An investigation of causes of disease among wild and captive New Zealand falcons *(Falco novaeseelandiae),* Australasian harriers *(Circus approximans)* and moreporks *(Ninox novaeseelandiae).*

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ABSTRACT

Infectious disease can play a role in the population dynamics of wildlife species. The introduction of exotic birds and mammals into New Zealand has led to the introduction of novel diseases into the New Zealand avifauna such as avian malaria and toxoplasmosis. However the role of disease in New Zealand's raptor population has not been widely reported. This study aims at investigating the presence and prevalence of disease among wild and captive New Zealand falcons *(Falco novaeseelandiae),* Australasian harrier *(Circus approximans)* and moreporks *(Ninox novaeseelandiae).*

A retrospective study of post-mortem databases (the Huia database and the Massey University post-mortem database) undertaken to determine the major causes of mortality in New Zealand's raptors between 1990 and 2014 revealed that trauma and infectious agents were the most frequently encountered causes of death in these birds. However, except for a single case report of serratospiculosis in a New Zealand falcon observed by Green et al in 2006, no other infectious agents have been reported among the country's raptors to date in the peer reviewed literature. During the review of post-mortem records, organisms like *Mycobacterium avium, Serratospiculum* sp, *Sarcocystis* spp, *Trichomonas galllinae* and several unidentified helminths were identified as contributing or definite causes of mortality in all three species of raptors. But neither *Plasmodium* spp nor *Toxoplasma gondii* infections have been demonstrated in these birds so far. Therefore, a separate study was designed to determine the presence of these pathogens in New Zealand falcon, Australasian harrier and morepork tissues, using established molecular techniques.

Molecular analysis of archived New Zealand raptor tissues confirmed the presence of both *Plasmodium* spp (10/117; 8.5%) and *T. gondii* (9/117; 7.7%) in all three species of raptors. *Plasmodium* strains identified were *P. elongatum* GRW6, *P.* sp AFTRU5, and *P. relictum* GRW4 and SGS1. Surprisingly, two Australasian harriers and one morepork tested for the presence of both *Plasmodium* spp and *T. gondii* as concomitant infections. However, it is unknown whether any of the positive tested birds suffered from clinical infections, since post-mortem records had no record of clinical signs of disease associated with either infections in these birds.

Once the presence of the aforementioned pathogens among New Zealand raptors was established, an attempt was made to investigate their presence among live raptor populations as well. Blood samples were collected from raptors being admitted to Wildbase Hospital, Massey University, Palmerston North and Wingspan- Birds of Prey Research Centre, Rotorua. Molecular analysis of these samples by PCR did not reveal the presence of *Plasmodium* spp in any of the

tested birds, but one New Zealand falcon, Australasian harrier and morepork each tested positive for the presence of *T. gondii*. Interestingly, none of the positive birds showed any signs of clinical illness that may be associated with toxoplasmosis in raptors. We also analysed faecal samples and throat swabs from these birds to determine the presence of pathogens like *Caryospora* spp, *Serratospiculum* spp, *Salmonella* spp and *T. gallinae,* since many of these organisms have been detected in New Zealand and are also found affecting raptors in other parts of the world. However, apart from eggs resembling *Capillaria* spp, none of the other pathogens listed above were identified.

My study has some limitations such as a small sample size and a geographic bias in terms of birds being submitted to Massey University, Palmerston North for post-mortem analysis. But this research may be regarded as the first report of *Plasmodium* spp and *T. gondii* infections among New Zealand's three well-known raptor species and further research is required to determine the prevalence of these pathogens among the country's total raptor population, pathogenicity of the organisms towards them and the role of these birds in the epidemiology of these diseases within New Zealand

DECLARATION

The studies presented in this thesis were completed by the author whilst a postgraduate student in the Institute of Veterinary, Animal and Biomedical Sciences, Massey University. I officially state that this is my own work and the views presented are mine, and that the contents have not been submitted for any other degree. I certify that to the best of my knowledge any help received in preparing this thesis and all sources used have been acknowledged in the thesis.

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Supervisor

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THESIS STRUCTURE AND FORMAT

The structure of the thesis consists of five parts, a literature review (Chapter 1) that details the various infectious diseases affecting birds of the families Falconidae, Accipitridae and Strigidae in different parts of the world and a summary of the natural history of New Zealand's raptors; a retrospective analysis of post mortem records to document the various causes of mortality in the aforementioned birds between 1994 and 2014 (Chapter 2); a chapter describing the investigation of *Plasmodium* spp and *T. gondii* in three species of New Zealand raptors through molecular analysis of archived post mortem tissues (Chapter 3); a similar chapter involving the identification of these organisms along with *Salmonella* spp, *Trichomonas gallinae, Serratospiculum* spp and *Caryospora* spp in live wild and captive New Zealand falcons, Australasian harriers and moreporks (Chapter 4); and finally a discussion of the research findings with comments on the general fitness of New Zealand raptors and future implications on the conservation of New Zealand falcons (Chapter 5).

The research chapters have been written with the intension to publish and as such there is some duplication in the introduction and methods sections and relevant references can be found at the end of each chapter.

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