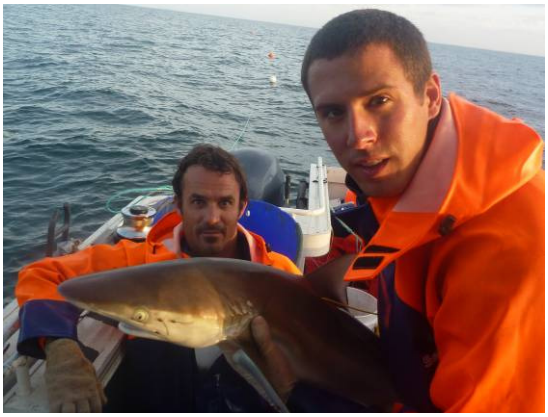
Understanding the residence time and movement patterns of whaler sharks (*Carcharhinus* spp.) along the Adelaide metropolitan beaches



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Six month progress report to the Australian Animal Tracking and Monitoring System (AATAMS)

Introduction

Whaler sharks are common coastal and pelagic sharks that inhabit temperate and tropical waters. Two species of whaler sharks are found in South Australia, the dusky whaler (*Carcharhinus obscurus*) and the bronze whaler (*C. brachyurus*). Sharks have been highlighted as species of conservation concern due to their life history characteristics (slow reproductive cycles, smaller litter sizes, slow growth rates, late ages-at-maturity) and slow rebound potential resulting in a high susceptibility to overfishing (Holden 1973; Musick 1999; Stevens et al. 2000). Whaler sharks have been identified as having particularly slow reproductive output with the demographics of the dusky whaler making it among the most vulnerable vertebrates to depletion by fisheries (Romine et al. 2009). As a result, the dusky whaler was recently listed under the IUCN Red List as 'Vulnerable'.

However, whaler sharks (including dusky whalers) are commercially targeted in various fisheries around Australia. In South Australia, whaler sharks are targeted during the warmer months between September and May with increased effort during the snapper closure when commercial fishers shift their fishing effort towards alternative species. The annual commercial catches of whaler sharks average approximately 100 tonnes since 1990 with most of the catches taken within Gulf St Vincent and Spencer Gulf. Whaler sharks are also targeted recreationally. Off metropolitan Adelaide, whaler sharks are caught from jetties and boats every year by enthusiastic recreational and game fishers. Fishing effort by these anglers extends from Grange up to St Kilda and as far north as Port Wakefield. Recently a large pregnant bronze whaler washed up dead on a metropolitan beach after being released by a game fisher. The effects of the fishing pressure from both sectors and the resilience of whaler sharks to the current fishing levels are unknown. Demographic studies have shown that whaler shark population would decline even at low levels of fishing mortality and suggest that stringent regulatory measures may be required to recover collapsed populations (Romine et al. 2009). However, there are currently no legislations managing the whaler shark fishery in South Australia.

Marine reserves and protected areas are often listed as useful management options to

protect marine organisms from extensive fishing pressure (Chapman et al. 2005; Heupel and Simpfendorfer 2005). These are only suitable for species that spent a relative large amount of time within specific locations that can be protected (Chapman et al. 2005). A preliminary analysis of game fish tag-recapture data suggests that whaler shark movement may be limited with nine sharks being recaptured where they were tagged, 28% recaptured <10 km from the tagging site, and the mean distance moved being only 195 km for 40 recaptured sharks (NSW DPI, P. Rogers un published data). However, conventional tagging only provides information on the release and capture locations and does not provide any data on the movements of sharks between release and capture. Information on how often and how long sharks utilise specific areas, as well as how far and how frequently they disperse is central to evaluating the potential efficiency of using marine reserves to protect sharks from overfishing. Acoustic telemetry (see methods for more information) enables continuous recording of the presence/absence of tagged organisms at specific locations and assess their residence time and site fidelity. The deployment of receivers in a line also facilitates assessing if tagged organisms travel outside specific ranges.

The study used acoustic receivers and transmitters to provide an understanding of whaler sharks movements and residence times. The data obtained will be useful to assess the suitability of marine reserves or protected areas to protect sharks from overfishing and will help to better understand the potential impact of the fishing effort shift which takes place during the summer months in South Australia.

Specifically, we aim to:

- investigate the seasonality, residence time, and movement patterns of whaler sharks along the Adelaide metropolitan beaches;
- assess the suitability of marine reserve to protect whaler sharks from overfishing;
- provide management advice and recommendations to ensure long-term sustainability of the fisheries catching whaler sharks based on the improved knowledge of their movements and residence times;
- Initiate a network of acoustic receivers within South Australia.

Methods and progress to date

A network of 14 acoustic receivers was deployed along the Adelaide metropolitan beaches to monitor the movements of whaler sharks (Table 1, Fig. 1). Two receivers were deployed in Northern Gulf St Vincent off a sand bank where large numbers of whaler sharks have been caught commercially. One receiver was deployed of Semaphore Reef where large numbers of whaler sharks have been caught recreationally. One receiver was deployed next to the last navigation marker (Black Pole) at the end of the Port River Channel where whaler sharks have been caught recreationally, including the largest bronze whaler caught on recreational gear. Additionally, ten receivers were deployed as a curtain off Glenelg Beach from about 400 m from the reef outside Glenelg Beach to about 8 km offshore. Receivers were placed about 800 m from each other to allow overlapping acoustic coverage.

Table 1. Location of AATAMS receivers. 'Latitude' and 'Longitude' are in WGS84, decimal degree format; 'Date deployed' is in South Australian local time.

Receiver S/N	Station	Latitude	Longitude	Depth (m)	Date deployed
101744	Long Spit inside	-34.567317°	138.215800°	6.7	16/03/2010
101746	Long Spit outside	-34.606417°	138.149117°	16.5	16/03/2010
101747	Semaphore Reef	-34.826800°	138.439017°	7.7	16/03/2010
101798	Black Pole	-34.733567°	138.466933°	4	16/03/2010
101672	Glenelg Line 1	-34.979100°	138.503000°	6	25/01/2010
101673	Glenelg Line 2	-34.979100°	138.494500°	8	25/01/2010
101674	Glenelg Line 3	-34.979100°	138.486300°	9	25/01/2010
101675	Glenelg Line 4	-34.979100°	138.478400°	11	25/01/2010
101676	Glenelg Line 5	-34.979100°	138.470000°	13	25/01/2010
101678	Glenelg Line 6	-34.979100°	138.461600°	14	25/01/2010
101677	Glenelg Line 7	-34.979100°	138.453200°	15	25/01/2010
101679	Glenelg Line 8	-34.979100°	138.444900°	18	25/01/2010
101764	Glenelg Line 9	-34.979100°	138.436500°	20	25/01/2010
103308	Glenelg Line 10	-34.979100°	138.428600°	21	25/01/2010

Figure 1. Locations of acoustic receivers deployed in the Gulf St Vincent for the whaler shark project.

Eight receivers were additionally provided but have not yet been deployed because of the small numbers of whaler sharks inside the South Australian Gulfs during the winter period.

A total of eight whaler sharks (two *C. obscurus* and five *C. brachyurus*) ranging 780–132 mm TL were internally tagged with an acoustic transmitter (Table 2). Whaler sharks were caught using floating longlines. The longlines were 500 m long and leaders were separated at 3–6 m intervals. Circle tuna hooks (14/0) were crimped onto 1–2 m wire leaders (0.8 mm thick). Various floats (e.g., foam buoys and soft floats) of about 20–30 cm diameter were used to keep the longline close to the surface. Two longlines baited with mullet and mackerel were deployed each time with a soaking time of one hour.

Table 2. Details of whaler sharks tagged. All sharks we tagged in close proximity to the Long Spit sand bank. 'TL' represents total length over the curvature of the body in mm.

Species	TL	Sex	Acoustic S/N	ID code	Date
Carcharhinus brachyurus	1100	Female	1084084	49134	31/01/2010
Carcharhinus obscurus	1700	Male	1084082	49132	31/01/2010
Carcharhinus brachyurus	780	Male	1084083	49133	31/01/2010
Carcharhinus brachyurus	1060	Female	1084085	49135	31/01/2010
Carcharhinus obscurus	1070	Male	1084086	49136	31/01/2010
Carcharhinus brachyurus	1320	Male	1084087	49137	31/01/2010
Carcharhinus brachyurus	1230	Female	1084088	49138	31/01/2010

The captured fish were brought onto the boat and restrained using a sling. Water was circulated across the gills of the sharks using a bilge pump to ensure the continuous ventilation of the sharks throughout the surgery. A towel was place over the eyes of the shark to reduce capture and handling stress. A small incision (1.5–2 cm) was made posterior to the pelvic fins and a Vemco transmitter (V16-6H, code map 1303, minimal and maximum intervals between pulses of 50 and 110 seconds, respectively) was inserted into the body cavity. The incision was stitched with 2–3 non-continuous external sutures (3/0 Monosyn absorb violet 70cm, needle tapercut). Antibiotics (at a dose of 0.1ml/kg body weight) were injected into the dorsal musculature to prevent infection.

The receivers deployed for the purpose of this project initiated a South Australian network of acoustic receivers. Additionally, several acoustic receivers were also deployed as part of various other projects to complement this South Australian network (Fig. 2). Ten acoustic receivers were deployed in the top of Spencer Gulf for a Snapper (*Chrysophrys* sp) project. Ten acoustic receivers were also deployed around the Neptune Islands for a White Shark (*Carcharias* sp.) project. Eight receivers were deployed off Kangaroo Island to monitor Harlequin Fish (*Othos* sp.), and about 30 receivers were deployed in the Coorong for Bream (*Acanthopagrus* sp.) and Congoli (*Pseudaphritis* sp.). This South Australian network forms part of the growing national acoustic network that enables to monitor the movements and large-scale migrations of tagged organism around Australia. This study will also provide information about the movements of white sharks around the metropolitan beaches. Over 60 White Sharks have already been tagged with acoustic transmitters by CSIRO and it is likely these white sharks will also be detected by the receivers deployed during this project.

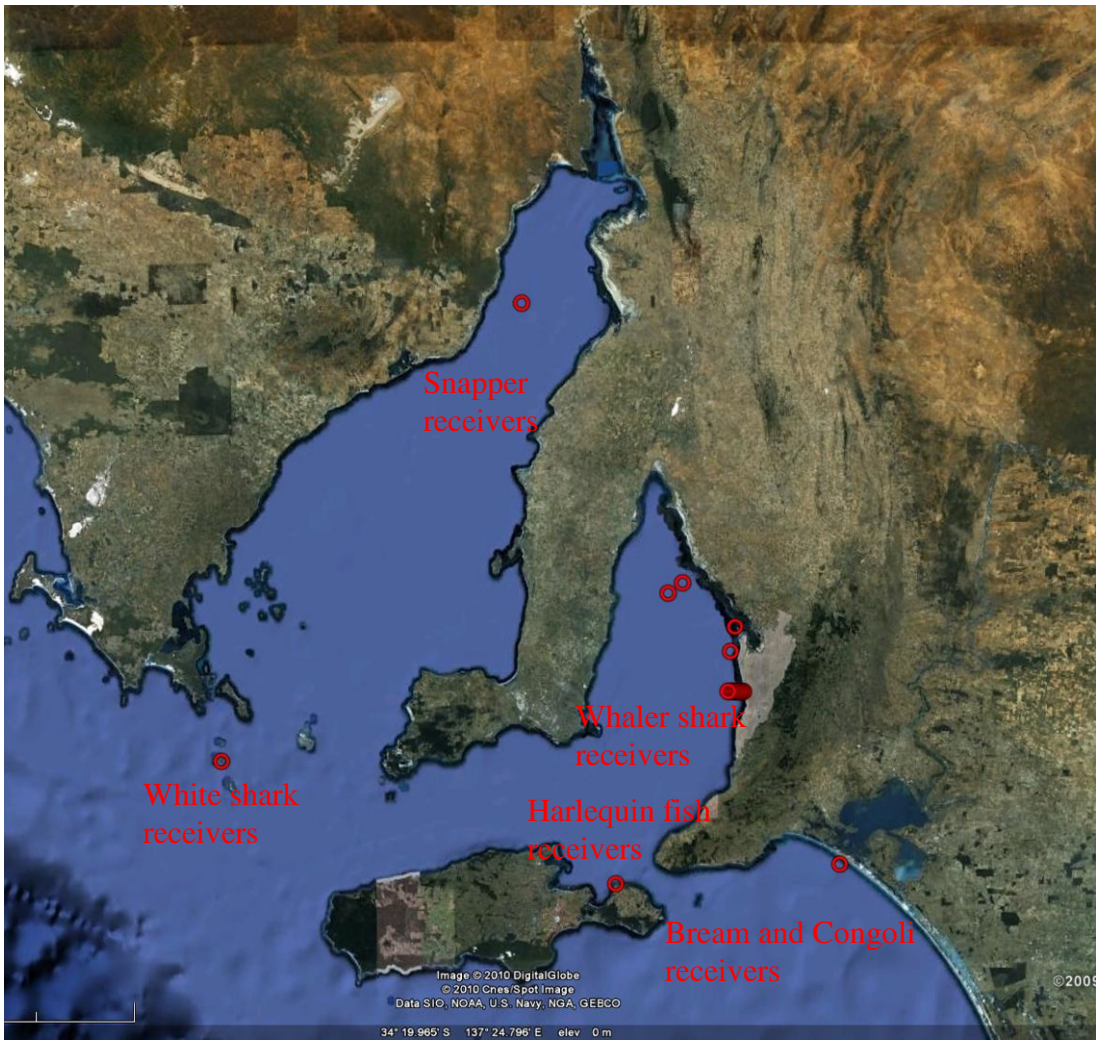

Figure 1. Locations of acoustic receivers forming the South Australian acoustic network.

Media coverage and community outreach

Since the receivers were allocated, the whaler shark project was exposed in 'The Advertiser' and within the Nature Foundation of South Australia newsletter which provided funding for the tags. We also presented some of our group's research to various community events such as the University of the Third Age, fundraising events towards shark conservation and to various tourist groups undertaking white shark cage-diving expeditions. Details of the media coverage and community presentation are presented below:

- Nature Foundation of South Australia Nature Matters Newsletter (May 2010). Article about whaler shark and white shark projects.
- 'The Advertiser' (27th April 2010) Fish and implant tracking chips. Article about the whaler shark tagging project.
- **Huveneers, C**. November 2009/December 2010/January 2010/May 2010/June 2010. Shark research in South Australia. Rodney Fox Shark Expeditions, North Neptune Island, South Australia
- **Huveneers, C**. December 2010. Shark research in South Australia. University of the Third Age (U3A) Club – Aldinga Library, South Australia
- **Huveneers, C**. January 2010. Shark ecology in South Australia. Presentation towards a shark fundraising event in collaboration with CCSA, Adelaide, South Australia

Expected schedule

Thirteen additional acoustic transmitters have been purchased and will be deployed as soon as whaler sharks return inside the South Australian Gulfs. It is expected that whaler sharks will be tagged in November–December 2010.

The eight additional AATAMS receivers will be deployed in October 2010 prior to the arrival of whaler sharks. Four receivers will be deployed between Semaphore Reef and the Semaphore Jetty to create a curtain and provide some directionality of movements between the Glenelg Line and the Semaphore Line. The remaining four receivers will be deployed off St Kilda approximately 2 km from Black Pole in an area where whaler sharks are known to occur in large numbers during October–November. Acoustic receivers forming the Glenelg Line will be recovered, downloaded, serviced and re-deployed in January–February 2011. The four AATAMS receivers already deployed will be recovered, downloaded, serviced and re-deployed between October 2010 and February 2011.

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