MACHINE LEARNING AND MULTI-SENSOR TAGS BREATHE NEW LIFE INTO THE SPATIAL ECOLOGY OF SEA TURTLES*

Jenna L. Hounslow[1,2], Sabrina Fossette[3], Wei Chong[1,2], Randa Bali[1,2], Anton D. Tucker[3], Scott D. Whiting[3], and Adrian C. Gleiss[1,2]

[1]*Centre for Sustainable Aquatic Ecosystems, Harry Butler Institute, Murdoch University*
[2]*Environmental and Conservation Sciences, Murdoch University*
[3]*Biodiversity and Conservation Science, Department of Biodiversity, Conservation and Attractions*

Effective management and mitigation of in-water threats affecting sea turtles (e.g., gear entanglement, habitat modification) require a spatially explicit understanding of sea turtle activity, since the impact of threats is most likely context dependent. However, data on the spatial ecology of sea turtles generally only allows for minor inference regarding how a given location is used. Contemporary multi-sensor biologging tools allow us to quantify behaviour in highly resolved detail, via high-resolution movement sensors (e.g., accelerometers, magnetometers), which can be linked to distinct behaviours (e.g., resting, foraging, mating) when ground-truthed by direct observation, such as via animal-borne video cameras. Here, we demonstrate how such data, combined with automatic machine learning and GPS telemetry can generate spatially explicit maps of sea turtle activity, which may prove valuable for spatial management. From 2018 – 2021 we equipped adult flatback turtles (*Natator depressus*) (*n* = 51; CCL 72.5- 98.9 cm) with biologgers (CATS-Diary, *n*= 22 and CATS-Cam, *n*= 29) at Roebuck Bay, Western Australia for up to 1 week each. We collected > 102 days total movement data, with ~ 5 % (115 h) of the data associated with concurrently recorded video. Behavioural activity-budgets were estimated by first isolating dives (*n*= 7074) from the depth records and describing their respective features (phase durations, depth, activity, body posture, track characteristics). Dives with associated video footage were allocated with presence or absence of foraging and resting behaviours and a supervised machine learning algorithm was employed to assign behaviours to the remaining dives without available video footage, based on the dive features. Boosted regression tree

(BRT) models were trained and validated using the descriptive dive features. Validated BRTs for each behaviour were then used to predict presence or absence of foraging and resting during each dive over the entire dataset (including data where no video observation was available) and integrated with tags' GPS location data to create activity specific maps of turtle behaviour. Both validated BRT models performed exceptionally well (AUC; foraging = 0.939, resting = 0.926). Foraging dives were characteristic of shorter duration bottom phases with increased depth fluctuation and greater tortuosity than dives where no foraging was evident. Whereas resting dives were characterised by lower locomotory activity during the bottom phase of the dive and longer duration bottom and ascent phases. Predicted event rates for each behaviour overall were 43.23 % (foraging) and 33.29 % (resting). For 24.17 % dives, both behaviours occurred during the dive, reinforcing that sea turtle dives are often multi-purpose in nature. The location of foraging behaviour displayed a high degree of overlap with dives that did not include foraging, however foraging behaviour occurred over a sub-section of the total area occupied. Our automated machine learning approach is applicable to a broad range of other species; therefore, our method could significantly contribute to spatial management, for instance by regulation of vessel traffic and improving marine park zoning.

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Paul A. Whittock, Anton D. Tucker, and Lisa Belskis

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Southeast Fisheries Science Centre
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Miami, Florida 33149

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