

## 4.7 | Continental-scale shark migrations

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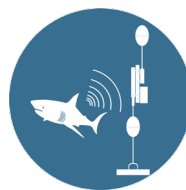
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### Summary

Understanding movement and connectivity of populations is critical to management and conservation efforts. Through the IMOS Animal Tracking Facility the movements of bull sharks were tracked along the east coast of Australia between Sydney Harbour and the central Great Barrier Reef (GBR). This continental-scale tracking data identified previously unknown population connections with large numbers of bull sharks making return trips between Sydney and the GBR and revealing the importance of both of these regions for this species.

### Key Data Streams



Acoustic Telemetry

## Rationale

Movement and connectivity of marine populations is increasingly important as human use and environmental change alter ocean ecosystems. Identifying movement patterns is particularly important for species that move long distances and thus link ecosystems (e.g., coastal and offshore regions). The ability to move across state or national boundaries is also a topic of concern for management and conservation efforts. Large predators are key components of ecosystems due to their ability to directly (through predation) and indirectly (through fear affecting prey movements and distribution) affect other species. Here we investigate the capacity for large predators to connect habitats and affect an array of communities. In addition, understanding how they move, connect habitats and interact with other species can help define their role in ecosystems, which can help identify potential consequences of any population declines.

## Methods

Movements of bull sharks were examined using acoustic telemetry receiver arrays along the east coast of Australia spanning from Sydney Harbour to the central Great Barrier Reef (GBR). Acoustic tracking data were obtained from the Integrated Marine Observing System (IMOS) Animal Tracking Facility and examined to define the extent and timing of movement of tagged sharks (Australian Ocean Data Network dataset: "IMOS - Animal Tracking Facility - Acoustic Tracking - Quality Controlled Detections (2007 -2017)"). A total of 114 bull sharks were fitted with acoustic transmitters – 75 in NSW and 39 in QLD (Figure 1). Straight line distances between detection locations were determined to approximate movement along the coast. To examine the level of connectivity among acoustic receiver arrays, a chord diagram was compiled to define incoming and outgoing movements of individuals.



Figure 1. Measuring and tagging a captured bull shark in QLD.

## Results and Interpretation

Approximately half ( $n = 36$ ) of the bull sharks tagged in NSW moved north into tropical regions. Seventeen individuals moved north and did not return to NSW. Both males and females were recorded undertaking long-range movements. Straight line distances were estimated at 60 – 1770 km one way (Figure 2). Several individuals were recorded making multiple, repeat movements between NSW and QLD, in some cases as many as five subsequent trips. The majority of repeat movements were completed by female sharks. Larger individuals were more likely to move than smaller individuals, suggesting differences in behaviour by life stage. By contrast, only one shark tagged in QLD moved into NSW, but 25% of QLD tagged sharks moved to southern reefs or inshore habitats. Some of the individuals tagged in QLD remained resident in the area throughout the study period and 50% of individuals that left their tagging area (central GBR) returned to the area. Connectivity analysis reflected the high degree of movement among locations and the scale of movement exhibited by this species (Figure 3).

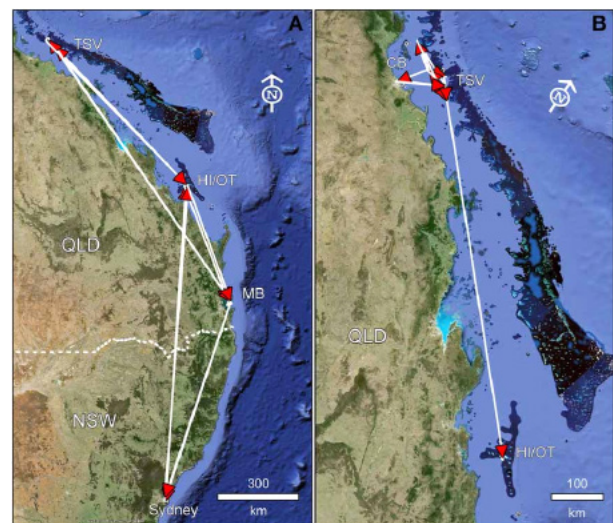


Figure 2. Straight line movements of an individual released in (A) NSW and (B) QLD based on detections on acoustic arrays beyond their capture location. Sourced from Heupel et al., 2015.

These results reveal complex linkages along the east coast of Australia, which suggest a tropical reef-based population comprised of individuals that migrate to multiple regions. Continental-scale acoustic telemetry systems can help define long-range movements and connectivity of broadly moving species such as large sharks. This analysis also revealed the importance of the GBR for adult bull sharks, which was previously unknown. The scale of movement and capacity to connect coastal temperate habitat to tropical reef habitat through movement suggest bull sharks could play a key role in ecosystem functions and energy linkage along the east coast of Australia.

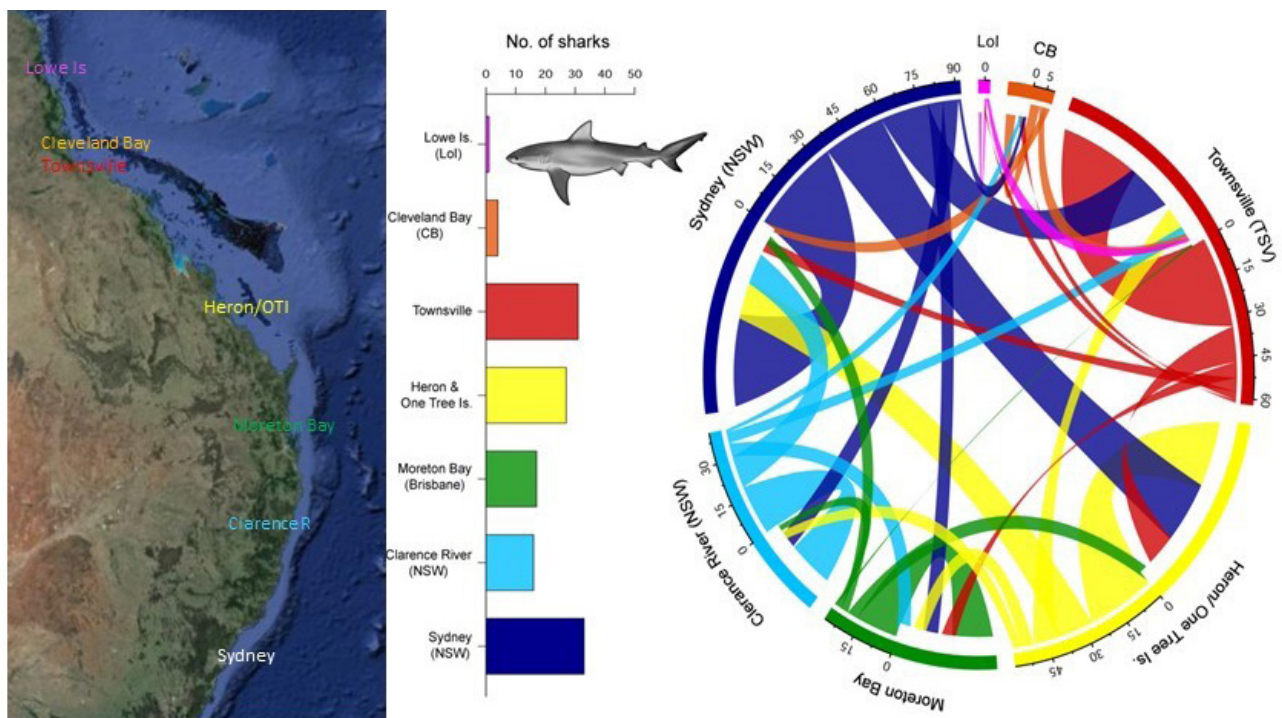


Figure 3. Map indicating the location of acoustic receiver arrays along the east coast of Australia and associated connectivity plot (chord diagram), indicating movement of individuals between receiver arrays. Sourced from Heupel et al., 2015.

## Implications for people and ecosystems

The previously unknown importance of bull sharks in large marine ecosystems has been elucidated through data obtained via the IMOS Animal Tracking Facility. The analysis of bull shark movements highlights the complex challenges faced by managers when species move broadly and cross jurisdictional boundaries. Movement across state boundaries emphasises the need for cooperation among management agencies to ensure sharks receive adequate protection during their migrations. These data underscore the potential for sharks to move outside Australian waters and that this should be considered in international management agreements. This study reveals the capacity of acoustic telemetry networks to obtain valuable movement data can guide effective management and conservation policies for highly mobile species.

## Acknowledgements

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## Data Sources

IMOS Acoustic Telemetry.

<http://imos.org.au/facilities/animaltracking/acoustictelemetry/>

## References

Heupel, M.R., Simpfendorfer, C.A., Espinoza, M., Smoothey, A.F., Tobin, A., Peddemors, V. 2015. Conservation challenges of sharks with continental scale migrations. *Frontiers in Marine Science*. doi: 10.3389/fmars.2015.00012.