LakeScience Rotorua

A newsletter about research on the Rotorua Lakes

Produced as an occasional publication by the LakesWater Quality Society, in association with the Royal Society of NZ (Rotorua Branch)

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Welcome to the sixth issue of our email newsletter for those involved in or interested in scientific or management work on the Rotorua Lakes. It is up to **you** to make this informal newsletter a success by providing it with copy – our Society is merely providing the vehicle. We email it free of charge to all those who attended the Rotorua Lakes 2001 Symposium and are on email, and also to anyone else who requests it. If you don't wish to receive future copies, please email us. We will snail mail it on request. The newsletters will also be posted on the Royal Society (Rotorua Branch) website at www.rotorua.rsnz.org. If you are interested in, or working on lakes, but not the Rotorua Lakes, we are still very happy to receive material from you and to send you newsletters.

The more copy we receive, the more frequently we will be able to send this newsletter out. Electronic copy is preferred but not essential. Only minimal editing is carried out. We hope to send another issue out in March 2003 – given sufficient copy.
Technical content of all contributions is essentially the responsibility of the authors

All material and correspondence relating to *LakeScience Rotorua* to Nick Miller, millern@wave.co.nz, 91 Te Akau Road, R D 4, ROTORUA.

We wish all of our readers a happy and peaceful festive season.

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NEWS

Rotorua Lakes 2002 Workshop: follow-up news

This workshop was held in Rotorua on Friday 20 September 2002. It dealt with the science and technology of sewering small lakeside settlements in the Rotorua District. Approximately 115 people attended, with representatives from local government, Crown Research Institutes, Government agencies, Universities, consulting firms, commerce, iwi and local residents.

Discussion focussed largely on Okawa Bay (Rotoiti) but Lake Okareka also received some attention. It is becoming increasingly apparent that there is still much to be learnt about Okawa Bay. Although a scientific case may be made that diverting sewage from this Bay will only have a limited overall effect when compared to an apparent large inflow of nutrients from the lakebed, the scientific personnel present were unanimous that the sewerage work should be undertaken, for the long term benefit of the Bay. The Rotorua District Council obviously took this message on board, as they have recently voted to proceed with the Okawa Bay Wastewater Scheme.

Rotorua Lakes 2003 is to take place
The LakesWater Quality Society has been awarded a generous grant from Environment Bay of Plenty's Environmental Enhancement Fund. This grant is for the purpose of organising and hosting a two-day symposium to be held in Rotorua next year. This symposium will be directed towards the consideration of practical land management options for improving the water quality in the Rotorua Lakes. A wide range of scientific personnel, local government representatives, representatives of major land users and interested locals are expected to attend. The precise date has yet to be set, but is likely to be in October 2003. The overall format will be similar to that of last year's symposium (Rotorua Lakes 2001) with presented papers and extensive open discussion forums.

Dr Vivienne Cassie-Cooper honoured
We were delighted to hear that Dr Vivienne Cassie-Cooper was awarded a prestigious Life Membership of the Australian Society for Phycology and Aquatic Botany (ASPAB) at a conference in Perth in October. A richly deserved acknowledgment of Vivienne's long-term commitment to the study of the New Zealand algal flora.

ROTORUA LAKES BIBLIOGRAPHY
A bibliography on matters relating to the water quality of the Rotorua Lakes is being prepared by an MLIS (Master of Library and Information Studies) student, in partial fulfilment of the course requirements of this degree. This bibliography is currently being prepared and the project will last over the summer. The resulting bibliography, prepared under the auspices of Environment BOP and with assistance from Victoria and Waikato Universities, is expected to be made available to those interested in or working on the lakes.

If you know of reports or publications that you think should be included, but which might not be readily available, it would be appreciated if you would contact the student concerned, so that as many items as possible are listed.

Contact: Claire Miller, email: cmiller@wave.co.nz

Here is a speculative contribution from Rowland Burdon, of Forest Research, Rotorua.
IRON - A JOKER IN THE PACK?
Rowland Burden

Much recent research on the open ocean has centred on the role of different nutrients limiting primary production by phytoplankton. This has been prompted, at least in part, by hopes that such production could be increased and serve as a means of greater carbon sequestration. A major finding has been that the addition of iron (Fe) to the ocean can lead to a dramatic increase in the primary production (Scientific American 287(2): 38-45 (August 2002)). This has been attributed to the added Fe enabling cyanobacteria (blue-green algae) to achieve greatly higher levels of nitrogen (N) fixation.

Despite the local, short-term responses, there are grave doubts as to whether adding large amounts of Fe to extensive areas the ocean would achieve any net long-term increase in carbon sequestration; indeed, there are reasons why it might actually be counterproductive. However, there is the question of whether the responses to Fe addition in the ocean may have some lessons for managing lakes.

A tantalising question for lake management is what are the conditions under which N-fixing cyanobacteria (NFCB), such as Anabaena, can flare up into blooms, with very adverse consequences for a lake's ecology, if not for human recreation and health as well. On the one hand, there is some tendency for to be favoured by N-limited trophic states, and this was evidently expressed strongly in blooms of Anabaena in the Wairua arm of Lake Tarawera during successive winters in the 1980s after

the planting of radiata pine was followed by greatly reduced inflows of N. It was apparently also exemplified by N-fixing cyanobacterial blooms stopping in a reservoir downstream of Canberra after N-stripping was discontinued (fide R.L. Oliver). On the other hand, N-limited states can very often exist without NFCB developing; moreover, such blooms may not be vigorous and not be associated with high levels of N-fixation, while if NFCB already exist they can respond strongly to added N. In many situations, the failure of N-fixing cyanobacteria to dominate can be attributed to climatic conditions such as windy weather or prevailing temperatures, but there are plenty of situations where no ready explanation exists.

Unless the conditions needed for NFCB to develop can be defined and achieved, maintaining a N-limited state seems to leave a residual risk of NFCB.

This leads back to the question of Fe. While a very abundant element, the available concentrations in lakes are often problematic. Historical analytical data for Fe loadings are evidently of little help. In the Tarawera case, reduced pH, resulting from the pine plantings may have elevated Fe inflows, and possibly phosphorus (P) inflows. Inorganic Fe and P can precipitate out together, depending on pH, but one may need to take account of fluctuating availability of different nutrients and the capacity of cyanobacteria to accumulate substantial reserves of some nutrients. Moreover, studies on some coastal waters of Australia
(Proceedings, 5th International Conf. on Toxic Cyanobacteria) have implicated iron in favouring a N-fixing cyanobacterium. They have also raised possibilities of Fe occurring in organic bioavailable forms
produced by forests (cf Environmental Science & Technology 1 Jan. 2000, p. 14A), which may make the exact role of Fe difficult to pin down.

[Thanks to Nick Miller for references cited in this last paragraph]

Courtesy of Greg Manzano, Rotorua District Council, here is a copy of a document recently submitted to the RDC Works Committee.

His Worship the Mayor
Chairperson and Members
WORKS COMMITTEE

Greg Manzano
Utilities Planning Manager

NOVEMBER 2002

LAKE OKAREKA ACTION PLAN DEVELOPMENT (8508409)

Introduction

A report outlining the broad principles towards the improvement of water quality at Lake Okareka was presented to the Committee on August 2002. The Committee resolved to accept the principles presented and approved that they be discussed with EBOP and the Okareka community.

At the same time, EBOP released a Working Paper entitled Lake Okareka Draft Action Plan which identified potential actions to reduce nutrient load to Lake Okareka.

During the Lake Water Quality Society Workshop on 20 September 2002, the similarities of the two papers was recognised. It was agreed that RDC and EBOP work together towards the development of an action plan for the improvement of water quality at Lake Okareka.

RDC and EBOP Officers met on 16 October 2002 to identify further works needed and develop a programme towards the completion of the action plan. The RDC and EBOP Officers in that meeting were later named as the Okareka Action Plan Steering Group. This report outlines the details of action items agreed in the meeting.

Programme

The agreed timeframe for the completion of the action plan is one year starting from November 2002.

A flow chart schedule showing the activities and proposed timelines is attached.

Details of the identified activities are presented in the following sections:

1) Letters to Interested Parties (Mid November 2002)

A letter will be sent at the start of the project to interested parties (refer to 5 below) to explain the process and their role in the action plan development. It will also invite the interested parties to name their representative to a working party that will be formed later.

2) Draft RDC/EBOP Action Plan for Lake Okareka (Completed before Christmas 2002)

The draft report will be a combination of the RDC and EBOP reports described earlier.

The report will highlight that the ultimate objective of the action plan is to reduce the current TLI at Lake Okareka to 3.0 which could be achieved by reducing the nutrient inputs to 2.3 Tons of Nitrogen and 0.07 Tons of Phosphorus.

The report will also include the following:

a) Identification of working party membership
b) Brief to working party
c) Programme for implementation
d) New data
e) Funding options
f) Possible management options
g) Strategy for handling growth

RDC and EBOP staff are now currently working on the draft report.

3) Public Meeting (January 2003)

The aim of the public meeting is to discuss with the wider community the completed draft action plan. The interested parties will also be requested to nominate their representative to the working party.

4) RDC/EBOP Political Report (Early February 2003)

A report will be prepared to both Councils to inform them on the progress of the action plan development, specifically the response of the community to the draft plan. Initial ideas on funding strategies will also be presented.

5) Working Party Set Up and Work on the Action Plan (February/March 2003)

After their nomination in January, the working party members will be provided with a copy of the draft action plan and asked to undertake a SWOT (Strength, Weakness, Opportunities, Threats) analysis on the plan. They will also be asked to undertake specific work as described in their brief. The proposed composition of the working party and their specific brief and required outputs is shown on the table below:

Working Party Member	Brief / Required Output
DOC & Fish and Game	• SWOT Analysis • Identify potential wetland sites and issues • Management of wildlife
Federated Farmers	• SWOT Analysis • Disseminate information to members • Farming cost • Nutrient/farming management practices • National philosophy on Nutrient Budgeting
Land Owners Large → Big Blocks Small → Lifestyle	• SWOT Analysis • Aspirations – willingness to convert or retire land • View on conversion of land
LORA (Lake Okareka Ratepayers Association)	• SWOT Analysis • Promotion of the concept and options to the local community • Catchment Values
Tangata Whenua	• SWOT Analysis • Meeting their cultural expectations
RDC/EBOP Steering Group	Project Management and Public Information / Promotion
Finance	Funding Concepts/Options

6) Working Party Output Discussion (April 2003)

This will be a one day extensive consultation meeting whereby the output of individual members of the working party are presented and discussed.

7) Funding Policy Development (July 2003)

This is intended to be a continuous process of consultation meetings between RDC and EBOP at staff level, starting from the time that the draft action plan is completed. It will be necessary at a later stage in the process that the political level of each council be involved in the consultation meetings. A common draft funding policy will then be submitted to the two Council's separately by July 2003.

8) Agree on the Options (August 2003)

RDC and EBOP after considering all of the information gathered in the process will then undertake an evaluation of all the options and agree on the option/s to be implemented.

A final draft of the action plan will then be prepared.

9) Public Consultation (September – October 2003)

The final draft of the action plan will then be circulated to the interested parties, the members of the working party and to the general public for final submission. A public meeting may be necessary to discuss the issues and options presented.

The action plan will then be finalised incorporating any agreed changes resulting from the public consultation.

10) Action Plan Adopted by both Councils (November 2003)

The final Action Plan will then be submitted to both Council's for adoption.

RECOMMENDATION E02/11/072

A) THAT THE REPORT BE RECEIVED

B) THAT RDC FORM A WORKING PARTY CONSISTING OF STAFF AND COUNCILLORS TO ADDRESS FUNDING POLICY ISSUES FOR LAKESIDE COMMUNITIES WATER QUALITY IMROVEMENT PROJECTS

CONTRIBUTION FROM BIOLOGICAL SCIENCES AT WAIKATO UNIVERSITY
David Hamilton

Eloise Ryan has recently started a field-based study in Lakes Tarawera, Okareka and Tikitapu. The study examines the vertical variability of phytoplankton species assemblages in each lake. These lakes all exhibit strong deep chlorophyll maxima, and this study will elucidate differences in nutrient status, light and temperature regimes between surface and deep phytoplankton communities.

Eloise and David Hamilton presented talks on the Rotorua lakes to the New Zealand Limnological Society meeting in Greymouth in November. Eloise also presented her work at the Australian Society for Phycology and Aquatic Botany (ASPAB) conference in Perth where she was awarded the best student oral presentation prize. David gave a talk on "A record of decline of water quality in the Rotorua lakes using dissolved oxygen". Lakes Tikitapu, Okareka and Okataina have shown progressive declines in summer concentrations of dissolved oxygen in bottom waters over the past 3-4 decades. Exotic macrophyte introductions may have brought about a decline in dissolved oxygen in Lake Okataina, where the catchment is largely unchanged through time. In Lake Tikitapu, an obvious change in the mixing dynamics, most likely due to decreased geothermal inputs, appears to have had a follow-on effect in reducing the dissolved oxygen levels.

David Burger is continuing his Ph.D. study on nutrient fluxes in Lake Rotorua. Stirred benthic chambers are being used to quantify nutrient fluxes from the sediment at three sites in the lake. The permanently marked sites are located at 7, 14 and 20m depths between the Ngongotaha boat ramp and Mokoia Island. Sample runs have been undertaken in September, October and December, and further experiments are planned for February, May and August 2003. The light and dark chambers penetrate into the sediment and isolate the sediment and overlying water. The chambers are sampled at regular time intervals over 100 hours and nutrient release rates are then calculated based on the changes in nutrient concentration over time. Sedimentation traps, to measure downward nutrient fluxes, have also been deployed during the chamber experiments. Additionally, a permanent thermistor chain has been deployed to log temperature changes throughout the water column over one year. This will identify

stratification and mixing patterns in the lake, both of which are important processes governing nutrient release rates and availability to algae.

Here is the executive Summary from a NIWA report on the effects of stormwater on Lake Rotorua, as presented to the RDC Works Committee in November. Among other information, it was shown that urban stormwater contributes 2% of the total nitrogen and 5% of the total phosphorus inputs to the lake nutrient load annually.

Executive Summary

Rotorua City's stormwater reticulation system involves discharge to Lake Rotorua, either directly via sub surface drains or indirectly via discharge to streams passing through the urban areas. Contaminants washed by rainfall from impervious surfaces such as roofs and roads may have undesirable effects on aquatic organisms residing in either the water column or sediments of these receiving waters.

The potential impact on these habitats has been assessed by several means, ranging from prediction on the basis of stormwater characteristics and toxicity testing, to observation via biological surveys in streams and areas of Lake Rotorua close to stormwater discharge points.

From this information it is concluded that:

- Rotorua City's stormwater contains all of the contaminants conventionally associated with urban stormwater;
- contaminant concentrations fall into the low-to-average range observed for other New Zealand cities;
- nonetheless, contaminant concentrations can be an order of magnitude higher than appropriate water quality guidelines and would require a considerable dilution to comply with USEPA water quality guidelines. Since this dilution is not likely to be available in streams having a significant proportion of their catchment urbanised, this will result in short-term exceedances of water quality guidelines for some contaminants in streams during rainfall events;
- stormwater contamination of stream sediments is evident. Although this can lead to a long-term ecological impact, in contrast to the short-term impact in the water column caused by a rainfall event, sediment quality information indicates that this is not a serious issue in the urban streams;
- laboratory-based tests on stormwater samples confirm predictions of the relative toxicity of stormwater originating from different urban landuses and largely confirm the predictions of dilution required to meet a no-effects threshold in the receiving waters. The required. dilution is more available in Lake Rotorua than it is in the streams passing through Rotorua City;
- predictions based on water and sediment quality guidelines and on toxicity testing are moderated by the results of a biological survey of several urban streams. This survey concluded that there was measurable but minor degradation of stream habitat due to both elevated flows and stormwater contaminants. However, stream quality compared favourably with that found in other NZ cities. Specifically, the streams remain a suitable habitat for important species such as rainbow trout;
- lake sediments at sites receiving stormwater discharge showed low levels of contaminants normally associated with urban stormwater. Heavy metal contaminant concentrations were significantly lower than a severe sediment quality guideline, below which undesirable effects are seldom observed;

- although urban stormwater contains elevated levels of heavy metals such as zinc (Zn) and copper (Cu), both of which are potentially toxic to aquatic organisms, the concentrations of these metals in bulk lake water are approximately an order of magnitude lower than water quality guidelines which provide protection against long-term (chronic) undesirable effects;

- some contaminant bioaccumulation was evident in freshwater mussels and bullies resident in Lake Rotorua. For the mussels, contaminant concentrations were not markedly higher than those found in earlier studies for animals residing in areas of the lake well-removed from urban activities. For the bullies, contaminant concentrations were at least an order of magnitude lower than threshold (10% impact) concentrations;

- transplanted mussels showed no heavy metal bioaccumulation over a 70 day period but transplanted snails proved more sensitive. The urban stormwater signal was more perceptible at the Government Gardens location than at Utuhina and stronger at both than at the non-urban Waiteti location, although differences between all sites were not great;

- a survey of macroinvertebrate composition at the lake sites provides an integration of all other predictions and observations. Results are consistent with the measurable but weak signal of urban stormwater discharge seen in lake sediment and invertebrate bioaccumulation surveys. Invertebrate species richness (diversity) increased in the order Government Gardens < Utuhina < Waiteti, but the differences in overall community composition between the Utuhina and Waiteti locations were found to be not significant. This is a noteworthy conclusion, because the Utuhina location receives approximately 35% of Rotorua City's stormwater runoff whereas the Waiteti location receives the discharge from a rural landuse catchment.

From all the information gathered in this study, it is concluded that there is some impact on urban stream reaches due to their use to convey stormwater, but that this impact has not resulted in marked changes in or effects on receiving water communities or keystone species. For Lake Rotorua, the evidence from a number of approaches is that, while signals of urban stormwater discharge are detectable, these signals are small. Our considered conclusion is that consequent environmental impact is minor.