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**The ecology and conservation of  
green turtles (*Chelonia mydas*) in New Zealand**

A thesis submitted in partial fulfilment of the requirements

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In the southwestern Pacific Ocean at the edge of their range, post-pelagic green turtles (*Chelonia mydas*) recruit into neritic developmental habitats of northern New Zealand. Photo cover of New Zealand Journal of Marine and Freshwater Research 2016, 50(4), 549-565, courtesy of Steve Hathaway.

## Abstract

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Historically, little consideration has been given to the occurrence, ecology or conservation of the green turtle (*Chelonia mydas*) in temperate New Zealand. Located geographically at the southern boundary of the distributional range of green turtles in the southwestern Pacific, reports of this species in New Zealand are often overlooked as occasional visitors or stragglers incidentally carried by ocean currents. This convention may be reasonable when considering the temperature constrained distribution of this poikilothermic marine reptile. Despite this, green turtles have been reported in New Zealand waters for more than 100 years, yet no study has undertaken any in depth investigation as to their occurrence in this region. Therefore, this thesis investigated the presence of green turtles in New Zealand waters to test the hypothesis that their occurrence is ephemeral and incidental.

Opportunistic data and samples collected between 1895 and 2013 was collated, reviewed and analysed to investigate several lines of empirical enquiry, including spatio-temporal distribution, population structure, genetic origin, diet composition and anthropogenic effects. Sighting, stranding, and incidental capture revealed a year round presence of post-pelagic immature juveniles to large sub-adult green turtles across northern New Zealand (ca. 34°-38° S). Such occurrence exists despite sea surface temperatures averaging only 14 °C during austral winters. The aggregation exhibited a female:male sex ratio of 1.7:1 which is similar to that reported from proximate warm temperate foraging grounds in eastern Australia. Size frequency data indicated that green turtles recruit to neritic habitats of the North Island at ca. 40.8 cm curved carapace length. This reflects a natural post-oceanic settlement pattern rather than oceanic-phase stragglers incidentally blown ashore by storm and other stochastic events. Supporting this rationale for natural recruitment, diet component data demonstrates that once green turtles settle into New Zealand's nearshore coastal habitats, they transition to a benthic foraging strategy. Notably, green turtles in New Zealand do not ontogenetically transition from omnivory to obligate herbivory with age, but instead consume a variable diet of primarily macroalgae and benthic macro invertebrates. Overall, the confirmation

of feeding in New Zealand substantially extends the southern foraging limit for green turtles in the Pacific Ocean.

Genetic analyses of ~770 base pair sequences of mitochondrial (mt) DNA was conducted on 42 stranded green turtles to characterize the genetic structure of this aggregation. Results identified 15 haplotypes including one orphan haplotype from widely dispersed green turtle stocks across the western, central, and eastern Pacific Ocean. When compared to other regional nesting rookeries and foraging grounds, the New Zealand aggregation exemplified its unique composition, predominantly due to the large proportion of haplotypes from the endemic eastern Pacific clade. These results provide a genetic link to east Pacific stocks in the southwestern Pacific; identifying previously undefined regional connectivity and trans-oceanic dispersal for eastern Pacific green turtles.

In order to assess potential human impacts, gross necropsies were conducted on green turtles found stranded in northern New Zealand between 2007 and 2013. Anthropogenic effects predominantly associated with the ingestion of plastic marine debris were identified as the likely cause for the majority of strandings in the North Island. Propeller strike and incidental capture in recreational fisheries were further shown to impact green turtles, particularly for turtles inhabiting neritic habitats adjacent to densely populated urban centres of northeastern New Zealand.

Overall, data presented here supports the hypothesis that New Zealand northern neritic habitats provide a transitional developmental habitat for immature green turtles at the edge of their range in the southwestern Pacific Ocean. Genetic analysis reveals this aggregation is unique when compared to other regional foraging grounds, exhibiting links to discrete genetic stocks from across the Pacific Ocean. In addition, the cause of the exponential increase in records observed over time remains unclear, therefore warrants further research and monitoring of this endangered marine reptile; particularly in light of climate-mediated environmental change presently experienced in the region.

## Acknowledgements

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“If you change, the world changes.”

It's hard to know when my journey began, maybe it was when I was young when I watched the undersea adventures of Jacques Cousteau or David Attenborough's '*The Living Planet*'; maybe it evolved later, during the long night watches aboard the *R Tucker Thompson* as we sailed to protest French nuclear testing in Moruroa. Whatever the catalyst, it has led me to this point, a culmination of many years work and stubborn determination to make a difference. Getting this far was no small feat, and certainly would not have been achievable without the support, inspiration and belief of many people along the way. At its inception, the research would have never got off the ground were it not for Craig Thorburn and Mike Bhana who dusted off my satellite tracking proposal and made it part of '*Ocean Zoo*'. Like me, you both saw its research and awareness potential; and let's face it we all love a good adventure. Thanks also to Andrew Baker and Andrew Christie (AJ) for the support and laughs along the way. A big thanks to Kelly Tarlton's and its staff for all the support (and laughs) and rehabilitation of marine turtles over the years – how things have changed for the better! As the project gained momentum, thanks to Steve Cook (Cookie) and Steve O'Shea from Auckland University of Technology (AUT) for pushing me to take on the PhD; looking back now I can thank you although a few years ago I wasn't so sure.

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