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# Effects of Multiple Heavy Metals on Estuarine Communities

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A thesis submitted in partial fulfilment of the requirements for  
the degree of Doctor of Philosophy in Marine Science,  
The University of Auckland, 2010.

## Frontispiece



The rolling mill and barrels that were used to produce metal-spiked sediments.

## Abstract

Aquatic ecosystems are threatened by various natural and anthropogenic stressors. Their simultaneous effects can result in additive or complex non-additive effects. In the region of Auckland, New Zealand, the primary sediment contaminants of concern include stormwater-derived copper (Cu), lead (Pb) and zinc (Zn). The simultaneous effects of these metals on estuarine infauna were assessed through field and laboratory experiments. In the field, Cu, Zn and a mixture of Cu, Pb and Zn negatively affected the colonisation of infauna. In the laboratory, the survival rate of the deposit feeding bivalve *Macomona liliana* was reduced by Cu and Zn, and the combined effects of these metals were cumulative. The effects of Pb, however, were not evident.

A second field experiment explored the nature of the simultaneous effects of Cu and Zn on colonisation. Results depended on the particular response variable being examined. Additive effects were detected for the mean log abundances of the polychaetes *Prionospio* sp. and *Scoloplos cylindifer*, for species richness and for the multivariate response of the community as a whole. In contrast, antagonistic effects were detected for the mean log abundances of total infauna and the polychaete *Heteromastus* sp.

Sub-lethal impacts can result in longer-term effects on benthic communities, including through bioaccumulation of metals. A second laboratory experiment measured bioaccumulation of heavy metals in the bivalves, *M. liliana* and *Austrovenus stutchburyi*. Both species accumulated Pb and Zn, but bioaccumulation of Cu was slight in *A. stutchburyi* and not evident at all in *M. liliana*. The presence of Pb increased the bioavailability of Cu and/or Zn and, therefore, uptake of these metals by the bivalves in some cases.

These results clearly showed direct negative and cumulative effects of Cu and Zn and potential indirect effects of Pb on estuarine infauna, highlighting the importance of considering the co-occurrence of multiple metals when assessing their ecological impacts. Manipulative field experiments need to be combined with laboratory ecotoxicological studies in order to unravel the combined and interactive effects of multiple metals so that their potential impacts on estuarine communities may be accurately modelled and predicted.

## Acknowledgment

Firstly, I would like to thank my supervisor Marti Anderson. It has been an awesome journey for me, and I appreciate everything you have taught me! Thank you for your support, encouragement and constructive criticism, scientific and non-scientific discussions and Oxford English grammar.

I also thank all my supervisors, Jenny Webster-Brown, Alwyn Rees, Richard Taylor and Rich Ford, for their advice and comments. Thanks to Arthur, Murray, Brady, Peter, Brian, Jo, John, Viv and Alan for making my research possible. At the city campus, I thank David Jenkinson and Russell Clarke for helping me with metal analyses. Thanks to Mat Pawley for helping me with logistic regressions. Thanks to those who helped me with my field work: Amy, Adam, Peter, Kyle, Matt, Shah, Charlie and Nadine. Thanks to Megan for sharing the pain of working in the mud.

Thanks to Amy, my best friend and field buddy in Leigh, for inviting me, again and again, to various social activities even though you knew I would not come. Thanks to Matt for fish, random jokes and hugs, Adam for lunch-time music sessions and prayer meetings, Andrea and Anke for dancing, Richie for leek soup, Corinna for nice evening chats, Naree and Guy for the amazing sailing trip and Karen for swimming.

To my parents, Shoji and Mieko Fukunaga, I cannot thank you enough for your unconditional love, support, and encouragement throughout my education abroad. I would not have been able to make it this far without you.

In Hawaii, I am most grateful to Char, Vince and Madison “Mochi” Au for providing me a roof every time I needed some escape from my research. Thanks to Sam and Kathy Fong, Mihoko and Shawn Yacavone, Maiko Nakano and Kim Andrews for being such awesome friends. Thanks to Guy, Eddie, Erika, Jo-Ann, Clinton, Donna Mae, Carol, Janice, Sue, Chuck and Ana for simply making me feel home. You guys are da best!

This study would not have been possible without the New Zealand International Doctoral Research Scholarship from Education New Zealand.

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