THE INFLUENCE OF NUTRIENT CONCENTRATION ON ALGAL BIOMASS AND INVERTEBRATE COMMUNITIES IN AGRICULTURAL STREAMS

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Ecology at Massey University, Palmerston North, New Zealand.

Mark Peter Hamer

2003

Erratum Sheet

Page 16 line 3. effect should be spelt affect, these words are mixed up throughout the thesis.

Page 20 line 5. Acid washed water bottles were used to store the water samples in.

Page 20 line 12. Minimum detection limits were given as zero for both nitrate and phosphorous in the DR/2010 spectrophotometer procedures manual.

Page 20 line 14. Stone size class was determined in the field using a "gravelometer".

Page 21 line 18. Metrices should be spelt Metrics, this word is spelt incorrectly throughout the thesis.

Page 23 line 8. The Spearman rank correlation coefficient symbol should be r_s.

Page 26 Table 1. The units for conductivity are μS/cm.

Page 28 Figure 2C. Conductivity units of ms/L should be μS/cm.

Page 32 Figure 4. The Trichoptera section of the graph does not include Hydroptilidae and the Diptera section does not include Chironomidae.

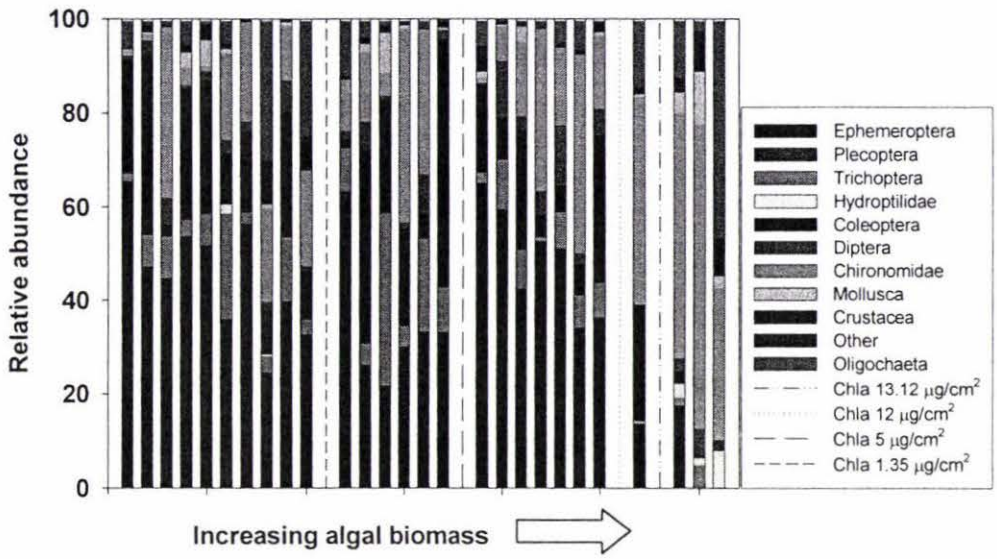

Figure 4. Mean relative abundance of invertebrate groups collected at 27 sites in the Manawatu, February 2002. Sites are arranged from lowest algal biomass (0.21 µg/cm^2) to greatest biomass (18.54 µg/cm^2). Ministry for the Environment maximum chlorophyll a (Chla) guidelines of 5 µg/cm^2 for high benthic biodiversity (long dashed line) and 12 µg/cm^2 for good recreational aesthetics (dotted line) are shown. This studies mean chlorophyll a recommendations to delineate differing stream health of 1.35 µg/cm^2 for clean water fauna (short dashed line) and 13.12 µg/cm^2 for severely polluted water (dash-dot line) are also shown.

Page 33 Figure 5. "time since" represents the time since the last rainfall event in which 20mm or more of rain fell.

Page 35 Table 6. Orthocladinae Sp 2 should be spelt Orthocladiinae Sp 2.

Page 37 line 15. Accrual times were estimated from the time since the last major rainfall event.

Page 55 line 17. Should read "Invertebrate densities however are rarely likely to be high enough to reduce algal biomass to any great extent (only locally) in natural streams due to varying biotic and abiotic dynamics (Clausen and Biggs 1997; Wellnitz and Ward 1998)."

Page 59 line 17. Add in "The Phankuch stability score was evaluated to determine the relative stability of the 3 sites."

Page 60 line 9. The distance measure used was Sorenson-Bray and the linkage technique was the Centroid clustering technique.

Page 62 figure 1. Replicates from sample occasion 1, 2 and 3 were used to calculate standard errors.

Page 70 line 9. Should read "Although the phosphorous addition did not significantly increase stream algal biomass, there were indirect effects on higher trophic levels, especially EPT."

Page 79 line 19. It should be noted that bacteria and fungi in streams can also attain nuisance proportions and have the potential to be important factors relating to dairy conversions as well.

Abstract

High nutrient inputs have generally been identified as responsible for the degradation of lowland rivers and lakes in New Zealand and internationally. Nutrients have been shown to influence algal community growth rate and composition. In turn algae can have strong effects on invertebrate communities (density, richness, composition, distribution, structure and function). This study investigates the effect of nutrients on algal biomass and higher trophic levels to determine the importance of nutrient loading on stream ecosystems.

Twenty six agricultural streams were surveyed in the Manawatu region in February, 2002. Algal biomass was greater in streams with high nitrate levels. Invertebrate communities differed in terms of the quantitative macroinvertebrate community index (QMCI), Ephemeroptera, Plecoptera and Trichoptera (EPT) individuals and taxa between sites with high and low algal biomass. Regression analysis was used to relate the "quality" of the invertebrate community to stream algal biomass. At 13.2 $\mu g/cm^2$ of chlorophyll *a* there was a dramatic shift in invertebrate community composition to more pollution tolerant taxa.

In the Hawke's Bay region nutrient concentration was experimentally increased in 3 low order streams in the summer of 2002/2003. Increased nutrient concentration did not affect stream algal biomass. There were however changes in the proportions of EPT in the enriched community. I propose that these changes in EPT were in response to increased algal growth rates and constrained any increase in algal biomass. Therefore changes in landuse intensity may affect invertebrate community structure.

Explanation of the text

This thesis consists of 4 chapters, a general introduction to the topics that I will cover, 2 data chapters and then a general discussion with implications for management. There is some repetition of introductions, methods and figure numbers throughout the thesis as I am planning to submit chapters 2 and 3 as stand alone scientific papers. The chapters are then followed by appendices containing additional data.

Acknowledgements

I extend a great deal of gratitude to my supervisor Dr Russell Death for all his assistance from the conception of this project to its completion. His guidance has been invaluable every step of the way from sampling protocols to statistical analysis and funding, his help was greatly appreciated.

I thank Nigel Ironside from the Hawke's Bay Regional Council for standing up to the Environmental Regulation officers for me and wavering the consent application fees. I would also like to thank Brett Stansfield and Neil Faulknor for help in identifying study sites.

I would like to thank all the landowners that gave me access to streams and rivers on their properties. A special thanks goes to John and Debbie Waldin, Dale Tatum and Ray and Carol Seymour for allowing me to add fertiliser to streams running through their properties.

Thanks to all the other postgraduate students that have encouraged, supported and helped and along the way. Getting drunk is so much easier with good friends like you guys around, cheers. Thanks to all the ecology department staff especially Barbara Just, Erica Reid, Ian Henderson, Mike Joy, Scott Carver and Jens Jorgensen.

A very big thank you has to go to my entire family for all their emotional, moral and financial support as my university tenure kept extending.

Table of contents