

**1. Project title**

Assessing migration patterns and population status of Whale Sharks (*Rhincodon typus*)

**2. Chief investigator:**

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Name	Mark Meekan	
Institutional Affiliation	Australian Institute of Marine Science	

**3. Project summary**

This research will support ongoing studies that identify the migratory cycle of the Western Australian whale shark population and define its habitat in relation to physical and biological oceanography. It will build linkages with and harness whale shark research activity (including tagging, photo-identification and genetics) in other areas of the Indian Ocean and encourage capacity building with an aim to relating whale shark observations to ocean dynamics to help explain whale shark movements, develop a program of international research, assess population status on both local and regional scales.

**4. Project objectives**

Each year from March to May, whale sharks (*Rhincodon typus*), aggregate on the continental shelf of the central Western Australian coast. At Ningaloo Reef, whale sharks are often found swimming close to the reef front, within a few kilometres of the shore and in water of less than 50 m deep. A tourist industry based on snorkelling with the sharks in this area has developed over the last 10 years and is now worth over \$20 m annually to the local economy of the Ningaloo region. The project aims to:

- 1) Determine regional long-term movement patterns of whale sharks at Ningaloo Reef and at other sites visited by these whale sharks (Christmas Island, Indonesia) during their migrations.
- 2) Examine fine and broad-scale movement paths with respect to physical oceanographic features and biological productivity
- 3) Improve estimates of population abundance, demographic parameters and long-term (decadal) trends in population size and composition
- 4) Examine the effects of tourism interactions with whale sharks on re-sightings
- 5) Build links and develop capacity in the Indian Ocean with the aims of increasing observations of movements on an ocean basin scale and providing the first regional estimates of population size and status of whale sharks

Achievement of these aims is vital if the areas important to sharks are to be protected within the framework of a multi-use (fishing, oil prospecting, tourism etc) marine park. However, protection will also require documentation of whale shark migration patterns. These animals are known to travel great distances (1000's of km) and this behaviour may make them vulnerable to both artisanal and commercial fisheries in Southeast Asia and the Indian Ocean. Ultimately, establishment of ecotourism industries in these areas may offer an alternative to exploitation of these animals as a food resource.

By identifying the important habitats at Ningaloo, localities where fishermen target whale sharks, the feasibility of whale shark ecotourism in neighboring areas such as Indonesia and tagging sharks at other sites visited on their migration path, such as Christmas Island, the outcome of the project has direct and concrete benefits for the conservation of this threatened species. This information will also have implications for the management of a species that currently supports a

major regional industry and is a seasonal basis of much of the economy of the Exmouth region. The project is a collaborative effort with various Australian and US institutions involved in the research. Through information sharing, it seeks to develop a regional network of research groups based in the Indian Ocean that will allow the results of the project to be placed within a regional context. The project addresses the DEH 2007/08 research priority area A17 as well as supporting actions to achieve objectives of the DEH Whale Shark Recovery Plan by contributing towards information gaps to develop appropriate conservation and management regimes for whale sharks on local and international scales.

## 5. **Project methodology**

This proposal will support an ongoing project that aims to provide managers with data that will aid in the development of appropriate conservation and management regimes. There are 4 major components to this research project:

### **1) *Satellite tagging***

Whale sharks will be tracked using a combination of Wildlife Computers SPOT-4 and SPLASH tags. SPOT tags transmit to the ARGOS satellite system when the aerial and switch break the surface. Location and surface temperature data are transmitted. Estimates of location can be as precise as <150 m. SPLASH tags also archive and transmit depth data. We will use two attachment methods. Tags will be embedded in a buoyant, hydrodynamic housing that will be linked to a nylon coated stainless steel tether anchored to the side of a delron collar.

The collar fits around the base of the first dorsal fin and is attached using a modified stainless steel underwater RAMSET applicator. Some tags will be embedded directly in the delron collar alleviating possible problems with the tether catching on underwater obstructions. The SPLASH tags will sample and store, in electronic memory, measurements of hydrostatic pressure (water depth, m), water temperature, and ambient light level every 60 seconds, and transmit summary histogram data on maximum dive depth (m), dive duration (min), time-at-depth, and time-at-temperature to earth-orbiting ARGOS satellites every ca 45 seconds when the transmitter is at the sea-surface. Regions of high residency where the sharks are clearly not in transit will be identified from the tracking data. The physical and biological characteristics of these areas will be obtained from remote sensing data, from the environmental data collected by the tags and from oceanographic models. Using this approach we will be able to identify regions of local productivity that aggregate whale sharks and to characterize their biotic and abiotic features including sea surface temperature, water column structure and primary productivity.

### **2) Photo-identification**

Photographs of the spot and stripe patterns on the flanks of whale sharks can uniquely identify individuals. These photographs can be used in mark-recapture models to describe aspects of the population demography including trends in population abundance and composition, and also to study the effects of interactions with tourists on the behaviour patterns of sharks. Photographs are taken of each shark encountered during tagging (see above). These are combined with those taken by ecotourism operators throughout the whale shark season and with a library of identification photographs that we have accrued that covers more than a decade at Ningaloo (>1,000 images, beginning from 1992). Resightings of individuals at weekly, monthly and annual intervals will be added to our mark-recapture models to improve estimates of population size, and most importantly, long term trends in abundance and composition. Matching of photographs for this work will be done with a software image analysis system that we have now adapted and refined for use with whale sharks. Additionally, this information can also be used to examine the effects of encounter histories of sharks with tourist operators on the chances of re-sightings. Finally, our photo-identification library can be compared with those accrued by collaborating research groups working on whale sharks in other parts of the Indian Ocean, notably in Mozambique and the Seychelles. By pooling these libraries, we will be able to determine if we can identify any animals previously sighted at Ningaloo at these localities (and vice versa) and to begin to provide population estimates for whale sharks at regional and Indian Ocean scales.

### **3) Genetic tagging**

'Genetagging' uses the microsatellite DNA profile of a fish as a life-long indelible tag. This type of tagging is currently in a developmental phase in Australia and has been evaluated for whale sharks by our research group during 2006. We have validated some critical elements for use in a standard monitoring protocol including laboratory work verifying that microsatellite sequences can be retrieved from small samples of whale shark tissue. Secondly, we have developed a humane technique to reliably remove very small samples of tissue. This latter point is essential if the technique is to achieve broad acceptance by all involved in the conservation of whale shark populations in Australia, including ecotourism operators. Now that these techniques are established, the project has begun to harvest tissue and genetically tag sharks. It is envisaged that in future this work will proceed in collaboration with ecotourist operators and the Department of the Environment and Conservation (DEC). The ultimate aim is to fingerprint the majority of the Ningaloo population of sharks (approximately 200-300 individuals). This will allow validation of photo-identification techniques and also enable us to determine if sharks visiting Ningaloo are being harvested to supply markets in Asia.

## **6. Data collection and analysis**

Satellite tagging, photo-identification and genetic tagging programs will be undertaken concurrently during 2 weeks of field work in January 2008 at Christmas Island and in April-May 2008 at Ningaloo

Reef. The work uses a 7m vessel to voyage to waters on the outside of the reef. Whale sharks are located using a light plane that directs the surface vessel to the vicinity so that snorkelers can access free swimming sharks. It is envisaged that a minimum of 4 Splash satellite tags and a further 7-8 Pop-off Archival Tags (PAT) will be attached to sharks during field work at Christmas Island and at Ningaloo Reef. These will remain attached to sharks for up to 18 months after deployment.

**Additional data collection**

We will liaise with ecotourist operators and with DEC to obtain photographs and tissue collections from sharks encountered during the 2008 whale shark ecotourism season (April-June) at Ningaloo. These will be combined with existing photo-libraries and photographs from Christmas Island and tissue samples obtained by collaborating research groups at other localities in the Indian Ocean, such as Mozambique and the Seychelles during 2008.

**Data Analysis**

We will compare whale shark track and diving data with satellite remote sensing information of ocean colour and temperature to infer oceanographic influences on whale shark movements at country, regional and Indian Ocean scales. Photo-identification databases will provide resightings of individuals at weekly, monthly and annual intervals. These will be subjected to mark-recapture analysis to improve estimates of population size, long term trends in abundance and composition. We have recently developed and modified software so that matching of photographs for this work can be done automatically, vastly increasing the speed of analysis. By collaborating with researchers at other localities we will access photo-identification libraries through out the Indian Ocean. Using the software, we will search these databases for images of individuals that have visited Ningaloo Reef and Christmas Island, providing a second means of tracking migration patterns and population linkages. The resighting data sets will also be analysed using mark-recapture techniques to provide a first estimate of population size and composition on a regional scale for whale sharks. Tissue samples obtained during tagging and by DEC staff will be analysed in the laboratory to determine genetic tags.

**7. Project work plan**

Activity to be undertaken	Est. start date (mm/yy)	Est. finish date (mm/yy)
• Purchase of satellite tags	Nov 07	Nov 07
• Field work at Christmas Island	Jan 08	Jan 08
• Field work at Ningaloo Reef	April 08	May 08
• Report on field work, establishment of website for tracks , analysis of photo-identification libraries	June 08	June 08
• Receipt and analysis of photo-identification libraries from ecotourist operators, genetic sample analysis	August 08	Sept 08
• Modelling of population demography and abundance	Sept 08	Dec 08
• Final report detailing project outcomes	Jan 09	

**8. Project outputs**

Expected outputs	Date of completion (mm/yy)
Report on field work outcomes	June 2008
Establishment of website for tracks	July 2008
Seminar presentations. Results of the study will be presented in a national (Australian Marine Sciences Association) or international conference (American Elasmobranch Society)	July 2008
Final Report	Jan 2009

**9. Organisation Details**

Organisation Name	Australian Institute of Marine Science
Registered Office	Cape Cleveland Road, CAPE FERGUSON QLD 4816
Principal Place of Business	Cape Cleveland Road, CAPE FERGUSON QLD 4816
Date and Place of Incorporation	Commonwealth Government Entity – Not incorporated
Trading and Business Names	Australian Institute of Marine Science
Registered Business Number	n/a
Australian Business Number	78 961 616 230
Registered for GST?	Yes - Effective from 01 Jul 2000

