean your boat

CHECK CLEAN DRY
BETWEEN WATERWAYS

Some lakes are infested with submerged weed beds. These weeds can sprout from a single fragment and spread quickly. They take over the native lake plant beds which are home to many native species, and displace them with dense, thick, tall, weed material. The good news is that some lakes are free of these weeds. The bad news is that it only takes a fragment of weed stuck on a boat or propeller to start a new infestation.

WHAT CAN YOU DO?

Pest fish (e.g. koi carp, rudd and catfish) in the lakes can also cause problems. The Rotorua lakes don't have many pest fish species yet. These fish stir up lakebed sediments as they look for food, eat and remove aquatic plants and prey on native fish and their eggs. This makes lake water murky and wipes out native species. It also increases nutrients and algae, as floating sediments can release nutrients into the water column (which algae use to grow). They can also alter the food web so there is less zooplankton to eat algae. Fish eggs can be transported on weed attached to boat trailers.

The alga *Didymosphenia germinata* (didymo) is an invasive species that occupies freshwater areas. Didymo forms large mats on the bottom of rivers and streams affecting plant growth, food sources for fish and recreational enjoyment. Once didymo has established in a waterway it is virtually impossible to eradicate. The South Island of New Zealand is currently a controlled area for didymo, while the North Island is thought to be didymo free. And we want to keep it that way!

To stop the spread of aquatic pests, waterway users need to follow the Check, Clean, Dry routine if moving between waterways. Check and remove all obvious clumps of weed

from items that have been in the water. Clean all items for at least one minute with a 5 percent detergent solution. Dry all items completely for a period of at least 48 hours. This is particularly important if you are boating in more than one lake, for example moving from Lake Rotoehu to Lake Rotomā.

Look after lake edges

If you own lakeside property, create a plant buffer zone along the margins and low lying areas around the lake margin. Lake edge buffer zones help capture water runoff during storms. These can be full of sediments and/or nutrients. Without a vegetation zone, large amounts of sediment and nutrients can run off roads, lawns and farmland directly into the lake.

Call Bay of Plenty Regional Council to find out what you can plant and where.

Looking after your lakeside property will have many benefits including:

- Soaking up nutrients that can lead to algal blooms.
- Absorb pollutants.
- Remove dissolved nitrogen.
- Provide a home for fish to shelter and forage among the reeds.
- Make the lake look more pleasant and attractive.

Here are some other ideas to help protect lake water quality:

- Use sediment traps when exposing soil near a stream or lake edge. These are ponds or areas that allow sediment to settle out of water and runoff. They trap the sediment, avoiding build up around wetlands and sandy beaches.
- Choose garden plants that don't need much fertiliser to stay healthy. If you use fertiliser, only apply small amounts of slow-release fertilisers.

If you live along a lake edge, here are some more things you can do:

Build a wetland

Don't remove native plants and reeds in the water. Check out whether you can build your own wetland (or floating wetland) area. Call Bay of Plenty Regional Council for more information.

Grow a "soft" boundary

If you want to define the boundary between your property and the lake, use a "soft" edge like a thick hedge or a row of native shrubs. Don't build a "hard" edge, like a concrete or brick wall.

Consider other lake users

- Take your rubbish home, including biodegradable waste.
- Do not feed ducks, geese or swans in swimming areas. This encourages them to stay in these areas and their waste is a source of faecal coliforms.

Join a care group

- Join a landcare group to restore and look after your lake edges. If one doesn't exist, get together with your friends and start one. Bay of Plenty Regional Council and Rotorua District Council support landcare groups with training, resources and expertise.
- Build a floating wetland as a community group; these can be used in areas which are not suitable for conventional wetlands. Contact Bay of Plenty Regional Council for advice on creating and funding floating wetlands.

Where to get more information

Bay of Plenty Regional Council

Phone: 0800 ENV BOP (368 267)
Email: info@envbop.govt.nz
Website: www.envbop.govt.nz

Rotorua District Council

Phone: 07 348 4199
Email: mail@rdc.govt.nz
Website: www.rdc.govt.nz

Te Arawa Lakes Trust

Phone: 0508 TE ARAWA (832 729)
Website: www.tearawa.iwi.nz