Turtles and vessels: threat evaluation and behavioural studies of green turtles in near-shore foraging grounds

Thesis submitted by

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Declaration on Ethics

The research presented and reported in this thesis was conducted within the guidelines for research ethics outlined in the *Joint NHMRC/AVCC Statement and Guidelines on Research Practice* (1997), the *James Cook University Policy on Experimentation Ethics. Standard Practices and Guidelines* (2001), and the *James Cook University Statement and Guidelines on Research Practice* (2001). The proposed research methodology received clearance from the James Cook University Ethics Review Committee (approval numbers A843, A898 and A948).

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Statement on the contribution of others

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Publications associated with this thesis

The four papers listed below are based on Chapters 2, 4, 6 and 7 respectively.

- HAZEL, J. & GYURIS, E. (2006) Vessel-related mortality of sea turtles in Queensland, Australia. *Wildlife Research* 33, 149-154

- HAZEL, J., LAWLER, I. R., MARSH, H. & ROBSON, S. (2007) Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research* 3, 105-113

- HAZEL, J., LAWLER, I.R.. & HAMANN, M, (2009) Diving at the shallow end: Green turtle behaviour in near-shore foraging habitat. *Journal of Experimental Marine Biology and Ecology* 371, 84–92

- HAZEL, J. (2009) Evaluation of fast-acquisition GPS in stationary tests and fine-scale tracking of green turtles. *Journal of Experimental Marine Biology and Ecology* 374, 58-68

Abstract

This study aimed to (1) evaluate vessel strike as a threat to marine turtles in Queensland, Australia, (2) investigate behavioural responses of free-living green turtles to vessel traffic, (3) study diving behaviour of green turtles in foraging grounds adjacent to vessel traffic, (4) test established and novel methods for recording fine-scale geographic movement by green turtles and gain insight into the spatial behaviour of turtles in shallow foraging habitat.

Analysis of stranding records collected by the Queensland Environment Protection Authority indicated that, for the Queensland east coast during the period 1999-2002, an average of 65 documented turtle deaths annually were ascribed to collisions with vessels. This number represented an extremely conservative indication of actual mortality because no systematic surveys for stranded animals were conducted and records were contingent on chance discoveries and on motivation of members of the public to report findings. The records showed a high degree of geographic concentration, green turtles comprised the majority of vessel-related records, followed by loggerhead turtles, and the majority of cases concerned adult and sub-adult turtles. Based on these findings, subsequent behavioural research in pursuit of aims 2 to 4 focussed on green turtles of adult and sub-adult age classes in Moreton Bay, which wass the area with the highest recorded incidence of turtle mortality from vessel strike.

Field research investigated behavioural responses of green turtles to an approaching vessel. Visual observations were conducted from a moving vessel that served a dual role as stimulus for potential turtle responses and as observation platform. During experimental vessel transits the proportion of turtles that fled to avoid the vessel decreased significantly as vessel speed increased and turtles that fled from moderate and fast approaches did so at significantly shorter distances from the vessel than turtles that fled from slow approaches.

For telemetry studies, green turtles were captured individually and equipped with time-depth recorders and ultrasonic transmitters. Ten telemetry sessions were distributed over 2 years to cover seasonal variation in sea temperature from 14ºC to 30ºC. These sessions provided diving data for a total of 19 turtles with curved carapace lengths in the range 49 to 118 cm. Three of the study turtles were additionally equipped with a Fastloc GPS (FGPS) device that used novel technology, specifically designed to record fine-scale movements of marine animals that surface too briefly for effective use of standard GPS. Detailed data were obtained for FGPS accuracy and efficiency, tested during extensive stationary trials. FGPS performance during live deployment was compared with two alternative methods, namely boat-based ultrasonic tracking and Argos Platform Transmitter Terminals.

Overall findings of telemetry sessions revealed that dive duration increased as sea temperature decreased, showing strong negative correlation by day and by night. Study turtles made resting dives that were 3 to 4 times longer in median duration, and six times longer in maximum duration, at cool temperatures than dives made at warm temperatures, but there was no evidence of winter diapause or location shift to avoid cold water. Diurnal dives were shallower and shorter than nocturnal dives, with diel patterns also evident in dawn and dusk peaks in occupation of depths within 1 m of the surface, elevated diurnal occupation of depths 1 to 2 m below the surface and elevated nocturnal occupation of depths >2 m.

The FGPS-equipped turtles (n = 3) used modest short-term activity ranges, remained within <4.7 km of their capture-release locations and favoured shallow water with 86% of locations at charted depths ≤3 m and the deepest location at 5.9 m. Fine-scale movements of each turtle varied from day to day with respect to tortuosity and areas traversed. Statistically significant day-night differences were evident in average rates of movement (greater by day) and in habitat selection, where diurnal locations had greater seagrass density while nocturnal locations featured deeper bathymetry. Individual turtles revisited some of their centres of activity on multiple occasions although none of the study turtles travelled consistently between the same day-night pair of sites as has been reported elsewhere.

In combination the diving and movement data showed that study turtles consistently and continuously used the shallow margins of the bay where human activities tend to be concentrated, thereby increasing their exposure to anthropogenic threats including vessel strike. Coupled with the evidence that reliable evasion responses occur only with very slow vessels, this thesis confirms the need for management strategies that restrict vessel speed or routes in order to reduce the cumulative risk of vessel strike in key turtle habitat subject to frequent vessel traffic.

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