

Fine-scale behaviour of whale sharks off Mafia Island, Tanzania

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Background

Mafia Island off the Tanzanian coast features a year-round resident whale shark population. Many of the sharks are seen regularly, making this a great natural laboratory to study their behaviour in detail. At the same time, whale sharks here also face threats locally from net entanglement and boat strike. We therefore set out to determine their fine-scale behaviour using novel telemetry methods in order to establish a profound baseline.

Approach

We conducted field work at Mafia Island from November–December 2015 and used 3D tags (Open Tags) and satellite tags (Desert Star SeaTagMODs) to examine whale shark behaviour. 3D tags recorded depth, temperature, acceleration as well as gyrometer and magnetometer readings at 200 data points per second. Satellite tags recorded depth, temperature, acceleration and geolocation. We attached 3D behavioural tags to the first dorsal fin using a padded clamp, and double-tagged some of the sharks with satellite tags attached with a titanium dart anchor and short tether. We manually retrieved both types of tags. A total of 117 hours of 3D tag data and 53 days of satellite tag data were recorded. Data were analysed in R.

Results

The attachment method using a padded clamp kept the tags in a stable position throughout their deployment period, although minor scarring of the fin was evident. We suggest some further improvements to the clamp to reduce scarring. Preliminary dive depth analysis of 3D tag data indicates that whale sharks largely stayed in shallow water, with an average swimming depth of just 4.7 m, SE: ± 0.008 . The sharks also spent 10.4 hours, SD: ± 2.2 or 44.4% of the day swimming near or at the surface (depth < 2 m), indicating extensive surface feeding behaviour or surface swimming. We will clarify which behaviours were exhibited following further analysis of acceleration and gyrometer data. A simple one-way ANOVA revealed a significant difference between dive depth during the day and night ($p < 0.005$). During daytime, the deepest dive was to 18.8 m, with an overall mean depth of $3 \text{ m} \pm 0.007$. The deepest recorded dive (29.8 m) occurred at night. Mean dive depth at night was two times higher, at $6.4 \text{ m} \pm 0.012$. Time spent above 2 m was twofold higher during the day with $6.9 \text{ h} \pm 1.9$ than at night with $3.5 \text{ h} \pm 1.2$, indicating that a diel behavioural shift occurred.

Conclusion

3D telemetry is an emerging technique that provides unprecedented insight into whale shark behaviour. Here, we show some initial results that indicate the potential applications for this technology. We will continue analysing gyrometer and acceleration data that allow us to further distinguish and quantify behaviours, such as feeding and search behaviour.

Keywords: telemetry, behaviour, movement, spatio-temporal

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