White Shark population and abundance trends

Evidence-based information is needed to address high-priority actions in the National Recovery Plan for the White Shark (*Carcharodon carcharias*) to underpin population and risk assessments, and to support local-scale policies and management.

This project developed, tested and applied tools for estimating the abundance and population status of White Sharks in Australian waters, including the first ever empirical estimate of adult White Shark abundance. Elements of this task included confirming population structure, identifying habitats, developing measures of key population attributes, and improving information on movement patterns. This built on research data gathered in the past decade.

Approach

Genetic data from individual sharks were analysed to identify sibling relationships, (sharks that share one or both parents), the most informative of which are half-sibling pairs from different birth-years. Genetic-based mark-recapture analysis provided the first empirical estimates of adult abundance and the basis for estimating reproductive frequency and adult survival. It also shed light on population structure (see story on page 46).

Acoustic tags (5–10 year duration) and satellite tagging were used to trace movement patterns (including residency and depth-swimming behaviour), identify habitats, examine growth rates, and further explore population structure. Aerial and vessel-based surveys at nursery areas were trialled to provide estimates of juvenile abundance. These data support a population model being developed to estimate total population abundance and population trend for eastern Australia.

Key findings

Detections of acoustic-tagged juvenile sharks continue to provide movement data and, over time, will provide survival estimates. Juveniles were recorded on 273 acoustic receivers spanning the eastern Australian coast, from Lady Elliott Island in the southern Great Barrier Reef to Flinders Island off north-eastern Tasmania (more than 179,000 detections). A shark tagged in New South Wales was detected on receiver arrays in New Zealand and several sharks tagged by New Zealand colleagues were detected in eastern Australia. These data highlight the utility of broad-scale acoustic receiver arrays deployed under the Integrated Marine Observing System and data-sharing between partner institutions.

Tagging data continue to support a two-population model for White Sharks in Australia, separated east and west by Bass Strait, and the migration of juveniles along the eastern seaboard between eastern Tasmania/south-eastern Victoria and the southern Great Barrier Reef. They provide further evidence of shark movements between eastern Australia and New Zealand, and multi-year return and occupancy of two known east coast nursery areas (Port Stephens, NSW and 90 Mile Beach-Corner Inlet, Vic).

Tagging data predict a higher level of movement and potential for gene flow (or transient movement of non-breeding sharks) between Australia and New Zealand than between the east and west of Bass Strait.

Tissue samples were collated from 331 White Sharks (129 'eastern population', 185 'western population' and 17 from New Zealand). Genetic analyses have identified half-sibling and full-sibling sharks in the relatively limited number of east coast samples. Adult population size for eastern Australia was estimated at 750–1200 individuals; further analyses will improve this estimate. Genetic data also support the two-population structure across Australia, with a low interchange rate between populations. These data will provide the first empirically derived estimates of reproductive frequency and, with further sample analysis, adult mortality rates. These measures are needed for population models to estimate total population sizes for juveniles and adults, and to assess the relative and cumulative effects of mortalities over the whole life span.

The finding of half-sibling matches in a small number of sharks (51) analysed as a trial from the western population suggests the size of this population may also be estimated in future (with further sample analyses and refinements).

Tagging of adults in South Australia combined with vessel-based and aerial surveys of the southern Australian coast are providing the first evidence for nursery areas west of Bass Strait.

ABOVE: **Acoustic and satellite tagging were used to trace White Shark movement patterns, identify habitats, examine growth rates and explore population structure.** Image: Justin Gilligan, NSW DPI

New knowledge and opportunities

Tools developed in this project provide for the first empirical estimates of adult population size of a highly vagile threatened marine species. They provide the basis for effective monitoring that could be applied to assess other marine species for which population data are poor. Further refinements of the genetic technique will enable estimates of single-generation abundance trends, without the need for long-term monitoring. This represents a paradigm shift in the capacity to define conservation needs for this and similar threatened species.

Opportunities exist to improve knowledge of the western White Shark population (including identifying nursery areas), to continue tissue sampling tagged sharks, and to apply the integrated genetic analysis and modelling approach to estimate population size and status. A similar approach is now being applied to the Grey Nurse Shark and could be applied to other species of concern such as the Mako Shark, the Dugong, and turtles.

Outputs and outcomes

This project has developed the first empirically-derived adult White Shark population estimates (worldwide) and provides the basis for estimating measures of key population attributes (reproductive frequency, survival rates) needed to estimate population trends. It has identified key habitats in eastern Australia and laid the groundwork for estimating total population size and status in Australian waters.

Science-based advice was provided to support conservation actions, management of shark-based tourism, and policy regarding public safety. In the government sphere, advice has been provided to Federal and State agencies, departments and ministers (including the Environment Protection Authority of Western Australia, the Federal Department of the Environment, New South Wales Department of Primary Industries and the South Australian Department of Environment, Water and Natural Resources).

Reports and journal papers have been generated on topics including novel genetic techniques for estimating population parameters, mark-recapture modelling, tagging and tracking, movements and aggregations, habitat, and health.

ABOVE: **Acoustic-tagged juvenile sharks continue to provide management data and, over time, will provide survival estimates to support a White Shark population model.** Image: Justin Gilligan, NSW DPI

CONTACT
Barry Bruce
barry.bruce@csiro.au
(03) 6232 5413