Zooplankton composition and a water quality assessment of seventeen Waikato lakes using rotifer community composition

CBER Contract Report 80

Client report prepared for
Environment Waikato

by

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Contents

Executive Summary | 1
Introduction | 2
Methods | 3
Results and Discussion | 3
  Community composition | 3
  Trophic state assessment | 7
References | 11

Appendix 1: List of “indicator” rotifer species recorded during this survey | 13
Executive Summary

Zooplankton species composition was documented from 17 Waikato lakes from net haul samples collected in late 2007 (summer) and early 2008 (autumn). The lakes examined were Harihari, Mangahia, Maratoto, Ngahewa, Ohinewai, Okowhao, Parangi, Rotokawau, Rotomanuka, Serpentine East, Serpentine North, Serpentine South, Taharoa, Tutaeinanga, Waahi, Waikare and Whangape.

A variety of species was observed during the study, including 41 rotifer, 5 cladoceran and 3 copepod taxa, mites and mysid shrimps. Most taxa recorded were typical inhabitants of New Zealand lakes. However, there appears to be a growing non-indigenous component to the zooplankton, with the freshwater jellyfish *Craspedacusta sowerbyi* (2 lakes), the rotifer *Conochilus exigus* (1 lake) and two *Daphnia* species (*D. dentifera* and an apparently new invader; widespread) recorded during this study.

Rotifer-inferred TLI estimates ranked the lakes from best to poorest in the following order: Lake Serpentine East (3.38), Maratoto (3.43), Serpentine South (3.76), Harihari (4.74), Ngahewa (4.93), Parangi (5.00), Mangahia (5.03), Serpentine North (5.10), Rotomanuka (5.32), Taharoa (5.68), Okowhao (6.11), Tutaeinanga (6.15), Ohinewai (6.67), Waikare (6.79), Rotokawau (7.46), Whangape (7.66) and Waahi (7.88). This ranking is comparable to assessments made using different methods elsewhere. In a previous Waikato lake study, the rotifer-inferred TLI value from Lake Taharoa samples collected in late 2006 was 2.7 (i.e., oligotrophic). A higher value in the current study may indicate that the rotifer community had a delayed response to a recent decline in water quality in this lake. Alternatively, it strengthens the supposition that accurate assessments using this method should be made when several (i.e., quarterly) samples are taken throughout the year. Nevertheless, the maximum difference in inferred TLI values between summer and autumn samples from a single lake in the current study was 2.0.
Introduction

In late 2007 and early 2008, Environment Waikato conducted surveys of 17 lakes in the Waikato region: Lakes Harihari, Mangahia, Maratoto, Ngahewa, Ohinewai, Okowhao, Parangi, Rotokawau, Rotomanuka, Serpentine East, Serpentine North, Serpentine South, Taharoa, Tutaeinanga, Waahi, Waikare and Whangape. Most of these lakes have little historic data relating to their water quality or biology. Additionally, some sites have limited access possibilities, further precluding the collection of long term water quality data. The inference of lake trophic state and other water quality characteristics typically relies on monthly sampling of a variety of indicators, but for lakes that are isolated or have difficult access such fine-scale monitoring is difficult or unfeasible. Biotic indices are commonly used in such circumstances as they integrate biological, physical and chemical factors over time, allowing for less fine-scale monitoring than traditional methods. Duggan et al. (2001a, b) found that trophic state was the major determinant of rotifer distribution among North Island lakes, and based on these responses developed a quantitative bioindicator index using rotifer community composition for inferring Trophic Lake Index (TLI) values (sensu Burns et al. 1999). This approach was used for ten Waikato lakes using single samples collected in late 2006 (see Duggan 2007). However, although rotifer-inferred TLI values ranked lakes similarly to an order predetermined by Environment Waikato, there were some discrepancies. One possible reason for these problems was that only single samples were used, as opposed to the quarterly sampling recommended by Duggan et al. (2001a).

In this report, zooplankton community composition was documented from plankton hauls from fourteen lakes sampled in late 2007 (summer) and early 2008 (autumn)(i.e., two samples from each lake). From the resulting species datasets, the Rotifer Community Index of Duggan et al. (2001a) was used to infer lake water quality.
Methods

Seventeen lakes were sampled by Environment Waikato staff for this study. Zooplankton were sampled from a central (or deep) position in each lake in late 2007 and early 2008, using vertical hauls through the entire water column with a plankton net (40µm mesh size; haul speed ~1 m.s\(^{-1}\)). Samples were immediately preserved using ethanol.

In the laboratory, preserved samples were examined for zooplankton community composition. As rotifers are the zooplankton group most useful for water quality monitoring, samples were enumerated until a total of at least 200 individuals of “indicator species” were recorded; i.e., species that have an assigned TLI optima and tolerance score given by Duggan et al. (2001a). Based on the resulting lists, the bioindicator scheme of Duggan et al. (2001a) was used to infer trophic state. All identifications were made to species level wherever possible.

Results and Discussion

Community composition

A wide variety of zooplankton taxa were recorded during the study. Forty one rotifer, five cladoceran and three copepod taxa were distinguished, as well as planktonic mites, mysid shrimps and the freshwater jellyfish *Craspedacusta sowerbyi* (Table 1). Most taxa were fairly typical North Island lake inhabitants. All of the rotifers recorded in this survey were also found in the North Island survey of Duggan et al. (2001a, 2002) except for *Brachionus lyratus* and *Polyarthra vulgaris*. Both of these species were recorded in the previous study of ten Waikato lakes by Duggan (2007), and are therefore not unusual. In this report I have not differentiated the records of *Brachionus lyratus* from *B. angularis* as they appeared morphologically very similar, and to form a gradient in morphology that made it difficult to confidently assign these specimens to one or the
other taxon. However, both are present in the Waikato lakes. *Conochilus exiguus* was recorded from Lake Serpentine East. This species is interesting in that it has only been recorded previously from Lakes Rotomanuka and Rotomanuka South in New Zealand, and outside of New Zealand only from North America, prompting Duggan et al. (2002, 2006) to suggest that this may constitute a non-indigenous species to New Zealand. Given the three New Zealand records to date are from a restricted geographical area this contention seemingly still holds.

Crustacean species recorded were generally also typical inhabitants of North Island lakes, and were similar to those recorded in the previous survey of Duggan (2007). The copepods *Boeckella delicata*, *Calamoecia lucasi* and *Mesocyclops leuckarti* were common representatives in the lakes, and are common components of the zooplankton in New Zealand more broadly (Chapman & Lewis 1976). Of the cladocerans, two *Ceriodaphnia* species were recorded that were not found in the previous Waikato lakes survey. However, both have previously been recorded as common in the Waikato lakes (Greenwood et al. 1991). In this survey I have grouped the *Daphnia* species as one taxon. *Daphnia dentifera*, a recently discovered North American non-indigenous species (Duggan et al. 2006), likely makes up a number of these records. However, a second morphologically similar, but larger, *Daphnia* species was also present in some lakes, which appears to constitute a new and previously unrecognised non-indigenous species. Further research is required to confidently assign a species name to this species, and to accurately differentiate it from *D. dentifera* in the samples. The mysid shrimp *Tenagomysis chiltoni* was recorded in Lakes Waahi and Waikare, where it has been recorded previously in great numbers (Chapman et al. 1991). Finally, the freshwater jellyfish *Craspedacusta sowerbyi*, a probable invader from China, was
Table 1. Zooplankton species present in the net hauls from seventeen Waikato lakes. Lakes are ordered alphabetically.

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**ROTIFERA**
- Anuraeopsis fissa
- Ascomorpha ovalis
- Asplanchna brightwelli
- Asplanchna priodonta
- Brachionus angularis/lyratus
- Brachionus budapedisnensis
- Brachionus caliciflorus
- Brachionus quadridentatus
- Cephalodella gibba
- Collotheca sp.
- Conochilus coenobasis
- Conochilus dossuarius
- Conochilus exiguus
- Conochilus unicornis
- Epiphantes macrourus
- Filinia novaezealandiae
- Filinia pejleri
- Filinia longiseta
- Hexarthra intermedia
- Hexarthra mira
- Keratella cochlearis
- Keratella procurea
- Keratella slacki
- Keratella tecta
- Keratella tropica
- Lecane bulla
- Lecane flexilis
- Lecane lunaris
- Monommata sp.
- Polyarthra dolichoptera
- Polyarthra vulgaris
- Pompholyx sp.
- Synchaeta longipes
- Synchaeta oblonga
- Synchaeta pecinata
- Trichocerca pusilla
- Trichocerca similis
- Trichocerca styliata
- Trichocerca tenuior
- Bdelloids

**ARTHROPODA**
- Cladocceans
  - Bosmina meridionalis
  - Ceriodaphnia cl. puchella
  - Ceriodaphnia dubia
  - Chyadorus sp.
  - Daphnia spp.

**Copepods**
- Boeckella delicata
- Calamoecia lucasi
- Mesocyclops leuckarti nauplii

**Mites**
- Mysid shrimp: Tenagomysis chiltoni

**Cnidaria**: Craspedacusta sowerbyi
Table 1 (cont). Zooplankton species present in the net hauls from seventeen Waikato lakes. Lakes are ordered alphabetically.

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**ARTHROPODA**

Cladoceans
- Bosmina meridionalis
- Ceriodaphnia cf. puchella
- Ceriodaphnia dubia
- Chydorus sp.
- Daphnia spp.
- Mites
- Mysid shrimp: Tenagomysis chiltoni
- CNIDARIA: Craspedacusta sowerbyi

Copepods
- Boeckella delicata
- Calamoecia lucasi
- Mesocioclops leuckarti
- nauplii

Mites
- X

Mysid shrimp: Tenagomysis chiltoni
- X

CNIDARIA: Craspedacusta sowerbyi
- X
recorded from Lake Serpentine East and Lake Serpentine North. Individuals recorded were very small, so it is unclear whether they formed a significant summer bloom. It is not known whether this species has been previously observed in these lakes, but it has been recorded widely through a number of Waikato lakes in the past (Boothroyd et al. 2002). Overall, with the presence of *Craspedacusta sowerbyi*, *Conochilus exigus*, and now potentially two non-indigenous *Daphnia* species, the Waikato lakes appear to have a high, and growing, representation of non-indigenous zooplankton species.

*Trophic state assessment*

Based on rotifer inferred TLI values, Lake Serpentine East had the best water quality, followed by Lakes Maratoto and Serpentine South (all mesotrophic; Table 1; Figure 1). Lakes Harihari and Ngahewa were assessed as eutrophic, while Lakes Parangi, Mangahia, Serpentine North, Rotomanuka and Taharoa were all assessed as supertrophic. All other lakes were assessed as hypertrophic, with Lakes Rotokawau, Whangape and Waahi all inferred to possess the poorest water quality (inferred TLIs >7: Figure 1). Although monitored data does not exist for most of these lakes to compare the rotifer inferred TLI results, the assessed rankings calculated here do not seem unreasonable. For example, lake order here was similar to that provided by Edwards et al. (2007) using the LakeSPI index, with Lake Serpentine East and South at the top of their assessment, and Lakes Whangape and Waahi at the bottom.

In the previous study of ten Waikato lakes by Duggan (2007), Lake Taharoa was assessed by the rotifer inferred TLI method as having good water quality (inferred TLI = 2.7), not in accordance with the lakes marked decline in water quality over the previous
Table 1. Rotifer inferred TLI values for 17 Waikato lakes from late 2007 (summer), early 2008 (autumn) samples, and an average of these values. Lakes are ordered from lowest to highest inferred TLI values.

<table>
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two years (pers. comm., Keri Neilson, Environment Waikato). However, the rotifer inferred TLI value from the current survey indicates that the water quality of Lake Taharoa is far worse than was assessed previously (average TLI = 5.7). Such a result would have more accurately reflected the rankings of lakes determined by Environment Waikato in the previous study. This may indicate that the zooplankton community composition may not have immediately responded to the change in water quality. Alternatively, the variance in assessed TLI values may have been a result of the need to obtain several samples from different times of the year to accurately infer lake trophic state. It was recommended by Duggan et al. (2001a) that four quarterly plankton samples be collected over a year and these be averaged to obtain an accurate trophic state assessment, as assessments made from single samples sometimes show wide variability (i.e., up to 4 TLI units for some samples; Duggan 1999). In the current study, the average

Figure 1: Averaged rotifer inferred TLI values from samples collected in late 2007 and early 2008 from seventeen Waikato Lakes. Lakes are ordered from lowest to highest inferred TLI values.
difference in inferred TLI values between summer and autumn samples was 0.9 across all lakes, with a maximum difference of 2.0 for Lake Waikare.
References


Duggan, I.C., Green, J.D. & Thomasson, K. (2001b), Do rotifers have potential as bioindicators of lake trophic state? *Verhandlungen - Internationale Vereinigung für Theoretische und Angewandte Limnologie* 27: 3497-3502.


Appendix 1

List of “indicator” rotifer species recorded during this survey as a percentage of all indicator taxa. Indicator taxa are ordered based on TLI optima from lowest to highest.
Appendix 1 (cont)

List of “indicator” rotifer species recorded during this survey as a percentage of all indicator taxa. Indicator taxa are ordered based on TLI optima from lowest to highest.