

Quantitative movement analysis: tracking sea turtles, seals and marine birds in the global ocean

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The last decade has seen the development of reliable satellite tracking equipment that has allowed routine long-term (months to years) tracking of a range of marine vertebrates including turtles, seals and sea birds. This project will focus on examining a number of cutting-edge questions related to patterns of movement and habitat use including both “blue skies” questions on animal orientation as well as more applied questions on marine conservation planning.

This studentship will suit candidates with interests in quantitative ecology, statistics and ecological or mathematical modelling or computer science, given its focus on quantitative movement analysis, GIS data analysis and data mining techniques. It may also suit students with interests in marine vertebrate ecology, as it will involve some targeted deployment of tracking equipment onto marine vertebrates at sites around the world.

Some of the contemporary questions that will be addressed include:

Orientation of sea turtles travelling across the open ocean: Using data-sets emerging from long-term tracking of adult loggerhead turtles travelling across the Mediterranean from their breeding grounds in Greece, green turtles travelling across the Indian Ocean from their breeding grounds on the Chagos Archipelago as well as juvenile loggerhead turtles moving in the South Pacific, the student will examine whether turtles show directed swimming to take account of current advection that may lead them off-route and how they approach and locate isolated targets such as small islands. In this way the extent and resolution of the geospatial map that turtles use will be assessed in relation to laboratory experiments that have shown the potential for turtles to use geomagnetic maps in long-distance movements.

Habitat use by both breeding and foraging turtles: Using tracking data from around the world (including the Indian Ocean, Pacific and Atlantic) across a range of sea turtle species the student will use high-resolution Fastloc-GPS tracking to assess the habitat use by sea turtles in both their breeding and foraging locations. The extent of space use will be compared to habitat quality and diet, including comparison between species and populations in different parts of their range. This work will involve GIS analysis of space use and be used to develop informed conservation strategies in terms of protected area designation.

Drift scenarios for juveniles: The student will use oceanographic techniques including Lagrangian drift trajectories and ocean particle tracking models to consider the drift scenarios for hatchling sea turtles. This work will be embedded within questions regarding the ontogeny of migration in sea

turtles (e.g. do adults travel to those sites they experienced as drifting hatchlings?), implications of climate change in terms of drift scenarios and consideration of the global distribution of sea turtles in terms of the proximity of beaches to suitable current regimes.

Meta-analysis of movement patterns across diverse species: The advent of comparable (Argos and Fastloc-GPS) tracking data for a range of marine vertebrates (turtles, seals, birds) allows the patterns of movement across taxa to be considered such as migration distances, course directness and migration periodicity. The student will compare and contrast the movement patterns across a range of contrasting marine vertebrates.

For further details please contact: g.hays@deakin.edu.au

See: <http://scholar.google.co.uk/citations?user=7rc3SmAAAAAJ&hl=en&oi=ao>

Further reading on our recent work in this area:

- Fossette S, Putman NF, Lohmann KJ, Marsh R, Hays GC (2012). A biologist's guide to assessing ocean currents: a review. *Marine Ecology Progress Series*, 457, 285-301. doi: 10.3354/meps09581
- Hays GC, Fossette S, Katselidis KA, Schofield G, Gravenor MB (2010). Breeding periodicity for male sea turtles, operational sex ratios, and implications in the face of climate change. *Conservation Biology* 24, 1636–1643. doi: 10.1111/j.1523-1739.2010.01531.x
- Hays GC, Fossette S, Katselidis KA, Mariani P, Schofield G (2010). Ontogenetic development of migration: Lagrangian drift trajectories suggest a new paradigm for sea turtles. *Journal of Royal Society Interface* 7, 1319-1327. doi:10.1098/rsif.2010.0009.
- Hays GC, Scott R (2013). Global patterns for upper ceilings on migration distance in sea turtles and comparisons with fish, birds and mammals. *Functional Ecology* 27, 748–756. doi: 10.1111/1365-2435.12073
- Lohmann KJ, Luschi P, Hays GC (2008). Goal navigation and island-finding in sea turtles. *Journal of Experimental Marine Biology and Ecology* 356, 83–95. doi:10.1016/j.jembe.2007.12.017
- Schofield G, Scott R, Dimadi A, Fossette S, Katselidis KA, Koutsoubas D, Lilley MKS, Pantis JD, Karagouni AD, Hays GC (2013). Evidence-based marine protected area planning for a highly mobile endangered marine vertebrate. *Biological Conservation* 161, 101–109. <http://dx.doi.org/10.1016/j.biocon.2013.03.004>
- Schofield G, Dimadi A, Fossette S, Katselidis KA, Koutsoubas D, Lilley MKS, Luckman A, Pantis JD, Karagouni AD, Hays GC (2013). The importance of sample size: tracking large numbers of individuals to infer population level dispersal and core areas for protection. *Diversity and Distributions*. doi: 10.1111/ddi.12077
- Scott R, Marsh R, Hays GC (2012). Life in the really slow lane: loggerhead sea turtles mature late relative to other reptiles. *Functional Ecology*, 26, 227-235. doi: 10.1111/j.1365-2435.2011.01915.x
- Scott R, Marsh R, Hays GC (2012). A little movement orientated to the geomagnetic field makes a big difference in strong flows. *Marine Biology*, 159, 481-488. doi 10.1007/s00227-011-1825-1