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# **Heavy metal concentrations in mallards in New Zealand**

A thesis presented  
in partial fulfilment of the requirements  
for the degree of

Masters of Science in Conservation Biology  
Massey University  
Palmerston North, New Zealand

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2018



## To my Grandfather, Gerald Gibb.

(Gibb and MacMahon, 1955)

I miss your late-night phone calls about the elusive iPad off button, your well-worn stories, your passion for learning, but most of all, I miss your endless enthusiasm and support for 'my ducks' and their lead.

I'm not sure who should apologise the most- you for leaving right before my original due date, or me for not writing fast enough.

I'm sorry you never got to see the full story.



## Abstract

This study aimed to identify the exposure of two geographically separated populations of mallard ducks (*Anas platyrhynchos*) and a cross-section of native waterbirds to three heavy metals. The concentrations of cadmium (Cd), copper (Cu), and lead (Pb) were determined in the liver, blood, and eggshell of mallard ducks and in archived liver samples from 71 native waterbirds. By using mallards as a bioindicator to establish the bioavailability and contamination of the New Zealand waterfowl ecosystems to these three heavy metals, the pollution rate and possible dangers to both environment and human health can be established. Exposure to all three metals is widespread in mallards, with all livers and blood samples showing detectable levels of all metals. Eggshells concentrations were low for Cd (3.5%) and Pb (13.6%), and detectable levels of Cu were found in all eggshells, reflecting its status as a trace mineral.

Pb is a nonessential, highly toxic heavy metal that is of concern to waterfowl due to the use of Pb shot ammunition for hunting. Ingestion rates of Pb shot were examined through analyses of mallard gizzard contents, and while Pb ingestion was found, there was a significant decrease in both sites from rates recorded prior to Pb shot restrictions. Mallards from the Waikato site were found to have significantly higher concentrations of Pb, in both liver and blood, suggesting that the bioavailability within this region is higher than Southland. For native waterbirds, only two pāteke (*Anas chlorotis*) from Aotea (Great Barrier Island) had hepatic Pb concentrations consistent with toxic levels of exposure.

Cd is a toxic carcinogen known to adversely affect reproduction and survival. In mallards, while Cd blood concentrations were low, 32.4% of livers had elevated Cd above background levels and 16.1% of livers were above the maximum allowable threshold in offal for human consumption. Whio (*Hymenolaimus malacorhynchos*) from the West Coast of the South Island and pāteke from Aotea were found to have hepatic Cd concentrations that suggest high environmental exposure of Cd within these two regions.

Cu is an essential trace element, however in excess it can produce toxic effects. A high proportion (15.8%) of mallards were found to have hepatic Cu concentrations elevated above toxic thresholds. In contrast to the rural living mallards, native waterbirds all had only physiologically normal hepatic concentrations of Cu.

This study provides evidence for contamination of New Zealand waterfowl ecosystems with these three heavy metals, suggests that consumption of waterfowl livers may be contraindicated for human health, and that heavy metal exposure in mallards is at levels consistent with adverse effects on individual and population level health in these important game birds.



# Acknowledgements

First of all, I would like to thank my two amazing supervisors, Brett Gartrell and Phil Battley. Your guidance, humour, and knowledge have been indispensable to this whole ordeal. Thank you for the numerous revisions and edits, grammar lessons and only laughing a little at the plethora of misspelt words. You were fantastic supervisors, the perfect balance of leaving me to figure it out, coupled with an open door or email with a suggestion (read answer) when I needed it.

This study would not have been possible without the support, drive, and funding from New Zealand Fish and Game and its many passionate staff. To David Klee, thank you for always being a phone call away, your offers of help, the ute full of dead ducks, and your many edits. It's been a long road with a few stumbling blocks, but we got there! To Jenn Sheppard, thank you for always being willing to share your data, knowledge, field staff, and home. Without your study for mine to piggy back on this thesis would be a whole lot shorter but not nearly as complete. To all the volunteer banders in the Waikato, who sexed, banded and patiently held birds during bleedings- life would have much more stressful without you. To Southland Fish and Game, especially Erin Garrick and Zane Moss, thank you for organising the hunters and collection of their ducks and trapping for the post-breeding bloods, while also welcoming the stray researchers we tacked on. To the hunters of both regions, who happily filled their freezers with over 350 carcasses, thanks for sharing your hunt and I am truly sorry I am taking away your Pâté. And of course, to Mike McGlynn for introducing me to the people who started this all.

This thesis is a compilation of hard work, setbacks, adventures, triumphs, and being in the right place at the right time. To my weird and wonderful family. I can never thank you enough. Mum and Dad, for sticking by me with every mishap, disappointment and escapade that we have been through during the last 29 years. You have taught me the value of persistence and self-belief. To my three brothers; Sam, Tim and Toby. I am forever in your debt for teaching me how to stand up for myself and to get back up after every hit life throws at you. Your friendships will always be my favourites.

Catherine Jardine, Alex Wilson, Sarah Jamison, and Isabel Castro. For being the four woman who taught me uncountable things about our world and its birds with enough passion and fire to have changed the whole course of my life. You pushed me, vouched for me and supported me to a point where you have shaped my life in a way I can never truly repay you for. There is no way I would have ever gotten here without you all. To Heather Major and Ian Jones, the three months I spent on Gareloi with you cemented in my mind the want and need to return to academics and, of course how to deal with not showering for three months (a very valuable lesson).



For my extra two editors; Jaime Grant and Felix Vaux. I still don't know why you agreed but I am beyond thankful you did! I am at your editing disposal whenever you need. To all the people at Wildbase- Stu Hunter, I learned a stupid amount from you in the post-mortem room! Thanks for always being happy to answer all my questions and I think I can now place 'bittern autopsier' on my CV (and just hope that if tested, the answer is 'a car did it'). To Aditi Sriram, thanks for going first with the lead, it was fantastic to be able to pick your brain. To Kathryn Strang and Emily Koot, thanks for endless coffee/tea breaks which were sometimes needed, but most often blatant procrastination. Thank you for always being there to bounce ideas off and help with any little pesky problems that arose (Emily: read that map fiasco). I don't know who I would rather vent about postgrad with. To Doug Armstrong, for always having an open door for a chat and for being beyond patient with me during that Bayesian statistics debacle. To the lab technicians; Paul Barrett, Tracy Harris, Shaun Nielsen, and Cleland Wallace for sorting out problems, shortages, and not complaining too much about the number of ducks I had to store (or their blood). And to Sharon, I don't know how that department would run without you.

To the non-post grads who had the misfortune of living with me during this process; Alise Yates, Callum Scully, and Caitlin O'shea. Thanks for always having unclaimed chocolate or baking in the house, for letting me bring wild animals home (and just rolling with it), and for always making the flat a home. I would also like acknowledge Karthik Ram for the Wes Anderson R colour palette theme you gifted the world. You coloured this train when it was well and truly lost.

Finally, I would like to thank the whole Massey Ecology department, for being a haven of knowledge, support, passion, science, and eccentricities. Thank you for showing me the type of scientist I hope to become (and allowing me to get a degree I am actually proud of). It was wonderful to be counted as one of you for these past few years.

This project was funded primarily by the Fish and Game Council Research Grant, as well as contributions from the Department of Conservation Research Grant, Massey University Ecology Bursary, the Manawatu Postgraduate Woman's Scholarship, and Land and Water Habitat Trust Scholarship. Without this support this project could not have gone ahead.

P.S. This thesis began with a mudfish translocation, and if my grandfather hadn't stolen the show, this thesis would be dedicated to those mudfish who, tragically lost their home to the ever-straightening Northern Motorway. I'm sure this research will trickle back to you somehow.

# Contents

<b>Abstract .....</b>	<b>i</b>
<b><u>Chapter One: General Introduction .....</u></b>	<b>7</b>
1.1 Heavy metals .....	9
1.2 The triple threat; heavy metals in New Zealand waterfowl.....	13
1.2.1 Cadmium .....	13
1.2.2 Copper .....	18
1.2.3 Lead .....	22
1.3 Waterfowl as bioindicators .....	26
1.3.1 Birds as bioindicators .....	26
1.3.2 Effect of age .....	27
1.3.3 Effect of sex.....	28
1.3.4 Tissues storage.....	28
1.4 General Introduction.....	32
1.4.1 Research objectives .....	32
1.4.3 Study Species.....	32
1.4.4 Structure of thesis .....	33
<b><u>Chapter Two: Heavy metals concentrations in the blood and eggshells of mallards (Anas platyrhynchos). .....</u></b>	<b>35</b>
2.0 Abstract .....	37
2.1 Introduction .....	38
2.2 Materials and Methods .....	40
2.2.1 Sample sites .....	40
2.2.2 Sample collection .....	41
2.2.3 Statistical analysis .....	45
2.3 Results .....	45
2.3.1 Pre-breeding season blood samples .....	45
2.3.2 Post-breeding season blood samples .....	49
2.3.3 Eggshells.....	54
2.3.4 Interactions between sample types .....	56
2.4 Discussion .....	58
<b><u>Chapter Three: Hepatic concentrations of heavy metals in mallards (Anas platyrhynchos). .....</u></b>	<b>69</b>
3.0 Abstract .....	71

3.1 Introduction.....	72
3.2 Materials and Methods.....	74
3.2.1 Sample sites .....	74
3.2.2 Sample collection.....	74
3.2.3 Ingested shot analysis.....	76
3.2.4 Toxicology .....	77
3.2.5 Statistical analysis .....	77
3.3 Results.....	78
3.3.1 Variation between site, sex, and age cohorts .....	78
3.3.2 Variation between month of collection .....	80
3.3.3 Thresholds for toxicity .....	84
3.3.4 Prevalence of ingested shot.....	84
3.4 Discussion.....	86
<b><u>Chapter Four: Heavy metal in native freshwater birds of New Zealand .....</u></b>	<b>99</b>
4.0 Abstract .....	101
4.1 Introduction.....	102
4.2 Material and Methods .....	104
4.2.1 Database use and sample collection.....	104
4.2.2 Laboratory analysis .....	105
4.2.3 Statistical analysis .....	105
4.3 Results.....	108
4.3.1 Metal toxicity thresholds.....	110
4.3.2 Variation between species.....	111
4.3.3 Variation between sex, age, season, and year of collection. ....	115
4.4 Discussion.....	116
<b>General discussion: The heavy load to bear .....</b>	<b>123</b>
5.1 Cadmium.....	126
5.2 Copper.....	127
5.3 Lead .....	129
5.4 Mallards as bioindicators of the New Zealand environment .....	130
5.5 Management and public health recommendations .....	130
5.6 Concluding remarks .....	131
<b>References.....</b>	<b>134</b>
<b>Appendix 1: Pilot study .....</b>	<b>154</b>