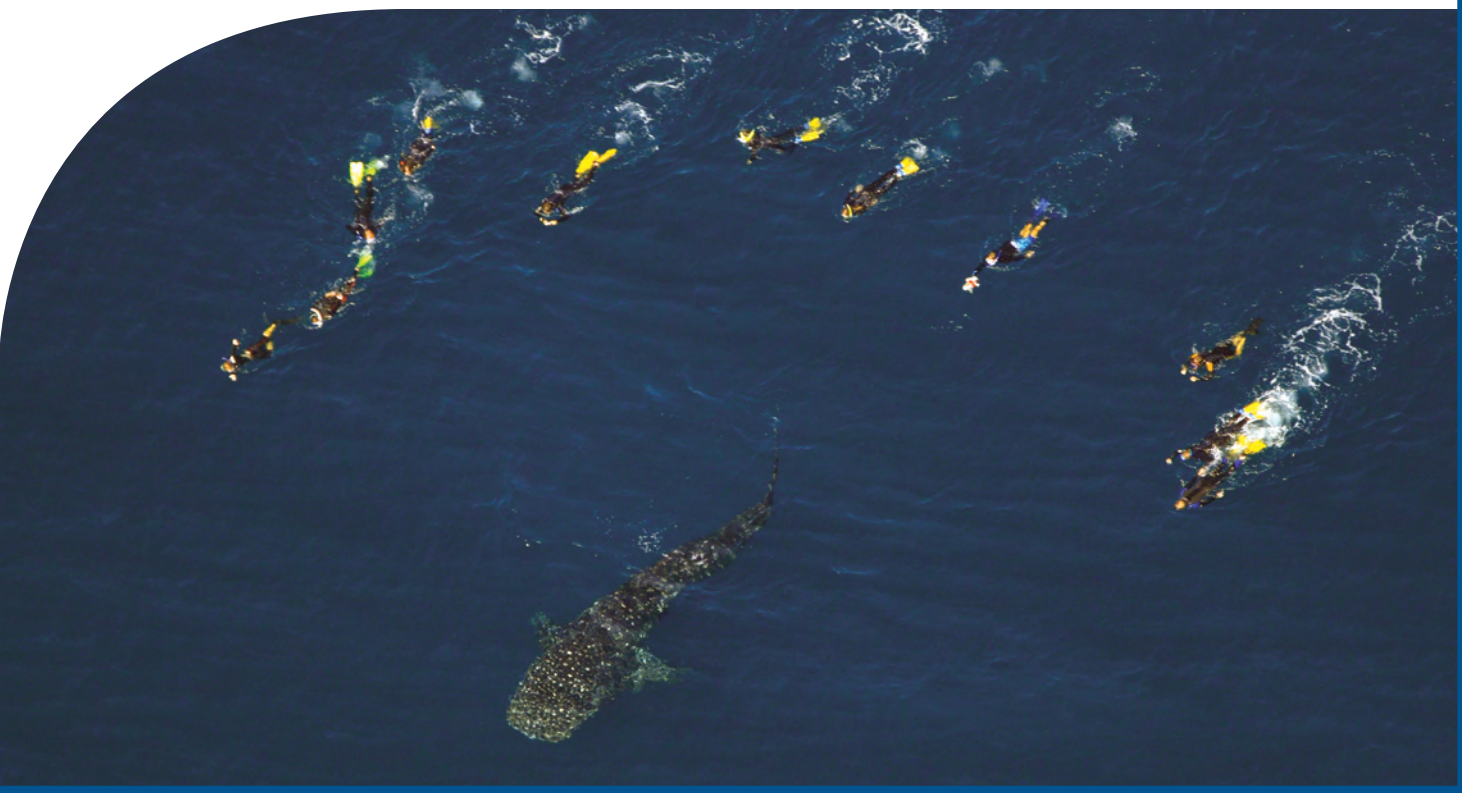
Whale shark management

with particular reference to Ningaloo Marine Park

Wildlife management program no. 57

Department of Parks and Wildlife

2013



Department of Parks and Wildlife

NINGALOO COAST WORLD HERITAGE

CARING FOR OUR COUNTRY

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FOREWORD

This wildlife management program has been prepared within the framework laid down in Department of Parks and Wildlife (DPaW) Policy Statement no. 44 (CALM 1992), which provides for the preparation of written wildlife management programs to guide the management and protection of any taxon, or group of taxa, and their habitats. Wildlife management programs may be prepared for threatened taxon or taxa that are subject to harvesting or other exploitation through human interaction. The exploitation of whale sharks through commercial interactions has been identified as a matter requiring a wildlife management program.

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LIST OF ACRONYMS

AIMS	Australian Institute of Marine Science
CALM Act	*Conservation and Land Management Act 1984*
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
DEC	Department of Environment and Conservation (now DPaW – Department of Parks and Wildlife)
DPaW	Department of Parks and Wildlife (previously DEC – Department of Environment and Conservation)
DMS	Dimethyl sulfide
DoT	Department of Transport
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FRM Act	*Fish Resources Management Act 1984*
IUCN	International Union for the Conservation of Nature – The World Conservation Union
MoU	Memorandum of Understanding
MPRA	Marine Parks and Reserves Authority
NMP	Ningaloo Marine Park
SOI	Southern Oscillation Index
SST	Sea Surface Temperature
UNCLOS	*United Nations Convention on the Law of the Sea*
UNESCO	United Nations Educational, Scientific and Cultural Organization
WC Act	*Wildlife Conservation Act 1950*

SUMMARY

Whale shark management with particular reference to Ningaloo Marine Park, *Wildlife Management Program no. 57* (2013) has been approved by the Director General of the Department of Parks and Wildlife (DPaW) and endorsed by the Marine Parks and Reserves Authority (MPRA).

This wildlife management program replaces and updates the original program approved in 1997 and directs the management of whale sharks, with specific reference to whale shark interaction in reserves – particularly Ningaloo Marine Park (NMP).

The whale shark (*Rhincodon typus*) is a protected species within all Western Australian state waters. DPaW has a legislative responsibility to manage wildlife on DPaW-managed lands and waters under the *Conservation and Land Management Act 1984*, and to manage fauna for conservation statewide under the *Wildlife Conservation Act 1950*. Whale sharks are listed as 'other specially protected fauna' under the *Wildlife Conservation Act 1950.* Nationally, they are listed as 'vulnerable' and a 'migratory species' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999,* and have international recognition.

The threats to whale sharks are principally due to human interactions (harvesting) outside state and Commonwealth of Australia waters, and these are outside the scope of a state wildlife management program. Human interactions (recreation and tourism) within state and Commonwealth waters pose a potential risk to whale sharks and are therefore managed to minimise this risk.

A seasonal aggregation of whale sharks occurs in the waters of NMP from March to July, sometimes extending to August each year, with occasional sightings outside of this season. This aggregation is one of the largest in the world and its uniqueness has contributed to the Ningaloo Coast being inscribed on the World Heritage List, acknowledging it as one of the outstanding natural places in the world and reaffirming the whale shark as a conservation icon. An expanding tourist industry, focusing on human/whale shark interactions, has developed around the shark's seasonal occurrence.

DPaW has managed commercial whale shark tourism since 1993 through a system of controls, including the licensing of a limited number of operators for whale shark interaction tours. The level of interaction with whale sharks associated with this activity justifies that a wildlife management program be developed and implemented.

There is still much to learn about the biology and ecology of the animal despite increased efforts in research and monitoring during the past decade (see Appendix 1). Whale sharks probably have innate biological characteristics, like many other sharks, such as large size, slow growth, late maturation and extended longevity. These characteristics may limit recruitment and make the species susceptible to exploitation. It is unclear whether increased tourism and other anthropogenic pressures are presently generating any detrimental impacts on individual whale sharks or the group as a whole. With the limited information currently available, evidence of any impacts is difficult to obtain and interpret, and for this reason a precautionary approach to management will continue to be adopted.

This wildlife management program presents DPaW's approach to the management of whale shark interactions in reserves, the necessary contextual information, and how and why DPaW has adopted this approach. This includes:

- a review of the available information on the biology and ecology of the whale shark and the reasons for management (Appendix 1)
- legislation, DPaW's statutory requirements and government policy relevant to whale shark interaction management and the responsibilities of relevant authorities and government agencies (Section 2)
- how management priorities have been determined and the management framework (Section 3)
- the management, research and monitoring, and education strategies developed to achieve the dual objectives of sustainable whale shark interactions and conservation of the species (sections 4, 5 and 6).

The implementation of this management program is detailed (Section 7), including roles and responsibilities and the review processes designed to ensure the objectives are being met. These will ensure the management regime for whale shark interaction in reserves remains appropriate to meet the objectives.

The main elements of this management program are presented below, including the program's overarching vision and strategic objectives. The strategies required to achieve these objectives have been divided into three broad areas: management, research and monitoring, and education.

Vision

A healthy and natural whale shark population is maintained and supported by the management of a world-class and sustainable tourism industry which raises appreciation and understanding of whale sharks.

Strategic objectives

Conservation:

- To improve our understanding of whale shark ecology and ensure it is included in whale shark conservation and interaction management at NMP.
- To raise public awareness and appreciation of whale sharks and use their iconic status to promote broader marine conservation issues.

Sustainable tourism:

- To ensure whale shark interaction tours are undertaken in a sustainable manner.
- To ensure and further promote the status of whale sharks as one of the iconic species found within the NMP and Ningaloo Coast World Heritage Area in order to support a world-class ecotourism industry into the future.

Performance measures

The following performance measures have been identified to evaluate the performance of this wildlife management program. Where trends in performance are applicable, the desired trends are identified for each performance measure:

1. Number of reported whale shark sightings per season relative to search effort – constant or positive
2. Number of reported whale sharks with boat-strike injuries as a proportion of whale sharks encountered – negative
3. Commercial operators being aware of and compliant with regulatory and management regime, as measured through compliance and education programs – positive
4. Recreational users being aware of and compliant with regulatory and management regime, as measured through compliance and education programs – positive
5. Techniques developed for reviewing whale shark monitoring data for the potential impacts of interactions on whale shark behaviour
6. Impacts of interactions on whale shark occurrence and behaviour, as determined by review of whale shark monitoring data – constant or negative

Strategies

Management strategies (see Section 4.3):

- Maintain appropriate regulation of whale shark interaction in accordance with the *Wildlife Conservation Act 1950* and *Conservation and Land Management Act 1984* and Regulations.
- Ensure tour operators comply with licence conditions.
- Develop and implement a compliance monitoring program for recreational users within NMP in accordance with the *Wildlife Conservation (Close Season for Whale Sharks) Notice 1996.*
- Maintain close liaison with commercial licence holders.
- Review and update the code of conduct as new information becomes available, with consideration of tour operator needs.
- Review licence charges to ensure maximum equity and efficiency, and cost recovery in licence management.

Research and monitoring strategies (see Section 5.6):

- Review and analyse historic data and existing information to determine if wildlife interaction tourism has caused short- or long-term impacts on whale shark behaviour in NMP.
- Review and analyse historic data and existing information to determine the spatial and temporal variability in whale shark numbers in NMP.
- Review and analyse historic data and existing information to identify relationships between spatial and temporal patterns of whale shark activity and biological, biophysical and oceanographic variables associated with whale shark aggregation and migration.
- Review historic data and existing information to determine the local and regional migratory patterns of whale sharks.
- From the reviews above, identify gaps in knowledge and where appropriate support research (internal and external) that provides information with direct management relevance to improve whale shark interaction management.
- Develop and implement an integrated whale shark MER (Monitoring, Evaluation, Reporting) program.
- Review and use research and monitoring outcomes to inform management strategies, specifically to minimise any impacts.

Education strategies (see Section 6.5):

- Raise community awareness of whale sharks and broader conservation issues through education and training programs.
- Develop and implement training and education strategies regarding tourism pressures facing whale sharks in NMP to achieve world's best-practice tour operations.
- Develop an education strategy aimed at reducing the risk of vessel strike by recreational and commercial vessels within NMP and other marine reserves.
- Provide knowledge and assistance to support development of whale shark conservation education programs globally.

1 INTRODUCTION

The whale shark (*Rhincodon typus*) is listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species as 'vulnerable' due to the impact of harvesting on their populations. In Australia, they are protected by way of their listing as 'vulnerable' and a 'migratory species' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under the Western Australian *Wildlife Conservation Act 1950*, the whale shark is a protected species within all Western Australian state waters. The whale shark has also recently been listed as 'other specially protected fauna' under the *Wildlife Conservation Act 1950* in recognition of the need to manage human interactions to ensure they do not pose a threat to this species.

Like many other shark species, the whale shark has innate biological characteristics, such as large size, slow growth, late maturation and extended longevity that probably limits recruitment and makes it particularly susceptible to exploitation. These characteristics also suggest that populations are likely to be slow to recover. Estimating global whale shark populations is difficult due to a lack of data, although it is generally accepted that numbers are declining worldwide (Fowler 2000; Norman 2002). The lack of data means it can be difficult to provide adequate legislative measures to protect the species at a global level. The whale shark has, however, been listed on some international conventions and agreements despite these difficulties, which affords the species some degree of global protection.

The appeal of swimming with such enigmatic creatures has led to rapid growth in whale shark tourism around the world, however the long-term effects on whale shark behaviour and occurrence are unknown. The reserve waters seaward of the reef crest at Ningaloo Marine Park (NMP) play host to one of the world's largest known predictable aggregations of whale sharks from March through to July each year. The annual aggregation of whale sharks at NMP was first documented in the early 1980s, and NMP is now recognised around the world as a hotspot for whale shark interaction, and a model for sustainable nature-based tourism.

The Western Australian Department of Parks and Wildlife (DPaW) has a legislative responsibility to manage wildlife on DPaW-managed lands and waters under the *Conservation and Land Management Act 1984* (CALM Act), and to manage fauna for conservation statewide under the *Wildlife Conservation Act 1950* (WC Act). DPaW is committed to preparing and implementing written management programs for species requiring specific management to ensure their conservation is not threatened due to human activities.

DPaW also has a statutory requirement under section 33(1)(da) of the CALM Act to facilitate the public enjoyment of the natural attributes of public lands and reserved waters in a manner that does not compromise conservation and other management objectives. Management of whale shark interactions in marine reserves requires integration of DPaW's conservation and recreation functions, and the principle role of DPaW in this respect is to manage the commercial and recreational activities of visitors to ensure no negative impact on the conservation of whale sharks.

1.1 Human interaction

The whale shark's habit of swimming on or near the surface makes the species accessible for swim interaction, but also makes it susceptible to injuries caused by collisions with boats and propellers. Injuries from boat and propeller strikes are commonly recorded in photo identification (ID) libraries but there are limited data on the level of disturbance or mortality from boat traffic.

During the past two decades the number of tourism operations providing the opportunity for tourists to swim with whale sharks has increased globally. The popularity of whale shark tourism has increased the economic value of the 'live' fish in many areas. The development and control of whale shark interaction activities around the world is guided by legislation and a code of conduct to minimise negative interactions with the species. However, implementation of guidelines and enforcement of legislation have met with varying degrees of success. While ecotourism has a minimal impact on populations compared with exploitation by fisheries, there is still concern that unmanaged ecotourism and harassment could interfere with the natural behaviour and approachability of whale sharks.

The management of the commercial whale shark tourism industry at NMP is considered world's best-practice (Norman 2002; Rowat & Brooks 2012). Increasing trends in both tourism pressure and whale shark contacts have been observed in NMP since 1995 (Figure 1). While this suggests that increasing tourism pressure has not resulted in a negative impact on the number of whale shark sightings, the longer-term effects on whale sharks are unknown and monitoring will need to continue to ensure the activity remains sustainable. Commercial tourism operators in NMP continue to play an important role in collecting information on sightings and interactions (Figure 1).

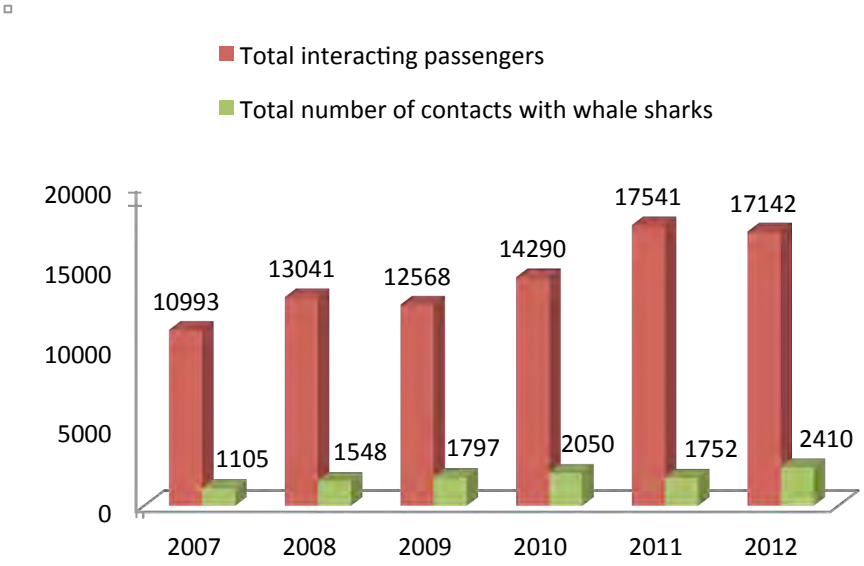


Figure 1: Total number of passengers interacting with whale sharks (red) and total number of contacts with whale sharks (green) recorded in Ningaloo Marine Park annually between 2007 and 2012.

The level of human involvement associated with whale shark interactions requires that a wildlife management program be implemented. The first program was developed in 1997 and provided a statement of the administrative, compliance auditing, education, research and monitoring measures to be followed to ensure that human/whale shark interactions in marine reserves, with particular reference to the NMP, were sustainable and achieved both conservation and recreation objectives.

This document has been developed after a review of the 1997 program. It provides up-to-date information on the biology, ecology (see Appendix 1) and current and potential threats facing whale sharks in NMP and makes recommendations on the future management, education, research and monitoring necessary to protect this species. It also takes into account the evolving nature of DPaW's management of this activity.

2 MANAGEMENT CONTEXT

2.1 Relevant legislation, conventions and agreements

2.1.1 International

International conventions and agreements are developed to ensure conservation of species and habitats through international cooperation. The whale shark is included in several international conventions and agreements.

2.1.1.1 Convention on Migratory Species

The Convention on Migratory Species (CMS) or Bonn Convention came into force in 1983 and now includes 117 parties. It provides a framework within which parties may tackle threats that operate throughout a species' range. Appendix II of the CMS lists 'migratory species which have an unfavourable conservation status and which require international agreements for their conservation and management, and species which have a conservation status which would significantly benefit from the international cooperation that could be achieved by an international agreement' (CMS 2004). In 1999 the whale shark was listed in Appendix II of the CMS. The CMS requires signatory countries to develop regional arrangements, that may be legally or non-legally binding, which will ensure the conservation of the whale shark (DEH 2005). These arrangements generally include several targeted conservation initiatives such as habitat protection and protection from the identified threats impacting adversely on the species.

Under the CMS whale sharks have recently gained further protection through the Memorandum of Understanding on the Conservation of Migratory Sharks, also referred to as the Sharks MoU. The first of its kind for sharks, the Sharks MoU aims to conserve migratory sharks wherever they occur in the world. The Sharks MoU began on 1 March 2010, with the original signatory countries being the Congo, Costa Rica, Ghana, Guinea, Kenya, Liberia, Palau, the Philippines, Senegal, Togo and the United States. Australia became the 14th country to sign the Sharks MoU, signing on 4 February 2011.

The Sharks MoU aims to:

- achieve and maintain a favourable conservation status for the seven shark species, which includes ensuring healthy and viable populations of these species remain in their existing habitats
- promote cooperation and information-sharing between countries that have signed the MoU
- improve understanding of migratory shark populations, key pressures and key habitats, and current and future actions to conserve these species.

2.1.1.2 International Union for the Conservation of Nature Red List of Threatened Species

In 2000 the whale shark was classified as 'vulnerable' on the IUCN's Red List of Threatened Species. The decision was based on declining populations indicated by reduced landings and actual levels of exploitation, as well as a projected or suspected population decline in the future based on potential levels of exploitation (Fowler 2000). The IUCN Red List of Threatened Species is widely recognised as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species.

2.1.1.3 Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was established to protect species of wild fauna and flora from over-exploitation through international trade. At present there are 176 parties to CITES, which operates by requiring these parties to regulate international trade in specimens of species listed in three Appendices in accordance with the provisions of the convention. Appendix II includes all species which, although not necessarily now threatened with extinction, may become so unless trade in specimens of such species is subject to strict regulation. The whale shark was listed on Appendix II of CITES in 2002. The whale shark met the criteria for listing in that 'it is known, inferred or projected that harvesting of specimens from the wild for international trade has, or may have, a detrimental impact on the species by exceeding, over an extended period, the level that can be continued in perpetuity' (CITES 2002). Parties to CITES have agreed to regulate any trade in whale shark products so that such trade will not have a detrimental impact on the survival of the species (DEH 2005). This requires fishing states to demonstrate that any exports were derived from a sustainably managed population and to enable monitoring of exports and imports.

2.1.1.4 United Nations Convention on the Law of the Sea

The United Nations Convention on the Law of the Sea (UNCLOS) defines the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. Provisions dealing with economic zones of coastal states and high seas require cooperation between states for the conservation and utilisation of highly migratory species. UNCLOS came into force in 1994 and currently 163 countries and the European Union have joined the convention. The whale shark is included in Annex 1 (Highly Migratory Species) of UNCLOS – recognising that coordinated management and assessment of shared migratory populations would promote an understanding of the cumulative impacts of fishing effort on the status of the shared populations (UNCLOS 1982). To date, no such initiatives are known to exist for whale sharks.

Under the UNCLOS, the United Nations Agreement on Straddling and Highly Migratory Fish Stocks was introduced in 1995, which has the potential to protect whale sharks by setting up direct actions to be undertaken (UNCSHMFS 1995). As yet, however, no action plans have been drawn up for whale sharks under this agreement.

2.1.1.5 Convention Concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention)

The Ningaloo Coast was officially inscribed to the World Heritage Convention on 24 June 2011. It is the 18th natural World Heritage property in Australia. The whale shark aggregation at NMP contributed to this inscription because it is one of the largest documented and reliable aggregations in the world.

The World Heritage Convention allows for sites of natural and/or cultural 'outstanding universal value' to be listed as World Heritage, providing international recognition and a means of protection. Nominations are assessed by the IUCN and then submitted to the World Heritage Committee, which then makes the decision to declare the area World Heritage or not. World Heritage properties are required to report on the condition of the property to the United Nations Educational, Scientific and Cultural Organization (UNESCO) every six years.

If the condition of a World Heritage property is determined to be under threat, the EPBC Act (see Section 2.1.2.1) is immediately implicated and the World Heritage Committee will request action to be taken to address this. As whale sharks were clearly identified as contributing to the values for which the World Heritage was declared, any activity likely to compromise those values or the factors that contribute to those values will be in breach of the EPBC Act. If the World Heritage property deteriorates to the extent that it has lost the characteristics that determined its inclusion in the first place, the World Heritage Committee may inscribe the property on the list of World Heritage in 'danger' and this may lead to eventual deletion of the property from the World Heritage List.

The Australian Government's Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) has primary responsibility for the development and implementation of national policy on World Heritage matters. An intergovernmental agreement gives DPaW responsibility for the day-to-day management of World Heritage areas with input from other agencies.

2.1.2 National

2.1.2.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

At the national level the whale shark is listed as 'vulnerable' under section 178 of the EPBC Act and a 'migratory species' established under section 209 of the Act. These listings were based on advice from the Commonwealth Threatened Species Scientific Committee derived from relevant information on threats to whale shark populations.

The whale shark was found to be eligible for listing under the EPBC Act based on evidence for past and probably future substantial reductions in the Australian whale shark population, primarily due to fishing pressures in the waters of other regional fishing nations such as the Philippines, Taiwan and India. Because it is probable that Australia shares whale shark populations with these regional nations and that hunting pressure would be expected to continue, it was concluded that a decline in the Australian population over time could be inferred or suspected (DEH 2005).

The EPBC Act protects the whale shark by making it an offence to kill, injure, take, trade, keep or move any member of a listed threatened species in a Commonwealth area without a permit. The EPBC Act also requires proponents of actions, which have or are likely to have a significant impact on listed threatened species, to refer the proposed action to DSEWPAC.

The EPBC Act provides for the development of recovery plans for listed species and ecological communities. The *Whale shark (Rhincodon typus) recovery plan (2005–2010)* aimed to maintain existing levels of protection for the whale shark in Australia while working to increase the level of protection afforded to the whale shark within the Indian Ocean and South East Asian region to enable population growth (with the ultimate aim to remove the species from the Act's threatened species list). The current recovery plan is awaiting review to assess its effectiveness.

2.1.3 State

2.1.3.1 Wildlife Conservation Act 1950

The *Wildlife Conservation Act 1950* (WC Act) is legislation passed by the State Government in 1950 that endeavours to conserve and protect the state's wildlife. Under the WC Act all native fauna are

protected and it is an offence to take, or deal with, protected fauna without a licence. Any activity that has the potential to interfere, disturb or harm a whale shark is illegal if conducted without an appropriate licence or if it does not comply with the conditions of an issued licence. The whale shark has also recently been listed as specially protected fauna in the category of 'other specially protected fauna' under section 14(4) of the WC Act in recognition of the need to manage human interactions to ensure they do not pose a threat to this species. This listing provides a greater level of protection through increased penalties, and an implied requirement to provide added protection through management activities and licensing. The Act applies to all land and all types of tenure in Western Australia.

2.1.3.2 Wildlife Conservation (Close Season for Whale Sharks) Notice 1996

Under section 14(2)(b) of the WC Act (as amended), the Minister may issue a close season for any fauna and place additional restrictions on the management of this fauna. Close season notices are published in the Government Gazette. Whale shark interaction is restricted through the Wildlife Conservation (Close Season for Whale Sharks) Notice 1996 (see Appendix 2). This notice establishes the legislative framework for whale shark interactions: it applies to ALL persons, including private vessels and swimmers interacting with a whale shark or coming into contact with a whale shark anywhere in the state at any time of year. The notice also details how the whale shark interaction must take place; that is, the code of conduct.

2.1.3.3 Conservation and Land Management Act 1984

The whale shark is also protected in waters reserved under the *Conservation and Land Management Act 1984* (CALM Act). The CALM Act allows the Western Australian Governor to reserve any part of Western Australian waters as a marine nature reserve, a marine park or a marine management area, and section 101c of that Act makes it an offence to take any fauna (which includes whale sharks) from that area without the necessary licences or lawful authorities.

Use of marine reserves, including the activities of visitors, is subject to the provisions of the CALM Act and its subsidiary legislation – the CALM Regulations 2002. The CALM Regulations require that lawful authority is obtained to conduct any commercial activities occurring within conservation reserves (including marine parks and marine nature reserves). This is achieved by licensing all commercial whale shark operations in NMP under the CALM Regulations, and tour operators adhering to conditions associated with their licences.

DPaW is responsible for the day-to-day management of whale shark interactions within NMP both in state and Commonwealth waters under a MoU between DPaW and DSEWPAC.

2.1.3.4 Fish Resources Management Act 1984

The whale shark is a protected fish under the *Fish Resources Management Act 1984* (FRM Act) and Fish Resources Management Regulations 1995, and section 46 makes it an offence for any person to take, possess, sell, consign or bring a whale shark into the state or into Western Australian waters. Recreational and commercial tourism activities involving human interaction with whale sharks within marine reserves must be managed in accordance with the provisions of the CALM Act.

2.2 DPaW's statutory requirements

DPaW has statutory responsibilities for the conservation of flora and fauna through the WC Act and the CALM Act. In relation to whale shark interactions in state waters, these include:

- being responsible for the conservation and protection of flora and fauna throughout the state for the benefit of present and future generations and in particular to administer the WC Act
- promoting and facilitating public recreation to the extent it is compatible with the conservation of the natural environment, consistent with the CALM Act, on DPaW-managed lands and waters
- carrying out research in relation to the management of lands and waters, and conservation and protection of flora and fauna.

2.2.1 Management plan for the Ningaloo Marine Park and Muiron Islands Management Area 2005–2015

The significance of whale sharks to the NMP's conservation objectives is recognised in the *Management plan for the Ningaloo Marine Park and Muiron Islands Management Area 2005–2015*. By outlining conservation principles for whale sharks this plan not only ensures protection of whale sharks but also the 'whale shark experience' and the tourism industry that has developed around the annual aggregation. The plan's primary purpose is to achieve a sustainable balance between protecting the environment for future generations and facilitating and managing the rapid increase in the area's recreational and commercial activities.

2.2.2 Licensing

DPaW has a clear responsibility to ensure that whale shark tours are managed equitably and sustainably, particularly considering that knowledge of the animal's biology and ecology is limited and the impacts of increased tourism on individual sharks or the population as a whole are unknown. To ensure whale sharks are protected from increasing tourism demand, a precautionary approach to licensing has been adopted (see Section 4.1).

2.2.3 Department of Transport (DoT) legislation

Boating in state waters is regulated by DoT through the *Marine Act 1983* and Navigable Waters Regulations and applies within marine conservation reserves. All vessels nominated for commercial whale shark operations must be in survey to DoT requirements and under the command of an appropriately qualified skipper.

2.3 State Government policy

Policies are developed to help DPaW meet its management objectives. These include policies for all management activities and issue plans for a range of topics, such as wildlife management programs. Key policies in relation to the management of whale shark interactions in marine reserves are DPaW Policy no. 44 (Wildlife Management Programs) and Policy no. 18 (Recreation, Tourism and Visitor Services). Management of whale shark interactions in marine reserves requires the integration of DPaW's conservation and recreation objectives.

2.3.1 Policy no. 44 (Wildlife Management Programs)

Policy no. 44 assists DPaW to achieve its conservation objectives. This policy statement sets out the objective to 'conserve and manage threatened, specially protected, or harvested taxa of flora and

fauna and their habitats, threatened ecological communities and other taxa in need of intensive management by the preparation and implementation of written wildlife management programs'.

A wildlife management program may be a threatened species or ecological community recovery plan or interim recovery plan, a regional or district threatened and priority flora management program, or a harvested taxa management program. Harvested taxa include species used as a recreational resource and a management program seeks to ensure ongoing use of the species is sustainable. This whale shark wildlife management program is an example of such a program.

2.3.2 Policy no. 18 (Recreation, Tourism and Visitor Services)

Policy no. 18 assists DPaW to achieve the recreation objective to 'provide world-class recreation and tourism opportunities, services and facilities for visitors to the public conservation estate while maintaining in perpetuity Western Australia's natural and cultural heritage'. When read in conjunction with the CALM Act and Regulations and other related policies, this statement provides the basis for planning and managing for recreation, tourism and associated visitor activities on DPaW-managed lands and waters.

DPaW has two major responsibilities in managing recreational tourism activities. These are to:

- protect the conservation values of an area
- help visitors develop an appreciation and understanding of the natural and cultural environment.

These responsibilities can be shared between DPaW and tour operators by:

- ensuring visitors obtain a quality experience through the provision of quality services, facilities and interpretation
- assisting in the protection and management of the nature conservation and cultural values
- ensuring that operations are conducted in an environmentally sustainable way.

2.3.3 Nature-based tourism review

As a consequence of the growth in numbers of commercial operators and the increasing complexities associated with managing nature-based tourism activities, DPaW and Tourism Western Australia jointly undertook a review of nature-based tourism in 2006 (Tourism Co-ordinates 2007). The review focused on the role of government and its relationship with the tourism industry, local government and other relevant organisations and stakeholders. The review resulted in several recommendations that would improve these relationships and also advance the government's environmental, social, cultural and economic goals. The review led to an integrated approach to ensure that tourism outcomes and conservation objectives could both be achieved in facilitating access to our National Parks, providing opportunities for tourism infrastructure development and improvements to commercial operating practices. The government adopted many of the recommendations of the review and the Ministers for Environment and Tourism announced the implementation of these in December 2011.

2.4 Responsibilities of authorities and government agencies

DPaW is primarily responsible for the management of whale shark interactions in NMP (Figure 2), including implementation of this whale shark wildlife management program. DPaW is also responsible for the day-to-day management of whale sharks within Western Australian Commonwealth waters, under an MoU between DPaW and DSEWPAC. DPaW consults with other

organisations (e.g. local government authorities, DoT) with responsibilities in the surrounding waters and coastal areas, to ensure the various regulatory and management practices are complementary. DPaW consults with external research organisations (e.g. AIMS, ECOCEAN) conducting whale shark research under DPaW permits in NMP.

Marine conservation reserves in Western Australia are vested in the Marine Parks and Reserves Authority (MPRA) under the CALM Act, and DPaW is responsible for managing these reserves on behalf of the MPRA. The MPRA is a statutory body reporting to the Western Australian Minister for Environment and plays an important role in the development of marine policy and management plans. It also audits the management of marine conservation reserves vested in the MPRA, including the ecological values identified within these areas, of which whale sharks are one such value. The audit function is an important role to ensure that DPaW's management of marine conservation reserves, including whale sharks, is meeting stated objectives and targets. The *Management plan for the Ningaloo Marine Park and Muiron Islands Management Area 2005–2015* provides the principle framework by which the MPRA will carry out an audit. The whale shark wildlife management program complements, and is in line with, the objectives and targets outlined for whale sharks in the management plan 2005–2015.

The authorities and agencies with statutory responsibilities in NMP are listed in Table 1.

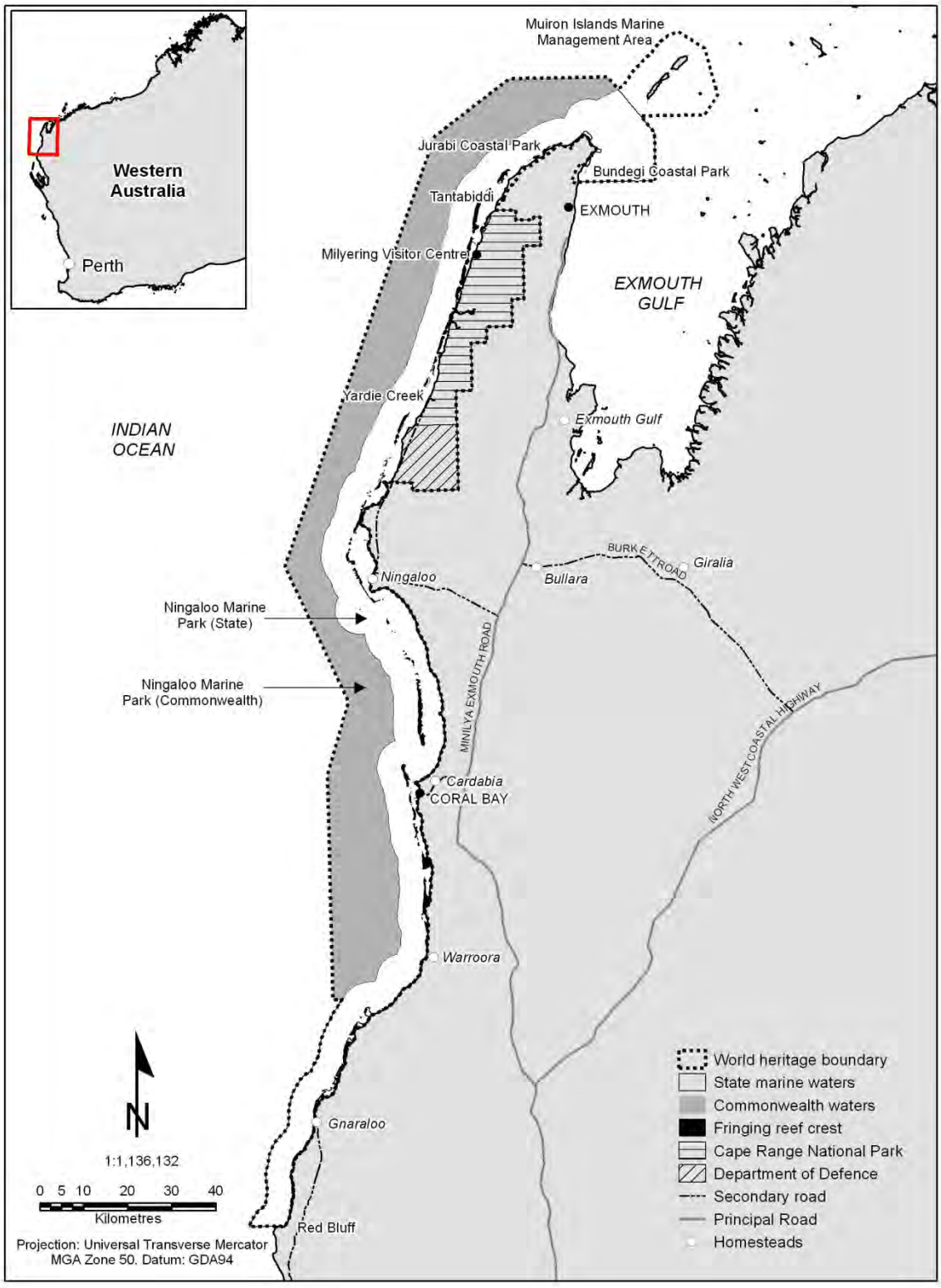


Figure 2: Ningaloo Marine Park

Table 1: Authorities and agencies with responsibilities in Ningaloo Marine Park

MPRA	• Vested body for NMP • Provides policy advice to the Minister for Environment • Audits the NMP and Muiron Islands management plan implementation by DPaW • Is consulted in relation to commercial operations licence applications
DPaW	• Manages whale shark interactions within NMP through: a. implementation of the whale shark wildlife management program b. coordination with other agencies and stakeholders c. implementation of education and public participation programs d. implementation of research and monitoring programs e. coordination of management intervention/compliance programs • Licences and manages whale shark operators to conduct commercial operations within NMP (state waters) • Is signatory to the MoU with DSEWPAC in regard to day-to-day management of whale sharks within NMP (Commonwealth waters) • Is signatory to the MoU with DSEWPAC in regard to World Heritage values management within NMP
DSEWPAC	• Manages NMP (Commonwealth waters) • Licences whale shark operators to conduct commercial operations within NMP (Commonwealth waters) • Is signatory to the MoU with DPaW in regard to day-to-day management of whale sharks within NMP (Commonwealth waters) • Is signatory to the MoU with DPaW in regard to World Heritage values management within NMP
Shire of Exmouth	• Manages the coastal infrastructure at Tantabiddi boat ramp used by Exmouth whale shark operators
DoT	• Responsible for all boating regulations, safety standards and marine pollution incidents • Manages the coastal infrastructure at the Coral Bay boat launching facility used by Coral Bay whale shark operators • Manages the issuing of commercial surveys for vessels allowing the carrying of paying passengers

3 MANAGEMENT FRAMEWORK

3.1 Vision

Whale sharks are of local, national and international significance. Because NMP hosts one of the largest reliable whale sharks aggregations in the world, the whale shark is seen as a conservation icon for Western Australia. The species' presence has helped increase protection for other marine species and communities both statewide and nationally, with their annual presence contributing to the World Heritage listing of the Ningaloo Coast. The whale shark tourism industry based around this exceptional phenomenon is acknowledged globally as best-practice and considered a successful model for sustainable nature-based tourism, inspiring other countries to establish similar conservation management programs to protect their aggregations (Norman 2002; Rowat & Brooks 2012). The vision statement reflects the importance of the whale shark aggregation and associated tourism industry in NMP felt by the local and wider community with regard to conservation and management.

Vision statement

A healthy and natural whale shark population is maintained and supported by the management of a world-class and sustainable tourism industry which raises appreciation and understanding of whale sharks.

3.2 Strategic objectives

Strategic objectives identify the primary aims of management and reflect the statutory responsibilities of the CALM Act. Strategic objectives provide broad direction to management for protecting whale sharks from the most likely future pressures (see Section 3.3).

Management of commercial whale shark interaction in marine reserves requires DPaW's conservation and recreation responsibilities to be integrated. The objectives have therefore been identified as:

Conservation:

- To improve our understanding of whale shark ecology and ensure it is included in whale shark conservation and interaction management at NMP.
- To raise public awareness and appreciation of whale sharks and use their iconic status to promote broader marine conservation issues.

Sustainable tourism:

- To ensure whale shark interaction tours are undertaken in a sustainable manner.
- To ensure and further promote the status of whale sharks as one of the iconic species found within NMP and Ningaloo Coast World Heritage Area in order to support a world-class ecotourism industry into the future.

These objectives must be addressed through the development and implementation of several strategies revolving around management, research and monitoring, and education. The current approaches to management, research and monitoring, and education are presented separately in

the following sections, along with the strategies that have been developed to achieve the strategic objectives.

3.3 Determining management priorities

The management of whale shark interactions in NMP aims to conserve whale shark populations, while maintaining opportunities for people to appreciate, enjoy and learn from the whale shark experience. While whale shark interaction management reflects a pro-active and precautionary approach to conserving whale shark populations, an important step in determining management priorities is to undertake a risk assessment by considering the likelihood and impact of existing and potential pressures affecting whale sharks.

The existing and potential pressures facing whale sharks in NMP have been identified as:

- accidental interference by swimmers
- intentional harassment by swimmers or vessels
- boat strike by commercial vessels
- boat strike by recreational vessels
- noise from commercial vessels
- noise from recreational vessels
- pollution and marine debris
- climate change.

Most of the identified potential disturbances to the whale shark population in NMP relate to interactions, both accidental and intentional, with people and vessels (including vessel noise). Accidental swimmer interference is likely to occur often, but is thought to result in only short-term impacts on behaviour and thus the impact is considered low. The level of intentional harassment of whale sharks is difficult to determine accurately and incidents are seldom reported. At present this impact is also considered low. There is evidence of boat strikes on whale sharks such as antifouling paint marks on their bodies and damage to fins possibly resulting from propeller contact. These marks and injuries are more likely to be caused through unintentional contact, either through boat strike or when individuals approach vessels – as has been observed at NMP (Rob D, 2012, pers. comm.). Although no mortalities due to boat strike have been reported, it is difficult to determine if boat strikes have caused death due to the sharks' natural reaction of diving to depth and out of sight when threatened. It is also hard to determine whether injuries resulting from boat strike occur within or outside NMP. The large-scale impacts of boat strikes on whale sharks in NMP are therefore difficult to measure. Whale sharks diving in response to ignition of nearby inboard boat motors have also been observed at NMP (Martin A, 2007, pers. comm.) – which may be a response to the low frequency sound of such motors – however the long-term impacts of vessel noise are unknown. Increased vessel activity in NMP has not resulted in whale shark observations decreasing and thus this impact is also considered low at present.

Information on the possible effects of pollution and marine debris are scarce. Potential effects from industrial development (oil and gas) within the area are largely unknown, but could have serious implications; for example, if an oil spill were to occur the health of individual whale sharks, or the group as a whole, could be affected both directly through ingestion of oil and indirectly through disruption to food sources. The potential impacts of seismic testing by the oil and gas industry on

whale sharks have yet to be investigated. The current incidence of entanglement of whale sharks in fishing gear or litter is considered low.

Possible effects of climate change are beginning to be investigated – information on how this may affect whale shark occurrence and food availability needs to be better understood so that appropriate management can be undertaken in response.

At present there is no evidence to suggest that current levels of human activity, both directly through interaction and indirectly through other anthropogenic sources, are demonstrably affecting whale shark aggregations off the Western Australian coast. However, to manage for potential impacts, and adapt management strategies accordingly, it is important to include monitoring of potential impacts in the management framework. These are included in the research and monitoring strategies presented in Section 5.6. It is important that management strategies and priorities can respond to changes in human/whale shark interaction patterns or to new knowledge acquired during the life of the wildlife management program. As such, an adaptive management approach will be taken.

4 MANAGEMENT

DPaW has responsibilities to manage lands and waters for the conservation of whale sharks and to promote and facilitate public recreation that the aggregation can support. To ensure potential human impacts are minimised to this high-profile species, DPaW has developed a management strategy through legislation and licensing. All commercial tourism interactions involving whale sharks within NMP are managed by way of a licensing system based on the provisions of the Wildlife Conservation Regulations 1970 (Regulation 15) and the CALM Act and Regulations 2002. Incidental non-commercial interactions both inside and outside of marine parks are regulated under the Wildlife Conservation (Close Season for Whale Sharks) Notice 1996, which is gazetted under the provisions of section 14(2)(b) of the WC Act (as amended). These legislative tools provide the mechanism that give DPaW the best opportunity to ensure that any interaction with whale sharks is managed sustainably and presents the lowest risk to the species within Western Australian waters.

4.1 Licensing of commercial operators

DPaW must ensure that individuals who interact with whale sharks are aware of how to protect whale sharks during their operations. This is done by issuing licences that specify the appropriate behaviour for interacting with whale sharks in reserves. Commercial operator licences and wildlife interaction licences are a regulatory arrangement between a tour operator and DPaW. The licences have established terms of operations that the operator must adhere to at all times. Whale shark operators must hold both a whale shark wildlife interaction licence and an E class 'restricted' commercial operations licence to conduct commercial whale shark tours in NMP.

4.1.1 Wildlife interaction licences

Whale sharks are native fauna and as such are protected under the provisions of the WC Act. DPaW issues wildlife interaction licences under the provisions of the Wildlife Conservation Regulations 1970 (Regulation 15). The whale shark wildlife interaction licence authorises a commercial tour operator and/or their employees/contractors to interact with whale sharks subject to the conditions attached to the licence and subject also to holding a commercial operations licence. The wildlife interaction licence covers essential actions and responsibilities of the vessel (skipper), whale shark guides and their passengers by stating what they MUST do and what they CANNOT do. The whale shark wildlife interaction licence details how the whale shark interaction must take place (i.e. the code of conduct). The licence schedule and conditions are included in Appendix 3.

4.1.2 Commercial operator licences

Commercial operator licences ensure that conservation reserves are managed in an ecologically sustainable manner. They are issued in accordance with Part 7 of the CALM Regulations 2002.

DPaW may grant either 'T' class (unrestricted) or 'E' class (restricted) licences depending on the nature or location of the commercial activity. 'T' class (unrestricted) licences are general licences where the commercial activity is open to many operators and the operation is managed only by a set of licence conditions. 'E' class (restricted) licences are granted when management of the operations requires a limit on the number of licences for commercial activities for either environmental, management or safety reasons. As whale sharks are native fauna protected under the WC Act, and have special international and national conservation status, it is necessary to restrict the number of

operators providing whale shark interaction tours. The limited knowledge of the species' biology and ecology, as well as the unknown impacts of increased tourism on individual sharks or the group as a whole, are also factors contributing to this restriction.

Conditions associated with this licence ensure that commercial whale shark interaction tours are undertaken in an environmentally sustainable way, to minimise the risk of injury to swimmers and to prevent the animals from being harmed or disturbed. The licence schedule and conditions are included in Appendix 4.

4.1.3 Licence extensions

Following a review of nature-based tourism, in December 2011 the Ministers for Environment and Tourism jointly announced implementation of the review's recommendations. One recommendation relates to the term of 'E' class (restricted) commercial operations licences which, subject to a performance review, can have their first period of five years increased to a period of 10 years (with a possible renewal of a further five years). This recommendation has the benefit of providing more stability for whale shark licence holders and gives them an incentive to achieve best-practice standards. Granting of the extension depends on the outcome of a performance review.

At the end of the renewal period, all whale shark commercial operations licences will be reallocated via a competitive expression of interest (EOI) process. This last occurred in 2008 with successful applicants receiving licences that began on 1 January 2009. This means that those licences so extended will expire on 31 December 2018 and may be renewed for a further five years. The selection criteria used during the EOI process were designed to ensure future operations achieved the highest level of sustainability (best-practice standards).

Whale shark wildlife interaction licences are valid for five years and are issued in conjunction with the commercial operations licences.

4.1.4 Licence numbers

The number of whale shark commercial operations licences for NMP was set at a maximum of 15, and has remained at this number since 1995. Originally there were 13 licences available to operate from Tantabiddi (northern waters) and two from Coral Bay (southern waters). In 2002 this was amended to 12 from Tantabiddi and three from Coral Bay. This has remained the case, despite demand for additional licences. Of the possible 15 licences to be allocated via a call for EOI in 2008, only 14 applications met the selection criteria to a satisfactory level.

Little information exists to determine whether interaction pressure from the current limit of 15 licences is ecologically sustainable in the long-term. Until there is a better understanding of how the present level of activity is affecting whale sharks, a precautionary approach will be adopted in relation to expansion of the industry. As more information becomes available through research and monitoring, the sustainability of the current cap of 15 licences can be reviewed.

4.1.5 Licence charges

DPaW recoups some of the costs of managing whale shark interactions from passengers via the commercial operators, according to the 'user pays' principle. Before 2013, this was achieved by way of a ticketing system where each passenger was issued a ticket, or whale shark experience pass, which showed they had contributed to whale shark conservation and management. The commercial

operator licence issued under the CALM Regulations established the requirement that each ticket would incur the DPaW licence charge. In 2013, the issuing of tickets was discontinued, as passenger information was being collected by an electronic monitoring system (EMS) onboard each vessel, and it was deemed this would provide the relevant passenger numbers to allow for invoicing. Revenue collected through commercial operations licences is retained for the implementation of the whale shark wildlife management program in NMP.

Historically, whale shark tours were conducted throughout April and May (coinciding with the peak whale shark aggregation at NMP), with the DPaW licence charge only being collected from 1 April to 31 May or during what was referred to as the 'paying season'. It became apparent that more whale shark tours were being undertaken outside of the paying season; however, the licence charge remained restricted to the paying season only. After consultation with the industry, DPaW decided to extend the paying season by two weeks every year to achieve cost recovery for the whale shark wildlife management program. This extension began in 2011 so that by 1 January 2014 all commercial whale shark interaction tours being conducted throughout the year would incur a licence charge, which is consistent with other types of restricted operations across the state. DPaW will review licence charges on an annual basis and once cost recovery has been achieved, the licence charge will be re-assessed. The current licence charges were set during the 2008 EOI process.

4.1.6 Industry code of conduct

The code of conduct is a set of interaction rules that licence holders must abide by when conducting their whale shark tours. DPaW developed this code of conduct in consultation with the industry and it represents a set of initial rules for vessel operators and swimmers when interacting with the sharks.

The code of conduct for swimmers (Figure 3) outlines the minimum separation distances and maximum number of swimmers, and bans the touching and riding of whale sharks as well as the use of flash photography and motorised propulsion aids. This is to ensure the whale sharks are not being harmed or disturbed during interactions and that the experience for swimmers is safe and enjoyable.

The code of conduct for vessels (Figure 4) outlines the minimum separation distances, speed and time limits for vessels, including safety tenders, when interacting with whale sharks. This is to minimise the risk of disturbance to normal whale shark behaviour, boat strike and vessel crowding, while providing a safe and enjoyable experience for passengers.

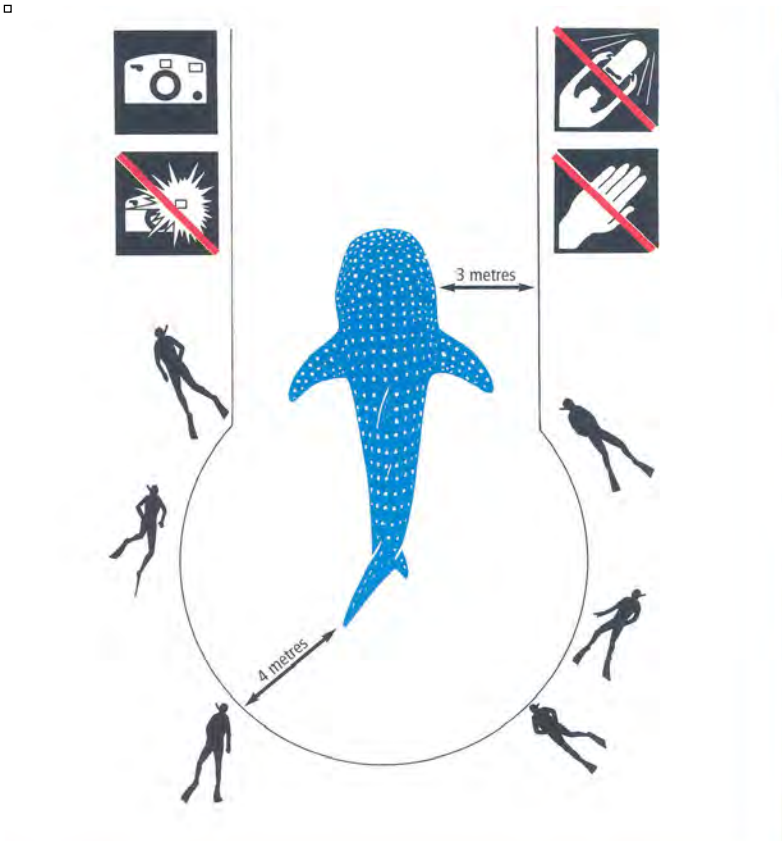


Figure 3: Whale shark interaction code of conduct for swimmers

The code was designed to be adjusted when new information came to hand. Several amendments have occurred since its inception including:

- increasing the minimum swimmer/shark separation distance from one metre to three metres from head and four metres from the tail
- banning the use of scuba for whale shark interaction
- formalising the process known as contact transition or 'handballing' which enables a second vessel to enter into the exclusive contact zone for the purposes of sharing the shark
- allowing all commercial whale shark vessels to wait at the 250 m exclusive contact zone perimeter when sharing a shark
- increasing the number of people allowed in the water during interactions to 10 swimmers plus one crew spotter and one crew videographer
- increasing the maximum number of passengers allowed on whale shark vessels during a tour from 20 to 23 to allow for non-whale-shark-interaction swimmers, provided that no more than 20 passengers are whale-shark-interaction swimmers.

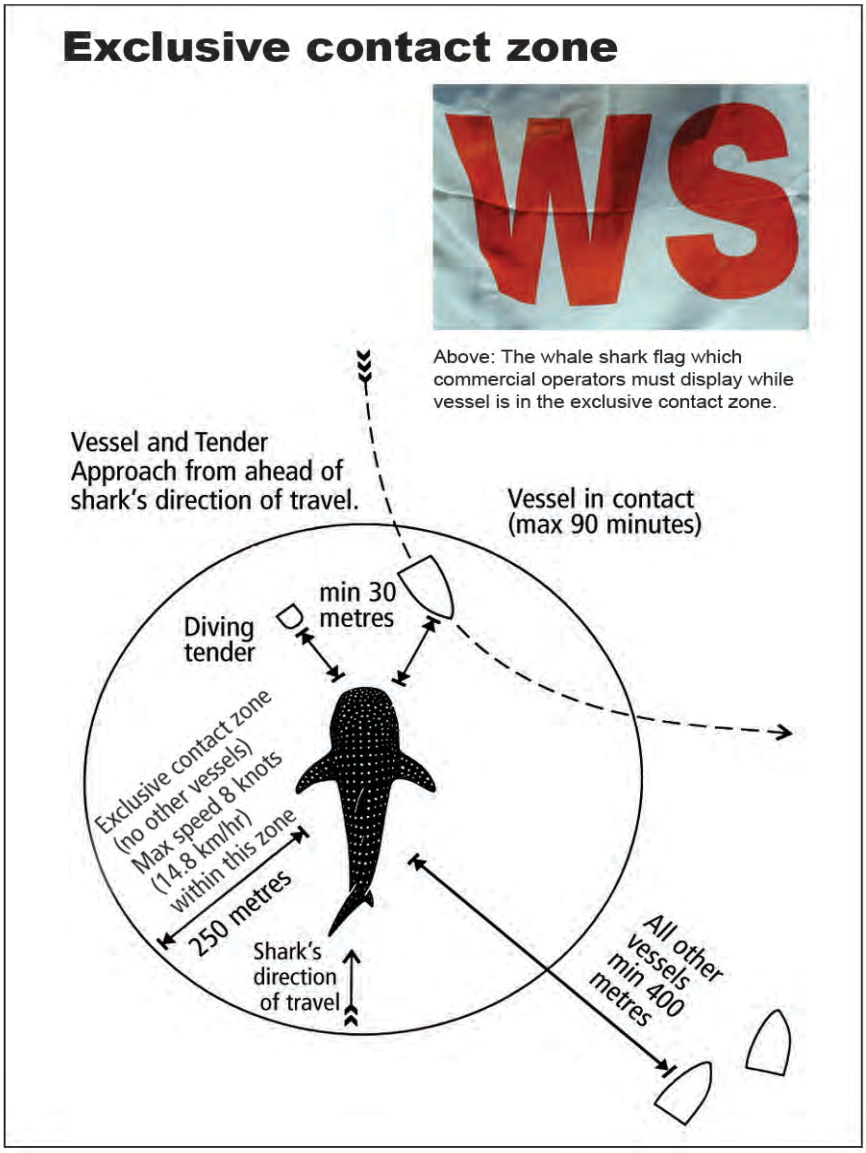


Figure 4: Whale shark interaction code of conduct for vessels

DPaW has a duty of care in relation to visitor safety in NMP, while DoT has primary responsibility for boating regulations, vessel and safety standards and certifying vessel operators for state waters. Commercial operators, as providers of the tourist activity, are primarily responsible for visitor safety and licence holders must have public liability insurance and indemnify DPaW from any claims arising from whale shark tours.

4.1.7 Compliance monitoring

DPaW undertakes compliance monitoring of human activities in NMP. DPaW's whale shark compliance program consists of boat ramp inspections, industry vessel placements, covert operations, aerial surveillance and boat patrols. Education is crucial to complement the compliance activities of DPaW staff.

Appropriate DPaW staff conduct regulatory surveillance of the on-water activities of commercial operators in NMP. This surveillance is to ensure compliance with the licence conditions and help operators meet their obligations. On-water surveillance consists of DPaW vessel patrols, industry

vessel placements and covert operations. DPaW vessel patrols can also target private operators to ensure they are complying with the requirements of the Wildlife Conservation (Close Season for Whale Sharks) Notice 1996.

Aerial surveillance of whale shark interactions has been conducted periodically, both in spotter planes hired by the industry and more recently in light aircraft hired specifically by DPaW. Monitoring by air provides an additional view of interactions that may not be so clear from a vessel. It also allows for a wider area to be monitored. Aerial surveillance has been used to monitor the effectiveness of the code of conduct in minimising disturbance to whale sharks.

4.1.8 Sustainability auditing

Visitor numbers to NMP are expected to increase steadily and DPaW, as the managing agency, has considered ways to ensure the operation of in-water whale shark interaction tours and associated activities are sustainable into the future. One way this has been achieved is through the development of sustainability-based licence conditions (environmental and social) that licence holders are assessed against annually to measure their performance. These conditions were developed by environmental consultants and introduced to commercial operations as selection criteria during the 2008 EOI process. Operators addressed these criteria in their applications and are now committed to fulfilling the conditions. In their proposals successful applicants had to demonstrate how they would meet the criteria and their commitments were included in their licence conditions. An independent auditor conducts the sustainability audits annually and operators are required to meet the audit's cost. As an incentive to achieve best-practice sustainable operations, if operators achieve a 100 per cent score in their audit they will not need to be audited in the subsequent year. This process encourages continual improvement.

4.1.9 Data collection

For decisions on the sustainable management of whale shark tourism to be effective, they need (where possible) to be based on reliable data that give an adequate understanding of the sharks' biology, demographics, ecology and threats. The industry can support this process by collecting information on the whale sharks encountered and the resulting interactions. These data will provide information on the industry's status and any seasonal fluctuations, and feedback to the commercial operators.

During the 1995 season a log book scheme was introduced as part of the conditions of the commercial operations licence to collect such data. The log books were extensively redesigned before the 1996 season and then again in 2001, in an effort to improve the quality and quantity of recorded information, while also ensuring the record sheets were easy to complete.

As a further measure to help operators improve their efficiency and accuracy in recording and providing log book information, DPaW introduced an electronic GPS-based log book system in 2009 – the EMS (Figure 5). The EMS automatically records GPS coordinates together with data on interactions and the biology of each shark that are manually inputted into the EMS by the operators. All data are transmitted via SMS directly into a central database. This presents benefits for the operators in respect of their obligations to comply with licence conditions and relieves them of some of the requirements, such as having to manually take GPS readings and interaction details (which are now completed electronically). It also means operators do not have to lodge log books physically, as the system does this automatically. Conservation benefits include having accurate data lodged in a

timely fashion in a format ready to be evaluated for season reporting and analysis. Paper log books were redesigned before 2009 to ensure they complemented the electronic system and are used only as a backup in the event of EMS failure or vessel breakdown and use of a substitute vessel in which the EMS is not installed. The new log sheet design is presented in Appendix 5.

Figure 5: Electronic monitoring system (EMS) unit displaying the message screen.

Data collected through the EMS include passenger numbers, the start and finish time of the tour, the start and finish time of each whale shark interaction, GPS coordinates of each interaction, size, sex, direction the shark is headed and whether it was shared with another vessel. Training in how to use the EMS is provided to all skippers and crew responsible for data collection, including a step-by-step user manual to keep onboard the vessel.

EMS records also include how many days each licence holder has been operating commercial whale shark tours and the number of passengers carried. Auditing of EMS data (and passenger experience tickets before 2013) provides the means to calculate licence charges for each operator. Reconciliation of EMS data (and experience ticket book stubs and unused ticket books before 2013), observations from boat ramp inspections and on-water and aerial surveillance allow cross-checks on the accuracy of individual operator records.

The EMS transmits data every minute to a central database including vessel position and speed. The database can also determine when a vessel is in contact with a whale shark so vessel speed within the exclusive contact zone can be monitored for compliance purposes (Figure 6). When complaints are received about operations, historical EMS data can be mapped to help compile evidence to support or disclaim such reports.

DPaW purchased 15 EMS units for industry use and rents the units to each operator. There are also data transmission and messaging fees that DPaW recoups from the operators. Operators who meet their own costs of operating the EMS are offered a reduction in their licence charges, but they can also opt to pay the full licence charge and have DPaW cover all EMS costs.

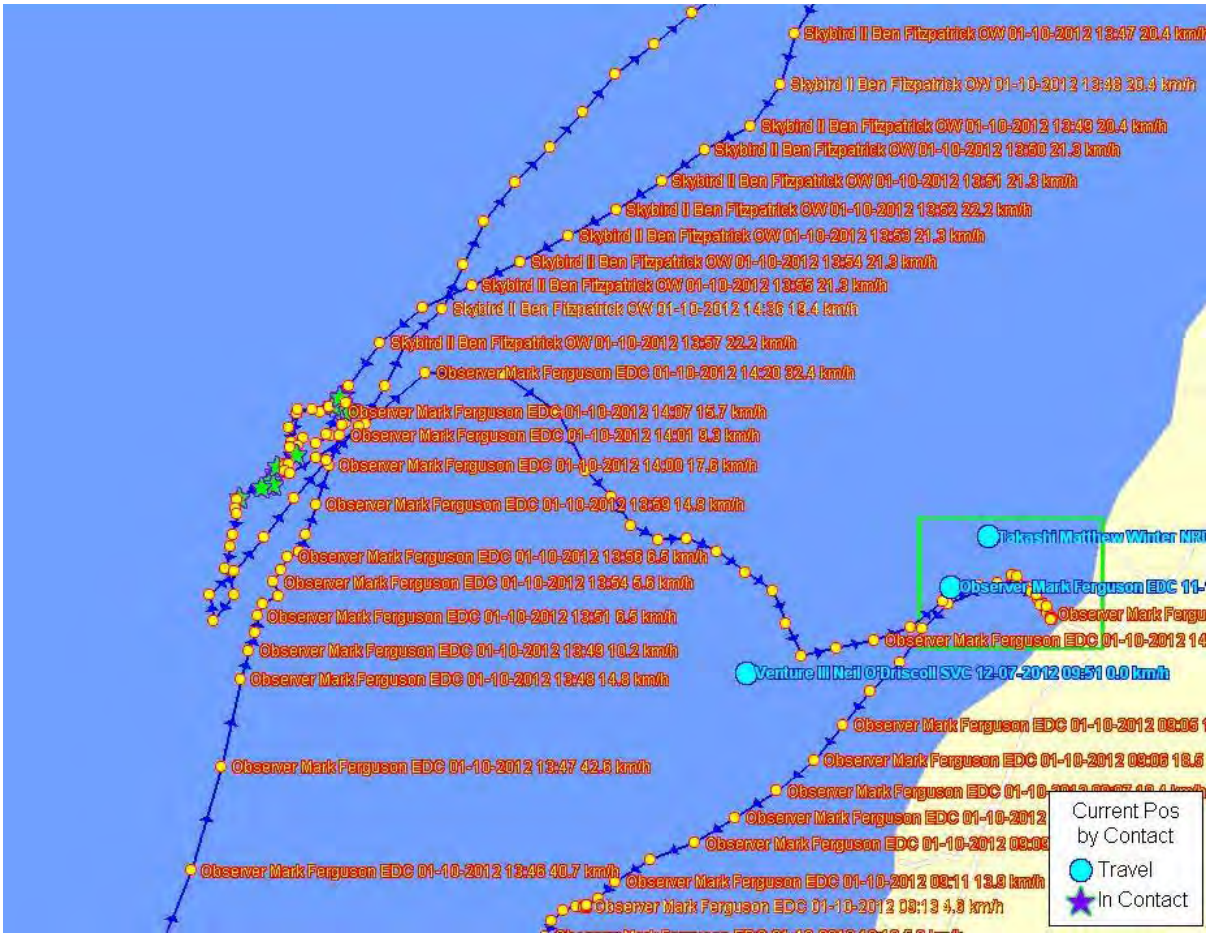


Figure 6: An example of the electronic monitoring system (EMS) tracking data.

4.1.10 Operator meetings

Consultation between the whale shark commercial operators and DPaW is essential for the effective management of whale shark interactions in NMP. A minimum of two DPaW/operator meetings should be held annually: one pre-season and one post-season. These meetings are important to provide an open forum for discussion of operational issues and other matters relating to management of the interactions. The meetings are also crucial to maintaining a good working relationship with the industry.

4.2 Recreational users

Members of the boating public also encounter whale sharks in state waters, both inside and outside marine parks, and monitoring of these activities is difficult. There are few reports of recreational users interfering with industry operations and training is provided to industry staff on how to deal with such situations. Because it is difficult to locate a whale shark without the use of a spotter plane, it is more likely that recreational users in the marine park will not see whale sharks at the surface – which means there is the potential for boat strike to occur. At present, interpretive material covering the whale shark code of conduct is available for recreational users in the form of a brochure and signage at Tantabiddi boat ramp in the northern waters of NMP (Figure 2). Education of recreational users should be continued and potentially increased to minimise the risk of boat strike and ensure recreational visitors are complying with the requirements of the Wildlife Conservation (Close Season for Whale Sharks) Notice 1996.

4.3 Management strategies

The following section outlines the management strategies identified to achieve this program's objectives). Actions have been recommended to address the strategies.

Strategy: Maintain appropriate regulation of whale shark interaction in accordance with the *Wildlife Conservation Act 1950* and *Conservation and Land Management Act 1984* and Regulations

Actions:

- Ensure commercial whale shark interactions are appropriately licensed under the WC Act and CALM Act and Regulations.
- Establish and implement administration and licensing procedures to monitor standard licence conditions.

Strategy: Ensure tour operators comply with licence conditions

Actions:

- Establish a compliance monitoring program schedule for the season that includes boat ramp inspections (monitoring active licences and passenger numbers), inspections on industry vessels, DPaW vessel patrols, covert operations and aerial surveillance.
- Use prepared checklists of licence conditions when conducting inspections on industry vessels and DPaW vessel patrols.
- Conduct an annual review of the compliance monitoring program (DPaW Whale Shark Management Team).

Strategy: Develop and implement a compliance monitoring program for recreational users within NMP in accordance with the Wildlife Conservation (Close Season for Whale Sharks) Notice 1996

Actions:

- Establish a recreational user compliance monitoring program using DPaW vessels and aerial surveillance to:
  - monitor recreational vessels interacting with whale sharks
  - monitor industry operations when recreational vessels are present to prevent and/or assist with conflict situations.

Strategy: Maintain close liaison with commercial licence holders

Actions:

- Continue pre- and post-season meetings with commercial licence holders.
- Continue to provide operators with a pre-season information letter that gives all the necessary information and forms they may require to operate throughout a season.
- Continue with electronic and phone communication as necessary.

Strategy: Review and update the code of conduct as new information becomes available, with consideration of tour operator needs

Action:

- Review and update the code of conduct through:
  - consultation with operators
  - discussion of recommendations with DPaW Whale Shark Management Team
  - liaison with DPaW wildlife licensing section to undertake changes and gain the Director's approval, if required.

Strategy: Review licence charges to ensure maximum equity and efficiency, and cost recovery in licence management

Actions:

- Conduct a financial review each year to calculate 'actual costs' of implementing the whale shark management program.
- Annually review licence charges.
- Undertake the financial and licence charge review in January each year (consistent with the whale shark program reports covering a calendar year), and present to operators at the pre-season meeting.

5 RESEARCH AND MONITORING

The accessibility of the seasonal aggregation of whale sharks at NMP provides an excellent opportunity – through collaboration between researchers, DPaW as the managing agency, and commercial operators – to study this enigmatic and poorly understood species. Strategic and long-term research and monitoring of whale shark biology and ecology should be the focus, so that the potential detrimental impacts of tourism pressure and other potential or actual threats can be minimised.

Whale sharks within NMP are being exposed to increasing pressure both from commercial tourism and recreational users of the area. In addition, these pressures can be compounded in seasons when there are fewer sharks present at the surface – which increases the pressure on individual animals. At present it is not understood whether this increased pressure has any detrimental impacts on individual animals or the group as a whole. In the short term, behavioural changes may be observed. In the longer term, occurrence, movement patterns and population dynamics could be affected. Because NMP is an important feeding area for whale sharks it is vital that pressures do not displace individuals or disrupt their feeding behaviour. There is still, however, little information available to determine the sustainability of the present levels of use. Other potential pressures such as oil and gas development and climate change are not well understood and need to be investigated more broadly to identify their potential impacts on whale shark populations. Until sound scientific information is compiled on which predictions can be based, a precautionary approach to management must be adopted.

5.1 Population monitoring

Sustainable management of whale shark/human interactions will require a clear understanding of the population dynamics of whale sharks. The identification and prediction of any long- or short-term impacts will require sound knowledge of the natural background patterns in the spatial and temporal variability of whale sharks. More specifically, this will require estimates of the size, size structure and distribution of whale shark populations. Obtaining such estimates for uncommon species such as whale sharks can be a complex and difficult task. Photo identification and aerial survey analysis are helping DPaW to achieve this – although as discussed in Section 4.0 of Appendix 1 – the methods have their limitations. As estimates are based on aggregations comprised predominantly of juvenile males, with very few females and adults, it may be more appropriate (for management purposes) to consider these estimates as resource size and monitor sustainable levels of use of this resource.

DPaW works collaboratively with whale shark videographers employed by commercial whale shark operators to provide photo ID libraries with images of sharks encountered each season at NMP. Under commercial operator licence conditions, video footage and/or still images must be provided to DPaW for processing, cataloguing and analysis. At present DPaW provides images to three research organisations undertaking population studies: AIMS, Hubbs-SeaWorld Research Institute and ECOCEAN. DPaW has initiated a training scheme for whale shark videographers to help them satisfy the image requirements for photo ID analysis and improve the quality and quantity of images, along with the sighting data for matching to images.

From photo ID analysis it has been estimated that 65 per cent of the whale sharks at NMP are return visitors with an estimated 86 to 177 individuals visiting each year (Holmberg et al. 2009). Population

estimates range between 278 and 589 individuals (Holmberg et al. 2008; Holmberg et al. 2009; Meekan et al. 2006). Whether the population or resource size at NMP is increasing or decreasing remains unclear (Bradshaw et al. 2008; Holmberg et al. 2009).

DPaW has also been monitoring trends in whale shark sightings using data collected by commercial operators. The general increasing trend in sightings during the past six years may indicate the resource size is stable or even increasing, but sighting data must be treated with caution as they represent the total number of encounters, and do not take into account multiple encounters with the same shark by different vessels, either on the same day or on different days.

Aerial survey data collected by spotter pilots since 2006 may also allow fluctuations in resource size to be monitored. When assessing fluctuations in sightings it is important to consider search effort. Mau and Wilson (2008) recognised that vessel time may not indicate search effort because vessels are not always actively searching for whale sharks. Therefore, use of vessel time data collected through DPaW commercial operator logbooks as search effort should be avoided or treated with caution. To monitor trends in whale shark availability track data collected by spotter pilots may be a better indicator of search effort – because they are actively searching for sharks – than vessel time.

For management purposes it is important to gauge the resource size to determine what levels of interaction are sustainable. Resource size should then be monitored so that the level of interaction, or tourism pressure, can be modified accordingly. What method is most suitable and cost efficient for monitoring the resource size needs to be established.

There has been some indication that the average size of whale sharks has declined at NMP based on visual estimates of lengths made by commercial operators (Bradshaw et al. 2008). It has, however, been argued that the reduction in average size has been due to new, smaller individuals being recruited into the aggregation rather than a decline in larger individuals. New technology based on digital photography or video is now being used to gain more accurate and precise in-water measurements of whale sharks (Figure 7). Stereo-photogrammetry produces a three-dimensional image of the subject from two angled cameras that can then be accurately measured using specialised software (Rowat & Brooks 2012). Use of this technique will not only provide more accurate length measurements of individual sharks but also help improve the accuracy of DPaW length estimation and the precision of estimates of mean lengths of whale sharks at NMP (Norman B, 2012, pers. comm.). Over time, accurate size data, in conjunction with photo ID, will also provide estimates of growth rates and age and eventually improve population models in conjunction with mark-recapture studies (Meekan M, 2012, pers. comm.).

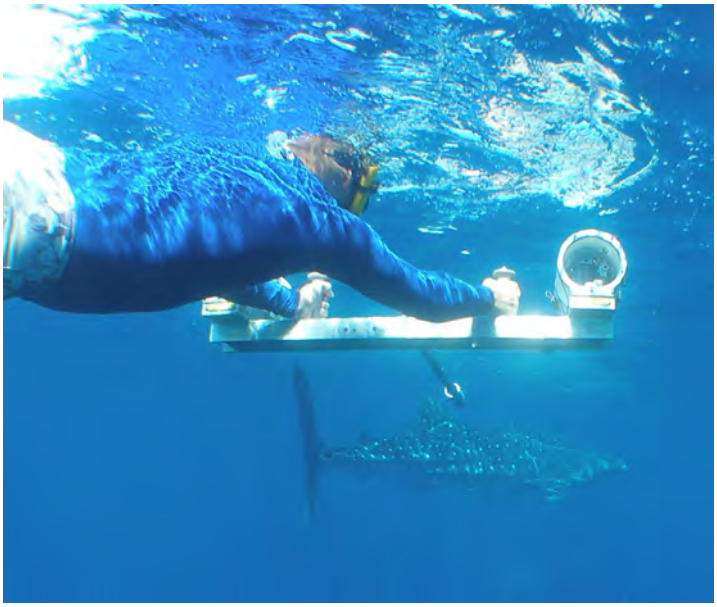


Figure 7: Researcher measuring shark length using stereo-photogrammetry

5.2 Interaction monitoring

Whale shark tourism around the world has grown strongly since the 1990s. At NMP the fledgling industry has set the benchmark for controlling interaction activities through a code of conduct and legislative controls on the numbers of operators and licences. Visitor numbers to NMP to interact with whale sharks have been steadily increasing (Figure 1) and the need to monitor the impacts of tourism on individual whale sharks and the population as a whole is growing in importance. Impacts can be considered either short or longer term. Each has important consequences for conservation of the species as well as sustainability of the industry. Norman (1999) identified a number of short-term impacts from snorkellers swimming with whale sharks in NMP including eye-rolling, banking, rapid diving and avoidance behaviour – all of which may disturb or stop effective feeding and/or diminish the experience of interacting with a whale shark. Similarly, preliminary results from a DPaW aerial monitoring program between 2007 and 2009 suggest some minor effects on the natural behaviour of whale sharks may have occurred during interactions (e.g. change in direction, swimming at depth). Results from NMP were consistent with short-term impacts observed from whale shark tourism in other countries (Quiros 2007; Pierce et al. 2010).

Norman (2002) suggested potential longer-term impacts might include disruption of normal feeding activities, avoidance by or displacement of whale sharks from certain areas, stress, injury and even mortality due to boat strikes. However a recent study by Sanzogni (2012), which examined potential longer-term impacts between years, found current levels of tourism in NMP were unlikely to decrease the chances of interactions with whale sharks in subsequent years. Similarly, the number of whale shark contacts recorded by tour operators has generally been increasing over time (Figure 1). It must be noted, however, that the total number of interactions does not necessarily provide a reliable estimate of the actual number of whale sharks visiting NMP each year because the same individual whale sharks may be encountered over and over again as opposed to new sharks being encountered. These studies also do not rule out the possibility of individual whale sharks becoming habituated by tourism. Behaviours that could lead to habituation that have been observed at NMP (as a direct result of interaction with humans) include circling and investigating swimmers, following

bubbles and being attracted to water outlets on the sides of vessels (Rob D, 2012, pers. comm.). This could in turn make them more vulnerable to other dangers including being caught by fishers when travelling to other jurisdictions outside the protection of Australian waters.

Another type of potential impact to whale sharks is injury from boat and propeller strikes. Such injuries are sometimes recorded in photo ID libraries, although there are limited data to estimate the magnitude of disturbance or mortality of whale sharks from boating. It is also difficult to determine if the injuries occurred inside or outside the NMP, which can complicate management. As recreational vessel use within NMP continues to increase, impacts from boating need to be monitored to ensure the population is not being negatively affected. The effectiveness of using photo ID to investigate the impacts of boating needs to be assessed.

Despite recent studies, there remains a lack of information for confidently estimating sustainable levels of interaction between tourists and whale sharks in NMP. Addressing this knowledge gap should be a priority for future research and monitoring. This is of particular importance given the industry has historically not operated near levels of full capacity (allowed by current licensing). A comprehensive understanding of impacts on whale sharks in NMP will require continued monitoring of levels of tourism pressure on the species in NMP – currently well monitored by operators recording the number of swimmers on each trip – and ongoing assessments of both short- and long-term impacts. The ongoing assessment of impacts will likely require a combination of methods and strategies.

Several methods have already been used to investigate the potential impacts of tourism on whale sharks including direct in-water observation (Norman 1999), aerial observations from spotter planes (DPaW unpublished data), photo ID to investigate long-term impacts (Sanzogni 2012) and photo ID to examine impacts from boat strikes (DPaW unpublished data). In addition, several other methods have been proposed for investigating impacts. For example, data-logging devices such as 'Daily Diaries' have been used to collect fine-scale data on movements of individual whale sharks. Daily Diaries are tags that record environmental and physical variables such as acceleration, depth and water temperature. Information collected by the Daily Diaries could be used to compare the behaviour of individual whale sharks exposed to tourism interactions with their natural behaviour. Similarly, the impacts of tourism on whale shark behaviour could also be investigated using crittercams (video cameras) attached to a shark's dorsal fin, if the camera can be deployed before an interaction occurs.

Research into satisfaction levels reported by participants in whale shark interaction tours has provided valuable information for formulating management strategies, as well as feedback on the extent to which the code of conduct was followed during the tour and the efficacy of educational and interpretive materials. For example, Catlin (2005) found that visitors participating in the whale shark experience desired more information about the biology and ecology of whale sharks than they were given on their tour. As a result of this finding, DPaW developed and implemented a Whale Shark Interaction Training course to provide information and interpretive material to whale shark commercial tour operator staff to then pass onto their passengers.

Catlin (2005) also found greater acceptance by passengers of a limit of 10 people in the water compared with studies conducted a decade previously (Davis et al. 2007). This indicates an

acceptance of the code of conduct and a possible positive outcome from changing the minimum distance approach to sharks from one metre to three metres (to reduce crowding around the shark).

DPaW supports commercial whale shark operators to collect and analyse visitor survey information: the aim being a better understanding of visitor satisfaction with their whale shark experience and tour. The survey also provides valuable information about whale shark clientele, how they source information, how often they visit and how important certain aspects are to the quality of their visit. This whole-of-industry information is useful to DPaW as well as to individual commercial operators. A trial was conducted in 2012 whereby DPaW entered and analysed the survey responses. Only three commercial operators used this service and hence its value and cost-effectiveness must be investigated to determine whether to continue it. Monitoring of the whale shark experience provides insight into management practices and should be undertaken periodically.

5.3 Environmental monitoring

The long-term sustainability of whale shark populations and whale shark tourism at NMP will rely on a clear understanding of the animal's natural patterns and fluctuations in distribution, the natural mechanisms responsible for these patterns and the identification of potential impacts from human interactions. Detecting the potential impacts of human interactions on whale shark behaviour, abundance and distribution is, however, a complex task given the large natural background variability associated with the species. Whale shark numbers at NMP vary widely from year to year and there is often large spatial variability in their occurrence within NMP. Identification of the natural mechanisms responsible for the aggregation at NMP will also be critical to ensure human activities will not affect the environmental conditions associated with the aggregation.

Early studies observed that the peak aggregation occurred between April and May in NMP, however during the past 10 years commercial operations have been conducted between March and July and sometimes as late as August. In 2010 whale sharks were seen in October, while in 2013 they were seen aggregating near Coral Bay in January (DPaW unpublished data). It is unknown whether this indicates a lengthening of the season or that there are simply more people on the water or in the air reporting sightings during shoulder periods. Sightings in southern NMP (where the Coral Bay industry operates from) have consistently ceased earlier than in northern waters (Tantabiddi access, where the Exmouth operators are based). This was initially thought to be due to the general northward trend of whale shark movement as the season progressed. Photo ID has now shown that individual whale sharks move north and south repeatedly throughout the season and consistent movement patterns in one direction are not necessarily the case. In 2010, when northern NMP recorded a 100 per cent contact success rate, operators in southern NMP had a very poor season. In contrast, in 2012 both southern and northern NMP had very high contact success rates and there were even records of whale sharks well south of the marine park including one sighting as far south as Albany, Western Australia. These fluctuations in occurrence are likely due to water temperature and the strength of the Leeuwin current bringing warm tropical water down the west coast (Meekan M, 2012, pers. comm.). Natural temporal and spatial patterns in whale shark abundance need to be understood before any short- or long-term impacts from commercial tourism can be detected.

Oceanographic data are proving to be highly valuable for understanding whale shark aggregations around the world. At NMP oceanographic data are being explored in the hope of learning more about how and why whale sharks come to NMP. Satellite remotely-sensed sea surface temperature

(SST), chlorophyll-a concentration and sea surface altimetry are being used to produce geostrophic current gradients, along with data from sharks tagged at NMP, to describe the whale sharks' habitat (Polovina J, 2012, pers. comm.). Preliminary analysis of the relationship between whale shark occurrence at NMP and oceanographic and atmospheric variables indicates that relative abundance of whale sharks was most strongly influenced by a combination of the El Niño Southern Oscillation Index (SOI) and SST, with SOI having the strongest effect. There is an indication that in La Niña conditions and higher SST, stronger Pacific trade winds drive the Leeuwin current southward and more whale sharks are observed (Sleeman et al. 2010).

Whale shark spatial data collected by spotter pilots and DPaW staff between 2006 and 2010 are being analysed in conjunction with oceanographic data. The aim is to better understand localised movement patterns of whale sharks within NMP. By comparing the occurrence of whale sharks with localised productivity pulses and SST, predictions of whale shark occurrence may be achievable (Meekan M, 2012, pers. comm.).

Spatial and temporal variability in food supply is being investigated by studies of plankton abundance and distribution in an effort to understand how this affects whale shark occurrence throughout the Indian Ocean. Information on optimal foraging behaviour and habitat selection due to high food abundance may be revealed.

A long-term monitoring program should be established to quantify inter-annual variability in the whale shark aggregation in NMP. Whether this can be done by continuing the spotter plane data collection program will be determined once the current dataset has been analysed. As our understanding of the mechanisms for the whale shark aggregation at NMP is still limited, the existing environmental data should be reviewed to identify the links between environmental variables and whale shark population variability. Once the drivers are established these can then be monitored to ensure human impacts in the area, including interaction pressure, oil and gas development and climate change, are not adversely affecting the conditions that support the whale shark aggregation at NMP.

In many areas, whale shark occurrence appears to be temporary and often linked to feeding during specific productivity events. The duration of the whale shark aggregation at NMP and where they are before, during and after the season are important questions for DPaW and the tourism industry to answer. A better understanding of movement patterns will help define appropriate spatial and temporal boundaries for interaction management and monitoring. Whale sharks at NMP are seen sporadically outside of the main season, which may suggest that some individuals remain in the area but move further offshore or into deeper water and thus are not seen as regularly. Other individuals are known to leave the area completely, generally in a northerly direction. Short- and long-term movements of whale sharks are being investigated through tracking studies but our understanding of the drivers for large-scale movements of the species is still limited. Current information should be reviewed to identify knowledge gaps and focus research and monitoring efforts in these areas.

One such knowledge gap is a lack of information on the annual geographical range of whale sharks sighted in NMP and how far they may travel if and when they leave NMP. Archival tags, which are designed to remain attached to the sharks until retrieved by hand, have already been deployed at NMP in the hope of answering this question. Several of these archival tags have been retrieved at NMP in the season subsequent to their deployment but results are not yet available. It is hoped that

commercial whale shark operators working collaboratively with researchers and DPaW will increase the number of tags able to be retrieved and in turn, the extra data collected will provide more detailed information on annual patterns of movement. Tags have been colour coded to identify which tags should be retrieved in a particular year. Due to the potential risks associated with the retrieval of tags, industry involvement has been low to date. This methodology relies on an adequate number of tags being retrieved and will be enhanced with industry support of the retrieval process.

5.4 Management issues

5.4.1 Licensing and reporting

The requirement for all researchers to apply for a research permit (Regulation 17 under the WC Act: Licence to take fauna for scientific purposes) before any studies begin in the marine park ensures that DPaW will be kept fully informed of all proposed whale shark research. This also allows DPaW to assess the value and applicability of proposed projects to inform ongoing management. Progress of these studies should be reported at least annually and the final results provided to DPaW at the completion of the research. It is important that emphasis is maintained on ensuring researchers comply with all conditions of their permits.

Communication between DPaW and researchers is crucial throughout the period of the research project, especially if it may interfere with commercial whale shark operations. Measures must be taken to avoid conflicts occurring, such as conducting research in an area away from commercial operations or providing clear direction on the steps to be taken to avoid interference with the industry. Whale shark operators must be informed of all proposed research activities at the pre-season operator meeting and it is essential that any feedback on information gained through research is provided.

It is important that DPaW coordinates all whale shark research to ensure an organised approach to the research is in place. There are many researchers doing similar studies and it is important that DPaW streamlines the research program to ensure it is getting the required information for making better management decisions on whale shark interactions.

Researchers and students often seek access to the monitoring data collected by DPaW through commercial whale shark operators. Any sharing of data must be undertaken through appropriate data sharing agreements. This allows DPaW to ensure that any additional information derived from its data is provided in a timely manner and available for management purposes. DPaW should also have the opportunity to review the information before any publication.

5.4.2 Industry involvement

Many of the research and monitoring studies undertaken within NMP require the involvement and cooperation of commercial whale shark operators. It is therefore important to keep them informed about the proposed studies and why they are necessary, as well as give feedback on the results and conclusions – especially if they are relevant to issues affecting commercial on-water operations and the management of whale shark tourism. High quality data are more likely to be received if operators understand why the information needs to be collected and realise the importance of their role in the conservation effort. The commercial operator electronic logbook scheme relies solely on the accurate input of data from licence holders, and NMP photo ID data rely to a large extent on useful images provided by the commercial whale shark videographers (both of which are required

under commercial operations licence conditions). Training is also provided to whale shark tourism industry staff to improve data quality.

5.4.3 International collaboration

As whale sharks have a global distribution and may undertake large-scale migrations, it is important that communication, collaboration and sharing of knowledge between scientists, managers and commercial operations occurs worldwide. Workshops and conferences have proven successful in achieving this and should be continued on a regular basis. This will allow for more-developed whale shark interaction management agencies to support those countries that are just getting established and sharing of research and monitoring techniques. By working as a global 'whale shark community', protection for whale sharks at an international level will be increased.

5.4.4 Funding

The continuation of existing or new research and monitoring programs will likely require external funds for resources additional to those generated through commercial operator licence charges until cost recovery is achieved. A range of grants and funding schemes available at state, national and international levels should be accessed for whale shark research.

5.5 Priorities

Despite all the research and monitoring effort since the regular aggregation at NMP was discovered, large knowledge gaps remain in relation to whale shark biology, ecology, life history, distribution and movement patterns, as well as potential tourism impacts. It is crucial to gain a better understanding of these aspects to determine sustainable levels of tourism. The identification of knowledge gaps after a thorough review of existing information, and subsequent prioritisation of research and monitoring strategies, is required to direct future research priorities.

5.6 Research and monitoring strategies

The following section outlines the research and monitoring strategies identified to achieve this program's objectives. Actions have been recommended to address the strategies. An inventory of current and ongoing whale shark research and monitoring projects is provided in Appendix 6.

Strategy: Continue to investigate and monitor the impacts of whale shark interaction tourism on whale sharks in NMP

Actions:

- Seek collaborative partnerships to analyse and review existing datasets (e.g. DPaW aerial behavioural data, operator data, photo ID data, aerial search effort data, crittercam, Daily Diaries) to investigate the potential impacts of whale shark tourism in NMP.
- Continue monitoring of tourism pressure and numbers of interactions by whale shark operators.
- Analyse interaction activity for each licence including spatial and temporal spread of interactions to determine current levels of interaction and extent of licence use.
- Review available methods for investigating impacts of tourism (including photo ID, aerial surveys, operator data, crittercam and Daily Diaries) and identify appropriate methods to use for ongoing studies.

- Seek collaborative partnerships for ongoing monitoring and investigation of the potential impacts of tourism.
- Commission a study to determine resource size and estimate pressure that the resource can sustain from whale shark tourism, including a sustainable number of licences.

Strategy: Continue to investigate spatial and temporal variability and changes in whale shark numbers in NMP

Actions:

- Review and collate all existing information on the natural spatial and temporal variability in whale shark numbers at NMP including:
  - operator data providing information on the number of whale shark contacts per year and vessel time
  - photo ID providing information on the number of individual whale sharks per year
  - aerial monitoring providing information on the number of whale shark sightings per year (also those which industry don't interact with) and search effort.
- Review available methods for investigating patterns of spatial and temporal variability of whale shark numbers in NMP and identify appropriate methods to use for ongoing studies.
- Seek collaborative partnerships for ongoing monitoring and investigation of patterns of spatial and temporal variability in whale shark numbers in NMP.

Strategy: Identify relationships between spatial and temporal patterns of whale shark activity and biological, biophysical and oceanographic variables associated with whale shark aggregation and migration

Actions:

- Review and collate all existing environmental information relevant to whale sharks at NMP and identify potential biological and oceanographic factors that may affect distribution of whale sharks (see Appendix 6, AIMS oceanographic and climate change studies, Indian Ocean zooplankton study).
- Seek collaborative partnerships to investigate the usefulness of spotter plane, GPS track and waypoint data for monitoring whale shark spatial and temporal patterns in distribution and links with biological and oceanographic information.
- If required, investigate re-establishing the DPaW whale shark spotter plane program in consultation with local aircraft charter companies.
- Identify knowledge gaps and identify studies and methods required to fill those gaps.

Strategy: Predict potential impacts of climate change on whale sharks in NMP

Actions:

- Support research examining potential impacts of climate change on the natural environment that may apply to whale sharks.

Strategy: Continue to investigate the local and regional patterns of movement of whale sharks

Actions:

- Review and collate all existing geographical movement information for whale sharks at NMP and report on what is known about geographical movement patterns to date (see Appendix 6, AIMS/CSIRO/Hubbs-SeaWorld/ECOCEAN tagging programs).
- Assess and identify appropriate methods to investigate migratory patterns of whale sharks (including Daily Diary tags, satellite tags and photo ID).
- Seek collaborative partnerships for ongoing investigations of patterns of movement.
- Where appropriate, seek industry cooperation in collection of tags.
- Identify knowledge gaps and the research and monitoring programs for filling those gaps.

Strategy: From the reviews above, identify knowledge gaps and where appropriate support research (internal and external) to support effective management of whale shark interactions

Actions:

- Identify and support research and monitoring programs that have direct relevance to the management of whale shark interactions.
- Identify knowledge gaps and research and monitoring programs for filling those gaps, including but not restricted to:
  - behavioural response and pressure sustainability studies
  - climate change and pollution studies
  - population studies
  - movement and environmental studies.

Strategy: Develop and implement an integrated whale shark MER program

Actions:

- Review current monitoring methodology (e.g. DPaW aerial behavioural study, crittercam, Daily Diary data) to determine the effectiveness for monitoring behavioural responses of whale sharks to identified current and potential pressures.
- Develop and implement an integrated MER program that measures pressures and informs management.

Strategy: Review and use research and monitoring outcomes to inform management strategies, particularly to minimise impacts

Actions:

- Request researchers provide, at a minimum, annual progress reports for all studies, and present to the DPaW Whale Shark Management Team for review.
- Annually review monitoring and research outcomes to determine if any indicate the need for changes to improve management.
- If required, implement management changes in consultation with the DPaW Whale Shark Management Team.

6 EDUCATION

Developing industry and community support for whale shark interaction management is critical to the effectiveness of the wildlife management program. Increased understanding will foster a sense of ownership and acceptance of the need for restrictions, which will subsequently lead to better protection of whale sharks. Education is an important strategy adopted by DPaW in partnership with tour operators to ensure that visitors and stakeholders have a sound understanding of the conservation and management issues associated with whale sharks. This strategy is achieved through provision of interpretive material, public presentations and whale shark interaction training courses for industry staff. Tour operators are an integral component of educating visitors and DPaW recognises the need to support and promote this collaboration where possible.

6.1 Interpretive material

The 'Experiencing Whale Sharks in NMP' brochure is the main means of disseminating whale shark conservation and interaction information to the general public. The brochure summarises whale shark biology and conservation and outlines the interaction code of conduct. It should be distributed at public boat ramps and visitor information centres or handed out directly to the general public during whale shark presentations. Brochures are also provided to all commercial whale shark operators for distribution to passengers participating in whale shark tours.

Commercial whale shark operators are also provided with laminated whale shark code of conduct posters for display on vessels and at shop fronts. There is also a permanent whale shark information panel at the Tantabiddi boat launching facility and seasonal information boards at the Milyering Visitors Centre in Cape Range National Park (Figure 2).

Interpretive material targeting recreational users could be improved through distribution of brochures, signage placement and presentations to recreational user groups to reduce the potential for boat strike and harassment of whale sharks.

6.2 Public presentations

In 2005, DPaW initiated a program of weekly evening public whale shark presentations as a way to disseminate more detailed information on whale shark biology and ecology, along with essential management and conservation information. This program proved successful initially but interest has diminished in recent years, possibly as a result of better information being provided during tours. As a minimum, whale shark presentations should be included in school holiday programs and on demand for visiting school/travel/media groups. Talks by visiting whale shark researchers have proven popular with the community – DPaW can facilitate these presentations which provide vital feedback and results from the research being conducted in the area.

6.3 Ningaloo Whale Shark Festival

The town of Exmouth hosts the Ningaloo Whale Shark Festival to celebrate the annual aggregation of whale sharks at NMP. The festival is organised by members of the community and is an important event for the town attracting many visitors. Displays, workshops and exhibits contribute to education and awareness about the need to protect whale sharks and their environment. DPaW, as the manager of whale shark interactions in NMP, plays an important role in supporting this event, both financially and by providing a whale shark interpretive display.

6.4 DPaW Interacting with Whale Sharks course

In 2006 this course was developed by the then Department of Environment and Conservation with the aim of improving and streamlining the delivery of whale shark interaction tourism in NMP.

The course objectives are to:

- improve and streamline the knowledge of whale shark tour operator staff on whale shark biology, ecology, conservation issues and DPaW whale shark interaction management at NMP
- improve the relationship between DPaW and the industry and create an open channel of communication
- minimise the negative human impacts on whale sharks during interaction while delivering a high quality tourism experience to customers
- increase compliance with licence conditions and improve data collection
- improve the quality and quantity of images provided to DPaW by whale shark videographers for photo ID through a videographer workshop.

The aim is to provide hands-on, practical training for staff working for licensed commercial whale shark tour operators as they provide the main face-to-face contact for tour passengers and are integral to raising public awareness and delivering whale shark education. Another important goal is to reduce the occurrence of operational and compliance issues that DPaW deals with annually.

DPaW is supporting education and training opportunities to improve management and conservation of whale shark aggregations globally by providing its training material to other countries. The Western Australian code of conduct has already been adapted and implemented in many countries that host regular whale shark aggregations including Belize, Mexico, the Maldives, Mozambique and the Philippines. DPaW's management program is viewed as leading the way in whale shark conservation and management.

6.5 Education strategies

The following section outlines the education strategies identified to achieve this program's objectives. Actions have been recommended that need to be undertaken to address the strategies.

Strategy: Raise community awareness of whale sharks and broader conservation issues through education and training programs

Actions:

- Conduct whale shark talks at Milyering Visitor's Centre as part of interpretive and education programs.
- Conduct whale shark talks at Coral Bay when appropriate.
- Conduct whale shark talks for school/travel/media groups as requested.
- Organise community talks by visiting whale shark researchers and/or present recent whale shark findings of interest to the community.
- Update the DPaW whale shark brochure and provide up-to-date material regarding whale sharks in other relevant literature and publications.
- Continue to sponsor and provide whale shark interpretive marquee for annual Ningaloo Whale Shark Festival.
- Publish DPaW annual whale shark reports on DPaW whale shark internet pages.
- Develop key whale shark messages and utilise social media to educate and inform the local and broader community on these messages.

Strategy: Develop and implement training and education strategies regarding tourism pressures facing whale sharks in NMP to achieve world's best-practice tour operations

Actions:

- Implement new Interacting with Whale Sharks course through eLearning and workshops.
- Review and improve Interacting with Whale Sharks course as necessary.

Strategy: Develop an education strategy aimed at reducing the risk of vessel strike by recreational and commercial vessels within NMP and other marine reserves

- Develop an education strategy that includes:
  - vessel and swimmer code of conduct signage at Tantabiddi and Coral Bay in a prominent location targeting both recreational and commercial users (e.g. current signage at Tantabiddi in the information shelter is primarily used by tour participants who receive code of conduct information on the tour; recreational users don't necessarily see it)
  - 'Watch your speed' sign at Tantabiddi and Coral Bay during whale shark season
  - brochure distribution at all venues that recreational users may frequent
  - code of conduct briefings as part of all game fishing competitions and any other relevant occasions during whale shark season in which recreational users can be targeted
  - educate industry staff during Interacting with Whale Sharks course
  - boat ramp education (complements compliance program).

Strategy: Provide knowledge and assistance to aid in the development of whale shark conservation education programs globally

Actions:

- Continue to provide DPaW education and training material to international organisations as requested.
- Continue to assist international organisations with enquiries as requested.
- Continue to present at regional and international conferences/workshops as appropriate.

7 IMPLEMENTATION AND REVIEW

7.1 DPaW roles and responsibilities

DPaW has the lead role in implementation of this wildlife program. The strategies outlined in sections 4.3, 5.6 and 6.5 will be implemented as resources and priorities allow. Various sections within DPaW will need to play a role and be assigned responsibilities to ensure the efficient and effective implementation of this management program. Roles and responsibilities of various sections within DPaW are detailed below.

DPaW Exmouth District:

DPaW Exmouth District is responsible for the day-to-day management of the whale shark interactions and will include associated strategies in successive annual works programs. A DPaW Whale Shark Conservation Officer may be appointed to manage the day-to-day operations and interactions of this program. That position will operate from the Exmouth District office, under the supervision of the Marine Program Coordinator and Exmouth District Manager. The Exmouth District Manager (or delegate) will be a member of the DPaW Whale Shark Management Team and the Whale Shark Conservation Officer will provide administrative support for the team.

DPaW Marine Science Program:

DPaW Marine Science Program will provide advice for and assist the research and monitoring program, particularly in developing an effective MER program. They will support the assessment and coordination of the research being undertaken by external organisations and agencies. A member of the Marine Science Program will be a member of the DPaW Whale Shark Management Team.

DPaW Nature Protection Branch:

DPaW Nature Protection Branch administers and regulates licensing procedures and thus will be responsible for the provision and management of licensing relevant to whale shark interactions. It will play a role in regulation and compliance strategies. A member of the Nature Protection Branch will be a member of the DPaW Whale Shark Management Team.

DPaW Policy and Tourism Branch:

Provide advice and direction in relation to strategies associated with recreation, tourism and the development of policy. A member of the Policy and Tourism Branch will be a member of the DPaW Whale Shark Management Team. The branch is also responsible for administering the commercial operations licensing system.

DPaW Species and Communities Branch:

Provide advice and direction on management and conservation strategies relating to both whale shark interaction and conservation. Provide advice, if required, on research, monitoring and education strategies. A member of Species and Communities Branch will be a member of the DPaW Whale Shark Management Team.

DPaW Whale Shark Management Team:

The DPaW Whale Shark Management Team will review the effectiveness of the wildlife management program at the end of each season. This team will comprise:

- Exmouth District Manager, or delegate (chairperson)
- Nature Protection Branch representative
- Marine Science representative
- Species and Communities Branch representative
- Policy and Tourism Branch representative.

Team members will report to their respective Directors at their discretion should issues arise.

Review of the wildlife management program will examine:

- success in terms of achieving objectives
- overall cost-effectiveness of the program.

This will be achieved through:

- a review of the previous season in relation to strategic objectives, strategies and performance measures
- an assessment of monitoring results
- an assessment of operational and management issues
- an assessment of research findings including recommendations for changes to management practices
- recommendations on further research and monitoring
- a financial review.

This information will be presented in a DPaW report made available to the public. The DPaW Whale Shark Conservation Officer is responsible for compiling and presenting this information.

7.2 Other roles and responsibilities

7.2.1 Commercial whale shark licence holders and other stakeholders

Ideally a Whale Shark Advisory Committee (WSAC) would be formed to improve communication channels between DPaW, commercial whale shark licence holders and other stakeholders, and for review of the whale shark management program. However, external consultation with whale shark licence holders has determined that the current approach of having DPaW/operator pre- and post-season meetings is the best forum for improving communication channels, with the opportunity to invite other external stakeholders to attend/present if deemed necessary. An informal Whale Shark Working Group will be established for the purposes of reviewing the whale shark management program.

Licence holders have responsibilities to comply with their licence conditions but can also play a role in research and monitoring – their feedback on the program is valued and will be regularly sought by DPaW's Whale Shark Management Team.

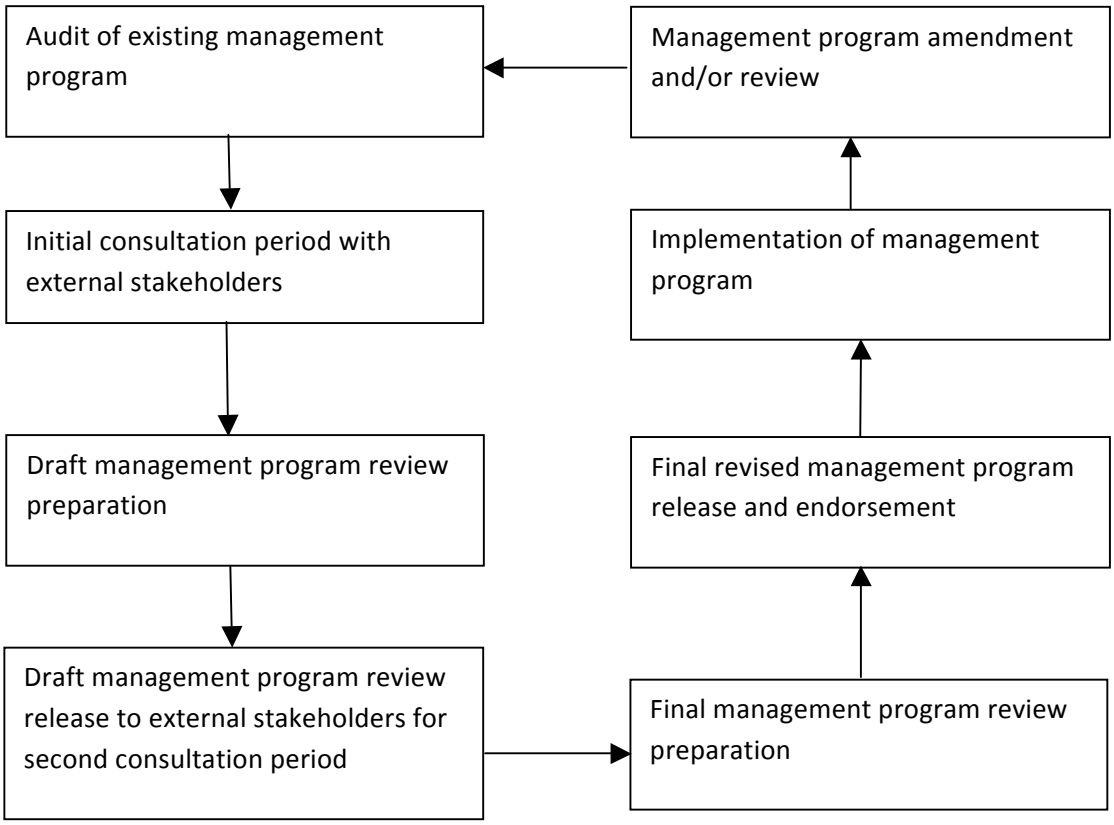
7.2.2 Links with Marine Parks and Reserves Authority reporting

The MPRA audits DPaW's management of Western Australian marine parks and reserves including NMP through a formal review process. The audits include reports on the status of the key ecological values of the reserves, which includes whale sharks, and assesses the effectiveness of current strategies in place. The MPRA is also consulted in regard to granting of commercial operations licences pursuant to the CALM Regulations.

7.3 Review of the whale shark wildlife management program

The wildlife management program will cover whale shark interaction management for a period of 10 years from the date the plan is approved, unless new information provides for the revision of the plan before that date. At the end of the 10-year period, the program will be reviewed with public consultation, and re-submitted to DPaW and the MPRA for endorsement. The CALM Act specifies that if a revision does not occur by the end of the program's specified life span, the program will remain in force in its original form, unless it is either revoked by the Minister for Environment or until a new program is approved.

The process of reviewing the whale shark management program is as follows:



The whale shark wildlife management program review has been developed in consultation with key stakeholders in the following ways:

- individuals and organisations helped to identify issues to be considered during the development of the draft wildlife management program though a questionnaire
- a Whale Shark Working Group was formed to promote communication and consultation through electronic means

- meetings were held with key stakeholders to provide opportunities for input and to update on progress
- written submissions received during the external stakeholder submission period were analysed and considered in the preparation of the final wildlife management program review.

7.4 Application of the whale shark wildlife management program

Whale sharks occur along the inshore waters of the western and north-western coasts of Western Australia. At present, however, there is no evidence to determine if individuals aggregating in NMP are the same as the ones seen along the rest of the coastline. Interaction with whale sharks has been steadily increasing, via commercial and private vessels, and some interest in developing commercial whale shark tourism out of Kalbarri is emerging. This means the potential for individual whale sharks to be exposed to human interactions may increase both spatially and temporally, and any detrimental impacts from these interactions could be cumulative – affecting the animals directly or altering their natural behaviour. As whale sharks are protected within all state waters (under the WC Act) and the activities of both commercial and recreational vessels and swimmers interacting with them are controlled throughout the year – under the Wildlife Conservation (Close Season for Whale Sharks) Notice 1996 – it is appropriate for the strategies (management, research and monitoring, and education) outlined in this management program to be applied wherever relevant (and modified where necessary), in existing and future CALM Act marine reserves. The management principles detailed in this wildlife management program are also recommended for whale shark interaction in state waters outside marine reserves.

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APPENDICES

Appendix 1 – Species biological, ecological and population information

1.0 Description of species

The whale shark, *Rhincodon typus* (Smith 1828), is the sole representative of family Rhincodontidae, one of seven families and about 42 species within the Order Orectolobiformes, which consists of mostly bottom-dwelling species, including nurse sharks (Ginglymostomatidae), leopard sharks (Stegostomatidae), long tailed carpet sharks (Hemiscyllidae) and wobbegongs (Orectolobidae). The taxonomic interrelationships between these families are based on a number of anatomical and morphological similarities, including skeletal anatomy, tooth and dermal denticle morphology, fin placement and barbel morphology (Compagno 1973; Dingerkus 1985). The whale shark is the only pelagic species within the Order and the only member to feed on plankton (Fowler 2000).

The whale shark is the largest fish in the world, reaching a length of 15–20 m (Colman 1997; Fowler 2000; Norman 2002). The body of the whale shark is spindle shaped and fusiform (widest in the middle and tapering to the ends) and is characterised by three prominent longitudinal ridges along its dorsal flanks, a large first dorsal fin and semi-lunate caudal fin (Rowat & Brooks 2012). The first dorsal fin is much larger than the second dorsal fin and set rearward on the body. In small juveniles the upper lobe of the caudal fin is considerably longer than the lower lobe. The body is streamlined with a depressed, broad and flattened head. The mouth is transverse, very large and terminal (nearly at the tip of the snout). Gill slits are very large, modified internally into filtering screens (Compagno 1984; Colman 1997; Rowat & Brooks 2012).

The whale shark has a unique 'checkerboard' pattern of light spots and light stripes on a dark background (Compagno 1984; Last & Stevens 1994; Colman 1997; Fowler 2000). This pattern of lines and spots on the skin of each shark enables them to 'blend' into their surroundings. This 'camouflage' makes the sharks less conspicuous in their oceanic environment. The spots and stripes provide disruptive colouration while the lighter ventral surface provides a counter-shading effect when viewed from below (Wilson & Martin 2003). This defensive camouflage may be especially important during their early years in reducing predation on smaller sharks (Rowat & Brooks 2012). The patterning is unique to individuals and does not appear to change over time, enabling it to be used to identify individual sharks (Norman 1999; Fowler 2000). Other functions of the distinctive pattern of body marks may be a result of its evolutionary relationship with bottom-dwelling carpet sharks which often have distinctive body patterns (Colman 1997). Distinctive markings in a pelagic species could be linked to social activities such as postural displays and recognition processes. Another possibility is that these pigment patterns could be an adaptation for radiation shielding – important in a species that may spend a significant proportion of time in surface waters possibly exposed to high levels of ultraviolet radiation (Colman 1997).

The whale shark's eyes are small and located behind the angle of the jaw. Just behind each of the whale shark's eyes is a round hole called a spiracle. This hole is a primitive gill slit present in many other sharks and rays. The skin on the back of the whale shark is thicker and tougher than that of any other species in the world, reaching up to 14 cm thick, and the outer layer is covered in overlapping dermal denticals (Taylor 1994).

The whale shark is one of the three species of very large filter-feeding sharks that occur in Western Australian waters, the other two being the basking shark *Cetorhinus maximus* and the megamouth shark *Megachasma pelagios* (Colman 1997).

2.0 Distribution and habitat

Whale sharks are thought to be cosmopolitan in distribution, occurring in all tropical and warm temperate seas (Colman 1997). They are usually found in a band around the equator between latitudes 30°N and 35°S, in both oceanic and coastal waters and within reef lagoons (Compagno 1984; Norman 2002) (Figure A1). In Australia whale sharks occur mainly off northern Western Australia, the Northern Territory and Queensland, with isolated reports from New South Wales and Victoria (Wolfson 1986). Within Australian waters whale shark aggregations are known to occur reliably at NMP and Christmas Island in Western Australia, and possibly in the Coral Sea.

Whale sharks have been reported from the Maldives, Seychelles and Comores Islands, Madagascar, South Africa, Mozambique, Kenya, Pakistan, India, Sri Lanka, Thailand, Malaysia, Indonesia, Mauritius, Taiwan, Honduras, Belize, Mexico, the Galapagos Islands, Chile, the Philippines and northern Borneo (Colman 1997; Norman 2002).

Whale shark aggregations around the world are associated with environmental and oceanographic features including upwellings or high productivity areas, currents and eddies, food pulses, surface temperatures between 25 and 35°C, deep channels and vertical mixing (Hoffman et al. 1981; Arnbom & Papastavrou 1998; Iwasaki 1970; Eckert & Stewart 2001). While Compagno (1984) suggests this species prefers waters with temperatures between 21 and 25°C, the whale sharks sighted at NMP in Western Australia are predominantly found in waters with temperatures averaging 27°C (Norman 1999).

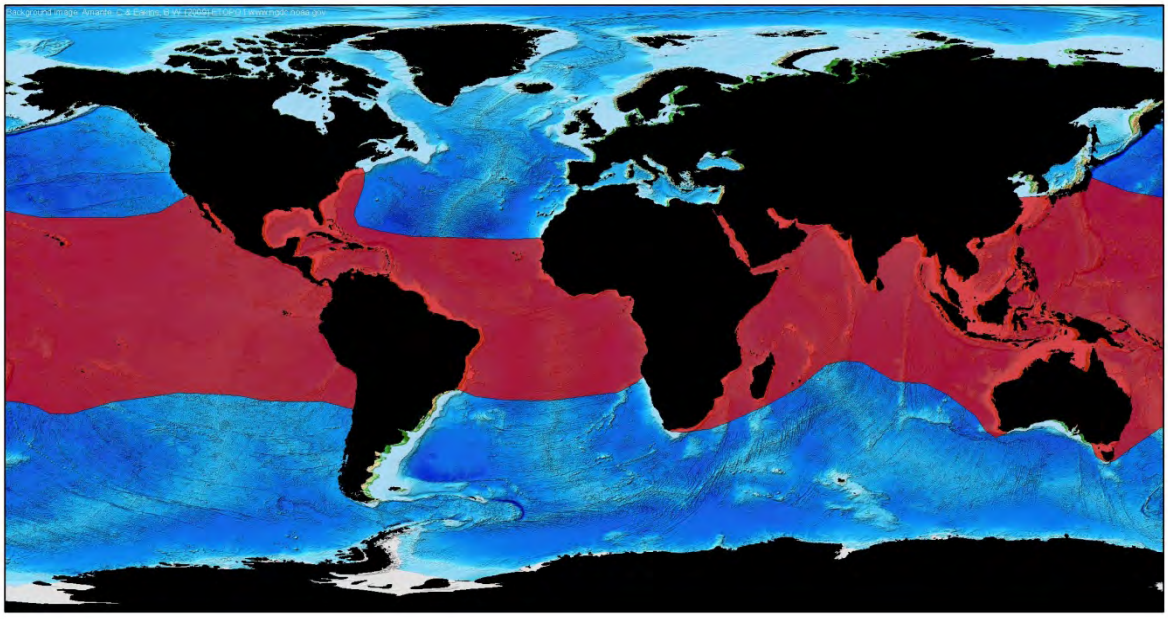

Figure A1: Whale shark global distribution (red areas indicate confirmed distribution).

At NMP, whale sharks aggregate between the months of March and July, sometimes extending into August. The aggregation has been linked to productivity events associated with mass coral spawning episodes and the unique current system along the north-west coastline where the Leeuwin current and Ningaloo current interact (Figure A2). Preliminary analysis of the relationship between whale shark occurrence at NMP and oceanographic and atmospheric variables indicates that relative

abundance of whale sharks was most strongly influenced by a combination of the El Niño Southern Oscillation Index (SOI) and sea surface temperature (SST), with SOI having the strongest effect. There is an indication that in La Niña conditions and higher SST, stronger Pacific trade winds drive the Leeuwin current southward and more whale sharks are observed (Sleeman et al. 2010).

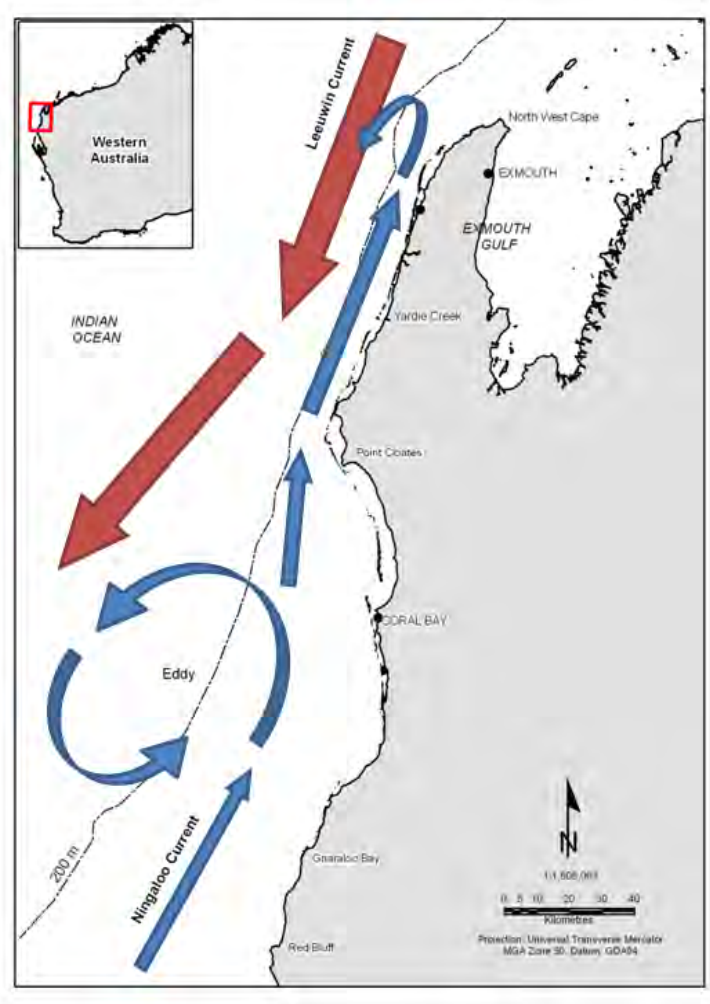

Figure A2: Current patterns at Ningaloo Reef Marine Park during March and April.

Large numbers of whale sharks are observed off Christmas Island during December and January coinciding with the red crab spawning event. In the Coral Sea regular sightings of whale sharks occur in October and November in association with aggregations of tuna, and have been associated with large concentrations of spawning lantern fish rather than with the coral spawning along the Great Barrier Reef (Colman 1997).

The whale shark is a pelagic species and therefore availability of physical habitat is not considered to be limiting, unless associated with seasonal food concentration. Few seasonal whale shark habitats have been surveyed to assess extent, status and threats to their existence, and research is lacking on the environmental factors important to the species (Norman 2002). Damage caused to the marine environment by pollution, overfishing, the introduction of invasive species and global warming present threats to the persistence of the whale shark in Australian waters (DEH 2005). Nursery and mating grounds are yet to be identified.

3.0 Biology and ecology

Feeding

The whale shark is a filter-feeder that consumes a variety of plankton and nekton, including small crustaceans such as krill, crab larvae and copepods, small schooling fishes such as sardines, anchovies, mackerel, and occasionally larger prey such as small tuna, albacore and squid (Compagno 1984; Last & Stevens 1994). Phytoplankton and macroalgae may also form part of the diet, however it is possible that algal matter found in the gut contents could have been swallowed accidentally, either during the course of normal feeding activities or while being captured (Colman, 1997).

The whale shark has a large terminal mouth, which is in front of the eyes and large gill slits. The teeth of the whale shark number some 6000, but are very small, 2 mm in length and appear to be vestigial (Taylor 2007). The different feeding mechanisms of filter-feeding sharks have been discussed at length (Colman 1997; Stevens 2007; Taylor 2007). The dense filter screens of whale sharks act as more efficient filters for short suction intakes, in contrast to the flowthrough system of the other two species of filter-feeding shark (Taylor et al. 1983). Whale sharks can capture larger more active nekton, but are not so well adapted for concentrating diffuse plankton, probably making them more dependent on dense aggregations of prey (Stevens 2007).

Three distinct feeding behaviours have been observed at NMP: passive, active and vertical feeding. Passive feeding, which resembles the ram filter-feeding of the basking shark, is observed most commonly where individuals are seen cruising with their mouth agape. The whale shark is not dependent on forward motion to operate its filtration mechanism, but rather relies on a versatile 'suction' filter-feeding method, which enables it to draw water into the mouth at higher velocities than 'dynamic' filter-feeders, such as the basking shark. When actively feeding, the whale shark pumps large volumes of water through the gills at speed, causing the gills to flare out. The five gill slits are relatively large; only the basking shark has larger gills. The whale shark can sieve prey items as small as one millimetre through the fine mesh of the gill rakers. They are able to open their mouths to a width greater than one metre to optimise feeding. Vertical feeding, where individuals hang vertically in the water and 'actively' feed by opening their mouths and sucking in prey-rich water, has also been described in whale shark aggregations around the world (Nelson & Eckert 2007). Prey abundance may be the driving force determining which of the three feeding techniques is used (Nelson & Eckert 2007; Stevens 2007). Active feeding appears to be triggered by aggregations of small crustaceans (including euphausids), squid, anchovy and sardines.

Groups of individuals have been observed 'actively' feeding at dusk or after dark by ploughing the surface waters with mouth agape and jaw distended. At NMP, and more recently at the Muiron Islands (north-west Australia), individuals and groups of whale sharks have been observed actively feeding at dusk on swarms of the tropical krill *Pseudeuphausia latifrons* (Taylor 1994; Wilson E, 2012, pers. obs.). Whale sharks have also been observed 'coughing', which is thought to be a mechanism employed to clear or flush the gill rakers of accumulated food particles.

Anatomy and physiology

There have been few investigations into the anatomy of whale sharks but like all sharks, the whale shark has a number of hydrodynamic adaptations that increase their efficiency, including dermal

denticals covering the skin which reduce drag and surface noise production. They have a skeleton made of lightweight, flexible cartilage (Gudger 1915) and lack a rib-cage which saves weight and is somewhat compensated by a sub-dermal complex mesh corset of collagen fibres (Martin 2005), which also functions as a flexible external skeleton. Locomotory muscles from the backbone are attached to this corset in a light and mechanically efficient system (Rowat & Brooks 2012). The whale shark's ability to perform deep dives may be attributed to the high proportion of white myotomal locomotory muscle, which reacts very rapidly but builds up lactic acid, thought to be primarily used for short rapid bursts of speed (Rowat & Brooks 2012; Wilson & Martin 2003).

Due to the difficulty of conducting physiological studies on a fish of this size, very little is known and most information available has come from captive specimens. Blood samples from two healthy whale sharks taken at the Georgia Aquarium (United States) showed they had typical elasmobranch erythrocytes similar to those of other orectolobiform sharks and white blood cell differentials similar to other elasmobranchs (Old & Huveneers 2006). Samples from two other captive individuals which later died, showed elevated white blood cell counts as their condition deteriorated (Dove et al. 2010). This information would indicate that whale shark physiology is typical for an elasmobranch.

Sensory biology

The whale shark has relatively small circular eyes with a circular pupil, laterally situated on the sides of the head, giving the species a large field of vision (Martin 2007; Rowat & Brooks 2012). However, its visual abilities are unknown. Because of the broad, blunt shape of the head and the position of the eyes well back from the tip of the snout, whale sharks are likely to have blind spots directly in front of their noses and immediately behind their heads (Hueter et al. 2004). Clarke and Nelson (1997) suggest that vision may play a smaller part in feeding than olfaction (sense of smell). Whale sharks do not have any eyelids but are able to 'close' their eyes by rotating them and sucking them back into their head. This behaviour is often observed when camera strobes or flashlights are fired close to the whale shark's head (Norman 1999; Martin 2007). Martin (2007) suggests whale sharks are capable of discerning movement at close range.

Much work has been done on chemoreception in predatory sharks (Hueter et al. 2004), but little is known of olfaction in filter-feeding sharks. Martin (2007) suggests that they would have similar chemo-sensory detection abilities to those of the nurse shark (as the olfactory capsules in this species are spherical and moderately large) and that it is reasonable to expect the whale shark possesses acute olfactory sensitivity. Rowat and Brooks (2012) suggest that dimethyl sulphide (DMS) may be used as a scent trail for whale sharks similar to the ability of some seabirds to detect areas of high plankton productivity by following DMS given off when phytoplankton are grazed by herbivorous zooplankton.

Hearing in whale sharks has not been studied, but many species of shark are known to be highly sensitive to irregularly pulsed, low frequency sounds, especially in the range of 20–400 Hz (Myrberg 2001). The whale shark has the largest known inner ear in the animal kingdom and the diameters of the semicircular canals are close to the theoretical maximum size for such structures (Muller 1999). This should make whale sharks most responsive to long wavelength, low frequency sounds (Myrberg 2001). Martin (2007) observed whale sharks diving in response to ignition of nearby inboard boat motors, which may be a response to the low frequency sound of such motors.

Whale sharks possess a mechano-sensory lateral line system similar to all sharks; however, its capabilities in this species are largely unknown (Martin 2007; Rowat & Brooks 2012). Some pelagic and bottom-dwelling sharks react to water currents, due largely to this lateral line system (Kleerekoper 1978; Peach 2002) and a similar response has been seen in whale sharks that have been tracked with satellite tags (Hsu et al. 2007; Rowat & Gore 2007). The cutaneous sensory system in sharks is little known, but Quiros (2005, 2007) suggests their tactile senses are acute due to their rapid response to being touched by swimmers.

Whale sharks have Ampullae of Lorenzini, pit-like organs clustered around the head, like other shark species which detect weak electric and magnetic fields and may be used as a navigational aid (Rowat & Brooks 2012). These organs are also able to detect minute bio-electrical fields, enabling some shark species to detect hidden prey (Kalmijn 1984). Rowat & Brooks (2012) suggest this sense may play a major role in feeding and prey capture in whale sharks.

The megamouth shark *Megachasma pelagios* is the only shark to have a smaller brain relative to body mass than the whale shark (Yopak & Frank 2009). One brain characteristic shared by whale sharks is an exceptionally large cerebellum with the highest levels of foliation in the corpus (Yopak & Frank 2009). This characteristic has been linked to agile prey-capture abilities, high levels of habitat awareness and the ability to perform complex motor-skill tasks – which may be important in the extensive dives of this species to great depths (Hueter et al. 2008) and its long distance migrations (Eckert & Stewart 2001; Wilson et al. 2006).

Reproduction and life history

Information on reproduction and development in whale sharks is limited. Courtship and copulation of whale sharks have not been reported, and pregnant females and very small individuals have very rarely been encountered (Colman 1997; Fowler 2000; Martin 2007; Rowat & Brooks 2012). Martin (2007) suggests the mating behaviour of whale sharks can be inferred from that of closely related shark species such as nurse sharks, where the male whale shark's ability to hang on and successfully copulate with the larger female may be a test of his fitness as a mate. Intromission itself is likely to be similar to that in other sharks in that it occurs via a single clasper inserted into the female's cloaca (Carrier et al. 1994; Martin 2007).

Most sites reporting whale sharks consist mainly of juvenile males and areas important for courtship, mating and birthing are yet to be found (Fowler 2000). Females are regularly reported from the Galapagos, Philippines and south of Baja in the eastern Pacific Ocean (Fowler 2000; Eckert & Stewart 2001). The method of reproduction in whale sharks was unclear until a pregnant female, measuring 10.6 m, was landed in Chen-Kung fish market in Taiwan in 1995 (Joung et al. 1996). Dissection of this specimen showed that whale sharks are ovoviviparous (i.e. eggs hatch and develop in the uterus) (Fowler 2000; Rowat & Brooks 2012). The twin uteri of this specimen contained 304 embryos, with many still in their egg cases with external yolk sacs and also many out of the egg cases and without a yolk sac. Three levels of development were seen in the embryos, which ranged from 42–64 cm in length, with the largest being free of their egg cases, with no external yolk sacs, ready to be released (Rowat & Brooks 2012). This litter is the largest recorded from any shark species and suggests the reproductive cycle may be similar to that of the closely related ovoviviparous nurse shark which also produces a large litter (Fowler 2000).

Data on sex ratios are also limited. A sex ratio of approximately 1:1 was reported for the 297 embryos removed from the pregnant female in Taiwan, with 150 females and 147 males (Chang et al. 1997; Joung et al. 1996). Most whale sharks encountered at NMP and at other aggregation sites are males, with a male to female ratio of close to 3:1. Only a few sites have reported female dominated aggregations. On the basis of current information it is not possible to determine whether sexual segregation of either a behavioural or geographical nature occurs (Colman 1997). Borrell et al. (2011) suggested that females have a different, more pelagic diet based on stable-isotope analysis, which could provide an explanation for the segregation of sexes.

Genetic analysis of 29 of the pups preserved from the Taiwanese female whale shark found they all had the same father (Schmidt et al. 2010). This strongly supports monoandry, where a single male sires the entire litter. The fact that the embryos were at varied stages of development indicates the female is able to store sperm with fertilisation of the eggs staged over a period of time. This mechanism has been reported for other shark species including blue sharks and gummy sharks. If the genetic make-up of the Taiwanese litter is typical for whale sharks it may show they mate rarely, with a single individual, and that breeding or mating grounds with large numbers of adults are unlikely to be found for this species (Rowat & Brooks 2012).

Only 19 whale shark specimens less than 1.5 m in length have been reported in the scientific literature (Rowat & Brooks 2012). These reports indicate pups may vary considerably in size at birth compared with those found in the Taiwanese litter. It is still unknown whether there are birthing grounds or their location, and the scarcity of pups reported presents a significant barrier to fully understanding the life history of whale sharks. Specimens found in the stomach and gut contents of blue shark and blue marlin suggest an oceanic existence, which may present a safer environment with fewer predators for pups than a coastal one.

It is speculated that whale sharks may have a lifespan of more than 100 years (Colman 1997), which would make the whale shark one of the longest living animals in the world.

Size and growth

The maximum size of whale sharks is difficult to estimate due to the difficulty in accurately measuring large sharks (Colman 1997; Rowat & Brooks 2012). The largest specimen reported was by a Taiwanese fishery in 1987 that recorded a 20 m whale shark, 34 tonnes in mass (Chen et al. 1997). Most records range between 3 and 10 m in length, with few sightings of specimens less than 3 m in length reported globally.

Information about size at sexual maturity is sparse (Colman 1997; Rowat & Brooks 2012). Taylor (1994) suggested whale sharks do not reach sexual maturity until they are over 30 years of age and over 9 m in length while Fowler (2000) calculated maturity at 7.69 m in length and 21.4 years of age. Calculations from stranded individuals based on clasper calcification and ovary development suggest that males mature at 9 m total length and females are the same or perhaps larger (Pai et al. 1983; Satyanarayana Rao 1986; Beckley et al. 1997; Wintner 2000). Observations (360) based on clasper morphology at NMP found that 95 per cent of male whale sharks were mature at 9.1 m total length, while 50 per cent were mature at 8.1 m total length (Norman & Stevens 2007).

Little is known about growth rates in whale sharks due to the difficult nature of measuring whale sharks in the water (Colman 1997; Rowat & Brooks 2012). Information has generally been derived from dead specimens, of which the sample size is low given not many strandings occur globally, or from animals held in captivity (Colman 1997; Fowler 2000; Stevens 2007). Rowat and Brooks (2012) summarise from the information available that neonatal pups grew faster in captivity than larger juveniles and juveniles greater than 3.5 m total length showed variable rates, with females growing faster than males. Nishida (2001) recorded a growth rate of 97.8 cm per year in a captive individual that was 0.6 m long initially, over a period of 1157 days. Uchida et al. (2000) recorded a growth rate of 29.5 cm per year in a captive specimen that was 3.65 m long initially, over a period of 2056 days. Wintner (2000), using the number of growth rings in the vertebral column compared with total length from stranded specimens, predicted growth was slightly slower than observed rates from captive studies – likely due to the reliable availability of food in aquariums. Pauly (1997) estimated a gradual slowing of growth to maturity, based on information for many shark species.

4.0 Population structure

Determining size, structure and distribution of rare marine species such as the whale shark is difficult, however abundance can be estimated using mark-recapture methodology. Individual whale sharks can be identified by natural marks/scars or by physically marking the shark with an identification tag. Conventional tag-recapture studies are characterised by large numbers of individuals being tagged, low percentage of returns, high tag loss and irregular return times and often a lack of necessary information such as accurate measurements of returned individuals. Colman (1997) suggested that tagging of this nature was inappropriate for population monitoring of whale sharks at NMP due to potential interference with the commercial whale shark tourism industry, and the ability to obtain data on population size and shark return rates using non-invasive techniques such as aerial surveys and photo-identification. Because of this, DPaW has not adopted identification tagging studies for monitoring population size at NMP.

Taylor (1994) was the first to attempt to identify individual whale sharks and estimate the numbers present at NMP through photographic studies in the mid 1980s. This work suggested that individuals could be identified through scars, deformities and marking patterns behind the gill slits (Taylor 1994). Further studies from NMP (Norman 2004) identified that the spot pattern of the lateral area behind the gill slits was unique and could be used as a naturally occurring mark to identify individual whale sharks. The identification and subsequent resighting of several individuals over different years indicated that some whale sharks displayed seasonal philopatry and had an affinity for the area. These studies led to the establishment of a central, comprehensive photo-identification library, which uses a computer program based on a Groth algorithm for matching astronomical data to match whale shark spot patterns from the lateral area (Arzoumanian et al. 2005). This library, now known as ECOCEAN, estimated that 65 per cent of the whale sharks at NMP were philopatric (Holmberg et al. 2008) and open population models estimated 86–177 individuals were present each year (Holmberg et al. 2009).

In a study conducted by Meekan et al. (2006) between 1992 and 2004, a total of 276 individuals were identified: 61 were observed multiple times with 25 observed between different years, reconfirming the philopatric nature of some individuals in this aggregation. Using closed population models, Meekan et al. (2006) estimated a super-population attending Ningaloo Reef of 278–589

individuals and with open models of 319–436 individuals. The reason for this difference in population estimates is due to the open and closed models making different assumptions about rates of loss and gain from the stock (Meekan M, 2012, pers. comm.). Individuals have now been identified over a 19-year period confirming a moderately long-term stability of the lateral spot patterns (Norman B, 2012, pers. comm.) and the reliability of photo ID as a tool for identifying individuals.

Similar population studies from other areas showed the presence of a large proportion of transient whale sharks similar to the aggregation at NMP where most whale sharks were also male and immature. Brooks et al. (2010) suggested these transient aggregations of whale sharks did not comprise the only or even the principle communities of this species. Estimations of whale shark populations are constrained because most sightings come from aggregations comprised mainly of juvenile males, with very few females or adults (Rowat & Brooks 2012). Interpretation of results can also complicate matters; for example, there have been conflicting studies at NMP on whether the whale shark population is increasing or decreasing (Bradshaw et al. 2008; Holmberg et al. 2009). Without data on the adults, all population estimations derived from aggregation sites should be considered an indication of overall status of regional whale shark populations (Rowat & Brooks 2012).

Another method trialled to estimate whale shark abundance is that of aerial surveying. Aerial surveys can provide robust datasets for monitoring, but there are many challenges in obtaining defensible absolute population estimates, and certain biases are inherent in the data collection (Pollock et al. 2006). Few surveys account for the period of time whale sharks spend at depths where they are not visible, meaning only those at the surface are counted, which probably represent only a portion of the number actually present at any one time (Marsh & Sinclair 1989). Also the sharks must be in the transect being surveyed when the aircraft passes over (whale sharks are highly mobile so they can easily move into or out of the survey zone). The problem of availability bias is particularly challenging for a marine animal that is not obligated to surface, as in the case of a whale shark. Despite the limitations, aerial monitoring can provide rapid surveys over large areas and relative estimates of abundance.

Aerial surveys targeting whale sharks have been conducted opportunistically at NMP but no methodology had been developed to estimate absolute whale shark population size. DPaW has conducted only 15 dedicated aerial surveys since 1990. In 2007, DPaW contracted Hodgson and Marsh to assess the effectiveness of aerial surveys for monitoring whale shark abundance and/or distribution within NMP. Due to the low number of sharks sighted over the trial (nine aerial surveys) it was deemed inappropriate to estimate whale shark population size for NMP based on these surveys (Hodgson & Marsh 2007) and considered not a cost-effective option for NMP. Based on these findings, DPaW has not continued dedicated monitoring of whale shark population size in NMP through aerial surveillance.

From a conservation perspective, it is critical to determine whether the whale shark is represented by a single global breeding population or numerous, reproductively isolated populations. If whale sharks from different areas are reproductively isolated, the removal of many individuals from one breeding population may not threaten the survival of the entire species. On the other hand, if there is a single, global population, the hunting of whale sharks anywhere in the oceans diminishes the

odds for continued survival of the species as a whole. Early studies indicated a single global population with movements between groups and interbreeding likely. Therefore conservation management strategies must address worldwide protection of these animals.

Samples of muscle and other tissues are being used in an effort to better understand how individuals within the various whale shark aggregations in different localities are related. Castro et al. (2007) found no evidence of geographical clustering and while there were statistically significant haplotype frequency differences between samples from the Atlantic and Indo-Pacific ocean regions, haplotypes were shared between different areas with no significant genetic subdivision and the most common haplotypes were found globally. Ramirez-Macias et al. (2007) found little likelihood of inter-region or inter-ocean genetic differences between whale sharks from the Gulf of California, Mexico and from the North Pacific Ocean and that females might exhibit natal-philopatry breeding and pupping in the same area as they were born, while males moved to other areas to mate. Schmidt et al. (2009) found that the genetic make-up of whale shark populations in the Pacific Ocean was very similar to that in the Indian Ocean and both were similar to that found in the Caribbean and Atlantic Ocean. It is likely there is significant gene flow and thus segregated breeding populations are unlikely (Schmidt et al. 2009). To date, 45 haplotypes have been identified for *Rhincodon typus* from mitochondrial DNA control region.

Bearing in mind the apparent regional segregation indicated by photo ID (Speed *et al*. 2007), which seems to contradict genetic findings, whale shark genetics is an area of research that requires further studies globally. Scientists collect tissue samples annually from the NMP aggregation to supplement global studies. To prevent interference with the commercial whale shark operators most sampling is conducted away from their areas of operation.

Studies conducted on the genetics of parasites unique to whale sharks seem to support segregation of whale shark aggregations within the Indian Ocean, with clear separation between west and east Indian Ocean aggregations (Meekan M, 2012, pers. comm.).

5.0 Movement patterns

Whale sharks are not regarded as social animals and are most often encountered singly, however aggregations have been reported from several areas around the world and these occurrences appear to be temporary and linked to productivity events rather than social interactions (Rowat & Brooks 2012). Whale sharks can travel great distances but consistent migration patterns are yet to be identified. Movements are generally thought to be related to increases in local productivity and changes in water temperature, currents, winds and other environmental parameters (Compagno 1984). Different locations appear to be preferred at various times of the year and they may undertake either fairly localised migrations or alternatively large-scale trans-oceanic movements governed by the timing and location of production pulses and possibly by breeding behaviour. Further research may show, like some other large sharks, that this species is resident at some stages in its life cycle (e.g. while immature) and migratory at others. Young pups may be oceanic and it is possible that male and female sharks have different patterns of migratory behaviour and distribution (Fowler 2000). Tagging studies are revealing information on whale shark movement patterns both geographically and vertically within the water column.

Geographical movements

Whale sharks have been known to travel very long distances (>1000 km) (Eckert & Stewart 2001; Hsu et al. 2007; Rowat & Gore 2007; Wilson et al. 2006). Early studies showed that some whale sharks observed at NMP move away from Australia towards Asia. Pop-up Archival Tags (PAT) are archival satellite tags which collect data describing depth, light and location of a shark for extended periods (figures A3 and A4). Two sharks were successfully tagged with PATs in 2002 (Figure A5). The first moved offshore from NMP passing Christmas Island and travelling more than 2000 km. The second shark moved in excess of 1700 km into Indonesian waters. Sharks tracked in 2003–04 travelled north-east along the continental shelf before moving offshore into the north-eastern Indian Ocean (Wilson et al. 2006). Further satellite tracking studies conducted in 2005 showed three sharks travelled north after leaving NMP towards Timor, Indonesia and far into the Indian Ocean (Figure A6). Wilson et al. (2006) suggested that whale sharks undertake short-distance migrations and return to Ningaloo Reef at one-year intervals and those movements appeared to correlate with the retreat of warm SST isotherms towards the equator in late winter. It appears the movement patterns of sharks from NMP may also be influenced by persistent warm water eddies, chlorophyll blooms and current patterns. Other studies show whale shark movements being influenced by prevailing geostrophic currents, boundary currents and local bathymetry (Hsu et al. 2007; Rowat & Gore 2007).

Similar studies in other parts of the world have confirmed the species' ability to travel long distances and move through waters under different jurisdictions. This highlights the need for conservation and management efforts to be coordinated at a regional or international level.

Figure A3: Pop-up Archival Satellite Tag (PAT) in situ

Figure A4: Archival tag deployed by AIMS in situ

Photo ID can also be used to track whale sharks and provides a non-invasive alternative to tagging. Many locations around the world are conducting photo ID studies and contributing to ECOCEAN, the global photo ID database. Several matches between Mexico, Honduras, Belize and the United States coast of the Gulf of Mexico have been reported (Norman B, 2012, pers. comm.), indicating movement patterns between these locales. To date there have been no matches between individuals photographed at NMP and elsewhere in the Indian Ocean or worldwide. This may suggest

that some individuals at NMP undertake more localised movement patterns. An advantage of using photo ID for population studies is that citizen scientists can contribute their photographs, thereby increasing the quantity and geographical extent of available data (Holmberg et al. 2008).

At a more local level, photo ID is providing evidence that whale sharks regularly move north and south along the back of Ningaloo Reef throughout the main season – many sharks are resighted between Coral Bay and the northern waters of NMP. As for the sightings occasionally reported from other areas along the Western Australian coast such as Kalbarri, Perth and even Albany, it is still uncertain whether these individuals are the same ones that visit NMP because no photographs have been obtained for these individuals.

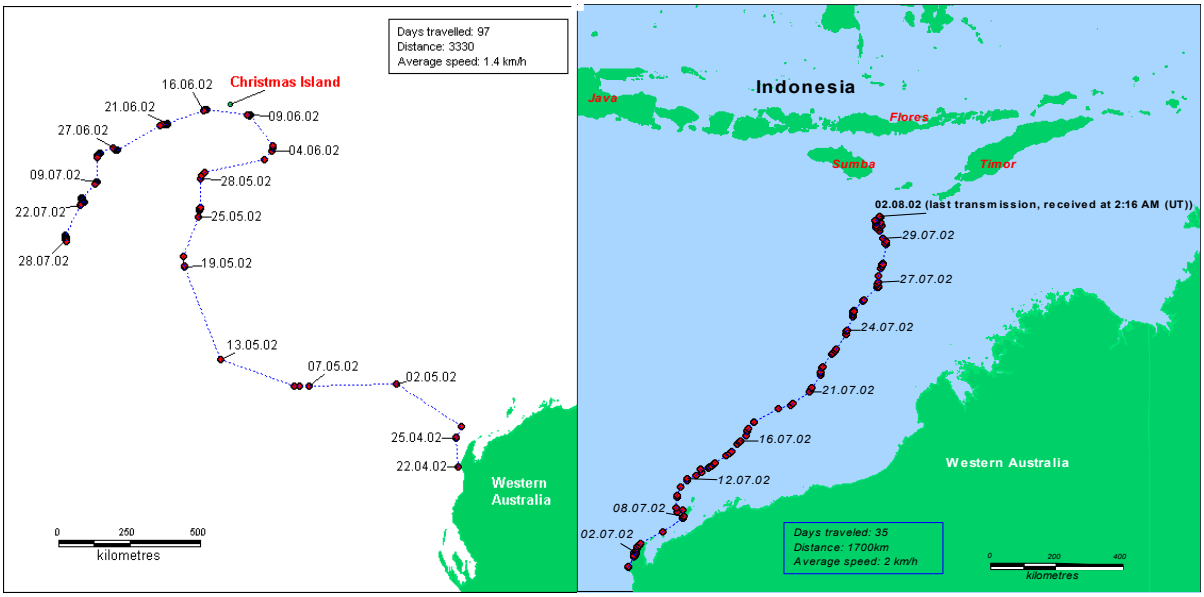

Figure A5: Tracks of two sharks tagged with PATs in 2002 (source: www.cmar.csiro.au)

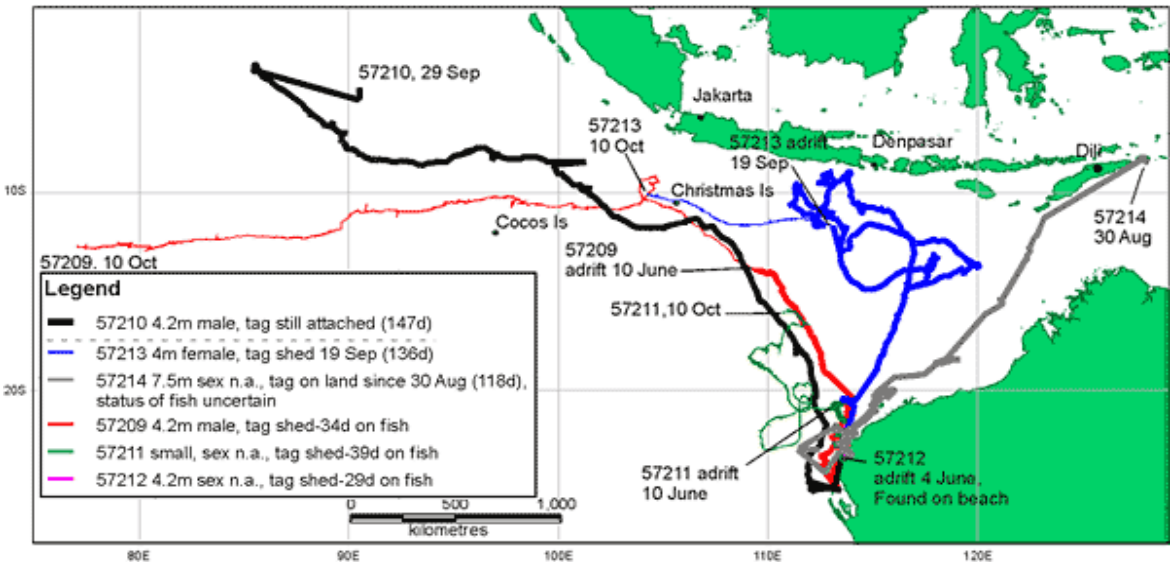

Figure A6: Tracks of six sharks tagged with satellite tags in 2005 (source: www.cmar.csiro.au)

Acoustic tags have been successfully used to track whale sharks at NMP for short periods, revealing more information about the shark's short-term movements. Acoustic tags allow the position of the shark to be determined using acoustic telemetry (ultrasonic 'pinger' tags that can be followed using a hydrophone system in a boat). The establishment of acoustic arrays have also enabled long-term monitoring of movements of multiple individuals and this system is successfully in place at NMP. Similar systems have been used in the Gulf of Mexico and western Caribbean. These studies provide additional data to supplement photo ID, showing sharks return annually, and move north and south along Ningaloo Reef. They can also track sharks in areas where tour boats don't go (Norman B, 2012, pers. comm.) and provide information on residency rates (Meekan M, 2012, pers. comm.).

Vertical movements and diving behaviour

Whale sharks routinely move between the sea surface and depth (Wilson et al. 2006). Early acoustic tracking studies at NMP suggest that individual whale sharks may not necessarily behave in the same way in regard to vertical movement patterns. Acoustic tag data support understanding of the short-term movements and natural behaviour of whale sharks and provide information on swimming speeds, depth profiles and positions in relation to associated features in the surrounding water column and ocean floor. The in situ depth and temperature data collected by tags reveal much about the habits and habitats of whale sharks.

Acoustic tagging studies at NMP have shown the whale sharks are feeding while spending time in the area. Data retrieved from acoustic tags showed sharks were following ocean ridges where plankton accumulate, as well as the vertical migration of plankton to the surface at night.

Improvements in archival tagging technology have improved tracking studies and subsequently revealed whale sharks have a broader ecological range than first thought. Not only do they exploit coastal and epipelagic (0–200 m) zones, their vertical behaviour shows they also target mesopelagic (200–1000 m) and bathypelagic (>1000 m) zones – potentially detecting concentrations of prey in these layers or following olfactory trails leading to them (Rowat & Brooks 2012; Wilson et al. 2006).

Global studies of this type indicate that whale sharks do dive to depths within the mesopelagic zone and potentially dive to depths greater than 1500 m. Some tags are programmed to detach at a particular depth limit to prevent the tag being crushed, due to extreme pressures, and data being lost. Some individuals are reaching and even penetrating these limits, but those diving to these depths spend little time there. It is likely most time spent by individuals is within the epipelagic zone. Wilson et al. (2006) demonstrated that individuals tagged at NMP dived to depths of 980 m (limit of tags used) but greater than 40 per cent of the time was spent in waters less than 15 m deep and greater than 50 per cent at less than 30 m. Individuals also dived deeper during the day than at night and abrupt changes between day and night swimming patterns and deep dives often occurred at dawn and dusk (Wilson et al. 2006). In Belize this crepuscular diving has been linked to the influence of the lunar phases on the depth range, which corresponds with the timing of local snapper spawning events (Graham et al. 2006).

All studies show that vertical movement patterns of whale sharks are complex and differ between coastal and offshore locations. For example, at NMP whale sharks have been recorded targeting surface schools of the tropical krill *Pseudeuphausia latifrons* (Taylor 1994) during the day, while on the outer North West Shelf, where large numbers of *P. latifrons* have been captured, a whale shark

was tracked swimming at depth during the day. The depths to which whale sharks are diving show they can tolerate a wide range of temperatures to as low as 2.2°C. Their large body mass may allow for such deep diving by providing sufficient thermal inertia to avoid excessive heat loss.

The use of video cameras in recording short-term whale shark movements has provided further insights into whale shark behaviour. Early footage confirmed that whale sharks feed while at NMP and revealed they save energy when diving by using their negative buoyancy to glide during descents, while ascents were characterised by strong locomotory activity. Power requirements of ascents increased with the square of degrees pitch and were significantly greater than both level and descent swimming (Gleiss et al. 2009; Meekan M, 2012, pers. comm.).

All tagging studies have potential problems with the premature detachment of tags, due largely to the wide-ranging nature of this species. Whale sharks dive to depths where the pressure would crush tags and hence detachment mechanisms triggered by depth are used to prevent data loss. Tethered satellite tags have also been used but may become snagged, which has led to satellite tags being mounted directly onto the dorsal fin, however recent evidence has shown this type of attachment can disfigure dorsal fins (Rob D, 2012, pers. comm.).

In an attempt to overcome the problem of premature detachment of tags, researchers have been trialling the use of archival tags that remain on the sharks until they are retrieved by hand. This means they are not programmed to release at a particular depth nor require a long tether to allow data to be transmitted to satellites and so are more likely to remain attached to the shark for a year and even longer. Archival tags are small microprocessor-based data recorders that continuously record seawater temperature and hydrostatic pressure (depth). Since no other types of tags have remained on for an entire year, actual migration routes conducted by individuals returning to a location have not yet been documented. It is hoped that these archival tags will achieve this.

6.0 Faunal associations

Several species of fish including pilot fish (*Naucrates doctor* and *Gnathanodon speciosus*), remoras (*Remora* spp.), sharksuckers (*Echenei naucrates*) and cobia (*Rachycentron canadum*) (Colman 1997; Rowat & Brooks 2012) are often associated with whale sharks. Schools of pelagic fish such as tuna, bonito, mackerel and bait fish including sardines and anchovies are often seen accompanying whale sharks, likely feeding on the same prey organisms (Colman 1997).

Whale sharks have also been recorded in areas of high productivity with other filter-feeding species, such as mobulids including the giant manta (*Manta birostris*) off Baja California, Mexico (Wolfson 1987) and off the Zuytdorp Cliffs, north of Kalbarri, Western Australia (Colman 1997). Rowat & Brooks (2012) detail other records of mobulid species sighted with whale sharks including the reef manta (*Manta alfredi*), the shortfin devilray (*Mobula kuhlii*) and pygmy devilray (*Mobula eregoodootenkee*).

Whale sharks are seldom seen with other shark species although there have been reports of whale sharks swimming among schooling hammerhead sharks (*Sphyrna lewini*) off Baja California (Wolfson 1987) and tiger sharks (*Galeocerdo cuvieri*) off the Galapagos Islands (Arnbom & Papastavrou 1988). Whale sharks and basking sharks (*Cetorhinus maximus*) are rarely sighted together due to temperature separation between habitats (Rowat & Brooks 2012), however where warm currents

are deflected into cold water, such as Monterey Bay, California (Ebert et al. 2004) and off southern Brazil (Gadig 2007), sightings of these two species have been recorded.

Other animals associated with this species include parasitic copepods and several have been identified (Norman 2000; Rowat & Brooks 2012) but two species seem to be unique to them: *Prosaetes rhinodontis* and *Pandarus rhincodonicus* (Norman 2000).

7.0 Mortality

Anthropogenic mortality

The whale shark's habit of swimming on or near the surface make it susceptible to injuries caused by collisions with boats and propellers. Injuries from boat and propeller strikes are commonly recorded in photo ID libraries but there are limited data on the level of disturbance or mortality from boat traffic.

Whale sharks are slow growing and late maturing and are therefore potentially at risk from targeted fishing practices. Whale shark meat became a delicacy in Taiwanese restaurants in the early 1990s (Chen & Phipps 2002) and had a reputation as the world's most expensive shark meat: tofu shark. The main products traded include liver oil, meat, fins, cartilage, skin, stomach and intestines (Joung et al. 1996). The demand for tofu shark led to the consequent expansion of the Indian, Philippine and Taiwanese fisheries, all of which have proven to be short-lived (Rowat & Brooks 2012). Declining catch data indicated over-exploitation had been occurring and led to the closure of these targeted fisheries, the last being in Taiwan which closed in 2007.

Whale sharks are also taken in other areas as by-catch in net fisheries targeting other species such as tuna. Some purse-seine fisheries use whale sharks as an indicator of tuna presence and set nets around them (Iwasaki 1970), often leading to entanglement and damage to fishing gear. The level of mortality due to this type of fishing is uncertain, however records show that in some fisheries the individuals are in most cases released from the nets alive.

Natural mortality

It is not known how often attacks on whale sharks by other predators occur but it is most likely that natural mortality is highest in the early juvenile stages. Juvenile whale sharks have been recovered from gut contents of other predatory species and the large number of pups found in the Taiwanese female indicates a high potential mortality rate. Photographic identification studies (Speed et al. 2008a) have shown a high incidence of bite marks and scars, suggesting the species is subject to attacks from various other predators through their juvenile and adult stages. It is clear that many individuals survive attacks from predators such as other large sharks (Fitzpatrick et al. 2006) and killer whales (*Orcinus orca*) (O'Sullivan & Mitchell 2000).

Whale shark strandings have been reported from the Indian Ocean coast off South Africa and off both the Indian Ocean and Pacific coasts of Australia, but are few in number (only seven in Australia) and the cause is unclear (Beckley et al. 1997; Speed et al. 2008b).

Appendix 2 – Wildlife Conservation (Close Season for Whale Sharks) Notice 1996

WILDLIFE CONSERVATION ACT 1950

WILDLIFE CONSERVATION (CLOSE SEASON FOR WHALE SHARKS) NOTICE 1996

Made by the Minister under section 14 (2) (a).

Citation

1. This notice may be cited as the *Wildlife Conservation (Close Season for Whale Sharks) Notice 1996.*

Object of this notice

2. The object of this notice is to allow limited interaction between humans and whale sharks in State waters, while protecting whale sharks from disturbance and molestation, by setting out acceptable approach distances, etc., for vessels, swimmers and divers when in proximity to a whale shark, and to prevent some other activities that may disturb whale sharks.

Interpretation

3. (1) In this notice –

"contact vessel" means a vessel, and any tender vessel accompanying the vessel, within a contact zone,

"contact zone" means the area within a radius of 250 metres of any whale shark that is in State waters;

"whale shark" means the fauna *Rhincodon typus*.

(2) It is the responsibility of the person in charge of a vessel to comply with a requirement placed on that vessel by this notice.

Declaration of a close season

4. (1) Subject to clauses 5 to 14, a close season is declared in respect of whale sharks in all State waters.

(2) The close season is for the period commencing on the day on which this notice is published in the *Government Gazette* until the day on which this notice is cancelled or this clause is varied by a notice under section 14 (2) (b) of the Act,

Restriction on number of vessels in or near contact zone

5. (1) A vessel must not enter a contact zone if another vessel is in the contact zone.

(2) If a vessel is in a contact zone and a second vessel is within 400 metres of the relevant whale shark, any other vessels must maintain a distance of at least 400 metres from that whale shark.

Restriction on period in contact zone

6. A contact vessel must not remain in the same contact zone for longer than 90 minutes.

Restriction on vessel speed in contact zone

7. (1) Subject to subclause (2), a contact vessel must not exceed 8 knots in a contact zone.

(2) If, for reasons of safety, a contact vessel must exceed 8 knots in a contact zone, that vessel must leave the contact zone as soon as is practicable.

Proximity of contact vessel to whale shark

8. A contact vessel must at all times maintain a distance of at least 30 metres from the nearest whale shark.

Direction of approach

9. If swimmers or divers are to enter the sea from a contact vessel to view a whale shark, the contact vessel must approach a whale shark from the opposite direction of travel to the whale shark's direction of travel.

Physical contact with whale sharks prohibited

10. Subject to clause 12, a person must not touch or ride on, or attempt to touch or ride on, a whale shark.

Proximity of swimmers or divers to whale shark

11. Subject to clause 12, a person in the sea must at all times maintain a distance of at least:

(a) 3 metres from the head or body of a whale shark, when approaching a whale shark from any direction; and
(b) 4 metres from the tail of a whale shark, when approaching the tail from any direction.

Exception when authorized under the Act

12. Clause 10 and 11 do not apply to a person who is authorized under the Act to make physical contact with a whale shark, if that contact is in accordance with the authorization (e.g. *authorized under a scientific licence)*.

Motorized swimming or diving aids, and other aids, prohibited

13. (1) A person must not use a submersible motorized or otherwise powered swimming or diving aid in a contact zone.

(2) A person must not use any device capable of towing or carrying a person, that is towed behind a vessel in a contact zone.

Other taking, etc., of whale sharks prohibited

14. (1) A person must not capture, disturb, molest or take in any other way, a whale shark unless that person does so in accordance with this notice and the *Wildlife Conservation Act 1950*, or unless it is lawful for that person to do so –

(a) *under the Fish Resources Management Act 1994*; or

(b) *under the Conservation and Land Management Act 1984*.

(2) To the extent that this notice and the *Wildlife Conservation (Fauna of Ningaloo Marine Park) Notice 1992** are inconsistent, this notice prevails.

[*Published in Gazette of 17 July 1992 at p. 3388-9]

P.G. FOSS, Minister for the Environment

Appendix 3 – Whale shark wildlife interaction licence

Department of
Environment and
Conservation
Our environment, our future

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

Correspondence: Locked Bag 30
Bentley Delivery Centre WA 6983

RECEIPT NO. AMOUNT
$0.00

WILDLIFE CONSERVATION ACT 1950
REGULATION 15

WHALE SHARK INTERACTION LICENCE

THE UNDERMENTIONED PERSON MAY INTERACT WITH WHALE SHARKS SUBJECT TO THE CONDITIONS ENDORSED ON AND ATTACHED TO THIS LICENCE.

DIRECTOR GENERAL

CONDITIONS

1 THE LICENSEE MAY INCLUDE A VIDEOGRAPHER IN THE TOUR GROUP AND IF SO, THE VIDEOGRAPHER DOES NOT COUNT TOWARD THE TOTAL NUMBER OF PASSENGERS TO BE CARRIED ON THE VESSEL AND WILL BE CONSIDERED PART OF THE CREW. THE VIDEOGRAPHER MUST HAVE LAWFUL AUTHORITY THROUGH THE LICENSEE'S COMMERCIAL OPERATIONS LICENCE OR VIA THE VIDEOGRAPHER'S OWN COMMERCIAL OPERATIONS LICENCE.

2 THE LICENSEE SHALL COMPLY WITH ALL DIRECTIONS ISSUED TO HIM BY AN AUTHORISED OFFICER OF THE DEPARTMENT OF ENVIRONMET AND CONSERVATION IN RESPECT OF WHALE SHARK ACTIVITIES.

3 THE LICENCE SHALL COMPLY WITH THE PROVISIONS OF THE CONSERVATION AND LAND MANAGEMENT ACT AND REGULATIONS, THE WILDLIFE CONSERVATION ACT AND REGULATIONS, CLOSE SEASON FOR WHALE SHARKS NOTICE 1996 AND ALL MARINE LEGISLATIVE PROVISIONS WHICH RELATE TO OPERATIONS AT SEA.

4 THE LICENSEE SHALL ENSURE RECORDS OF WHALE SHARK SIGHTINGS INCLUDING NUMBERS, DIRECTION OF TRAVEL AND LOCATION, THE NUMBER OF DAYS OPERATED AT SEA & THE NUMBER OF PASSENGERS CONVEYED ARE MAINTAINED ON A DAILY BASIS AND SUBMITTED TO THE DEC EXMOUTH OFFICE AT TWO(2) WEEKLY INTERVALS DURING THE OPERATION OF THE LICENCE, FOR THE LICENCE ACTIVITIES CONDUCTED DURING THE PREVIOUS TWO(2) WEEKS.

5 THE LICENSEE SHALL ENSURE THAT ALL DUE CARE IS TAKEN TO AVOID STRESSING OR INJURING WHALE SHARKS AND INTERACTION OPERATIONS ARE TO CEASE IMMEDIATELY IF ANY STRESS OR INJURY IS APPARENT.

6 THE LICENSEE SHALL FURNISH TO THE DIRECTOR GENERAL, ON THE EXPIRATION OF THIS LICENCE, A RETURN SHOWING FULL DETAILS OF THE RECORD OF OPERATIONS FOR THE TERM OF THIS LICENCE.

7 THIS LICENCE IS ISSUED SUBJECT TO ANY OTHER LICENCE, PERMIT OR OTHER REQUIREMENTS PURSUANT TO THE CONSERVATION AND LAND MANAGEMENT ACT 1984.

8 THIS LICENCE SHALL BE DISPLAYED IN A PROMINENT POSITION ON THE VESSEL SPECIFIED ON THIS LICENCE AND CANNOT BE TRANSFERRED FROM ONE VESSEL TO ANOTHER.

9 ALL VESSEL SKIPPERS OPERATING UNDER THE AUTHORITY OF THE LICENSEE HAVE BEEN DETERMINED TO BE ACTING AS AN AGENT OF THE LICENSEE AND SO ARE BOUND BY ALL CONDITIONS OF THIS LICENCE.

10 FURTHER CONDITIONS ARE ATTACHED.

SPECIES WHALE SHARK
(Pisces)

PURPOSE CONDUCT WHALE SHARK INTERACTION TOURS FROM THE VESSEL SPV794 WITHIN NINGALOO MARINE PARK

WILDLIFE CONSERVATION ACT 1950

WILDLIFE CONSERVATION REGULATIONS 1970

REGULATION 15 WHALE SHARK INTERACTION LICENCE

FURTHER CONDITIONS (9 to 13) RELATING TO LICENCE NUMBER _____

9 GENERAL

9.1 Whale Shark interactions authorised by this licence are limited to daylight hours only. (Research and special licences may be considered for night hours study.)

9.2 The licensee shall make available on request a position on their licensed vessel for a Department of Parks and Wildlife (DPaW) employee to monitor licence activities.

10 CONTACT ZONES

An exclusive contact zone of radius 250 metres applies around any Whale Shark and all vessel operations are restricted in such zones in accordance with the conditions of this licence.

The first licensed vessel to encroach within a Whale Shark's 250m radius contact zone and raises its Whale Shark flag will be deemed to be "in contact" with a Whale Shark.

10.1 The licensee and vessel skipper shall not operate within the exclusive contact zone when another licensed vessel is in contact with the whale shark unless doing so in compliance with contact transfer conditions 11.1 (i) to 11.1 (vi).

10.2 The licensee and vessel skipper may queue to have access to the shark by maintaining a minimum distance of no less than 250m from the contacted shark.

10.3 At no time shall the licensee and vessel skipper allow their vessel or its tender to exceed 8 knots within 250m of a Whale Shark or a vessel in contact with a Whale Shark

10.4 The licensee and vessel skipper shall not at any time allow their vessel or its tender to come closer than 30m to a Whale Shark

10.5 The licensee and vessel skipper shall ensure that their vessel spends no more than 90 minutes "in contact" with a Whale Shark (i.e. within the exclusive contact zone), and shall ensure that swimmers from its licensed vessel spend no more than 60 minutes in the water with the Shark from the time of first entry into the water.

10.6 The licensee and vessel skipper shall at all times have their Whale Shark Flag displayed in a clearly visible location on their vessel when “in contact” with a Whale Shark.

10.7 The licensee and vessel skipper shall not display their Whale Shark Flag when their vessel is not in contact with a whale shark.

10.8 Where two licensed vessels are within 250m of each other and a Whale Shark is sighted within 250m of both licensed vessels, the first licensed vessel that raises its Whale Shark flag is deemed to be the vessel in contact. The licensee and vessel skipper of the other vessel must immediately move to the closest point outside the contact zone without exceeding 8 knots.

10.9 In the event that two (2) or more licensed vessels “in contact” with Whale Sharks close to within 250 metres of each other the licensee and skipper of the “in contact” vessels shall cooperate with each other to ensure the safety of all swimmers and the Whale Sharks.

11 CONTACT TRANSFER TO ANOTHER LICENSED VESSEL

11.1 Where the skipper of a licensed vessel in contact with a Whale Shark wishes to transfer contact to another licensed vessel condition 10.1 is temporarily suspended. To transfer contact both skippers must comply with all contact transfer conditions 11.1(i) to 11.1 (vi) and in the following sequence:

11.1(i) When the licensed vessel “in contact” with a Whale Shark is about to conclude interaction operations, the skipper may initiate “contact transfer” of the Whale Shark to a second vessel.

11.1(ii) "Contact transfer" can only be initiated if the skipper of the "in contact" vessel formally invites the second vessel into contact zone via UHF radio.

11.1(iii) The skipper of the "in contact" vessel shall retrieve any swimmers in the water and must not deploy any additional swimmers once the second vessel has been invited into the contact zone.

11.1(iv) When the second vessel is formally invited into the contact zone the skipper may enter the contact zone, and the Whale Shark contact flag must be raised once the Whale Shark is sighted.

11.1(v) The skipper of the second vessel must not deploy any swimmers until after they have sighted the Whale Shark and raised their whale shark flag.

11.1(vi) During the process of contact transition two vessels may temporarily be located within the contact zone. The licensed vessel originally in contact must exit the contact zone directly and without delay once all swimmers have returned safely to the vessel.

12 LICENSED VESSELS AND THEIR DIVING TENDERS

12.1 The licensee shall ensure that its licensed vessel and tender only approach Sharks from ahead of the Shark's direction of travel and shall not drop swimmers and crew spotter into the water closer than 30 metres from the Shark.

12.2 The licensee shall ensure that its licensed vessel, its tender, crew and swimmers do not block, obstruct or interfere with the natural movement of Whale Sharks.

12.3 The licensee shall ensure that its licensed vessel clearly displays a dive flag (International Code Flag "A") when swimmers are in the water and shall maintain UHF or marine VHF radio contact with other approaching vessels to advise that swimming interactions are in progress.

13 SWIMMERS (DIVERS/SNORKELERS)

13.1 The licensee shall caution swimmers that Whale Sharks can inflict serious injury if it strikes a swimmer.

13.2 The licensee shall ensure swimmers do not touch, or ride on, or attempt to ride on a Whale Shark at any time and that the swimmers maintain a minimum distance of at least 3 metres from the head or body of a Whale Shark and 4 metres from its tail.

13.3 The licensee shall ensure swimmers and crew (including a permitted videographer/photographer associated with a licensed operation) do not undertake flash photography or use strobe lights or continuous lights for photography.

13.4 The licensee shall ensure swimmers and crew do not use a submersible motorized or otherwise powered swimming or diving aid in a contact zone.

13.5 The licensee shall ensure swimmers and crew do not use any device capable of towing or carrying a person that is towed behind a vessel in a contact zone.

13.6 The licensee shall ensure that the number of persons in the water at any one time with a Whale Shark shall not exceed ten (10) passengers excluding one (1) crew spotter and one (1) videographer. Companions of companion card holders will be included in this limit of ten (10) persons in the water with a Whale Shark at all times.

FURTHER CONDITIONS END

Appendix 4 – Commercial operations licence

SCHEDULE 2 COMMERCIAL OPERATIONS LICENCE CONDITIONS

DEFINITIONS

In this schedule of licence conditions, unless the context otherwise requires, the following words and terms have the meanings ascribed:

Act means the *Conservation and Land Management Act 1984*.

Approved vessel means the vessel nominated by the Operator to carry out the Operations and which has been approved by the Director General, or his Delegate.

CALM Land means land, or land and waters, to which the Act and Regulations apply, and includes caves and parts of caves on or under that land.

Companion Card holder means Passengers who hold a Companion Card® issued within Australia and who can present the card while on a Whale shark interaction tour.

Companion means a Passenger who is accompanying a Companion Card holder.

DPaW Whale Shark Interaction Training course means the training course provided by DPaW for which a certificate of completion is issued upon completion.

DPaW means the Department of Parks and Wildlife.

Delegate means a person employed by DPaW to whom a function of the Minister has been delegated under section 133(1) of the Act, or a person employed by DPaW to whom a function or functions of the CEO has or have been delegated under section 133(2) of the Act, as the case requires, or the District Manager where stated in these conditions.

Director General means the chief executive officer (CEO*) of DPaW (the department assisting the Minister in the administration of the Act), or a delegate of the CEO.

District Manager means the DPaW Exmouth District Manager.

EMS means an electronic monitoring system approved by the Director General, or his Delegate.

Fees means those fees payable in respect of entry onto CALM land or in respect of Operations conducted on CALM land, as specified in the Regulations and any other fees that the CEO has the power to levy.

Free-of-charge Passenger (FOC) means a Passenger for whom a licence charge has been waived by the Director General, or his Delegate by means of a 'free-of-charge' application form.

FOC application form means a form approved by the Director General, or his Delegate, which is to be used by the Operator to validate each FOC Passenger's position on the tour.

Licence means a commercial operations licence granted by the Director General, or his Delegate under the Regulations and includes all conditions on and attached to the licence.

Marine park means the Ningaloo Marine Park.

Minister means the Minister administering the Act, or a Delegate of the Minister.

Observer means those Passengers who are not Whale shark interaction swimmers.

Operator means a person or an incorporated body who holds a commercial operations licence.

Operations means the commercial Operations which may be undertaken by an operator pursuant to the Licence.

Paying Passenger means all Passengers except approved FOC Passengers, Repeat Passengers, Observers and Passengers und.

Passenger means those persons who are provided Operations by the Operator.

Reasonable extent may be determined by, but is not limited to, the following principles, and may be amended from time to time:

- That the Operator demonstrates that Whale shark interaction tours have been offered and the Operator is available to accept bookings for at least 50% of the paying season each year.
- That the licence holder is actively promoting Whale shark interaction tours to be available during the paying season demonstrated by the use of promotional material distributed within Exmouth or other markets and an easily available retail and/or wholesale booking system.
- Valid reasons for non-operation could include:
  - Adverse weather conditions that present a safety risk to Passengers;
  - Major breakdown of vessel or equipment; or

- Absence of whale sharks in the Ningaloo Marine Park for the duration of the paying season.

Regulations means the *Conservation and Land Management Regulations 2002* made under the Act.

Repeat Passenger means a Passenger who holds a 'whale shark experience' ticket from a ticket book issued to the licence holder during that calendar year.

Substitute vessel means any other vessel nominated by the Operator, to be used in place of the Approved vessel, to carry out the Operations.
Tender means any auxiliary vessel used as a part of the operation other than the Approved vessel or Substitute vessel when these vessels are the primary vessel.

Valid certificate means a DPaW Whale Shark Interaction Training certificate that is no more than five year old and which is relevant to the current Whale Shark Interaction Training Course syllabus. Updates or changes to the course syllabus will occur from time to time, which may invalidate otherwise valid certificates. Whether a certificate affected by a change in the course syllabus is deemed to be invalid or not will be subject to the discretion of the District Manager, who will take into consideration, the significance of the change to the course syllabus and the remaining time the certificate has to run.

Whale shark interaction tour means any tour where a Passenger enters the water whilst in the contact zone (contact zone meaning the same as specified in the wildlife interaction licence).

Whale shark interaction swimmer means any Passenger who undertakes in water interaction with a whale shark during the operation.

Whale shark number means a letter allocated in sequential order to each unique whale shark sighted during a whale shark interaction tour.

*** Note.** A reference to the 'CEO' in the Regulations is deemed to be a reference to the Director General of the Department and any reference on any documents, brochures or signs to the Department of Conservation and Land Management is deemed to be a reference to the Department of Parks and Wildlife in accordance with the general transitional provisions in the *Machinery of Government (Miscellaneous Amendments) Act 2006*.

INTERPRETATION

a. A reference to anything that the Operator must or must not do includes, where the context permits, the Operator's employees, agents, contractors and Passengers.

b. The singular includes the plural and vice versa.

c. A reference to any thing is a reference to the whole or any part of it and a reference to a group of things or persons is a reference to any one or more of them.

d. If the Operator consists of a partnership or joint venture, then:

   i. an obligation imposed on the Operator binds each person who comprises the Operator jointly and severally;
   ii. the act of one person who comprises the Operator binds the other persons who comprise the Operator; and
   iii. a breach by one person who comprises the Operator constitutes a breach by the Operator.

e. A reference to a statute, ordinance, code or other law includes regulations and other instruments under it and consolidations, amendments, re-enactments or replacements of any of them.

f. If a word or phrase is defined, other grammatical forms of that word or phrase have a corresponding meaning.

g. If the word "including" or "includes" is used, the words "without limitation" are taken to immediately follow.

LICENCE CONDITIONS

These conditions are subject to the *Conservation and Land Management Act 1984*, *Conservation and Land Management Regulations 2002, Wildlife Conservation Act 1950* and *Wildlife Conservation Regulations 1970* and are to be read in conjunction with the regulation 15 wildlife interaction licence issued in conjunction with this licence.

STANDARD OPERATING CONDITIONS

1. The Operator shall comply with and not contravene the conditions and restrictions set out in the Commercial Operator Handbook – Marine and the Commercial Operator Handbook – Terrestrial as varied from time to time by the Director General, or his Delegate.
2. The Operator acknowledges and agrees this Licence is not issued as of right and upon expiry the Operator acknowledges that the licence renewal may be subject to a competitive application process.
3. The Operator acknowledges and agrees that this Licence is not transferable and that the Operator shall explain to prospective purchasers of the business that the prospective purchasers would be required to make an application to the Director General, or his Delegate to obtain a replacement licence to continue the Operations.

4. The Operator shall maintain throughout the term of the Licence a wildlife interaction licence for whale sharks in accordance with the *Wildlife Conservation Act 1950* and *Wildlife Conservation Regulations 1970* (regulation 15) to conduct Whale shark interaction tours.

5. The Operator's name and licence number is to be clearly displayed on all promotional material distributed by the Operator or by any retailer (e.g. visitor centres, retailers dealing directly with the Operator and other commercial operators).

USE OF VESSELS

6. The Operator shall nominate one vessel to be the Approved vessel for the operation of the Licence and this vessel shall be approved by the District Manager before use.

7. The Operator shall ensure that the Approved vessel (or Substitute vessel if in use) is under the command of an appropriately qualified skipper for the period of the Licence. The Director General, or his Delegate may request evidence of this from time to time and the Operator will supply this on demand.

8. The Operator may nominate a Substitute vessel to be used during the operation of the Licence in the event that the Approved vessel is unavailable. The Operator shall apply in writing to the District Manager and shall include the length of time the Substitute vessel is planned to be used, the length and draft of the Substitute vessel and the Substitute vessel's SPV number. If approved this vessel shall be the Substitute vessel.

9. The Operator shall notify the District Manager in writing immediately when the Approved vessel resumes Operations. Should the Substitute vessel be required for a period exceeding the dates referred to in condition 8, the Operator shall re-apply for permission to extend.

10. The Operator shall ensure that the Approved vessel is wholly or partially owned or leased by the Operator. Should the Director General or his Delegate require verification of this, the Operator shall provide the relevant documentation within two weeks of the request.

11. The Operator shall not use any vessel as the Approved vessel or Substitute vessel if the vessel is to be used by another Whale shark interaction tour operator at that time.

12. Subject to the Approved vessel's (or Substitute vessel's, if in use) survey requirements, the Operator shall not carry more than twenty three (23) Passengers on the Approved vessel (or Substitute vessel if in use) during any Whale shark interaction tour, provided that no more than twenty (20) of the Passengers are Whale shark interaction swimmers.

13. Passengers under the age of 6 who are not Whale shark interaction swimmers, and Companions are not to be considered part of the maximum twenty three (23) Passengers or the maximum twenty (20) Whale shark interaction swimmers, as referred to in condition 12, on the Approved vessel (or Substitute vessel if in use) during any Whale shark interaction tour.

RECORDS OF OPERATION

14. The Operator shall allow EMS to be installed in and operated on the Operator's Approved vessel and shall ensure the EMS remains operational throughout the period from 1 March to 31 July each year.

15. The Operator shall operate the EMS for all Whale shark interaction tours conducted or as directed by the Director General or his Delegate, and shall notify DPaW if conducting tours before 1 March or after 31 July.

16. The Operator shall ensure that accurate data is input into the EMS for each Passenger, each Whale shark interaction tour and each whale shark interaction, or if directed by the District Manager, for every whale shark interaction tour throughout the year.

17. The Operator shall not interfere with or disconnect any EMS equipment provided and installed on the Operator's nominated vessel or substitute vessel without the permission of the Director General, or his Delegate, except in an emergency.

18. The Operator shall notify the DPaW Exmouth District office within 24 hours of any fault or condition occurring, that has caused or may cause a malfunction or damage to the EMS equipment, or of any emergency or incident that has necessitated interference with or the disconnection of the EMS equipment, or which has interfered with the communication of data from the EMS.

19. In the event of any failure or damage to the EMS equipment, or to facilitate maintenance of such equipment, the Operator shall make the vessel available at the next destination port to enable DPaW to install, maintain, replace or remove the EMS equipment or components of it, as required by the Director General, or his Delegate.

20. In the event of any failure or damage to the EMS equipment, or failure of transmission of data, the Operator shall manually make and preserve a full record of Operations during that period indicating, on a daily basis and in a form approved by the Director General, or his Delegate, details of:

    a) GPS location and start and finish times of interaction, the size and sex of whale sharks, the direction the whale shark is travelling, who the whale shark was handballed to, the number of adult, child, Observer, FOC and Repeat Passengers on board and all whale shark experience ticket numbers issued for all whale shark trips undertaken throughout the year, not just the paying season; and
    b) The Operator shall make this record available to the Director General or his Delegate on request and shall supply a copy of the record of Operations to the DPaW Exmouth office fortnightly, following the failure/damage of the EMS equipment or as required. The Operator may only use the manual log system until such time as the EMS is repaired or replaced and shall make all reasonable efforts to ensure the EMS is made operational at the earliest opportunity.

21. The Operator shall make the Approved vessel available for EMS installation and reinstallation upon request of the Director General, or his Delegate.

22. Before the end of a whale shark interaction tour, the Operator shall ensure that each Paying Passenger is issued with a whale shark experience ticket appropriate to the passenger's age group. A Ticket must be issued for each day or part thereof that the Passenger spends on a Whale shark interaction tour conducted by the Operator. The Operator shall ensure

that each ticket is issued from a ticket book allocated to the Operator for that year, is validated as required by the Director General and the number of each ticket is inputted into the EMS.

FEES AND CHARGES

23. The Operator shall pay for all costs associated with the installation of the EMS including but not limited to installation, reinstallation, aerial, weather protection, screens and any other additional equipment required by the Operator.

24. The Operator agrees that the Operator is responsible for the cost of all damage, maintenance or replacement of the EMS that is caused by the Operator's negligence or action including failure to appropriately protect the EMS from weather, water or other factors that may cause damage to the EMS. The Operator shall not be responsible for the repairs, maintenance or replacement due to manufacturer faults or general wear and tear of the EMS.

25. Should the Operator choose to install the EMS itself at the commencement of each season, the Operator shall make the EMS available to DPaW to undertake the annual reinstallation service and shall be responsible for the cost of service or repairs caused by faulty self-installation or installation not in accord with the manufacturer's instructions as well as any labour costs incurred in repairing or rectifying a faulty installation by an Operator.

26. In consideration for the Licence, the Operator shall pay to the Director General or his Delegate a licence charge that may be reviewed and amended on an annual basis (all charges in relation to the Licence are GST exempt). The Operator shall pay to the Director General, or his Delegate:
    a) a licence charge of $25.00 per adult per day and $12.50 per child between the ages of 6 and 16 per day for all Paying passengers carried during the operation of the Licence during any Whale shark interaction tour conducted in the period1 April to 28 June 2012, 1 April to 12 July 2013 and from 2014, during the period 1 January to 31 December in each year, until the expiry of the Licence. Such charges are payable on the date specified by the Director General, or his Delegate on the annual invoice;
    b) an annual (non-refundable) deposit on these charges equivalent to 50 adult Paying passengers on or before 31 March for each calendar year of the Licence. This deposit will be deducted from the amount payable under condition26 (a) and is the minimum annual licence charge payable; and

27. At DPaW's expense, and subject to it providing the Operator with seven (7) days written notice, DPaW may at any reasonable time arrange for a complete audit to be made of all returns and information that the Operator has provided pursuant to condition 26 against the Operator's business records. However, if such audit discloses that the appropriate Fees and charges have been understated by the Operator by more than two per cent (2%) against the returns tendered, then the Operator shall pay to DPaW the full cost of the audit along with the balance of any shortfall, within 30 days of the notification of the shortfall by the Director General, or his Delegate.

28. The Operator shall notify the Director General, or his Delegate of the Operator's date of completion for Whale shark interaction tours and within two weeks of the completion date the Operator shall return to the Director General, or his Delegate (via DPaW Exmouth district office) all unused whale shark experience tickets. The amount payable under condition 26(a) will be calculated by determining the difference between the number of tickets issued and the number of tickets returned.

MANAGEMENT OF FOC PASSENGERS & PASSENGERS UNDER THE AGE OF 6

29. The Operator shall maintain a FOC application form on the vessel for all FOC Passengers on a Whale shark interaction tour. The Operator shall use the FOC form to validate each FOC Passenger's position on the tour and shall present this form to an authorised officer upon request. If the Operator fails to produce the form when requested to do so by an authorised officer, or fails to complete the form in respect of each FOC Passenger, then they shall be deemed to be Paying Passengers for the purpose of licence charges.

30. Passengers under the age of 6 shall be recorded in the EMS or logbook under number of Passengers.

WILDLIFE INTERACTIONS

31. The Operator shall limit in-water whale shark interactions to snorkelling only. SCUBA diving or any type of compressed air diving during whale shark interactions is prohibited.

32. The Operator shall ensure that the Approved vessel (or Substitute vessel if in use) clearly displays a 'diver below' flag in the form of the international maritime signal flag 'A', and a 'whale shark' flag of a design approved by the Director General, or his Delegate to indicate when swimmers are in the water and when they are in contact with a whale shark.

33. The Operator shall ensure that every boat-based employee has successfully completed the DPaW Whale Shark Interaction Training course within 2 months of commencing their employment with the Operator, and the Operator shall ensure that all boat-based employees continue to hold a Valid certificate for the term of their boat-based employment.

34. The Operator shall display the whale shark interaction guidelines poster on the Approved vessel (or Substitute vessel if in use) at all times when conducting Whale shark interaction tours.

35. For the purposes of the wildlife interaction licence, all Passengers shall be included in the maximum of 10 Passengers allowed in the water during a whale shark interaction.

FILMING AND PHOTOGRAPHY

36. The Operator shall only use or allow on-board, a videographer, who is not an employee, agent or contractor of the Operator, who has lawful authority by way of a commercial operations licence to conduct this activity in the park.

37. The Operator may conduct filming and photography in the Ningaloo Marine Park in relation to activities allowed under this Licence with copyright privileges of all images being retained by the copyright owner.

38. Film footage or images taken of whale shark interactions during whale shark interaction tours shall be provided to DPaW every fortnight during the period that whale shark interaction tours are being conducted. Where possible, such film footage

or images shall include the rectangular area on the left hand side and/or right hand side of the whale shark incorporating the required photo identification reference points (top and bottom of fifth gill slit and trailing edge of pectoral fin), and any scarred or tagged areas. The footage or images shall be labelled with the date they were taken and the whale shark number. DPaW shall provide the media and meet the cost of transferring the images and/or film footage from the Operator to DPaW.

39. Images or film footage provided to DPaW under condition 38 may be used in DPaW's whale shark photo identification program and other whale shark identification research programs operating under a Regulation 17 Scientific Licence issued by DPaW pursuant to the *Wildlife Conservation Regulations 1970,* for the purpose of whale shark identification. Such images or film footage cannot be used for any other purpose without the written consent of the copyright owner and payment of associated charges if required.

40. The Operator shall attend an information session with the Exmouth District prior to undertaking any whale shark filming or photographic activity, unless otherwise exempted from this requirement by the District Manager.

41. The Operator shall ensure the following messages are conveyed in the narrative of any film containing whale shark images and footage produced under this Licence:

    a) Ningaloo Marine Park managed by DPaW, provides for the protection of whale sharks and their habitats during their annual occurrence at Ningaloo Marine Park.
    b) DPaW manage the whale shark tourism industry through a licensing program that primarily protects whale sharks from inappropriate tourism interactions whilst providing opportunities for visitors to have a sustainable "whale shark experience".

42. The Operator shall provide a copy of the final film product or any scientifically important unedited sequence to DPaW, if requested to do so by the District Manager. The cost of copying or transferring film product, film footage or images in accordance with such request will be met by DPaW.

43. The Operator shall comply with any request by the District Manager to preview the final film product to ensure that the DPaW policies, objectives and regulations have been met, prior to the distribution or public release of the final film product.

44. Where in DPaW's opinion, any photographs or film product produced under this Licence are likely to increase public appreciation of the cultural or natural environment, the Director General, or his Delegate may require that the Operator acknowledges the contribution of DPaW in any credits attached to the photograph or film product by the inclusion of the statement "Produced with the assistance of the Department of Parks and Wildlife".

SUSTAINABILITY CONDITIONS (These conditions may vary depending on the commitments made by the licence holder in their response to the sustainability selection criteria but relate to the following headings)

SUSTAINABILITY AUDITING

45. The Operator agrees to comply with all requirements of the expression of interest EOI 243 2008 and all commitments made in its submission and subsequent negotiations with DPaW.

46. The Operator acknowledges and agrees that it will be annually audited against sustainability conditions here on and on compliance with these sustainability licence conditions and with commitments made in its submission to (and subsequent negotiations involved in) the expression of interest process and these licence conditions.

47. The Operator shall pay for the cost of the annual audit which includes all costs including time spent to prepare, conduct, report on and follow up the Operator's audit as well as the auditor's travel and accommodation costs divided by the total number of Operators being audited. This amount will be invoiced by DPaW and the Operator shall pay the invoice on the date specified by the Director General on the invoice.

48. The Operator shall keep and make available records or other proof to demonstrate compliance with licence conditions to the auditor at the annual audit or to DPaW on request.

49. ACCREDITATION
50. MAINTENANCE OF NATURAL ECOLOGY
51. GREENHOUSE GAS EMISSIONS
52. SOLID WASTE PRODUCED DURING TOUR
53. NON-RENEWABLE ENERGY CONSUMED
54. ENVIRONMENTAL STEWARDSHIP IN COOPERATION WITH DPaW
55. REDUCED VEHICLE USE
56. FUEL AND CHEMICAL STORAGE, HANDLING, SPILL PROCEDURES
57. NOISE
58. INVOLVEMENT OF INDIGENOUS PEOPLE
59. CULTURALLY SENSITIVE BEHAVIOUR
60. INTERPRETIVE MATERIAL
61. SAFETY EQUIPMENT AND PROCEDURES
62. VISITOR FEEDBACK
63. MARKETING MATERIAL
64. SUPPORTING LOCAL BUSINESSES
65. MEMBERSHIP OF LOCAL ASSOCIATIONS
66. UNIVERSAL DESIGN AND ACCESS

Appendix 5 – DPaW whale shark interaction log sheet

Department of Environment and Conservation

Our environment, our future

Whale Shark Interaction Log

WSL	Date

Vessel	Tour / Start time	Number of passengers	Paying: Adults	Paying: Children	Other: Child under 6 yrs	Other: FOC	Other: Repeat	Whale Shark Experience pass	Pass number: From	Pass number: To
Recorder	**Finish time**									

SHARK	Position: Latitude Deg.	Min.	**Sec.**	Longtitude Deg.	Min.	Sec.	Shark Observations: Size	Sex	Direction	Contact information: Contact number	1	2	3	4	5	6	7	8	9	10
A										Start time										
										End time										
										Handballed										
B										Start time										
										End time										
										Handballed										
C										Start time										
										End time										
										Handballed										
D										Start time										
										End time										
										Handballed										
E										Start time										
										End time										
										Handballed										
F										Start time										
										End time										
										Handballed										

The vessel did not sail today due to:

☐ No bookings ☐ Vessel breakdown (maintenance) ☐ Poor weather ☐ Day off ☐ Other, please specify _____

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Appendix 6 – Inventory of ongoing current whale shark research and monitoring programs

INVENTORY OF CURRENT WHALE SHARK RESEARCH AND MONITORING PROGRAMS

WSCO – DPaW Whale Shark Conservation Officer

Field of study	Study method	Title	Description/objective/purpose	Organisation	Contact person	Status	Timeline	Report/paper produced
Population studies	Photo ID	DPaW whale shark photo ID monitoring program	To monitor variability in whale shark numbers through collection of industry footage for processing and cataloguing to compile images for photo ID analysis – images provided to AIMS, ECOCEAN and HSWRI. DPaW now undertakes ECOCEAN photo ID analysis	DPaW	WSCO	Ongoing	2005 to present	Data presented in DPaW whale shark annual report
Population studies	Photo ID	ECOCEAN whale shark photo ID library	To monitor whale shark populations	ECOCEAN	Brad Norman	Ongoing	1995 to present	Yes Holmberg et al. (2009)
Population studies	Photo ID	AIMS whale shark photo ID library	To monitor whale shark populations	AIMS	Mark Meekan	Ongoing	2005 to present	Yes Bradshaw et al. (2008)
Population studies	Operator EMS data collection	Number of whale shark contacts per year	Monitoring of whale shark contact variability through operator data	DPaW	WSCO	Ongoing	1995 to present	Data presented in DPaW whale shark annual report
Population studies	Aerial monitoring	Monitoring of whale shark sightings per flight using spotter pilot logsheet records	Monitoring of whale shark sighting variability through pilot records using search effort	DPaW	WSCO	Ongoing	2002 to present	Data presented in DPaW whale shark annual report
Impacts of tourism pressure	Photo ID/tourism Pressure	Does love hurt? A study of inter-annual ecotourism impacts on whale sharks at Ningaloo Reef, Western Australia	Determine potential long-term impacts of tourism on return rates of whale sharks using photo ID	UWA/AIMS	Robert Sanzogni/Mark Meekan	Honours thesis	2011–12	Unpublished thesis

Movement patterns	Tagging	Whale shark movement patterns	Monitoring of horizontal and vertical movement patterns using archival tags	AIMS	Mark Meekan	Ongoing	2003 to present	Technical report produced annually
Movement patterns	Tagging	Whale shark movement patterns	Monitoring of horizontal and vertical movement patterns using archival tags	HSWRI	Brent Stewart	Ongoing	2008 to present	Technical report produced annually
Movement patterns	Tagging	Whale shark movement patterns	Monitoring of return and residency rates using acoustic tags and arrays	ECOCEAN	Brad Norman	Ongoing	2011 to present	No
Genetics	DNA tissue sampling	Indian Ocean study to determine differences between aggregations	Monitoring of whale shark DNA tissue samples to determine differences in Indian Ocean aggregations	AIMS	Mark Meekan	Ongoing	2003 to present	No
Genetics	DNA tissue sampling	Genetic profiling of photo ID library sharks	Opportunistic tissue samples to create genetic profiles of sharks in ECOCEAN photo ID library	ECOCEAN	Brad Norman	Ongoing	?	No
Genetics	DNA tissue sampling	Parentage analysis		AIMS	Mark Meekan	Ongoing	2003 to present	No
Genetics	Parasite DNA analysis	Indian Ocean whale shark parasite DNA tissue sample analysis	Indian ocean study to determine differences between aggregations	AIMS	Mark Meekan	Ongoing	?	No
Impacts of tourism pressure	Crittercams	Whale shark behaviour and changes under interaction pressure	Monitoring of whale shark behaviour and impacts of tourism pressure on behaviour using crittercams	ECOCEAN	Brad Norman	Ongoing	2011 to present	No
Impacts of tourism pressure	Crittercams	Whale shark behaviour and changes under interaction pressure	Monitoring of whale shark behaviour and impacts of tourism pressure on behaviour using crittercams	AIMS	Mark Meekan	Ongoing	2007 to present	No
Impacts of tourism pressure	Daily Diary Tags	Whale shark behaviour and changes under interaction pressure	Monitoring of whale shark behaviour and impacts of tourism pressure on behaviour using Daily Diary tags	ECOCEAN	Brad Norman	Ongoing	2010 to present	No

Impacts of tourism pressure	Aerial monitoring	Aerial behavioural Program	Three-year study to monitor effectiveness of DPaW whale shark code of conduct 2007–09	DPaW	WSCO	Data awaiting analysis and reporting	2007–09	No
Environmental	Aerial monitoring	Aerial spatial program	Data collected through spotter pilots 2006–10 – track and waypoint data – looking at finer-scale movements of whale sharks along Ningaloo Reef in conjunction with AIMS oceanographic data	DPaW/AIMS	WSCO	Data awaiting analysis and reporting	2006–2010	No
Environmental	Plankton sampling	Indian Ocean zooplankton study	Monitoring of zooplankton abundance throughout Indian Ocean aggregation sites to determine links with whale shark abundance		Rowena White	Ongoing	2012–13	No
Environmental	?	Climate change impacts	Study to determine impacts of climate change on whale shark aggregations	AIMS	Mark Meekan	Ongoing	?	No
Tourism pressure	Operator EMS data collection	Number of interacting passengers/tours per year as a measure of tourism pressure	Monitoring of tourism pressure through operator data	DPaW	WSCO	Ongoing	1995 to present	Data presented in DPaW whale shark annual report
Ecology	Stereo-videography	Monitoring of accurate size/growth rates	Monitoring of accurate size using stereo-videography	ECOCEAN	Brad Norman	Ongoing	2011 to present	No
Ecology	Stereo-videography	Monitoring of accurate size/growth rates	Monitoring of accurate size using stereo-videography	AIMS	Mark Meekan	Ongoing	?	No

GLOSSARY

Barbel:	the slender, whisker like tactile organ near the mouth
Caudal:	from Latin caudum; tail
Cerebellum:	Latin for little brain
Chemoreception:	the physiological response of a sense organ to a chemical stimulus
Clasper:	male anatomical structure found in all sharks, rays and skates used for mating
Copepod:	group of small crustaceans found in the sea and nearly every freshwater habitat
Corpus:	a structure in the brain
Crepuscular:	active during dawn and dusk
Dermal denticle:	placoid scales found in the cartilaginous fishes
Elasmobranch:	any of numerous fishes of the class Chondrichthyes, characterised by a cartilaginous skeleton and placoid scales and including the sharks, rays and skates
Erythrocytes:	red blood cells
Fauna:	all of the animal life of any particular region or time
Flora:	all of the plant life of any particular region or time
Fusiform:	widest in the middle and tapering to the ends
Haplotype:	a combination of alleles (DNA sequences) at adjacent locations (loci) on the chromosome that are transmitted together
Intromission:	sexual intercourse
Isotope:	variants of a particular chemical element
Mitochondrial DNA:	DNA located in organelles called mitochondria, structures within eukaryotic cells that convert the chemical energy from food into a form that cells can use
Monoandry:	the practice of having one mate at the same time
Morphology:	the study of the form and structure of organisms and their specific structural features

Natal:	the homing process by which some adult animals return to their birthplace to reproduce
Nekton:	the aggregate of actively swimming aquatic organisms in a body of water (usually oceans or lakes) able to move independently of water currents
Olfaction:	sense of smell
Ovoviviparous:	mode of reproduction in animals in which eggs are produced and hatch within the mother's body
Pelagic:	living near the surface or in the water column of coastal, ocean and lake waters, but not on the bottom of the sea or the lake
Philopatry:	species that return in consecutive years to the same site or territory
Plankton:	the aggregate of passively floating, drifting, or somewhat motile organisms occurring in a body of water, primarily tiny algae and bacteria, small eggs and larvae of marine organisms, and protozoa and other minute predators
Semi-lunate:	half moon shaped
Spiracle:	a small respiratory opening behind the eye of certain fishes, such as sharks, rays and skates
Telemetry:	the science and technology of automatic measurement and transmission of data by wire, radio or other means from remote sources, to receiving stations for recording and analysis
Vestigial:	the term for genetically determined structures or attributes that have apparently lost most or all of their ancestral function in a given species

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