The First International Whale Shark Conference:

Promoting International Collaboration in Whale Shark Conservation, Science and Management

Conference Overview, Abstracts and Supplementary Proceedings

Edited by Tennille R. Irvine and John K. Keesing

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and

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Preface

In July 2004, the Western Australian Government released a Draft Management Plan for the Ningaloo Marine Park, coinciding with the provision of funding for marine research at Ningaloo Reef to support management activities. Due to the seasonal visitation of the highly migratory whale shark to the area, it was deemed important to provide a forum for sharing knowledge and promoting collaboration of the species. Consequently, the First International Whale Shark Conference (IWSC) was held at the Holiday Inn Hotel, Perth on 9-12 May 2005. The 87 delegates that participated in the conference (see pg 94 for details) reported on whale sharks in 23 countries through 51 oral presentations and 8 posters.

This supplementary proceedings begins with a summary of the conference outlining these presentations and posters and the Open Communiqué officially released at the conference by the by Hon Dr Judy Edwards, MLA Minister for Environment and Science for Western Australia. Subsequently, summaries of both the Conservation and Science Workshops describe not only the discussion that occurred, but the outcomes that have been achieved in the time since the IWSC. Nine conference papers are also presented here, covering the themes of conservation, management, ecotourism and science. These papers form only a subset of the presentations given at the IWSC and continue from an additional selection which has been published in a special issue of *Fisheries Research* (volume 84, March 2007); the abstracts of these papers have been reproduced in this volume beginning on page 63 with permission from the publisher Elsevier. Finally, the entire collection of abstracts for the IWSC presentations and posters are given in alphabetical order of the primary author.

We are grateful to the delegates who participated in this conference, especially those who assisted with post-conference outcome summaries, and the generous sponsors (see pg i) who allowed us to support the participation of international delegates. Many thanks to the conference organising committee, especially Lucy Kay, and to Sarah Irvine, Nicola Fox, Matt Harvey and Sheryn Prior for their assistance throughout the conference. We also gratefully acknowledge the reviewers of the papers in this supplementary proceedings.

Tennille R. Irvine and John K. Keesing
Editors

First International Whale Shark Conference.

Conference Overview, Abstracts and Supplementary Proceedings

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Conference Program

Day 1 – Monday 9 May 2005

Opening Ceremony

Welcome: John Keesing (Australia)

Official Opening: Hon Dr Judy Edwards (MLA Minister for Environment and Science)

Theme One: Conservation

Chair: John Keesing (Australia)

Plenary Session: Keiran McNamara (Australia) - Whale Sharks in Ningaloo Marine Park – Conservation and Sustainable Tourism

Sonya Fordham (USA) - International Conservation of Whale Sharks

David Rowat (Seychelles) - Indian Ocean whale sharks: a case for regional conservation

Chair: Sonya Fordham (USA)

Julien Colomer (Australia) - Australian Government conservation and management of whale sharks

Brad Norman (Australia) - Whale shark conservation: protecting 'critical habitats' and managing risks to the species

Michel Vely (Djibouti) - Whale Shark (Rhincodon typus) in Djibouti (Horn of Africa): Conciliation of Ecotourism Development, Conservation and Development of a Scientific Program

Aidan Martin (Canada) -Behavioural Ecology of Whale Sharks (Rhincodon typus): Research Opportunities and Implications for Ecotourism Management

David Rowat (Seychelles) -Regional scale horizontal migration and local scale vertical movements of whale sharks

Theme Two: Ecotourism

Chair: Brad Norman (Australia)

Plenary Session: Rachel Graham (Belize) - Iterative planning and adaptive management of whale shark tourism in Belize: global implications of lessons learnt from 1998 and 2004

Ruel Pine (Philippines) - Lessons Learned and Challenges in Setting-up a Community-Based Whale Shark Ecotourism Program: The Case of Donsol, Sorsogon

Angela Quiros (Philippines) - Monitoring Whale Shark Tourism in Donsol, Philippines: Examining tourist compliance to regulations and the effects of tourism on whale shark behavior

Claire Davies (Christmas Island, Australia) - Christmas Island – Ecotourism and Research

Nirari Cardenas-Torres (Mexico) - Community-based management through ecotourism in Bahia de los Angeles, Mexico

Information Session

John Keesing (Australia) - Developing a Conference Communique

Special Ningaloo Session

Chair: Jennie Cary (Australia)

Geoff Taylor (Australia) - Whale sharks – the early history, and the Ningaloo phenomenon

Peter Lake (Australia) - Ecotourism role in public awareness, research and community involvement.

Branka King (Australia) - The Whale Shark Industry, Exmouth / Coral Bay - Western Australia

Day 2 – Tuesday 10 May 2005

Theme Three: Science

Chair: Rachel Graham (Belize)

Plenary Session: John Stevens (Australia) - Whale shark biology: a review of published literature

Brent Stewart (USA) - A large fish and a large puzzle: preliminary information on the population genetics of the whale shark (*Rhincodon typus*)

Jennifer Schmidt (USA) - Development of a DNA micro satellite panel for the study of whale shark (*Rhincodon typus*) genetics and population biology

Deni Ramirez-Macias (Mexico) - Characterization of Molecular Markers for populational studies of the whale shark (*Rhincodon typus*, Smith, 1828) of the Gulf of California

Mark Meekan (Australia) - The World's Largest Fish is Getting Smaller

Chair: Mark Meekan (Australia)

Rachel Graham (Belize) - Patterns of diving whale shark over variable time scales and in relation to a predictable food source

Steve Wilson (USA) - Migratory movements and vertical behavior of whale sharks tagged at Ningaloo Reef, Western Australia

Robert Hueter (USA) - Biological studies of large feeding aggregations of whale sharks (*Rhincodon typus*) in the southern Gulf of Mexico

Jonathon Nelson (USA) - Foraging Ecology by Whale Sharks (*Rhincodon typus*) within Bahía de los Angeles, Baja California Norte, México

Jeffery Polovina (USA) - Investigating the ocean habitat of the Ningaloo Reef whale sharks

Chair: Steve Wilson (USA)

Jai Sleeman (Australia) - The influence of oceanographic and atmospheric processes on whale shark abundance at Ningaloo Reef, Western Australia

Huahsun Hsu (Taiwan) - Satellite tracking of young whale shark, *Rhincodon typus* in the North - western Pacific

David Rowat (Seychelles) - Aerial surveys and estimates of whale shark populations

Marie Levine (USA) - Satellite Tracking of Whale Sharks

Mananjo Jonahson (Madagascar) - Methodological approach for whale shark (*Rhincodon typus*) observations on the North Western coast of Madagascar

Chair: David Rowat (Seychelles)

Rachel Graham (Belize) - Estimating a global population of whale sharks: pitfalls and opportunities

Brad Norman (Australia) - Size, sex ratio, maturity status and occurrence of the whale shark (*Rhincodon typus*) at Ningaloo Reef in Western Australia

Geremy Cliff (South Africa) - Aerial census of whale sharks on the northern KwaZulu-Natal coast, South Africa 2001-2005

Marie Levine (USA) - Aerial Survey of Whale Sharks (*Rhincodon typus*) off the East Coast of Southern Africa from 1993 to 1998

Beena Kumari (India) - Role of remote sensing for strategic planning and conservation of whale shark: A case study in the Northern Arabian Sea

Poster Session

Lisa Carne (Belize) – Whale Shark Tourism at Gladden Spit Marine Reserve, Belize, Central America

Otto Bismarck Gazzano Gadig (Brazil) - Records of the Whale Shark, *Rhincodon typus*, along the Brazilian Coast (Western South Atlantic)

Ingo Lange (Singapore) - German-European School in Singapore – nature and conservation studies

Posters Continued

Jonathon Nelson (USA) - Seasonal comparison of whale shark (*Rhincodon typus*) distributions within Bahía de los Angeles, Baja California Norte, México between 1999 and 2002

Allison Richards (Australia) - Conservation Through Collaboration

Jose Remolina-Suárez (Mexico) - Domino Project. Whale shark ecology, population dynamics and management strategies in the Mexican Atlantic Ocean

Surasak Thongsukdee (Thailand) - Whale shark in Thailand

William White (Australia) - Whale Shark Landings in Indonesian Artisanal Shark and Ray Fisheries

Day 3 – Wednesday 11 May 2005

Theme Four: Socio-Economics

Chair: Rod Quartermain (Australia)

Plenary Session: David Wood (Australia) - Socio-Economics of Tourism at Ningaloo and Importance of Whale Sharks.

David Rowat (Seychelles) - Seychelles: A case study of community involvement in the development of whale shark ecotourism and the socio-economic impact

Fahmida Hanfee (India) - Transition from Whale Shark harvesting to protection in India.

Sarang Kulkarni (India) - Opportunities and Challenges in Research, Conservation and Management of Whale Shark along the coast of Gujarat

Mariana Diaz (New Zealand) - The importance of cross scale institutional arrangements for whale shark conservation and management: the experience from two coastal communities in Mexico

Special Whale shark Recognition/Observation Session

Chair: John Stevens (Australia)

Roland Mau (Australia) - Involving Tourism Operators in whale shark monitoring and research - Opportunities and Limitations at Ningaloo Marine Park

Brad Norman (Australia) - The ECOCEAN Whale Shark Photo-identification Library: A Centralized and Scalable Approach to Whale Shark Data Collection, Management, and Analysis

Jason Holmberg (USA) - An Astronomical Pattern-Matching Algorithm for Automated Identification of Whale Sharks (Rhincodon typus)

Michelle Press (USA) - Photo identification of whale sharks.

Volker Bassen (Kenya) - The East African Whale Sharks Trust

Theme Five: Management

Chair: Nick D'Adamo (Australia)

Plenary Session: Natalie Rodriguez-Dowdell (Mexico) - Property rights based management Whale shark ecotourism in Bahia de los Angeles, Baja California

Otto Gadig (Brazil) - Occurrence, Distribution and Conservation of the Whale Shark in the Western South Atlantic

Dhiresh Joshi (Presented by Vivek Talwar, India) - Campaign for Whale Shark Conservation: Experiences from Coastal Gujarat, Western India

Nimu Njonjo (Kenya) - Whale Sharks in Kenya

Jose Remolina Suarez (Presented by Natalie Rodriguez-Dowdell, Mexico) - Promoting International Collaboration in Whale Shark Conservation, Science and Management

Discussion Session

Chairs: John Keesing (Australia) and Denis Beros (Australia)

Discussion and Drafting of a Conference Communiqué

Day 4 – Thursday 12 May 2005

Two concurrent workshops

Workshop 1 (Science)
Chairs: Mark Meekan and John Keesing.

Workshop 2 (Conservation)
Chairs: Nick D'Adamo and Paul Gamblin

Release of Conference Communiqué by Hon Dr Judy Edwards (MLA Minister for Environment and Science)

Closing Session by John Keesing

Foreword:
Conference Summary

Introduction

The emergence of rapidly developing whale shark ecotourism in many parts of the world has lead to a heightened focus on concerns over continued legal and illegal harvest of whale sharks, as well as the lack of knowledge of all aspects of the biology and ecology or the world's largest fish. In order to generate international collaboration in conservation, research and sustainable tourism, Western Australia took the lead to facilitate the First International Whale Shark Conference (IWSC) that was held in Perth on 9-12 May 2005. With an emphasis on establishing outcomes to be achieved following the event, the objectives of this conference were:

- to bring researchers from across the full spectrum of relevant biological, physiological and social sciences, government and non-government representatives and ecotourism industry practitioners together;
- to provide a forum for sharing international experience and expertise;
- to set research and conservation priorities;
- to promote international collaboration;
- to facilitate the development and release of a Communiqué to capture the long term objectives for global whale shark conservation; and
- to summarise the status of knowledge on whale sharks.

Representatives of non-government organisations, government departments, the ecotourism industry, inter-governmental agencies and scientific experts assembled to share their knowledge, expertise and future visions of whale sharks. As research and conservation operate synonymously to ensure the long term survival of the whale shark it is necessary to provide a collaborative forum for all interests to work in partnership. Furthermore, for conservation to be viable both ecotourism stakeholder interests and community building socio-economic outcomes must be recognised. The ultimate objective held by all stakeholders of conservation of the species can be achieved through the combined efforts of scientists, managers and conservationists supporting one another.

Worldwide, separate instances of rapid increases in the amount of scientific research and the effectiveness of ecotourism management and conservation are evident, however, international collaboration of this highly migratory species remains minimal. A critical element of the IWSC was to create a strong awareness of the need for global collaboration and promote opportunities for such. The 87 delegates that participated in the conference (see page 94 for details) reported on whale sharks in 23 countries: Australia, Bangladesh, Belize, Brazil, Cuba, Djibouti, Honduras, India, Indonesia, Kenya, Madagascar, Maldives, Mexico, Mozambique, Philippines, Seychelles, Singapore, Somalia, South Africa, Sri Lanka, Taiwan, Tanzania and Thailand. With a strong international agenda, the IWSC brought together not only stakeholders of differing fields concerning whale sharks, but those of similar focus from across the globe. These alliances allow the sharing of knowledge and experience, making it possible for nations with recent research, ecotourism or conservation endeavours to learn from established situations.

The conference of 51 oral presentations and 8 posters was divided into 5 themes; science, conservation, ecotourism, socioeconomics and management, with each session providing extensive time for discussion to ensure an active rather than passive environment. Furthermore, 2 associated workshops were conducted to discuss how best to conserve, manage and research whale sharks internationally. The social program of the IWSC, including a poster session and conference dinner, provided additional opportunity for delegates to form networks with other individuals from across the globe to promote future collaboration.

Delegates displayed a remarkable enthusiasm to share information and experience, and a global commitment to address the population decline through developing agreed actions to remedy the ongoing threats to whale sharks and their habitats. The conference revealed results of new research, provided examples of symbiotic relationships between whale shark attributed tourism and conservation, and developed networks and project ideas. As a turning point for international efforts, ongoing collaboration continues as a result of the First International Whale Shark Conference and it is hoped that this will be sustained with biannual international meetings.

Summary of presentations

After a welcome by the IWSC organiser, Dr. John Keesing (CSIRO Marine and Atmospheric Research, Australia), the conference was officially opened by Hon Dr Judy Edwards, MLA Minister for the Environment and Science, Western Australia. The oral presentations of the conference were divided into thematic sessions; in addition to the 5 key themes, 2 additional special sessions were held in recognition of additional areas of interest, these were the Ningaloo region and whale shark recognition and observation. The following summaries are not given in order of presentation, but rather as a more meaningful dialogue.

Conservation

Several presentations reviewed details of the whale shark being the first shark species listed under the Convention on Migratory Species (CMS) and listed on Appendix II of the Convention on International Trade in Endangered Species (CITES). The main theme resounded by all was the immediate need for international collaboration efforts in conservation.

A plenary presentation, given by Keiran McNamara, described the successful relationship between management departments and the whale shark ecotourism industry at Ningaloo Marine Park, Western Australia, highlighting that the future of whale sharks in the area is dependant on activities and international efforts extending outside Australia. Sonya Fordham presented an overview of global whale shark conservation; reviewing international conventions and agreements and how this iconic species is enhancing status of other sharks worldwide. A regional perspective was discussed by David Rowat, examining the results of questionnaire responses from 10 Indian Ocean rim countries, with a focus on seasonal patterns of occurrence and perceived threats in each location. Further to this, Michel Vely reviewed conservation strategies in Djibouti through sustainable ecotourism with a similar emphasis on Indian Ocean regional collaboration. Julien Colomer described the Australian government domestic and international actions for conservation and management of the whale shark. A final conservation perspective was given by Brad Norman in a presentation that addressed the problems associated with the highly migratory nature of the whale shark and their dependence on specific areas and habitats critical to their life cycle.

Ecotourism

Ecotourism practices were discussed with a focus on promoting the industry as a key method in assisting conservation of the whale shark, providing it is well managed for minimal impact on the sharks. The successes and problems associated with establishing and managing ecotourism ventures in various localities were reviewed.

A plenary presentation by Rachel Graham discussed global whale shark tourism before concentrating on a case study of the astoundingly rapid expansion of the industry in the Belize Barrier Reef. Two presentations discussed the case of a new ecotourism venture in Donsol, Philippines; Ruel Pine described the challenges faced by the community such as resource sharing conflicts, enforcement and an ecotourism industry pursued in isolation of conservation and management frameworks. Angela Quiros subsequently examined tourist compliance to a code of conduct and whale shark behavioural changes in response to tourist activity. In another case study, Nirari Cardenas-Torres presented an account of ecotourism at Bahia de los Angeles, Mexico focusing on the development and implementation of a code of conduct by community based management. Claire Davies gave details of whale shark aggregations at Christmas Island, Australia following red land crab mass spawning and the potential for targeted ecotourism not yet occurring. Finally, Aidan Martin analysed the risks of rapidly developing ecotourism to whale shark behaviour and discussed the importance of ecotourism operators in the collection of basic behavioural and ecological data.

Ningaloo

Given the locality of the conference at the closest city to the Ningaloo Reef and interest due to significant research and effective management programs, a special session was conducted to provide delegates additional information on the area. Geoff Taylor gave an early history of whale shark presence at Ningaloo Reef, followed by information of feeding behaviour and plankton composition. Peter Lake and Branka King, tour operators in the Ningaloo region, both detailed the rapid expansion of the industry in the last decade and discussed tour operator collaboration with researchers and managers.

Science

As the conference theme with the most presentations, a full day was dedicated to the various scientific studies of whale shark; these were broadly grouped as research of genetics, population and demographics, satellite tagging, foraging behaviour and the application of satellite oceanographic data. John Stevens plenary

reviewed published literature illustrating that although there has been a large increase in recreational activity associated with whale sharks, much is still not known about the biology or ecology of the species.

Genetics

Research of genetics provides analysis of the social structure and breeding habits of the whale shark. Although presently based on small sample sizes, all studies presented suggest a single global population with no segregated breeding. Brent Stewart's study examined inter-region and inter-ocean genetic connectedness of whale shark populations based on mitochondrial DNA and Jennifer Schmidt described the development of methodology utilising microsatellite DNA. Preliminary work on the Gulf of California whale shark population was presented by Deni Ramirez-Macias; genetic data paralleled with observation of sex and distribution of juveniles indicated whale sharks may be philopatric with males moving to other areas when mature to mate while females breed and pup in the same area.

Population and Demographics

Studies of aerial surveys were described for the Seychelles by David Rowat and along the Kwa-Zulu Natal coast of South Africa by both Marie Levine and Geremy Cliff. For the Seychelles, Rowat indicated a gradual decline in whale shark population size from 2001-2004, this study was combined with a marker tag study with tag resightings of up to 19%. Initiated to determine the most suitable area for a satellite tagging study in Kwa-Zulu Natal, South Africa, Levine's research was conducted from 1993-1998. Cliff presented information of a survey from 2001 to 2005 with the objective of providing information for a possible ecotourism venture; results indicated too few sharks for a reliable industry.

Mark Meekan described the decline in average size and relative abundance of whale sharks at Ningaloo Reef, despite protection in Australian waters, and the correlation of abundance with El Nino Southern Oscillation. Brad Norman further examined the population structure of the Ningaloo whale sharks concluding that 85% of sexed sharks were male and analysis of size and clasper abrasion indicated that the total length at which 95% of males are mature is 9.11m. In another location, Robert Hueter gave details of the number, distribution, behaviour and migration of whale sharks in Quintana Roo, Mexico, which have mixed aggregation demographics in terms of size and sex. Rachel Graham described the demographics of the whale shark population off Gladden Spit, Belize. With the local aggregation part of regional population and evidence that 80% of sexed sharks are juvenile males and recent mating in mature males, these whale sharks cannot be considered representative of the regional population. This highlights the need for caution in determining global population of whale shark based on local observations. Mananjo Jonahson detailed the whale shark distribution in Madagascar, as determined by interviews with fishermen and reports from dive operators, and the establishment of a scientific study involving aerial surveys and satellite tagging.

Satellite Tagging

Satellite tagging studies showed a temperature preference of 25-35℃, with dives greater than 1000m to temperatures below 8℃, and the possibility of whale sharks using boundary/ geostrophic currents to aid movement. Whale sharks were satellite tagged and movements described from Gladden Spit, Belize by Rachel Graham, from Ningaloo Reef, Western Australia by Steve Wilson, in the north-west Pacific and around the islands of Taiwan by Huahsun Hsu, from the Seychelles by David Rowat and from South Africa by Marie Levine.

Foraging Behaviour

Jonathon Nelson presented research of whale shark feeding behaviour that concluded the 3 types of behaviours, ram, vertical and passive, are dependent on plankton density.

Application of Satellite Oceanographic Data

The correlation of satellite derived oceanographic information to whale shark presence may be used to describe whale shark habitat and the influence of their movement. Jeffery Polovina and Jai Sleeman presented studies examining remote sensing data related to the whale sharks at Ningaloo Reef utilising satellite tagged animals and distribution information from tour operators, respectively. Finally, a similar study was presented for the whale shark population off the coast of Gujarat, India by Beena Kumari.

Socio-economics

A plenary presentation by David Wood described the development of the community of Exmouth from a declining population in the early 1990s through ecotourism based on seasonal whale shark aggregations at Ningaloo Reef. Details of economic impact were discussed, as was the importance of whale sharks to allied service industries including local employment, employee accommodation and increased transport and

infrastructure to support tourist arrivals. David Rowat provided information on the economic context of whale sharks in Seychelles, with projections of the nation's estimated earning capacity from the whale shark ecotourism industry as compared to actual revenues achieved. Two presentations investigated the socio-economic affects of the 2001 ban on whale shark fishery in India, Fahmida Hanfee and Sarang Kulkarni both drew attention to the lack of infrastructure resulting in ecotourism remaining marginal. Mariana Diaz further questioned the widely held view that ecotourism is beneficial for economically vulnerable developing communities with a dependence on marine resources and the whale sharks in the area, using Mexican communities as an example.

Whale Shark Recognition and Observation

The focus of the special session on whale shark recognition and observation was the application of photo-identification as an alternative to conventional tagging methods to estimate population size and demography. Michelle Press found that the area posterior to gill slits, the dorsal fin, tail fin and presence of scars are useful for identification purposes and the technique was examined through comparative photo-identification of whale sharks from 3 independent photographic databases. Brad Norman presented information about the Ecocean photo-identification library established in 2002 that uses the area posterior to gill slits as a unique identifying pattern; the online database allows collection and sharing on global scale. Subsequently, Jason Holmberg described the astronomical pattern matching algorithm used by Ecocean to identify individual sharks by comparing spot patterns and its success rate in identifying matching images. Roland Mau discussed a departmental management program monitoring the whale shark ecotourism industry at Ningaloo Reef through standardised tour operator logbooks; the data of which, although has limited scientific accuracy, can be used to observe trends.

Management

Through presentations concerning whale sharks in Mexico, Brazil, India and Kenya, the common emphasis was on community involvement, whether it be conservation of the species or management of the ecotourism industry. Natalie Rodriguez-Dowdell gave a plenary presentation of a case study in Mexico, where although whale shark ecotourism was rapidly expanding, the local communities' quality of life had not significantly improved due to open access of the resource. The study determined the most efficient regime would be granting of a concession area for local user groups recognising their property rights. After describing the distribution of whale sharks in Western South Atlantic, Otto Gadig discussed the conservation efforts in Brazil including public education and government actions. Vivek Talwar, who presented on behalf of Dhiresh Joshi, described a conservation and education campaign in Gujarat, India involving religion, street theatre and school programs that was run to bring about pride of the whale shark to ensure effective management and conservation of the species. Two representatives of the East African Whale Shark Trust in Kenya, Nimu Njonjo and Volker Bassen, presented information about the Trust and its aim to conserve whale sharks through research, education, ecotourism and community based projects aimed at fishermen, residents and visitors. Finally, on behalf of Jose Remolina Suarez, Natalie Rodriguez-Dowdell presented information concerning the management of ecotourism activities on the north-east coast of the Yucatan Peninsula, Mexico. This project involved participation of local tour operators, government departments and academic institutions to produce management and conservation strategies, including an interaction code of conduct, training sessions for guides and a permit system for ecotourism operators.

Posters

Posters were displayed during a special evening session as part of the social program promoting delegates to communicate on a more informal level. The posters submitted were not only broad ranging in geographic extend but also in content from conservation and management to ecotourism to scientific study.

Conservation

In a poster, Ingo Lange described an international school program in Singapore focused on whale shark science and conservation. Allison Richards detailed the Ningaloo Whale Shark Watch Initiative that involves collaboration between guides, tour operators, management industries and researchers to collect information by standardised methods. Surasak Thongsukdee discussed the distribution of whale sharks in Thailand established by information from divers and tourists and the protection of the species in March 2000. William White described a survey of the artisanal fishery in Indonesia, details of anedotal reports from shark fin dealers and the difficulty in determining an accurate estimate of whale shark fishing in the country.

Ecotourism

Lisa Carne presented a poster on the rapid growth of the whale shark ecotourism industry in Gladden

Spit, Belize, where tourism guidelines and regulations created by community and stakeholder analysis were implemented in 2004.

Science

Posters by Otto Gadig and Jonathon Nelson described whale shark distribution along the Brazilian coast and within Bahia de los Angeles, Mexico, respectively. In addition, Nelson gave details of total length, sex and feeding behaviour of the whale sharks and information which suggests the animals may be following oceanographic cues in Gulf of California that are favourable for increased prey.

Management

A poster by Jose Remolina Suarez gave additional information following on from his oral presentation outlining whale shark management activities on the north-east coast of the Yucatan Peninsula, Mexico. The poster presented the different strategies being utilised in the area such as management, legislation and community participation, indicating the contact information for the person responsible for each component with the intent to promote collaboration.

Conference Communiqué

An open Communiqué was prepared with conference delegate participation during the international meeting and officially released on 12 May 2005 by Hon Dr Judy Edwards, MLA Minister for Environment and Science for Western Australia. Agreed by more than 80 delegates from 23 countries, the Communiqué called upon governments, nations, organisations and individuals to ensure the world-wide protection of whale sharks through cooperative action and drive a transition away from harvesting towards sustainable socio-economic uses. This document is shown on pg 7. Following the conference, the Communiqué was translated into French and Spanish for official release.

Workshops

Two concurrent workshops were held following three days of presentations to provide a forum for discussion to strategise international collaboration efforts in science and conservation. A Science Workshop, with the aim of developing regional and international collaboration, lead to the tabling of a list of issues deemed priority by participants and the establishment of a steering committee to develop global research goals. Leading scientists were in agreement that research should focus on photo identification, electronic tagging/ tracking and genetic studies as most appropriate to increasing knowledge of the species. A Conservation Workshop reviewed management and conservation efforts and what can be done to improve them. The key outcomes were agreement for developing a Convention on Migratory Species (CMS) listing proposal and the creation of an ongoing international correspondence network. Following the conference, summaries of both workshops were made available on the Marine Conservation Society Seychelles website (www.mcss.sc/iws.htm) to encourage participants to continue with the agreed actions. Thorough details of these workshops are provided in following sections, including the outcomes towards set priorities since the conference.

Conference excursions

The timing of the conference coincided with the whale shark migration to Ningaloo Reef in northern Western Australia. To give international visitors the opportunity to experience the whale shark ecotourism industry at Ningaloo Marine Park, 3 day pre and post conference excursions to the town of Exmouth to were available. Delegates were also offered the experience of a full day whale shark eco-tour with the tour company Ningaloo Blue, including swimming or diving with the world's largest fish.

In order to provide the Western Australian whale shark ecotourism stakeholders with information of the key outcomes of the conference, a post conference debrief presentation was given in Exmouth. This 2 hour event in the local recreation centre on 29 June 2005 was open to the public and attended by local residents, ecotourism operators, tourists and staff from the management authority, the Western Australian Department of Conservation and Land Management (CALM). Following a welcome by Jennie Cary of CALM, Brad Norman gave a presentation on behalf of the IWSC organising committee and participating delegates concerning the summary and results of the conference. Allison Richards from WWF then provided information regarding the whale shark photo identification library, highlighting its use by the tour operators in Exmouth. During the debrief session, the audience was able to ask questions and subsequently had the opportunity to socialise with presenters for further discussion following the formal presentations.

Publications

This supplementary conference proceedings includes the abstracts from all presentations and posters given at the First International Whale Shark Conference, arranged in alphabetical order by presenter surname. In addition, a selection of

papers given at the conference is presented here, in order grouping related themes. All contributed manuscripts were subject to a standard review process comprising 2 anonymous referee assessments; it must be noted that the abstracts given here were not exposed to this procedure. The submission of manuscripts was optional for conference delegates, and thus not a complete set is provided.

Furthermore, this supplementary proceedings has been published to complement a further eighteen papers published in a special issue of the *Fisheries Research* journal, titled *Whale Sharks: Science, Conservation and Management* (volume 84 published in March 2007). Given the high degree of subject linkage between several of the conference themes, papers comprising the journal issue were separated into two parts; Part I Science and Part II Conservation & Management. The papers published in the special conference proceedings issue of *Fisheries Research* are as follows:

Part I. Science

- J.D. Stevens. Whale shark (*Rhincodon typus*) biology and ecology: a review of the primary literature.
- R. Aidan Martin. A review of behavioural ecology of whale sharks (*Rhincodon typus*).
- Andrew Gifford, Leonard J.V. Compagno, Marie Levine and Alex Antoniou. Satellite tracking of whale sharks using tethered tags.
- Hua-Hsun Hsu, Shoou-Jeng Joung, Yih-Yia Liao and Kwang-Ming Liu. Satellite tracking of juvenile whale sharks, *Rhincodon typus*, in the Northwestern Pacific.
- D. Rowat and M. Gore. Regional scale horizontal and local scale vertical movements of whale sharks in the Indian Ocean off Seychelles.
- Geremy Cliff, Michael D Anderson-Reade, Andew P. Aitken, Graeme E. Charter and Victor M Peddemors. Aerial census of whale sharks (*Rhincodon typus*) on the northern KwaZulu-Natal coast, South Africa.
- Jonathan D. Nelson and Scott A. Eckert. Foraging ecology of whale sharks (*Rhincodon typus*) within Bahía de los Angeles, Baja California Norte, México.
- J. Geoff Taylor. Ram filter-feeding and nocturnal feeding of whale sharks (*Rhincodon typus*) at Ningaloo Reef, Western Australia.
- Rachel T. Graham and Callum M. Roberts. Assessing the size, growth rate and structure of a seasonal population of whale sharks (*Rhincodon typus* Smith 1828) using conventional tagging and photo identification.
- Bradley M. Norman and John D. Stevens. Size and maturity status of the whale shark (*Rhincodon typus*) at Ningaloo Reef in Western Australia.
- Dení Ramírez-Macías, Ricardo Vázquez-Juárez, Felipe Galván-Magaña, Adrián Munguía-Vega. Variations of the mitochondrial control region sequence in whale sharks (*Rhincodon typus*) from the Gulf of California, Mexico.

Part II. Conservation & Management

- David Rowat. Occurrence of whale shark (*Rhincodon typus*) in the Indian Ocean: a case for regional conservation.
- Angela L. Quiros. Tourist compliance to a Code of Conduct and the resulting effects on whale shark (*Rhincodon typus*) behavior in Donsol, Philippines.
- David Rowat and Udo Engelhardt. Seychelles: A case study of community involvement in the development of whale shark ecotourism and its socio economic impact.
- Nirari Cárdenas-Torres, Roberto Enríquez-Andrade and Natalie Rodríguez-Dowdell. Community-based management through ecotourism in Bahia de los Angeles, Mexico.
- Natalie Rodríguez-Dowdell, Roberto Enríquez-Andrade and Nirari Cárdenas-Torres. Property rights based management: Whale shark ecotourism in Bahia de los Angeles, Mexico.

Short Communications

- William T. White and Rachel Cavanagh. Whale shark landings in Indonesian artisanal shark and ray fisheries.
- Mananjo Jonahson and Simon Harding. Occurrence of whale sharks (*Rhincodon typus*) in Madagascar.

The information provided in the publication of conference presentations, workshop summaries and the outcomes achieved since the conference should encourage continued endeavours and collaboration. It is through coordinated international efforts, policy reform, community education, alternative uses and increased knowledge that whale sharks will be protected to ensure their survival.

Open Communiqué

International Whale Shark Conference - Perth, Australia, 9-12 May 2005

We the participants of the International Whale Shark Conference, comprising scientific experts and representatives of Non-Government Organisations, intergovernmental organisations, the eco-tourism industry and Western Australian government agencies, having assembled from 23 countries of the world at Perth, Australia in May 2005 with the objectives of:

Advancing local, regional and international efforts for the conservation of whale sharks, and

Facilitating regional and international collaboration in research on whale sharks,

Having heard fellow participants present 60 papers over 3 days in themes of Conservation, Science, Ecotourism, Socioeconomics and Management,

Agree that

There is cause for heightened concern over the state of global whale shark populations.

The state of scientific knowledge in regard to whale sharks is insufficient to determine the precise level of threat to the survival of whale sharks, however the evidence points to serious declines in the abundance of whale sharks in some parts of the world following even short periods of exploitation.

As such, there is wide scientific consensus on the need for urgent regional and international conservation measures.

Greater levels of whale shark protection can also ensure healthier economic outcomes for coastal communities around the world where whale sharks occur by encouraging and enabling them to prosper through the non-consumptive use of whale sharks, and as such we

Call upon Nations, Governments, Organisations and Individuals to act with intent and vigour to:

Ensure worldwide protection of the whale shark and its habitat for the maintenance of biodiversity, ecosystem health and appreciation by future generations; Facilitate a rapid transition away from harvesting of whale sharks in order to bring prosperity to communities through sustainable economic alternatives, such as ecotourism;

Secure a greater level of local, regional and international effort, cooperation and collaboration in scientific whale shark research including:

distribution, abundance, movement, behaviour, life-history biology, genetics and ecological interactions with and dependencies on the physical and bio-geochemical environment;

through the development of projects and the use of scientific and other networks; and

Secure a greater level of local, regional and international effort, cooperation and collaboration in whale shark conservation including:

wildlife and habitat protection agreements, fisheries monitoring and management programs, education, community-based conservation projects, economic feasibility studies, capacity building;

through the development of projects and the use of conservation and other networks; and

We also undertake to facilitate greater sharing of data and information of all types which support these goals and to meet again at a time in the future in conference to review progress.

Agreed by Conference in session and released 12 May 2005 at Perth, Australia

Conservation Workshop Summary and Outcomes

The Conservation Workshop was lead by Nick D'Adamo of Western Australia's Department of Conservation and Land Management (now the Department of Environment and Conservation) and Paul Gamblin of WWF Australia.

With the aim of facilitating mechanisms for collaborative efforts in management and conservation of this charismatic species, this workshop identified the key issues to be resolved, such as the global status of whale sharks, threats to them, and determining what can be done to improve conditions at local, regional and global levels. Workshop attendees identified the facets through which worldwide conservation could be improved to be administrative mechanisms (strengthening current treaties and conventions, and developing new mechanisms such as policies, rules and regulations); education; public participation (such as community monitoring); surveillance and enforcement; intervention; research; and monitoring. A prioritised list of actions was developed and from this the following main action items were outlined.

1. Convention on Migratory Species Agreement

The primary concern resounded by all workshop participants was the necessity of a Convention on Migratory Species (CMS) listing; it was realised that now is the time to act with a CMS scientific council meeting approaching. The Philippines successfully nominated whale sharks to CMS Appendix II in 1999, but no legally binding agreement exists. Under CMS, a Memorandum of Understanding (MOU) or an agreement can be developed for the species, also resulting in funding being more readily available for research and conservation. It was also recognised that the whale shark is further advanced in terms of conservation compared with other sharks, making it a good flagship species to target conservation efforts of other species. However, concern was raised that if a CMS listing does not occur, it is possible that the whale shark could be taken off the Convention on the Conservation on Migratory Species (CITES) listing and existing international agreements cannot be solely relied upon.

Discussion focused on how to proceed towards a CMS listing, recognising that an agreement in the action to be taken was necessary. There are two ways of moving for CMS listing; get the governments involved placing whale sharks on the agenda or go to the scientific end of CMS and approach them before their next science council meeting.

Following the conference

A draft recommendation on Migratory Sharks was submitted by Australia, New Zealand and Seychelles at the Eighth Meeting of the Conference of the Parties to the Convention on Migratory Species (CoP8) in Nairobi 20-25 November 2005. This applied to all shark species on the CMS appendices, which are currently the basking shark, great white shark and whale shark. The recommendation was adopted by CoP8 delegates, specifically calling upon range states of the migratory sharks listed on Appendix I or II to develop a global agreement and action plan, which may involve regional and/or species specific conservation plans, with the involvement of governments, intergovernmental organisations, non-governmental organisations and local communities.

The first meeting to develop an international Migratory Sharks conservation and management instrument, which was to be held in Mahe, Seychelles 24-26 January 2007, has been postponed until December 13-20th 2007. The meeting is an official intergovernmental meeting held under the auspices of the Convention on Migratory Species and will be hosted by the Ministry of Environment and Natural Resources, Government of Seychelles. The objectives of the meeting are to summarise the conservation status of sharks defined as migratory under CMS; examine existing international, regional and other initiatives to improve the conservation status of migratory sharks; and identify and elaborate an option for international cooperation under CMS. Further details of the meeting and relevant documents are available at the CMS web site at http://www.cms.int/sharks.

2. Communications

In regard to communication, the following points were raised:

- The conference summary and Communiqué are to be circulated those relevant, especially governments of the conference participants to assist in moves towards conservation in their countries.
- Standardised methodology techniques for data collection need to be dispersed globally.

- Economic and socio-economic information regarding ecotourism and economic alternatives needs to be further developed to determine what actions are needed, and this needs to be circulated to the relevant localities. It was also suggested that programs for compensation and economic alternatives should be developed for areas that are to be encouraged to cease harvesting.
- Information on how management and compliance applies in each country needs to be shared and it would be beneficial to establish an exchange program for those involved in management and tourism to learn from progress in other localities. Capacity building can also be strengthened by regional meetings to develop the skills of stakeholders.

Following the conference

- Following the conference informal summaries of the presentations, information from the workshops and the conference Communiqué were made available on the Marine Conservation Society, Seychelles website (www.mcss.sc) and delegates emailed to inform them of this. Additionally, the conference Communiqué was circulated at the Eighth Meeting of the Conference of the Parties to the Convention on Migratory Species (CoP8) in Nairobi 20-25 November 2005.
- Regional workshops thus far have been limited to the Mesoamerican Reef Region, with meetings held in 2006 in Belize and Honduras. The first in Belize focused on experiences in the ecotourism industry and management guidelines, while the second was aimed at the creation of laws to assist with ecotourism and research. These workshops have fostered the development of the Western Caribbean and Gulf of Mexico regional acoustic arrays which link key whale shark feeding sites.

3. Funding

Funding was a key issue discussed by workshop attendees, with concerns that at present funding is given primarily to scientists. Delegates were urged to think creatively and change from traditional approaches; applications could be strengthened by aiming towards tourism to create interest and both governments and the private sector need to be targeted. An additional suggestion was to create a marketing campaign with links to Ecocean's photo identification library to attract the attention of tourists.

4. Information Needs for Conservation

Conservation is not possible without the information necessary for management, calling for the need for prioritised conservation relevant research. Which scientific tools will best serve conservation was discussed, with the need for work towards integration of global information for complete whale shark distribution being addressed as a key issue. Additional information needs are quantification of previous natural abundance, current levels of harvest and mortality and projections of population decline if harvesting was to continue. Other points raised relating to information needs were:

- The need for standardised monitoring methods and scientific data collection. A manual for whale sharks could be built from the IUCN manual for standardised scientific data collection for turtles.
- An intelligence gathering system should be developed to encompass areas outside the current focus for research.
- Information gained from scientific projects needs to be disseminated for discussion; this can partly be done through the whale shark online network once established.

As a result of these discussions, a representative of the conservation workshop addressed the concurrent science workshop to raise these points.

Following the conference

Regional collaboration between specific monitoring programs in the Indian Ocean has been ongoing with collaborating organisations using standardised set-up regimes for data-storing satellite tags to allow regional comparisons to be made. Further collaboration has been in the sharing of photo-identification data through the use of the free-ware programme I3S, originally developed to help in the identification of ragged-tooth sharks in South Africa (http://www.reijns.com/i3s/). This programme allows researchers to sort through their daily ID photos using this as a virtual tagging system to enable catch, mark and recapture analysis of data. By utilising the same 'fingerprinting' system these digital IDs can be easily compiled into comparative regional databases which will enable estimations of population structure, survival rates, inter-aggregation movements, residency probabilities, threat from boating collisions and predation, and long-term population persistence probabilities. The system also allows for ready sorted submissions to the Ecocean online database which is now also incorporating the I3S algorithm.

5. Networks

All workshop participants agreed an online global whale shark community is essential for discussion to integrate information from different sectors and share knowledge and experience in order to aid

conservation and management. It is imperative that this be done on an international basis and would be beneficial if it incorporated a hierarchical structure to include local and regional networks as well. Various methods of doing this were discussed, with Ecocean, SRFME or PADI Project Aware being suggested as possible bases for the online forum. It was recognised that difficulties may arise with the use of data, and a suggestion made to establish a Memorandum of Understanding (MOU) to protect intellectual copyright if data is to be shared.

Following the conference

A global online community forum was launched under the Ecocean web site on 28 April 2006, this can be accessed at http://forum.ecocean.org. This potentially valuable resource is at present underutilised by the research community, with 56 registered users in January 2007. The forum is open to interested members of the general public and specialised researchers alike, encouraging free and open discussion and information sharing on any topics relating to the whale shark. Once registered, an individual can create a new post or continue a thread in a forum, search for keywords and authors of posts and email individual members directly. It is hoped that in the future this resource will be utilised more fully.

6. Community Involvement

Delegates participating in the Conservation Workshop recognised the importance of community participation for effective conservation and management strategies. The following points were raised:

- Several good examples of increasing awareness and information within a community were presented during the conference, such as the presentations by Dhiresh Joshi from Gujarat, India and Nimu Njonjo from Kenya, these examples provide a good model for such work in other localities.
- Indigenous cultures must be respected and indigenous links must be maintained in order to conserve the species, a connection can be made between traditional harvest and science with indigenous people promoted to help with data gathering.
- Additional stakeholders outside the core group should be identified in each area of whale shark presence, and approached for their involvement in order to use their strengths and resources to facilitate whale shark conservation. It is important that tourists and local residents feel that their contribution to conservation is important.
- An essential element of community participation is developing a feedback loop to ensure that those relevant are informed on progress. This is especially important for diving operators as they typically provide much information particularly in terms of photo identifications.

7. Need to Approach Those Not Represented at the IWSC

Both Project Aware and the Shark Trust were identified as not being represented at the First International Whale Shark Conference and efforts need to be made following the event for their cooperation in collaborative conservation efforts.

Following the conference

Since the conference, Ecocean, an international web-based photo-identification library, has joined forces with both the non-profit environmental organisation, Project Aware and the conservation charity, Shark Trust. The Project Aware and Shark Trust whale shark ID project allows divers to submit their photographs of whale sharks to researchers studying identification and migration patterns (see www.whalesharkproject.org). In their new collaboration, photos submitted in this way will also be submitted to the Ecocean library to build a single global database.

8. Increasing Pressure on Governments to Ban Legal Fishery

During the First International Whale Shark Conference, delegates heard presentations regarding the quota fishery in Taiwan and much discussion at the conservation workshop focused on targeting the governments of countries where whale shark fishery was legal to have it banned.

Following the conference

In support of international conservation pressure, the Taiwanese Council of Agriculture has reduced the country's whale shark fishing quota from 60 in 2006 to 30 in 2007, with the fishermen being compensated for their loss of income, and a ban on the fishery will be imposed in 2008. In addition, the government has imposed size limits restricting caught whale sharks to at least 4 m in length and prohibited all domestic sales and imports of whale shark meat. Additionally, an agreement now exists for the tagging of 30 whale sharks; plans for the tagging program are being made with Professor Kwang-Ming Liu and Professor Shoou-Jeng Joung at the National Taiwan Ocean University.

Science Workshop Summary and Outcomes

The Science Workshop was led by John Keesing (CSIRO Australia) and Mark Meekan (Australian Institute of Marine Science) who emphasised the important opportunity the workshop presented to identify key needs and priorities for research on whale sharks and to facilitate international collaboration on whale sharks.

A presentation was given by Bill Erb of the Intergovernmental Oceanographic Commission on the Global Ocean Observing System (GOOS) network. Highlighting the importance of the network of regional GOOS bodies, which cover the worldwide distribution of whale sharks, this was presented as a useful model for international cooperation and collaboration where there were focus issues of particular regional importance.

A discussion forum was held to determine priorities and mechanisms for global research collaboration, including time spent as separate groups for planning regional projects. As a result of these discussions the following priorities were established:

- The main information requirements relate to the need for more life history information, better understanding of migration habits and local, regional and global population estimates. Projects underway to achieve this include genetic studies, photo identification and tagging, but all require better coordination.
- The need to improve the extent of coverage and the quality of whale shark observation data. Important components of this are the production of standardised manuals on what data to collect and how to collect it and capability building workshops.
- The need to allocate experts from countries with established research programs to assist and advise countries developing new whale shark research programs.
- The creation of a data sharing network for accessing global information on the internet.

The following points cover the highlights from the group discussions on important issues and collaborative project planning:

Photographic libraries

- Researchers and the diving public should be encouraged to submit photos to the Ecocean Photo Identification library to allow better application.
- It was hoped that cooperation from the hard copy libraries such as in Western Australia and elsewhere and the PADI Project Aware / Shark Trust might lead to all photos being submitted to the Ecocean library such that there is one global system running. No one at the conference had any information or knowledge about the PADI Project Aware / Shark Trust database.

Identify and establish funding sources to help with regional and global projects

- It was agreed that a global project approach might work best and a proposal should be prepared to get funding for satellite tags to be distributed around the world in order to determine and better understand migration patterns. The National Science Foundation was seen as a potential funding source. To achieve this, an international whale shark research project steering committee was established to produce a proposal. The committee to be led by Robert Hueter (Mote Marine Laboratory, USA), was formed with the participation of the following people: John Stevens (CSIRO, Australia), Mark Meekan (Australian Institute of Marine Science, Australia), Rachel Graham (Wildlife Conservation Society, USA), Jennifer Schmidt (University of Illinios, USA), Brad Norman (Ecocean, Australia), Deni Ramirez-Macias (Department of Fisheries, Mexico), Geremy Cliff (Natal Shark Board, South Africa), David Rowat (Marine Conservation Society, Seychelles), Sarang Kulkarni (Reef Watch Marine Conservation, India), Volker Bassen (East African Whale Shark Trust, Kenya), Jason Holmberg (Ecocean, USA), Michelle Press (Florida Museum of Natural History, USA), Otto Gadig (Universidade Estadual Paulista, Brazil) and Michel Vely (Megaptera, Djibouti).
- Delegates agreed that a presentation be made at the Third Conference of the Indian Ocean Global Ocean Observing System (IOGOOS III) in August 2005 to assess the interest of IOGOOS in supporting the development of a project of regional collaboration.
- There was considerable interest from various funding organisations for a Pacific program and individual submissions should be made whenever possible. There is also a Wildlife Conservation Society plan for a Solomon or Fiji program, their regional people have advised that they were planning a Madagascar program;

WWF are also thought to be very interested in work in the Pacific due largely to their initial support of the research in the Philippines, this was considered an appropriate starting point.

Progress Since the Workshop

A number of initiatives since the workshop have targeted some of the discussion points presented during the workshop. Where known, these are summarised below:

Allocation of experts

Steve Kaiser (Kerzner International, Dubai) reports: Dr. Robert Hueter (Mote Marine Laboratory, USA) and Dr. John Stevens (CSIRO, Australia) will assist the Dubai Whale Shark Tagging and Monitoring Program starting in spring of 2007. The program, including the purchase of satellite tags, is a cooperative effort between the Dubai Environmental Ministry, Nakheel Environmental, Kerzner International, Mote Marine Laboratory, USA and CSIRO, Australia.

Additionally, Dr. Rachel Graham (Wildlife Conservation Society, USA) is working with NGO, Government and dive operator communities in both Honduras and Madagascar to implement whale shark research programs primarily based on photo-identification, acoustic and satellite tagging, development of sustainable encounter guidelines with stakeholders and characterisation of the tourism.

Submission of photos to Ecocean and linkage with Project AWARE and Shark Trust

Brad Norman (Ecocean, Australia) reports: Ecocean has joined forces with Project AWARE and Shark Trust, as desired at the workshop, further details are provided in the Conservation Workshop Summary.

IOGOOS III presentation

At the IOGOOS Workshop and Third Annual Meeting held in Bali, Indonesia on 9-12 August 2005 Dr. John Keesing (CSIRO, Australia) provided an overview of the outcomes of the 1st International Whale Shark Conference, described whale shark research, conservation, management and tourism in the Indian Ocean and presented a proposal for an IOGOOS pilot project for enhanced cooperation in the region. The concept of the proposal was that the projects would enhance cooperation in observations of whale sharks in the Indian Ocean and that the IOGOOS could play an oversight/coordination role, host regional meetings and encourage countries to provide necessary funding support. Priorities which could be addressed in such a project and that were common to the needs identified at the workshop and with the goals of IOGOOS are:

- Consolidating existing observations on whale shark occurrences in space and time in the Indian Ocean.
- Coordinating approaches to observation of whale sharks and data sharing.
- Determining capacity building needs to enhance and sustain the number and quality of whale shark observations in the Indian Ocean.
- Determining the highest priorities (location and time of year) for satellite tagging and opportunities to fund acquisition of tags.

Following this IOGOOS workshop, the Australian Institute of Marine Science (AIMS) and CSIRO have obtained some funding from the Western Australian government to assist with efforts to coordinate enhancing and sustaining observations of whale sharks in the Indian Ocean consistent with the proposal put to IOGOOS.

Genetic studies

Jennifer Schmidt (University of Illinios, USA) reports: Participating in the International Whale Shark Conference in May 2005 has led to significant progress towards generating a panel of whale shark microsatellite markers for population genetics studies. At the time of the conference, these studies were limited by the need to obtain larger numbers of whale shark tissue samples from many different geographic locations. “The interactions with other shark researchers that the IWSC facilitated has been enormously useful in overcoming this limitation. As a direct result of the conference, we established collaborative efforts with scientists and conservation organizations in several different countries, and these groups have contributed many samples to our study. While we previously had samples from India, Honduras, Galapagos, South Africa and Seychelles, we have now added samples from Australia, Djibouti, Singapore and most recently, Maldives. This endeavor has taken some time; all whale shark researchers are well aware of the difficulties in locating and studying these animals. With the valuable assistance of our collaborators, however, we are now poised to continue with large scale genetic analysis of global whale shark populations." (Jennifer Schmidt)

Large scale collaborative projects

Robert Hueter (Mote Marine Laboratory, USA) reports: The worldwide consortium of all whale shark researchers to study global patterns of whale shark distribution and movement was

judged to be impractical at this time. Current challenges to this ideal include limitations on resources, difficulties in identifying funding sources, and insufficient development of regional cooperation. However, multi-institutional collaborations have been developed as a direct result of the Perth meeting, and progress has been made towards the development of research proposals to fund regional studies of whale sharks. Joint efforts are continuing to develop these regional projects which, it is hoped, will lead to a follow-up to the Perth conference. At that next international meeting, integration of the various independent projects will be more feasible and the development of a joint multi-party proposal to various agencies, including the National Science Foundation, will be a more attainable goal.

Rachel Graham (Wildlife Conservation Society, USA) reports: Funding on a regional scale always presents challenges and as a result she has begun work on the use of acoustic arrays for tracking whale sharks on a small scale in Madagascar and hopes that other countries and groups will be interested in expanding the array in the Western Indian Ocean to help each country determine site fidelity patterns and timing and patterns of movements between countries and sites. More recently, Rachel obtained funding to work with Government, NGO and tourism partners throughout the Western Caribbean (Cuba, Mexico, Belize, Honduras, USA) and the Gulf of Mexico to develop a network of acoustic arrays to monitor the movements to and from the five known feeding sites and other habitats in the region. The array is now in place in Honduras, Belize, Gulf of Mexico (selected sites) with Cuba and Mexico to follow shortly. This array will be linked to the broad international acoustic monitoring effort known as the Ocean Tracking Network.

Continued regional and international meetings

Following the First International Whale Shark Conference in May 2005, a Mexican national meeting was held September 2005 in Holbox, Mexico. Regional workshops were held in Belize in September 2006 and Honduras in October 2006; both focused on the Mesoamerican Reef area. The workshop in Belize provided a forum to analyse existing and draft new whale shark observation guidelines for the Mesoamerican Reef Region and develop a draft project proposal for a regional program on whale shark sustainable management that includes research, training, stakeholder communication, implementation of best practices and policy development. The second regional meeting was arranged by the Honduran environmental agency, Secretary of Natural Resources and Atmosphere (SERNA), and the Bay Island Conservation Association (BICA). The meeting was well attended by government agencies, tour operators and researchers from Mexico, Belize and Honduras and focused on discussion regarding the creation of laws to assist with ecotourism and research.

In addition to regional workshops, it is hoped that collaboration in whale shark research, conservation and management will continue with biannual international conferences.

Planning is now in progress for the Second International Whale Shark Conference, which will be held at Holbox, Mexico on 25-30 August 2007. Further information is available at the website http://www.domino.conanp.gob.mx.

Campaign for whale shark conservation: Experiences from coastal Gujarat, India

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Abstract

The whale shark (*Rhincodon typus*) was commercially exploited on a large scale in the western Indian state of Gujarat; however, hunting of the whale shark was banned in India from May 2001, when it was placed under Schedule I of the Indian Wildlife (Protection) Act, 1972. A survey assigned by the Wildlife Trust of India to Taylor Nelson Sofres (TNS) was conducted in 2004 in Ahmedabad and Veraval to assess the awareness levels and attitudes towards the whale shark. The broad results of the survey showed that there was confusion about many aspects of the whale shark including its presence in local waters and legal protection. To dispel myths, bring about pride in the species and educate locals of the whale shark and its legal status, a campaign was devised which brought together a popular Hindu religious head, wildlife conservation non-government organisations, the government and the corporate sector. The campaign utilised testimonials from the religious head, traditional local street theatre, a life-sized inflatable model of the whale shark and various events at schools. As the campaign moved across the state, four coastal towns and the former capital of the state adopted the whale shark as the city's mascot. This paper describes the ongoing campaign and experiences from using various indigenous campaign tools in coastal towns of Gujarat from January 2003 to March 2005.

Keywords: whale shark, awareness, conservation, pride, Gujarat

1. Introduction

The whale shark (*Rhincodon typus),* listed in the IUCN Red List of Threatened Species (Norman, 2000), was threatened by large-scale commercial exploitation off the coast of Gujarat, India (Hanfee, 2001). The state of Gujarat is located on the west coast of India, spread between latitudes 20°1' to 24°7'N and has the longest coastline (1600km) in the country, 20% of the total coastline of India (Nair *et al.,* 2003). A preliminary survey of trade in sharks and shark products in India was carried out along the coastal states of West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra and Gujarat in during the period of 1996 and 1997 (Hanfee, 2001). It was revealed that whale shark fishing had become regular in Gujarat, with the animal being targeted for meat, fins, liver, skin and cartilage (Hanfee, 2001). This is the only state where the species was found to be exploited in large numbers, with Gujarat recording 591 whale shark killings during the survey period of 1999-2000 (Hanfee, 2001). Hunting of the species was banned in India in 2001 when the species was placed under Schedule I of the Wildlife (Protection) Act, 1972 (Wildlife Protection Act, 2003).

A survey assigned by the Wildlife Trust of India to Taylor Nelson Sofres (Taylor Nelson Sofres, 2004) was conducted in 2003 in Ahmedabad, an inland urban centre, and Veraval, an intermediate fishing port, to assess the awareness levels and attitudes towards the whale shark among citizens, policy makers and fishermen. The survey established baseline measures of local peoples' knowledge of whale sharks, and then tracked changes following a year long education campaign to indicate the campaign's effectiveness. Specifically, this survey monitored the local Gujarat citizen's knowledge of:

- the presence of whale shark in the waters off Gujarat,
- the lack of danger of the species to humans,
- the legal protection of the species, and
- the occurrence of illegal hunting.

Following the initial survey, which indicated a general lack of awareness of the whale shark along the coast of Gujarat, an education campaign was launched in January 2004 as a partnership between the Wildlife Trust of India, International Fund for Animal Welfare, TATA Chemicals and Gujarat Heavy Chemicals Limited. The main objective of this campaign was to bring about an attitudinal change in the various stakeholders responsible for the decline in whale shark numbers and threats of extinction, by educating them about

the protected status of the species under the Wildlife (Protection) Act of 1972. A great variety of events and indigenous tools were used in order to achieve these aims and reach out to the local communities of the area.

This paper describes the knowledge of the local community regarding whale sharks, the education and pride campaign used to increase awareness and the successfulness of this campaign based on the increased knowledge of community members.

2. Methods

An initial survey of local community members was conducted in December 2003, following this the education and conservation campaign ran from January 2004 to March 2005 and its effectiveness was judged by repeat survey completed by Taylor Nelson Sofres in March 2005 (Taylor Nelson Sofres, 2005).

2.1 Survey methodology

The Gujarat local community's knowledge regarding whale sharks was inferred by a survey of randomly selected residents assessing awareness and attitudes. Individuals were surveyed according to age; children 8 to 14 years, young adults 15 to 24 and adults were over the age of 24, and results were subsequently pooled to represent all citizens.

As it was perceived that opinion of those in the urban cities is influential to decision makers, the survey was conducted at both one urban centre and one coastal centre. Ahmedabad, the former capital and largest city in Gujarat, is the commercial, industrial and social hub and was thus chosen as the urban city for the study. Veraval, an intermediate level seaport in Gujarat situated at the coast of the open Arabian Sea and known to be the centre for whale shark fisheries in the past, was chosen as the coastal city to gain an understanding of whale shark trade.

The sampling procedure within each centre followed the "right hand rule" as a systematic method to eliminate interviewer bias in choosing households to

survey ensuring those surveyed can be considered representative of an area. Within each housing cluster an initial house was chosen at random from an electoral roll and the house to the right of this selected as the first household, interviews then continued in this right hand direction, turning right at the end of a housing row if needed, until the specified number of interviews is achieved.

The survey was given verbally as a series of questions. Firstly, respondents were asked whether they had heard of the whale shark, which is referred to in this paper as 'aided awareness'. Following this, awareness of the respondents was noted after being shown pictures of the whale shark, referred to as 'picture aided awareness'. Respondents were additionally asked to reply yes or no to whether they believed the whale shark to be dangerous to humans, found off the coast of Gujarat, protected by law, and fished in the waters of Gujarat.

2.2 Campaign methodology

The initial survey revealed that members of the Gujarat community had limited knowledge of fundamental aspects of the whale shark, calling for a vigorous campaign to:

- educate the citizens about the world's largest fish found off their shores,
- educate the citizens of the protection status of the whale shark,
- bring about awareness that this species is exploited through fishery, and
- generate pride in the whale shark.

The long-term conservation goal of this operation was to create admiration of the whale shark through a "Pride" campaign, thus bringing about increased participation in the conservation process and ensuring the long-term survival of the species rather than continued fishing. Such a state level pride is felt for the Asiatic Lion (*Panthera leo persica*) and has proved beneficial, it is hoped this campaign will do the same for the whale shark in Gujarat.

The campaign was devised using a combination of various tools aimed at specific audiences; a conservation message in religious discourses, a life-sized inflatable replica whale shark (Fig. 1) and a street play in the local language, each in their own way contributed in combination with other measures to reach a target audience. Various government departments, non-government organizations (NGOs)[1] and stakeholders were effectively involved in the campaign at all events,

[1] NGOs: Centre for Environmental Education (CEE), Gujarat Ecological and Educational Research Foundation, Ahmedabad Nature Lover's Association (ANALA), Vidyanangar Nature Club, Surat Nature Club, Sun Adventure, NEEDS, Comet Media Foundation, and Visnagar Adventure and Nature Society

Figure 1. The replica inflatable whale shark used in the education and conservation campaign

thereby creating a sense of ownership. This also effectively brought about enforcement at the decision maker level.

2.2.1 The religious touch

India is a culturally rich and diverse country, with a number of religious heads popularizing religious beliefs and influencing the attitudes of their followers. The "Save the Whale Shark Campaign" was launched involving the popular religious leader Morari Bapu in Ahmedabad in January 2004, and was the first time a religious leader had championed a wildlife cause in the country. This generated tremendous media interest and received wide coverage in all newspapers. Morari Bapu on his part spoke about the whale shark in his discourses in the state sensitizing the people towards the whale shark and its conservation. On the emotional front, he equated the whale shark as the pregnant daughter coming home for the birth of her child, as is the custom in most families in India, promoting a desire to protect the animal. The traditional values of hospitality and compassion to the migratory fish were also preached, based on Indian mythology of a fish being one of the incarnations of the God of Creation representing human eyes.

2.2.2 The street performance

A street play was used as a medium to spread the conservation and pride message to the coastal villages with information on the legal status and conservation issues woven into a lively 20-minute performance. The theme revolved around the pregnant daughter Vhali coming home, creating an emotional bond between the people of Gujarat and the fish. Vhali means "the loved one" in the local Gujarati language and the mere usage of this term has gone a long way in portraying the gentle nature of the fish. Twenty-eight street plays were enacted covering 14 fishing villages/towns which were known to be exploiting the whale shark[2], exposing over 10000 people to the message.

2.2.3 The inflatable whale shark

A 45ft life-sized inflatable model of the whale shark was created in April 2004 and used in all subsequent public events, generating a large amount of interest. This model was displayed at 25 different locations including schools and public functions, creating a visual equivalent communicating the size of the whale shark to those who may never have seen a live one.

2.2.4 The whale shark fun fair and outreach program

Various games based on a whale shark theme were designed in collaboration with the Centre for Environmental Education in Ahmedabad to disseminate information to school children. In addition to the interactive games, painting competitions and presentations were organized by the whale shark campaign team in collaboration with local non-government organisations. These activities were taken to 70 schools in 10 districts[3], reaching over 7000 children.

[2] Villages/towns: Byet Dwarka, Dalda, Rupen, Dwarka, Porbandar, Madhavpur, Sutrapada, Veraval, Mangrol, Khodinar, Diu, Wanakbara, Muldwarka, Junagadh (inland town)

[3] Districts: Ahmedabad, Vadodara, Bhavnagar, Surat, Nadiad, Anand, Kachchh, Visnagar, Jamnagar and Diu

2.2.5 Release of a short film

At a public function in the city of Ahmedabad, a special postal cover was released and a 15-minute film on the whale shark campaign was launched. The documentary was designed to showcase the docile nature of the whale shark and introduce the concept of whale shark tourism to generate interest among policy makers.

3. Post Campaign Results and Discussion

3.1 Awareness of the whale shark's existence

Table 1 indicates the increase in aided and picture aided awareness of whale sharks of all citizens is attributed to the increase of 10% and 14% in children and 5% and 7% in young adults, as that of adults did not significantly alter for either attribute.

Table 1. Local knowledge of whale shark existence.

	All citizens		Children		Young Adults		Adults	
	2004	2005	2004	2005	2004	2005	2004	2005
Aided Awareness (%)	64	68	52	62	72	77	66	65
Picture Aided Awareness (%)	72	79	62	76	80	87	73	75
n	425	336	125	96	124	111	176	129

These results suggest that the campaign events made more impact on the younger community than that of adults. It is most likely that awareness of the whale shark is greater when aided by a picture as individuals who have seen the animal did not previously know what it was. Results should be interpreted with caution as it is possible that high awareness levels may be attributed to respondents referring to sharks or whales in general, rather than the specific 'whale shark'.

3.2 Danger of the whale shark

Following the education campaign, the survey saw only a 3% reduction in the adult's perception that whale sharks are dangerous to humans, whereas the percentage of children with this view reduced by 25% (Table 2), indicating that the children gained the most from the campaign.

It is believed that local citizens who perceived the whale shark to be dangerous, did so due to the gigantic nature of the world's largest fish; the lessons incorporated into the community campaign to educate have been successful in terms of adjusting this view.

Table 2. Perceptions on the danger of the whale shark to humans.

	All citizens		Children		Young Adults		Adults	
	2004	2005	2004	2005	2004	2005	2004	2005
Dangerous (%)	53	46	74	49	45	44	47	44
n	245	336	58	96	83	111	104	129

3.3 Whale shark presence in Gujarat

The campaign was incredibly successful in terms of educating local residents that the whale shark migrates to the waters off the coast of Gujarat; for all age groups the knowledge of this significantly increased (Table 3).

Table 3. Knowledge of whale shark presence in Gujarat waters.

	All citizens		Children		Young Adults		Adults	
	2004	2005	2004	2005	2004	2005	2004	2005
Knowledge (%)	18	32	7	24	23	30	20	36
n	157	336	41	96	52	111	64	129

3.4 Legal status of the whale shark

The majority of the citizens believe the whale shark is not yet protected legally; however awareness regarding this increased significantly following the year long campaign, by 16% for children and 24% for adults (Table 4).

3.5 Whale shark fishery

The majority of the citizens were also unaware about the practice of killing the whale shark, with only 23% of children and 31% of adults recognising this, as shown in Table 4. Awareness did not increase significantly in adults, but did so for the children of the community following the education campaign (Table 4), indicating again that the children were more responsive to the campaign.

Table 4. Perceptions of the legal status of the whale shark and practice of illegal fishing (n).

	All citizens		Children		Young Adults		Adults	
	2004	2005	2004	2005	2004	2005	2004	2005
Protected Legally (%)	24 (157)	42 (336)	24 (41)	40 (96)	29 (52)	44 (111)	19 (64)	43 (129)
Illegal Fishing (%)	31 (245)	36 (426)	23 (58)	34 (127)	39 (83)	40 (127)	31 (104)	32 (172)

3.6 Impact of the pride and conservation campaign

The survey results clearly illustrate that the majority of citizens are not familiar with the whale shark. Although the campaign increased these levels for all aspects of existence, legality and hunting, it remains that the majority of the community have not been affected. The activities of this education and conservation campaign not only need to continue but be more varied and far reaching to continuing achieving its goals.

The involvement of the religious leader in the campaign drew tremendous media attention, once regional media had been made familiar with the whale shark further events needed minimal introduction. The street performance incorporating use of the life size inflatable whale shark had very high appeal among the community members along the coast. It was found that this form of education worked best in rural areas where people were inclined to participate as a source of entertainment. For children, the display of the inflatable whale shark and games revolving around the animal worked well at attracting their attention and the dissemination of information. The impact on the younger members of the community is evident in all results (Tables 1 to 4), with greater learning shown for this age group than any other. These activities will continue to be utilised in the future to educated more school children. The display of the inflatable whale shark at major functions was a great success wherever it was displayed, and this form of information dissemination was cost effective compared to other means.

As a direct outcome of the street play, fishermen who had never seen a live whale shark saved an individual accidentally entangled in October 2004 by cutting gill nets to the financial loss of the fishermen[4]. Subsequently, there were unconfirmed reports of five whale sharks being released by fishermen up to March 2005. In addition, the pride brought about by the campaign resulted in four towns along the coast, Porbandar, Dwarka, Okha and Diu, and an inland city, Ahmedabad adopting the whale shark as the city's mascot.

Finally, the involvement of policy makers at all events helped sensitize them to the need for conservation. As a result of this, the Gujarat State Forest Department and the Coast Guard have created a timetable to patrol the seas regularly to monitor any illegal poaching. The networking with various non-government organisations in the state helped spread the message as part of their activities. It was with the help of this network that within a short time and with limited resources, the pride and conservation campaign could reach eight districts of the state.

[4] For more information: www.wildlifetrustofindia.org/html/news/2004/041006_whale_shark.htm

Acknowledgements

In our endeavor to save the whale shark and instill pride in the citizens of Gujarat, we acknowledge the following: Morari Bapu for agreeing to be associated with the whale shark campaign and for propagating the message of conservation as a brand ambassador; Tata Chemicals Limited and the enthusiastic volunteers for partnering the campaign and enabling the campaign aims to move towards conservation goals; Gujarat Heavy Chemicals Limited for funding the campaign; the Gujarat State Forest Department for their active support for the campaign; the Coast Guard for taking the campaign through their community interaction programs and support of campaign events; GEER Foundation (the nodal agency for the National Green Corps) for their platform to spread the message to their network of schools; Centre for Environment Education for devising the games based on the whale shark theme and partnering the whale shark fun fair; the heads of the municipal councils of Porbandar, Diu, Dwarka, Okha and Ahmedabad for adopting the whale shark as their city's mascot; Jayantibhai Shah for establishing the initial contact with Morari Bapu; Nirmala Joshi for the storyline of the street play; Manish Patadia and his team for implementing the street play; Raju Thakur for his enthusiastic involvement in all aspects of the campaign; and the various local NGOs who conducted the campaign in their areas of operation.

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Conservation efforts of the East African Whale Shark Trust in Kenya

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Abstract

While it is known that the highly migratory nature of whale sharks results in the world's largest fish being found in the waters of Kenya, minimal research has been conducted into their distribution and abundance along the Kenyan coast. The whale shark is listed on Appendix II of the Convention on International Trade in Endangered Species (CITES) and the Convention on Migratory Species (CMS), however the species is not protected by law in Kenya and whale sharks fishing remains unchecked. The East African Whale Shark Trust (EAWST) was established in 2005; it is a non-profit organisation concerned with the conservation and research of the whale shark. This paper describes what is presently known about whale sharks in Kenya and the goals of the EAWST.

Keywords: Kenya, whale shark, conservation

1. Introduction

Whale sharks (*Rhincodon typus)* are found across the globe, including the waters of Kenya (UNEP, 1998; Norman, 2000; Compagno, 2001). Presently, there is very limited published information on whale sharks in Kenya, with no specific scientific research on distribution or abundance. In 1994, the IUCN and Kenya Wildlife Service conducted aerial surveys along the Kenyan coast to determine the occurrence and distribution of dugongs, turtles and cetaceans (Wamukoya *et al.*, 1995). This study also revealed sightings of approximately 60 whale sharks clustered along the coast with a higher frequency of sightings in northern waters and conservatively estimated the population to be 219 at the time (Wamukoya *et al.*, 1995; Colman, 1997).

Personal observation indicates that in recent years there has been a significant increase in the number of whale shark sightings along the Kenyan coast. Whale sharks are observed throughout the year, with the peak season in abundance being between the months of October and April. Whereas ten years ago 20 to 30 whale sharks would be sighted in a year, it is now not uncommon to see 20 a day during the whale shark peak season. Due to the lack of scientific research in the area it is not known what has caused this increase in whale shark abundance, however, local residents speculate it may be the result of an increase in mantis shrimp populations.

The increase in whale shark abundance along the coast of Kenya has resulted in the species becoming targeted; at present this industry remains unchecked. Fishing in Kenya is regulated by the Fisheries Department under the Fisheries Act, but this is poorly enforced (Obura *et al.*, 2002). The local fishing community in Kenya use the oil from whale shark liver to protect their fishing boats from rot and international demand for the product is growing. It has been anecdotally reported that a whale shark liver can be sold for more than US$170. Further, the fins fetch between US$80-130 per kilo (dried) and are in high demand in oriental cuisine.

In addition, perhaps the greatest threat to whale sharks in Kenya is the use of traditional mesh nets used by local fishermen to capture other fish species. It is not uncommon for whale sharks to get unintentionally caught and due to the cost of these nets being several months income to a fisherman, they cut the whale shark to remove the tangled portion in order to save their net, most often resulting in death. More information on this issue can be found at www.giantsharks.org.

The East African Whale Shark Trust (EAWST) was founded in 2005 in response to the increased whale shark population along the Kenyan coast and increased interest from the tourist sector. This non-profit organisation is the first whale shark conservation project of its kind along the Kenyan coast and aims to raise awareness and promote protection of the whale shark. The EAWST is operating from Aqualand Watersports Centre on Diani/Kinondo Beach in southern Kenya. The Diani–Chale coral reef area supports local indigenous fishing communities and an active tourism industry (Obura *et al.*, 2002). A National Marine Reserve was declared in 1994 under the

responsibility of Kenya Wildlife Service, within this designation traditional forms of fishing were permitted (Obura *et al.*, 2002). Declaration as a Marine Protected Area was stalled due to strong resistance from the fisher community whose perception was that they would lose their fishing grounds (Muthiga, 2003).

This paper outlines the goals of the East African Whale Shark Trust, the progress made thus far and the next steps to be taken. More information can be found on the EAWST's website http://www.giantsharks.org.

2. Goals of the EAWST

- To establish a permanent database for collecting and analysing the environmental and ecological parameters of the whale shark population size, movements and behaviour in the region, thus providing data to substantiate the decision making process in regards to eco-tourism, fisheries, conservation and protection both locally and regionally;

- To set up a center in order to conduct detailed research of the whale shark through a system of satellite tagging and tracking, collecting blood specimens for genetic tracing and close observation/filming in order to add to the world-wide knowledge base;

- To create an awareness among local fisherman through education as to the value of the whale shark both to the marine life ecosystem and to the tourist industry, including how they can benefit personally as ecotourism guides and how money raised can be directed back into the local community;

- To educate young Kenyans through a fun and informative program at local schools with the aim of promoting local interest and pride in the whale shark;

- To draft a whale shark sighting report form to be distributed to all local dive schools and fishing boat operators; eventually working closely with other whale shark organisations in order to gain a better understanding of whale shark migration patterns, distribution and feeding habits;

- To provide accredited tourism activities to visitors incorporating education, such as safaris affording the opportunity to swim, snorkel and dive with whale sharks following approved guidelines;

- To arrange sponsorships and funding from different environmental groups through sales of the EAWST's whale shark DVD and "adopt a whale shark" projects;

- To handle the collection of funding/sponsorship in the correct way, investing the revenue back into the EAWST.

3. Trustees of EAWST

Mr. Jan Westin, Founder of Universeum, Sweden
Mr. Carey Ngini, Corporate Executive, Kenya
Mr. Torben Rune, Managing Director, Southern Cross Safaris, Kenya

Ms. Jeni Kenyatta, PR Coordinator, Kenya

4. The Way Forward

The EAWST is currently planning marketing and fundraising campaigns involving the local community in order for funds to be raised to allow continued work of the Trust. In addition, film teams from Germany and Sweden visited the EAWST to film documentaries in November and December 2005, and a further documentary will soon be produced locally. Furthermore, contact with other whale shark societies has been made, in particular The Whale Shark Society based in the Seychelles and Hubbs-Seaworld Research Institute, USA. Steps are in place to begin the implementation of our goals, information regarding education issues can be found in Njonjo (this volume). Future projects include an annual research expedition with Hubbs-SeaWorld Research Institute, a volunteer program to aid education and research and several varied awareness campaigns aimed at the local community and tourists.

4.1. Whale shark research

With only a few dedicated research centers around the world, there are many gaps in our knowledge of whale sharks. Fascination is growing however, and it is crucial for research centers to liaise with others to share data and create a wider knowledge base. The EAWST provides a research centre for collecting and analysing data on the local whale shark population, its habits and movements.

Research will be carried out by the EAWST, together with Universeum and Chalmers University, both based in Sweden, with a focus investigating the increase in whale shark numbers in Kenyan waters. The design of satellite tags will be incorporated into the relevant doctorate program, which is of particular benefit to the EAWST given one satellite tag cost around US$4000 and is only expected to last approximately one year. In addition, scientists from

the Hubbs-Seaworld Research Institute in San Diego, USA visited the EAWST headquarters in November 2005 to initiate a satellite tagging program that will continue annually.

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Community initiative projects of the East African Whale Shark Trust

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Abstract

The East African Whale Shark Trust (EAWST) in Kenya was established to increase awareness and conservation of the whale shark. This is to be achieved by various research and education campaigns, with the education initiatives being designed specifically to target different stakeholders. Programs aimed at fishermen will focus on alternative fishing techniques, ecotourism and socio-economic aspects, while school children, people recently completing high school and tourists will be exposed to relevant activities to promote knowledge and conservation.

Keywords: Kenya, whale shark, conservation, education, community participation

1. Introduction

There is a local legend in East Africa that when God created the whale shark he was so pleased that he gave his angels handfuls of gold and silver coins to throw down onto its back, this is why it is called *papa shillingi* in Kiswahili, which translates as “shark covered in silver shillings”. Most fishermen talk at length about whale shark legends, in particular that if a fisherman is lost at sea the whale shark, as king of all sharks, will keep them safe and bring them home, protecting them from all other sharks.

Information concerning the current knowledge of whale sharks in Kenya is described in Bassen (this volume). The whale shark (*Rhincodon typus*) is listed on Appendix II of the Convention on International Trade in Endangered Species (CITES) which Kenya is a party to, requiring trade of whale shark products to be monitored (see www.cites.org for more information) and on the IUCN red list of threatened species (Norman, 2000). However, whale sharks are not protected in Kenya and are caught both unintentionally and intentionally, by traditional and commercial methods.

The local dug-out canoes used by the fishermen in Kenya are not much bigger than the average whale shark, and in the past these beautiful fish have been treated with a mixture of fear and respect particularly because of their size. Today however, it is well known that whale sharks are harmless to humans and easy to catch, even in a dug-out canoe. Whale shark fishery per se is not a widespread problem in Kenya, despite the alarming trend among local fishermen and fishing tycoons to fish even our most precious resources. However, there have been anecdotal reports of whale shark hunting in northern Kenya, near the Somali border and the industry remains unchecked. With the high value placed on its meat, fins and liver, coupled with the ever increasing pressures of poverty, the whale shark is at risk of becoming a targeted fishery species in these waters.

The East African Whale Shark Trust (EAWST) hopes to prevent the targeting of whale sharks by raising awareness and consciousness. The EAWST works hand in hand with other regional organisations, with the ultimate aim of attaining increased protection of the world’s largest fish. Further details of the Trust are provided in Bassen (this volume).

The most common problem along the Kenya coast regarding whale shark conservation is the traditional use of large mesh nylon drift nets which result in the animals being caught unintentionally. These fishing nets cost around US$420, and with the average fisherman earning the equivalent of US$100 - 300 per month, locals are not inclined to lose their net to save a whale shark. The East African Whale Shark Trust hopes to work with the local fishermen in promoting whale shark conservation, through improved fishing methods and education initiatives. In addition, the fishing communities will have a vested interest in the EAWST’s success because a proportion of the revenue will be channelled back into the local community.

Furthermore, the EAWST aims to raise general awareness of the whale shark and promote moves towards protection in Kenya by education

campaigns designed for specific audiences. This paper describes the initiatives of the EAWST aimed at fishermen, local residents and visitors.

2. Initiatives of the EAWST

2.1 Fishers initiative

The goals of the initiative aimed at fishermen are:

- to educate fishermen of the long term value of the whale shark;
- to conduct regular meetings with the fishermen to canvass their concerns so that the EAWST can help them financially with healthcare, school fees and similar needs, with the aim of forming good relations;
- to distribute forms to the fishermen to report whale shark sighting and use them to further distribute for the EAWST;
- to promote whale shark safaris with fishermen as guides;
- to encourage the eco-friendly sale of whale shark curios such as whale shark carvings.

Towards this first goal, education will highlight the special part whale sharks play in local folklore. For the young, this will be advertised as something popular; for the old as something of which to be very proud. There will be a special emphasis on the fact that the local people have lived alongside the whale shark for centuries and that there is a great deal that they can teach the EAWST researchers. Some of the most successful community projects in Kenya have worked because they are marketed as requiring collective expertise. Here, the EAWST endeavours to be perceived as “the fishermen’s trust”.

Reporting of whale shark sighting, the sale of whale shark carvings and work as whale shark tourism guides will create direct revenue to the local fishermen. Additionally, the EAWST will redirect a proportion of its funds back into the local villages making it a community project.

Local fishermen are eager to talk about whale sharks and possess impressive knowledge about whale shark movement. Many say they can “smell” a whale shark and know the moment they look at the sea and weather conditions where the whale sharks will be. The EAWST has translated questionnaires and sighting forms into the Kiswahili language to be further distributed.

2.2 Education initiatives

Due to the range of visitors to the Kenya coast, the EAWST will offer different education programs in an attempt to engage everybody. In regard to this, the EAWST goals are:

- to educate every child and visitor to Kenya about the whale shark;
- to offer different education packages for local schools and visitors

For the local schools the EAWST hopes to incorporate whale shark study as part of the science curriculum including a field trips and underwater footage presentations. Children tend to remember things that are made real to them as well as things that are fun. It is anticipated that they will love learning about the biggest fish in the ocean and having an opportunity to see them in real life.

For gap year students, that is people who have completed high school but take a year’s break from studies before university, education includes the viewing of whale shark documentaries and a PADI SCUBA diving course specialising in whale shark diving. Further, the EAWST is fortunate to have strong ties to Camps International and Camp Kenya, companies offering gap year students an opportunity to come to Kenya and work with local schools in activities such as building and painting classrooms. These students also have the opportunity to work on a specific marine project; the last project undertaken was focused on coral conservation. The EAWST aims to start whale shark awareness programs as part of the marine project work offered to the gap students.

Tourists will be educated about whale sharks through a range of initiatives including whale shark safaris to interact with the animal and an intensive accredited educative session including the PADI whale shark specialty for divers course.

The overall aim, in regards to ecotourism, is to raise awareness and heighten consciousness towards the conservation of the whale shark.

3. Problems Ahead

The primary threat to whale sharks in Kenya is “netting”, the traditional use of large mesh nylon drift nets moored to the reef by local fishermen, which often results in whale sharks becoming entangled. When this occurs the whale shark is cut to free the net without damage, rather than the other way around due to the high cost of the net to the fishermen. Additionally, whale sharks are targeted by commercial fishers, fuelled by the high demand for whale shark meat, fins and liver. There is very limited law enforcement in Kenya regarding the fishery industry (Obura *et al.*, 2002) making it

difficult to ensure that these commercial fisheries abide by CITES. More information on this issue can be found at www.giantsharks.org.

Additionally, as interest in whale sharks grows rapidly and the number of boat operators increase, whale sharks are at risk of injury from contact with propellers. A “code of conduct” for boat operators and tourists needs to be developed to ensure whale sharks are protected in Kenyan waters. Such management has proven effective for the whale shark ecotourism industries of many areas, such as Ningaloo Reef, Australia (Colman, 1997), Donsol, Philippines (Quiros, 2007) and Bahia de los Angeles, Mexico (Cárdenas-Torres *et al.*, 2007).

4. The Way Forward

In order to make progress towards whale shark conservation, the next steps for the East African Whale Shark Trust are to:

- Establish sustainable education programs;
- Establish a managed ecotourism industry;
- Raise funding for conservation, research and satellite tracking devices;
- Continue long term monitoring and sighting programs;
- Educate local fishermen on whale shark friendly fishing methods; and
- Create legislation to make whale shark hunting illegal.

Ultimately, the EAWST would like to make whale shark hunting illegal in Kenyan waters. More short term goals include establishing sustainable education programs for visitors, tourists and school children. In addition, the EAWST has launched a whale shark safari which embraces the concept of ecotourism, it is hoped this ecotourism industry will succeed and prove a better alternative to whale shark fishery for the local community. There are currently monitoring and whale shark sighting programs in place, with the local stakeholders working together with some of the main operators. A workshop has been established by the EAWST, where local fishermen are introduced to more environmentally friendly fishing methods, this is specifically aimed at ending the use of traditional drift nets. The EAWST continues to work together with the local community to ensure everyone is involved and a part of the conservation process.

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Australian Government conservation and management of whale sharks under the *Environment Protection and Biodiversity Conservation Act 1999*

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Abstract

The whale shark (*Rhincodon typus)* is listed as a vulnerable species under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Australian Government's jurisdiction over the whale shark extends 3 nautical miles from the Australian coastline to the outer edge of Australia's Exclusive Economic Zone (EEZ), known as the 'Commonwealth marine area'. Within this jurisdiction, the Australian Government has responsibilities for the conservation and management of whale sharks as set out in the EPBC Act. The Australian Government is also responsible for meeting Australia's international obligations with regard to whale sharks. This paper outlines the various tools available to the Australian Government for protecting whale sharks, and describes key initiatives, including threat-based recovery planning, and domestic and international recovery actions.

Keywords: Australia, government policy, management, whale shark

1. Introduction

Under the United Nations Convention on the Law of the Sea (UNCLOS), Australia has rights and responsibilities over 16 million square kilometres of ocean - more than twice the area of the Australian continent. The Commonwealth marine area includes areas beyond the coastal waters of each State and the Northern Territory, to the limits of Australia's Exclusive Economic Zone (EEZ). The EEZ extends 200 nautical miles (approximately 350 kilometres) from the coast. In some areas, the Commonwealth marine area also covers the continental shelf and slope, beyond 200 nautical miles. It also includes the waters in the EEZ around the Australian Antarctic Territory and Australia's External Territories, such as Norfolk, Christmas, Heard and Macdonald Islands.

Within the Commonwealth marine area live thousands of marine species, some of which are unique to Australia and all of which contribute to making Australia one of the most biodiversity rich of the developed countries. The Australian Government uses the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to protect and manage Australia's threatened, migratory and marine species within this area. Under the EPBC Act, the conservation and management of threatened marine species broadly involves:

- determining the threats faced by marine species;
- preventing, mitigating and/or managing those threats; and
- supporting the recovery of the species until they can be removed from the EPBC list of threatened species.

The Australian Government's long-term strategy for the recovery of threatened marine species includes scientific research, community education and awareness, partnership building, and working with relevant industries and other stakeholders to achieve practical species recovery outcomes. Additionally, using international treaties, agreements, and conventions, the Australian Government works cooperatively with other countries to ensure that migratory species are protected across their range.

2. Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides a legislative mechanism to protect listed threatened, migratory and marine species within Commonwealth areas. Under the EPBC Act, threatened species are listed under different categories, ranging from conservation dependent, vulnerable, endangered, critically endangered, extinct in the wild, to extinct. Migratory species listed under international agreements to which Australia is a party are included in a migratory species list under the EPBC Act. Whale sharks are listed as both vulnerable, and migratory under the EPBC Act.

Further information on the EPBC Act is available from http://www.deh.gov.au/epbc/about.

The EPBC Act affords protection to whale sharks by providing the species with legal protection, assessing potential impacts on whale sharks from Commonwealth managed and commercial export fisheries, assessing potential impacts on whale sharks from proposed actions, creating Marine Protected Areas (MPAs), and by requiring the Australian Government Minister for the Environment and Heritage to make a recovery plan for the species.

2.1 Permits

Under the EPBC Act, it is an offence to kill, injure, take or trade a whale shark in a Commonwealth area without a relevant permit issued by the Australian Government Minister for the Environment and Heritage. A permit would only be issued for activities that contribute significantly to the conservation of the species, or for actions that would not adversely affect the species, and that are in accordance with the recovery plan for the species. For example, researchers intending to attach a satellite tag to a whale shark in the Commonwealth marine area would require a permit to do so[1].

2.2 Environmental impact assessment

Under the EPBC Act, assessment and approval is required for actions that are likely to have a significant impact on a matter of national environmental significance. Matters of national environmental significance include threatened species and ecological communities, migratory species, World Heritage properties, National Heritage places, Ramsar wetlands of international significance, Commonwealth marine areas, and nuclear actions (including uranium mining)[2]. Assessment and approval is also required for actions that are likely to have a significant impact on the environment of Commonwealth land (even if taken outside Commonwealth land), and the environment anywhere in the world (if the action is undertaken by the Commonwealth). For example, the proposed development of oil drilling infrastructure near known whale shark aggregation sites may require assessment under the EPBC Act.

2.3 Sustainable fisheries assessment

The Australian Government plays a strong role in promoting ecologically sustainable management of fisheries and assessing their environmental performance, including their impact on listed threatened species, such as whale sharks. The environmental performance of fisheries managed under Commonwealth legislation, and those that are state export fisheries, are assessed independently in accordance with the Act. These assessments ensure that, over time, fisheries are managed in an ecologically sustainable way and conducted in accordance with the *Guidelines for the Ecologically Sustainable Management of Fisheries*. The Guidelines outline specific principles and objectives designed to ensure a strategic and transparent way of evaluating the ecological sustainability of fishery management arrangements[3].

2.4 Marine Protected Areas

Being responsible for the Commonwealth marine area, the Australian Government is able to create Marine Protected Areas (MPAs). Within Commonwealth waters, known whale shark aggregation sites occur in the coastal waters off Ningaloo Reef, at Christmas Island, and in the Coral Sea (Fig. 1). Ningaloo Reef, Christmas Island and the area of the Coral Sea within the Coringa-Herald National Nature Reserve and the Lihou Reef National Nature Reserve are all afforded a high level of protection through their status as protected areas under the EPBC Act[4]. Additional protection to Ningaloo Reef is afforded through its status as a Marine Park under Western Australia's *Conservation and Land Management Act 1984*[5]. As Ningaloo Reef is the largest known whale shark aggregation site in Australia, the Management Plan for the Park has specific management guidelines for the species.

2.5 Recovery plans

Under the EPBC Act, the Australian Government Minister for the Environment and Heritage may make or adopt and then implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act.

Recovery plans identify the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long-term survival in the wild of a threatened species or

[1] Further information on permits is available from: www.deh.gov.au/epbc/permits

[2] Further information on referrals, assessments and approvals is available from: www.deh.gov.au/epbc/assessmentsapprovals

[3] Further information on fisheries and the environment is available from: www.deh.gov.au/coasts/fisheries

[4] Further information on MPAs is available from: www.deh.gov.au/coasts/mpa

[5] Further information on Ningaloo Marine Park is available from: www.calm.wa.gov.au/national_parks/previous_parks_month/ningaloo.html

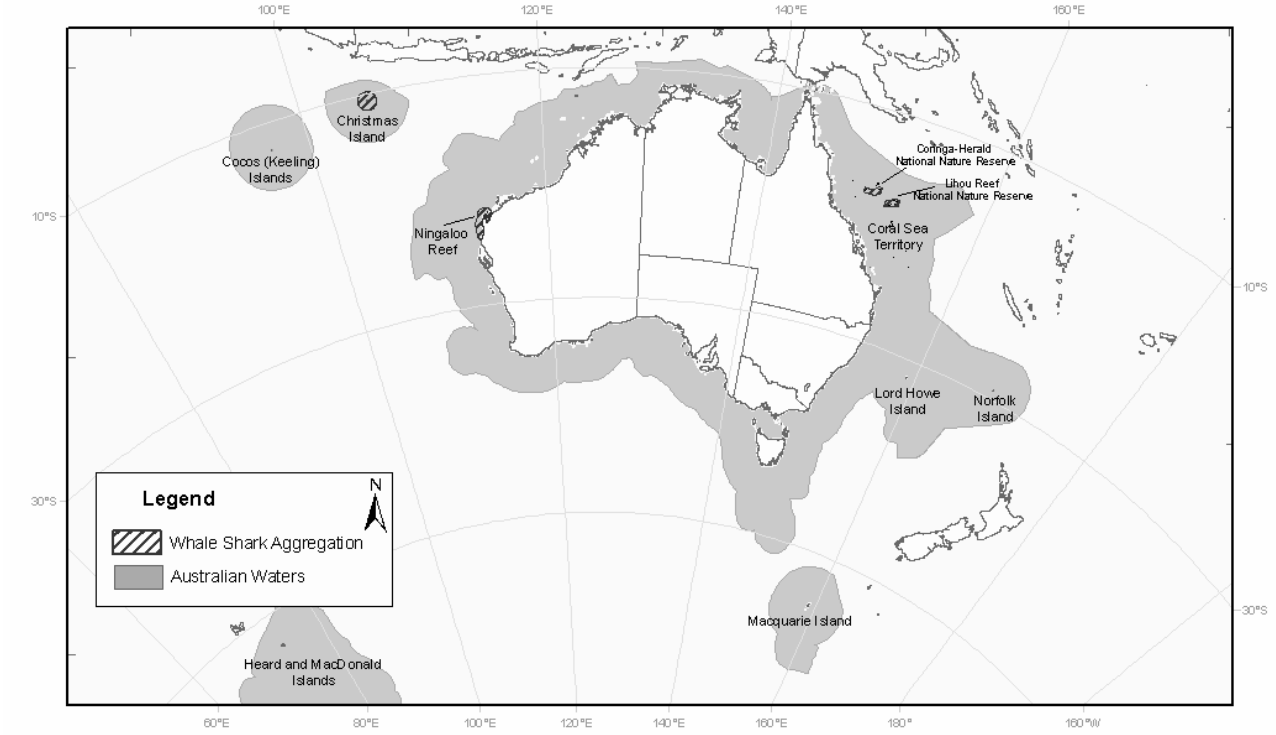

Figure 1. Whale shark aggregation sites in Australian waters (The aggregation sites on this map are an indicative distribution and do not represent the actual aggregation size or their exact location) (The Australian water boundary was derived from the Australian Maritime Boundaries Information System (AMBIS))

ecological community, and is one of the main tools used by the Australian Government for threatened species recovery.

Recovery plans are required to state what must be done to protect and restore important populations of threatened species and their habitat, as well as how to manage and reduce threatening processes. Recovery plans achieve this by providing a planned and logical framework for key interest groups and responsible government agencies to coordinate their work in the area of threatened species recovery.

3. The Whale Shark Recovery Planning Process

On 28 April 2005, the Minister for the Environment and Heritage, the Hon Ian Campbell, released the Whale Shark Recovery Plan, hereafter referred to as the Plan[6]. This is the first legislative instrument in the world specifically focused on whale shark recovery. The Plan was developed using streamlined methods to separate background biological information on the species from the statutory plan. Biological information on the species is contained in a non-statutory issues paper, so it can be readily updated with new information on the species when it becomes available[7]. The Plan was developed through a consultative mechanism providing for input of the public and other government jurisdictions in Australia.

For the Whale Shark Recovery Plan, a draft issues paper was first presented to a National Shark Recovery group for comment. This group advises the Australian Government Department of the Environment and Heritage (DEH) on how best to implement recovery plans, acting as a focal point for other shark conservation issues. The National Shark Recovery group is comprised of relevant Australian Government agencies, State Government, indigenous, industry and recreational fishing representatives, scientific experts, and non-governmental organisations (NGOs).

[6] Download the Whale Shark Recovery Plan: www.deh.gov.au/biodiversity/threatened/publications/recovery/r-typus

[7] Download the Whale Shark Issues Paper: www.deh.gov.au/biodiversity/threatened/publications/recovery/r-typus-issues

The draft recovery plan and draft issues paper were then presented to the Threatened Species Scientific Committee (TSSC). The TSSC was established under the EPBC Act, and advises the Australian Government Minister for the Environment and Heritage on the amendment and updating of lists for threatened species, threatened ecological communities, and key threatening processes, together with the making or adoption of recovery plans.

Comments from the public and other government jurisdictions in Australia on the draft whale shark recovery plan received during the comment period were very constructive and supportive, and helped finalise the contents of the draft plan.

4. Content of the Whale Shark Recovery Plan

The overarching goal of the Plan is to be able to remove the whale shark from the threatened species list of the EPBC Act. Specifically, the objective of the Whale Shark Recovery Plan is 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 Southeast Asian region, to enable population growth.

The main threat to whale sharks identified in both the recovery plan and issues paper is commercial harvesting that occurs outside of Australian waters. Following review and consideration of all possible threats, no anthropogenic threats were considered to be having an immediate impact on whale sharks within Australian waters. However, a range of other possible threats to whale sharks were considered including pollution, marine debris, boat strike, predation, disease, climate change, and direct disturbance from tourism, research or interference. None of these potential threats were considered to be having an impact on the numbers of whale sharks visiting Australian waters at present.

Given the absence of current anthropogenic threats to the whale shark in Australian waters, the recovery actions identified in the Recovery Plan are to:

1. Increase the level of cooperation with other range states, particularly in the Indian Ocean and Southeast Asian region to protect the whale shark, through engagement in multilateral fora such as the Convention on Migratory Species. Ideally increased cooperation will result in range state agreement to:
   - reduce fishing pressures on the species in the waters of other regional range states; and
   - halt the decline of the species in regional range states.
2. Monitor numbers of the whale shark visiting Australian waters to:
   - determine the rate of population change and population size by undertaking scientifically robust, regular and repeatable population surveys; and
   - identify any emerging actual impacts that will have an immediate impact on the species and thus on its recovery, and to facilitate the development of appropriate responses.

The EPBC Act requires that recovery plans be reviewed every 5 years. The performance of the Whale Shark Recovery Plan should be evaluated by a National Shark Recovery Group, who will report the results of their review to the Australian Government Minister for the Environment and Heritage, through the Threatened Species Scientific Committee.

5. Implementing the Whale Shark Recovery Plan in Australia

The Australian Government implements its domestic obligations regarding whale shark recovery through investments from the Natural Heritage Trust (NHT), a funding arrangement set up by the Australian Government in 1997 to help restore and conserve Australia's environment and natural resources. Since then, thousands of community groups and organisations have received funding for environmental and natural resource management projects[8]. The National Shark Recovery Group plays a key role in advising the Department of the Environment and Heritage how best to allocate NHT funds to help implement actions set out in the Whale Shark Recovery Plan. Possible actions may include developing a standardised population monitoring method incorporating satellite tracking, photo identification and genetic studies.

6. Implementing the Whale Shark Recovery Plan Internationally

The Australian Government has both international and domestic responsibilities with regard to whale sharks. Under the Australian constitution, the Australian Government has the responsibility to sign international conventions and enter into multilateral or bilateral agreements with other countries. Australia is signatory to a number of international conventions relevant to whale sharks,

[8] Further information on the NHT is available from: www.nht.gov.au

including the Convention on International Trade in Endangered Species of Fauna and Flora, or CITES, and the Convention on the Conservation on Migratory Species of Wild Animals (CMS).

CITES is an international agreement between Governments, which aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. There are currently 167 Parties to CITES[9]. India and the Philippines successfully listed whale sharks on Appendix II of CITES in 2002. Australia strongly supported this action by developing an identification guide for the species[10]. The Appendix II listing requires that international trade in whale sharks and their products be strictly controlled as such trade must satisfy a scientific non-detriment finding.

Australia is committed to helping CITES parties implement their responsibilities with regard to CITES-listed species, including whale sharks. For example, Australia is currently working with the Governments of India, Madagascar, the Philippines and the United Kingdom to develop standardised identification guides for CITES-listed shark species (whale shark, basking shark *Cetorhinus maximus* and great white shark *Carcharodon carcharias*). These standardised identification guides will help compliance and enforcement agencies detect illegal trade in CITES-listed sharks and shark products.

The CMS aims to conserve terrestrial, marine and avian migratory species throughout their range, and is currently supported by 89 parties. The Philippines successfully nominated whale sharks to CMS Appendix II in 1999. The Appendix II listing acknowledges that whale sharks need, or would significantly benefit from, international co-operation, and that range states in which whale sharks occur are encouraged to participate in global or regional Agreements for the conservation of the species[11].

Australia has been actively encouraging range states to take the lead on developing a regional arrangement under the CMS to enhance regional cooperation in the conservation of whale sharks. As most of the threats to whale shark occur outside Australian waters, the Australian Government believes this is the most appropriate way of progressing conservation objectives for the species, and will continue to work cooperatively with other range states to strengthen cooperation in the conservation of whale sharks.

7. Conclusion

The Australian Government is committed to the protection of whale sharks both in Australian waters and throughout the species' range. Through the legislative protection given to the species under the EPBC Act and the various international and regional agreements Australian is party to, the Australian Government looks forward to continuing its contribution to the protection of this, the world's largest fish.

[9] Further information on CITES is available from: www.cites.org

[10] CITES Identification Manual: www.deh.gov.au/coasts/publications/whale-shark-id/index.html

[11] Further information on the CMS is available from: www.cms.int

Whale shark management strategies, with the participation of local stakeholders, in Yum Balam, Mexico

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Abstract

Recently, a whale shark ecotourism industry has developed in Yum Balam, Mexico. Following rapid growth in the number of tourists participating and tour operators desiring to offer the service, a number of management strategies were implemented with stakeholder participation, in accordance with corresponding environmental regulations. The use of tourism operator logbooks has aided the evolution of management and provided basic information on the whale shark population visiting the area. Much can be learnt from such situations and these lessons are outlined.

Keywords: Mexico, whale shark, management, community participation, ecotourism

1. Introduction

Under Mexican law, there are two technical terms to describe the utilization of wild fauna: extractive use, referring to the removal of animals from their environment by means of hunting or capture, and non-extractive use, describing the means by which animals are admired or used without removal from their environment, such as tourism (eg. observation, swimming and diving). In Mexico, as in other countries where whale sharks aggregate, such as Australia (Mau and Wilson, this volume), Belize (Heyman *et al.*, 2001), Philippines (Pine *et al.*, this volume) and Seychelles (Rowat and Engelhardt, 2007), ecotourism activities are offered for tourists to interact with these iconic sharks.

Whale sharks are known to seasonally occur along much of the Mexican coastline, in particular, off the coasts of the Baja California Peninsula (Sea of Cortez, Pacific Ocean) and the Yucatan Peninsula (Caribbean Sea, Atlantic Ocean). In the northeast corner of the Yucatan Peninsula, where the waters of the Caribbean and the Gulf of Mexico merge, upwelling of cold water masses rich in nutrients cause increased phytoplankton and zooplankton production. This oceanic fertility subsequently leads to an increase in the activity of the entire food chain; thus large groups of fish, sea birds, sea turtles, manta rays, dolphins and several shark species, including the whale shark, are present. In addition, this site is located between two natural areas protected by the Mexican Government, the Yum Balam Flora and Fauna Protection Area and Contoy Natural Protected Area (Fig. 1).

The Yum Balam Flora and Fauna Protection Area was decreed by the Mexican government in 1994 and resulted in the immersion of community members in meetings, courses and workshops to increase their awareness of the importance of their relationship with nature, both in the social and economic contexts. At this site, whale sharks have been observed by local fishermen for many years, however there has never been a targeted whale shark fishery in the area. Whale sharks are known in this region as “domino”, due to the similarity of the round marks on their skin to those of the domino game pieces. In 2002, fishermen from Holbox Island, within the Yum Balam Flora and Fauna Protection Area, recognized that whale sharks could be exploited through the non-extractive use of tourism. The industry thrived rapidly and within two months the number of tourists to the area increased to approximately 1,500.

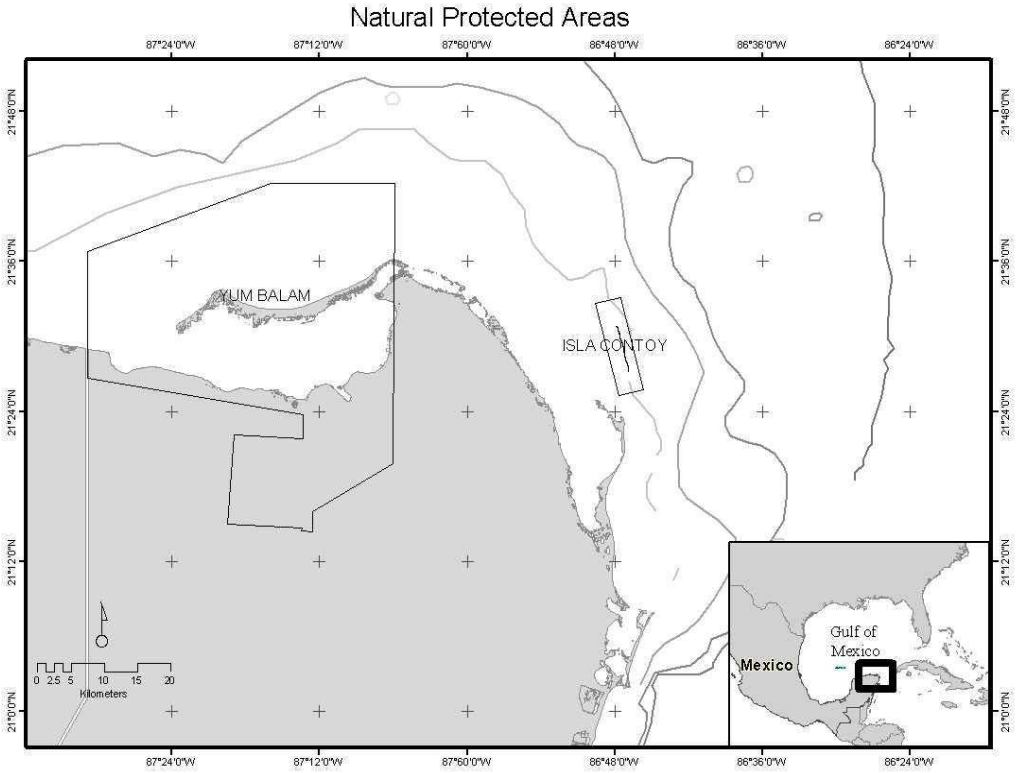

Figure 1. Yum Balam and Isla Contoy Natural Protected Areas, Mexico.

2. Management of the Ecotourism Industry

As the ecotourism industry increased rapidly and unregulated, direct impacts to the whale shark population became a concern. During swimming activities, tourists entered the water blocking the whale shark's path and very often made contact with the animal, in many instances holding the individual by the dorsal or caudal fins to ride on the shark. Concerned parties requested support from the management of the Yum Balam Protection Area and, as a result on these requests, a workshop was held in May of 2003, with the goal of defining strategies for effective management and conservation of the whale shark. The workshop was coordinated by the Secretariat of the Environment and Natural Resources (SEMAR), the National Commission of Natural Protected Areas (CONANP), WWF, the Secretariat of Tourism (SEDETUR) and the Mexican Association of Adventure Tourism and Ecotourism (AMTAVE). Participants included local authorities; experts in whale shark tourism, research and conservation; non-government organisations and local stakeholders (fishermen and tour operators) from Mexico, Belize and Honduras.

2.1 Outcomes from the whale shark workshop

The workshop identified the following points of concern:

- the improper behavior of tourists,
- the increased interest in whale shark related activities,
- the increase in requests by tourism providers to carry out the activity,
- the lack of inspection and monitoring,
- unclear legal status,
- the lack of information on the natural history of the species and its habitat, which is needed for decision making, and
- possible conflicts with other groups in the area such as fishermen.

As a result of discussions, and with the main objective being the protection of the whale sharks and the safety of visitors, the following code of conduct was established:

- activities may only be conducted during daylight hours, beginning half an hour after sunrise and finishing by half an hour before sunset,
- Holbox tourism providers will depart from North Beach and those from Chiquila will depart from North Beach Port,
- boats must be less than 12 m in length,
- maximum boat speed within the whale shark observation zone is 3 knots,
- a minimum distance of 100 m is to be kept between boats,

- the number of tourists per boat would not exceed a maximum of six people plus two crew members,
- boats will remain at a distance of at least 10 m from the whale shark,
- only 1 boat is to be associated with each whale shark, for a maximum interaction of 30 minutes,
- only two visitors with a guide are permitted in the water at any given time,
- only snorkeling and swimming are permitted (no SCUBA),
- swimmers must maintain a minimum distance of 5 m around the shark at all times,
- the use of safety vests is mandatory,
- the use of non-biodegradable sunscreens and suntan lotions is not permitted,
- the use of any apparatus that produces noise that could disturb the sharks is not permitted,
- inspection and monitoring must be implemented to assure that the code is followed,
- training is to be provided to improve the service given by tourist service providers and guides and to certify them as specialized guides.

Following the 2003 whale shark season, a second workshop took place in October that year to upgrade the code of conduct based on observed results. Two amendments were made to improve the activity and decrease risks to the sharks. Firstly, as the plankton can be incredibly dense, resulting in poor visibility (less than 3 meters), the distance kept by swimmers was reduced from 5 m to 2 m. Secondly, the number of tourists per boat, would depend on the boat size. Boats of 24 ft or less are permitted to carry 5 tourists; one additional passenger is permitted for each additional foot length to a maximum of 10 tourists on boats of 29 ft or more.

2.2 Permit system

As whale shark ecotourism activities occur both within the Yum Balam Flora and Fauna Protection Area and beyond the Mexican Territorial Sea, permits for whale shark tourism related activities must be submitted to two agencies: the General Direction of Wildlife, in fulfillment of the regulations of the General Law of Wildlife, and the National Commission of Natural Protected Areas, in fulfillment of the regulations of the General Law of the Ecological Balance and Protection of the Atmosphere within Protected Natural Areas. Both institutions adopted the code of conduct established in the workshop of May 2003, with all permit renewals subject to previous compliance. Applications for both permits are received in spring and must be renewed on yearly basis.

2.3 Training workshops and increased monitoring

To ensure compliance and performance of whale shark ecotourism activities, training has been provided to tour guides since 2004. This training includes education in safety (first aid and aquatic rescue), biology and ecology of whale sharks, snorkeling techniques and providing tourist guidance. During the first year of this program, 50 participants were involved on the courses and after examination, 24 were certified. During the training events, documents, materials and equipment were designed for both service providers and their tourists, with each participant receiving their own.

Since whale shark ecotourism commenced in 2002, the number of guides, visitors, length of the season and number of issued permits, has been registered. Table 1 summarizes this information for the period of 2002 to 2005, illustrating the growth of the industry.

Table 1. Increase in the whale shark tourism industry from 2002 to 2005.

Year	No. Permits	No. Guides	No. Tourists	Whale Shark Season
2002	0	10 Not Certified	1500	-
2003	42	24 Certified	3000	24 June-30 Sept.
2004	53	72 Certified	6593	13 May-30 Sept.
2005	90	71 Certified	9091	1 June-30 Aug.

As activities developed, surveillance became necessary and hence patrolling was established. Table 2 summarizes the inspection and surveillance actions on yearly basis, indicating which authorities were involved.

Table 2. Inspection of ecotourism activities for whale shark seasons.

Year	Inspection Events	Whale Shark Season	Participants*
2002	0	60 Days	N/A
2003	3 x 3 day inspections 6 x 1 day surveys	90 Days	7 PROFEPA 2 CONANP
2004	3 x 3 day inspections 18 x 1 day surveys	120 Days	4 PROFEPA 2 CONANP 6 SEMAR
2005	3 x 3 day inspections 12 x 1 day surveys	90 Days	6 PROFEPA 4 CONANP

* PROFEPA: Federal Government Protection of the Environment
CONANP: National Commission of Natural Protected Areas
SEMAR: Secretariat of the Environment and Natural Resources

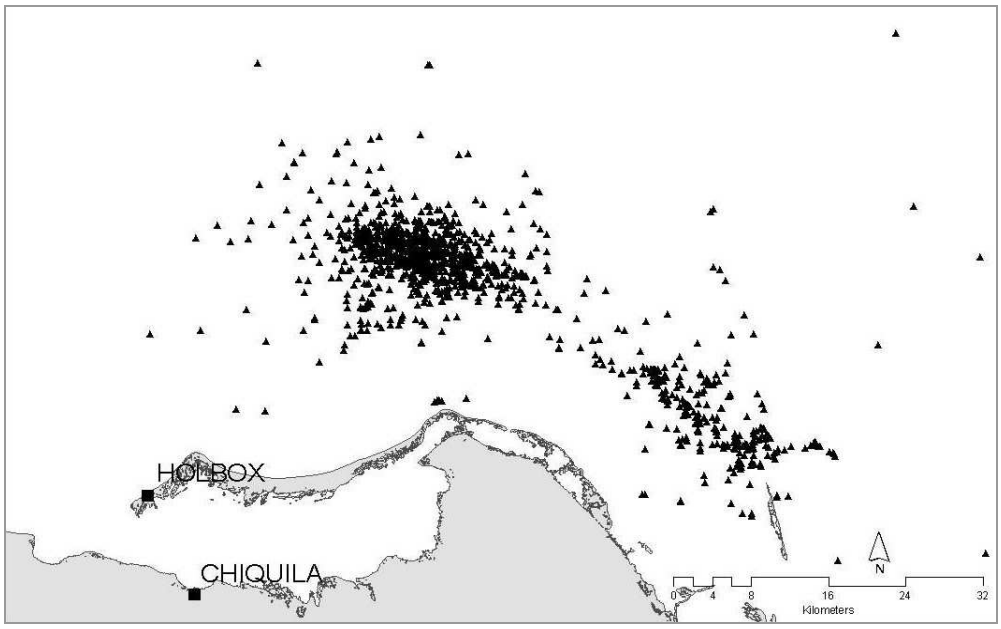

Figure 2. Distribution of whale sharks at time of observation, based on tourism operator logbooks (2003-2005).

2.4 Tourism operator logbooks

In order to collect information relating to the whale shark ecotourism industry and the whale sharks encountered, scientific data log sheets were distributed to permit holders and required to be completed for each whale shark interaction experience. These log sheets collected data regarding the sharks observed including location, sex and estimated length, and information of tourists participating including number per activity and nationality.

This data revealed that the number of whale shark tourism activities was greater on weekends than during the working week and peaked towards the end of July and beginning of August. The maximum number of boat trips made by a permit holder in a whale shark season was 52, with a minimum by another of 1 trip.

Based on information given by ecotourism providers in their log sheets, distribution of whale sharks at the time of their observation is presented in Figure 2. The total length of whale sharks observed ranged from 2m to 13m, with the most frequent being 7 m. The sex ratio of male to female sharks, where sex was able to be determined, was 1.8: 1.

In addition to capturing information pertaining to the whale sharks, the log sheets collected information regarding the tourists participating in interaction activities. Figure 3 illustrates the majority of those involved were international visitors, with small proportions from several countries.

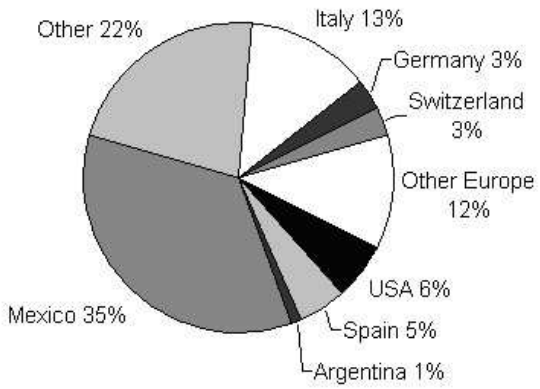

Figure 3. Nationality of tourists participating in whale shark interaction experiences.

3. Lessons Learned

The experience of newly developing ecotourism can be considered a social process which evolves as permit holders and guides become aware of the uniqueness of the activity. With time, as knowledge and experience develops, so will stakeholder understanding, especially regarding the importance of code of conduct compliance. In

order to ensure the success of this endeavor, the following must be permanently taken into account:

- the participation of all stakeholders,
- generation of biological and ecological information on the whale shark and socioeconomic information of the local communities,
- recovery of traditional knowledge,
- preference and support given to local community members,
- strengthening of legal aspects and monitoring, and
- continual evaluation and adaptation of the new industry.

4. Conclusion

The development of a new whale shark ecotourism industry in Yum Balam, Mexico, has resulted in increasing numbers of observers and thus an increasing number of tour operators. The development of training and management strategies is key to ensuring the industry is sustainable and minimizes impact to the whale shark in which it relies. Although compliance is increasing, surveillance activities should further increase in the short term due to the great demand of the activity.

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Challenges and lessons learned in setting-up a community-based whale shark ecotourism program: The case in Donsol, Philippines

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Abstract

The case in Donsol, Philippines provides insights on the challenges and lessons learned in establishing a community-based whale shark ecotourism venture. Whale shark ecotourism in Donsol came at the time when whale shark fishery in the Bohol Sea was experiencing a decline in catch and when the demand for whale shark meat was steadily increasing at the international Asian markets. In 1997, a decline of 27% in whale shark catch was observed in 5 major whale shark fishing grounds in the Bohol Sea, Philippines. On the other hand, the ecotourism based on whale shark viewing in Donsol has realized its potential for sustainable development through non-consumptive utilization of the species. It has provided economic benefits to the people of Donsol in terms of additional income opportunities to 328 local tourism front liners, new economic activities and improvement in the generation of local government revenues. Conservation measures, however, need to expand in order to improve the conservation of whale sharks and the management and rehabilitation of the entire coastal ecosystem on which the livelihood of fisherfolk depends. This means that a shift from species-based management to ecosystem-based management is necessary. The social and economic considerations of stakeholders, particularly the fishing communities who rely on coastal resources for their livelihood, are integral in sustaining conservation efforts in the area.

Keywords: ecotourism, whale shark, local government, municipal waters, stakeholders, community-based management

1. Introduction

1.1 Whale shark fisheries in the Philippines and policy development

Whale sharks, commonly known as Butanding in the Philippines, are observed in many areas of the country and were previously heavily hunted for their meat and fins. In a study conducted to asses the status of the fishery in central Visayas and northern Mindanao (Fig. 1), five sites were identified at which whale sharks were traditionally fished (Alava *et al.*, 1998). An alarming number of about 31 more fishery sites were also reported to be in existence or recently operational (Alava *et al.*, 1998). Traditional fishing grounds are not limited in areas within the Bohol Sea, but extend as far as the seas of Sulu. The fishery flourished and demand for whale shark meat and fins expanded from local and/or inter-island to national and international markets. In the mid-1990's increased demand from the Asian market resulted in increased prices for whale shark meat. In effect, this led to increased fishing pressure but decreased catch averages.

While whale sharks were butchered for their meat and fins in these areas, this was not the case in Donsol, a small fishing village in southern Luzon, an island in the Philippines (Fig. 1). In 1997 the presence of a large aggregation of whale sharks in the municipal waters of Donsol was reported to WWF-Philippines (Yaptinchay, 1999). This prompted WWF and other concerned groups and individuals to investigate the municipal waters of Donsol for the presence of whale sharks and to identify appropriate action for conservation. The initial findings revealed the potential for the community to benefit through whale shark ecotourism and this was recognized immediately by the local government unit of the town.

The following year marked the cascading of important social and political events that led to the establishment of a whale shark ecotourism program in Donsol which drastically changed the direction of whale shark conservation in the Philippines. With inputs from stakeholders, the local government unit (LGU) promptly passed a resolution declaring its municipal waters as a

sanctuary for the whale sharks, the first and only of its kind in the Philippines. The news about the presence of whale sharks in Donsol called the attention of Manila-based shark traders and the slaughter of at least 6 whale sharks in the adjacent town raised serious concerns and received media mileage resulting in the issuance of the Department of Agriculture's Fisheries Administrative Order No.193 (FAO 193, series of 1998). FAO 193 bans the taking, catching, selling, purchasing, possessing, transporting or exporting of whale sharks and manta rays, and ultimately, the establishment of a complete ban for the fishery and trade of whale sharks in the country. The ban was imposed without consultation with any communities that would have been affected. However, despite the national and local legislation in place, it is feared that whale sharks in the Philippines are still under threat due to continued strong demand for whale shark meat, fins and by-products in neighboring countries.

1.2 Opportunities in setting-up the community-based whale shark ecotourism venture

Concurrent with the media attention given to the whale sharks in Donsol, an influx of tourists occurred. At this stage, the community had no experience in tourism and the manner by which whale shark tours were operated and managed, this became the foremost concern for WWF-Philippines. There were no skilled tourism service providers; knowledge and understanding of the whale shark as a target species for conservation among the locals was wanting; the institutional arrangement over the management of related tourism was undefined; and it was unclear how to equitably share tourism revenue. Nevertheless, realizing that a carefully crafted management plan was needed, the community and LGU of Donsol lead the coordination of various sectors to implement a system that would meet the basic requirements of whale shark ecotourism.

WWF-Philippines partnered with the Donsol LGU and a local non-government organization and implemented a six-month “Whale Shark (Butanding) Ecotourism Development Project” funded by the United Nations Development Programme (UNDP). The project commenced in 1998 to investigate the social acceptability, economic viability and environmental sustainability of whale shark ecotourism. Specifically, the objectives of the project were to:

- gather baseline information on the whale sharks found in Southern Luzon to be used effectively in managing the associated resources and activities in the area;
- increase the awareness of the local community and the whole country on the conservation status of the whale sharks and the need for conservation;
- develop the local community’s capacity to properly manage the whale shark based ecotourism program and the conservation of the animals; and
- develop recommendations and guidelines for implementing a community-based whale shark ecotourism program, which will be embodied in the management plan.

2. Methods

2.1 The project site

The municipality of Donsol is part of the Province of Sorsogon which occupies the southern terminus of the Bicol Peninsula, south of Luzon Island, Philippines (Fig. 1). It has a total land area of 14,346 hectares and the most dominant land use within the municipality of Donsol is agriculture which covers an area of about 65% of the total land area. The coastal waters of Donsol are part of Burias Pass, this is a northwest-southeast oriented body of marine water that is bounded on the northeast by the Bicol Peninsula and on the southwest by the islands of Burias, Ticao and Masbate. Burias Pass is contiguous with the Ragay Gulf to the northwest and Ticao Pass to the southeast. Due to the proximity of the Burias Pass to the San Bernardino Strait, it is likely to be influenced by the flow of Pacific Ocean waters into the Philippine Islands. The total area of the municipal waters of Donsol is 27,780 hectares. Donsol is host to a population of 39,995 in its 51 barangays (villages), with 46% of the total population concentrated in its 11 coastal barangays.

2.2 Methodology

WWF-Philippines, together with the LGU of Donsol and the Donsol Municipal Tourism Council (DMTC), implemented the UNDP-assisted Whale Shark Eco-tourism Development Project for six months starting from July of 1998. The project provided a framework for community-based activities in the establishment of the whale shark ecotourism program. In 2004, WWF conducted a socio-economic study of the 11 coastal villages to determine options for coastal resource management planning. The activities undertaken were a whale shark survey, stakeholder analysis, an education campaign and a socio-economic study.

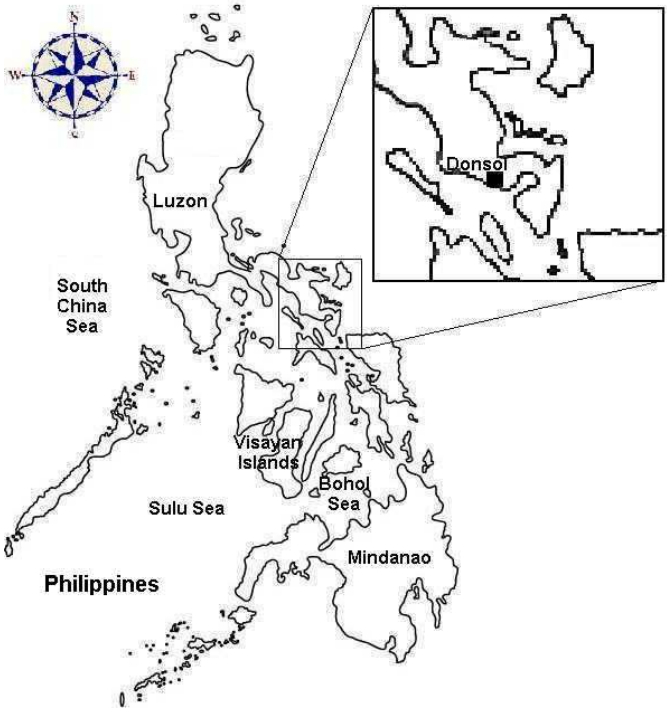

Figure 1. Location of Donsol in the Philippines.

2.2.1 Whale shark survey

Using structured questionnaires, the project team surveyed three provinces from the Bicol region and one from the eastern Visayas to determine the relative distribution of whale sharks based on encounters by local fisherfolk. The questionnaires were constructed in such a way that will gather information on whale shark seasonal migration patterns based on the frequency and regularity of sightings. Two hundred seventy (270) fishers in 13 municipalities across the provinces of Albay, Sorsogon, Masbate and Samar were randomly selected for the interview.

2.2.2 Stakeholder analysis

In a series of consultations and workshops, a stakeholder analysis was conducted to understand the sectoral interests and the possibilities and constraints of working with various stakeholders in relation to the project objectives. The process was participatory as different sectors were gathered together to identify the following: 1) sectors with stakes over whale shark ecotourism, 2) roles of each sector by legal mandate or by interests in the community, 3) resources of each sector, and 4) participation of stakeholders in the various activities required to develop a successful ecotourism program.

A series of consultations and workshops were undertaken to develop the ecotourism management plan. WWF drafted a workbook which was used as a tool in facilitating the management planning workshop with stakeholders. The workshop provided a venue for discussion of critical issues related to the proper development and management of tourism as a strategy for conserving the whale sharks in Donsol while providing a source of income for the local community.

2.2.3 Education campaign and capacity building

The project trained selected members of the fishing villages to deliver highly specialized whale shark based tourism services. The trainees were eventually organized to form the Butanding Interaction Officer (BIO) Association. A series of consultation and workshops were conducted to develop operating procedures and guidelines for proper delivery of whale shark interaction services. The Boat Operators Association (BOA) of Donsol was also part of the capacity building activities for tour delivery services.

Information, education and communication (IEC) materials were produced to increase awareness of the local community and the whole country on the present status of whale sharks and the need for conservation. A 10-minute video was produced to serve as a briefing tool for all tourists who take part in the whale shark interaction tours. It shows the entire procedure of participating in the interaction tour, lists the code of conduct that must be followed by tourists/swimmers, and informs visitors on the ecological importance of whale sharks in the marine ecosystem. The project also assisted the LGU in the establishment of a visitor center.

2.2.4 Socio-economic study

The socio-economic study mainly used interviews based on structured questionnaires for data gathering to determine social and economic profiles. A secondary data search and literature review was also conducted to supplement the available data. Data on visitor arrivals was collected from the municipal tourism office to determine the total number of visitors and the matching income generated by the LGU and other tourism front liners.

3. Results

3.1 Whale shark survey

Based on the data gathered from locals, whale sharks have been present in the study area since the 1960s. A number of respondents from each area, with the exception of Donsol, Pilar and

Sorsogon Bay, last saw whale sharks during the 1960s, suggesting that sightings were not common in these areas at the time of interview in 1998. The majority of respondents from 6 areas of a total of 13 last saw whale sharks during the year of the interview. Recent sightings in Donsol, Pilar, Sorsogon Bay and Bulan, which are located close to one another, indicate that these areas are an important sub-region in terms of whale shark presence and regularity of sightings.

At no locations were whale sharks observed all year round. Generally, whale sharks were absent for 1 to 3 of the summer months (June, July and August) in the northwest of the study area. In the southeast, there appeared to be 2 periods of absence: 1 to 3 of the summer months and 1 to 3 of the wet months (November, December and January). In Pio Duran, Masbate, Donsol, Pilar, Sorsogon Bay and Bulan, whale sharks were absent during 1 to 3 of the summer months and are present at all other times.

Whale sharks are seen frequently (daily or 3 times weekly) during the months when they are present in all fishing areas except Samar and Albay provinces. Whale sharks may be visible all day, as in the case in Pilar, Donsol and Matnog. They are generally more visible from dawn to 10am and from 5pm onwards; this phenomenon appears to be uniform throughout the entire study area.

In Donsol, 80% of the 43 respondents observed that whale sharks were present in their municipal waters. Eighty-eight percent (88%) of the respondents observed that whale sharks were present between the months of September and July, with 86% of respondents observing whale sharks daily during this period.

3.2 Stakeholder analysis

Stakeholders were categorized as belonging to the tourism industry (private companies, industry associations, tourists); government (local government units, national government agencies, special management bodies or development councils); non-government organizations and communities (Table 1).

An overwhelming willingness was demonstrated by the stakeholders to participate in the whale shark ecotourism program. A local tourism council was immediately created by the LGU in response to the perceived need to establish whale shark ecotourism. The major reasons for community interest were for personal economic interests, local income generation of the municipality, increased popularity of Donsol and local pride (Yaptinchay, 1999).

Table 1. Participating stakeholders in the establishment of whale shark ecotourism.

Interests	Stakeholders
Marketing and capacity building	Department of Tourism; Tourism councils
Research	Department of Environment and Natural Resources; WWF; University of the Philippines; volunteers
Implementation and local legislation	Local government units; Fisherfolk
Policies and law enforcement	Department of Agriculture – Bureau of Fisheries and Aquatic Resources; Municipal Fisheries and Aquatic Resources Management Council (MFARMC); Philippine National Police; Department of Defense; Coast Guard
Fund generation	WWF; UNDP; LGU
Industry	Resort owners; boat operators; tourism councils; tour operators

Partnerships were built so that expertise and knowledge for project implementation could be shared. The LGU, DMTC and WWF entered into a memorandum of agreement which determined each party's responsibilities in relation to project implementation. Strong local government, national government and private sector support was generated in terms of policy enactment, technical inputs, capacity development, and human and financial resource mobilization. The local legislative body of Donsol passed a local ordinance defining the authority of the LGU to control, operate and manage ecotourism projects. The Department of Tourism, together with tour operators, extended technical support to set up standards for visitor management, reservation bookings and marketing. The LGU passed laws which reinforce the system, policies and guidelines; which were developed together with the management plan.

A system was put in place for the orderly conduct of visitor management and whale shark tours. The system included the establishment of a visitor center, visitor management, booking system, pricing structure and fee collection, and whale shark interaction guidelines. Communities were organized and trained to deliver a highly specialized tour services for whale shark interactions with 35 fisherfolk the direct

beneficiaries of the whale shark tour service delivery training.

The Donsol Butanding Ecotourism Management Plan was developed together with the stakeholders. The plan discusses the issues and strategies involved in addressing conservation and tourism aspects of the management of the resource, and the policies and guidelines related to the operations of the whale shark ecotourism. It also describes the legal measures needed to fully implement the management plan. The need for a governing body to implement the management plan was recognized (Yaptinchay, 1999).

3.3 Socio-economic study

The findings of the social and economic analysis conducted by WWF-Philippines (2004) reinforce the need to place ecotourism under a larger package of economic benefits to sustain ecotourism and conservation-linked activities. Twenty-seven percent (27%) of the perceived issues/problems were attributed to illegal fishing, followed by financial problems (24%) and sanitation related to garbage disposal (14%). Issues and problems identified by the respondents are mostly environmental aspects, including the scarcity of fishes, rapid depletion of fish-stocks, destructive fishing activities and improper waste disposal, and financial aspects, such as an inadequate source of income and lack of capital. A lack of water and power supply and facilities are also among the major problems identified by respondents.

The number of tourists has steadily risen through recent years and is now responsible for generating additional income opportunities to 328 people in the year 2005. The beneficiaries are boat operators, interaction officers, boat captains and assistants, spotters, restaurant crew, home stay operators, mask and snorkel rental operators, tour operators and van drivers. Public and private investments have increased relative to the pre-ecotourism level. To date, there are now two (2) resorts, four (4) home stays, and one (1) lodging house operating in Donsol which are fully owned by Donsolanons. Table 2 describes the tourist arrival and the revenue generated by the LGU and the tour service providers. Clearly, there was a more than a 100% increase in the arrival of tourists from 2002 to 2004, with most being from the Philippines.

Similarly, significant increases in income were generated (Table 2). The largest revenue earners are the three major service providers: the LGU, interaction officers and boat operators. More than a 3 fold increase in revenue was generated from 2002 to 2004. Earnings of the LGU are attributed to registration fees and the 5% deduction from service providers amounts, and an almost 4 fold increase occurred from 2002 to 2004. The income of a tour service provider was found to be comparable to that of a local fisherman. During a regular month of the whale shark season, an interaction officer would make an average of five tour trips earning him revenue between US$273 – 364 in six to eight months of the year. On the other hand, the average fisherman of Donsol would earn annually US$387 from fishing (Soliman, 2004).

Table 2. Summary of tourist arrivals and revenue generated (US$) in 1998-2004.

	1998	1999	2002[a]	2003[b]	2004[c]	Total
# visitors	900	844	867	2,178	3,299	8,088
Philippines	-	-	728	1,896	2,619	5,243
International	-	-	139	282	580	1,001
# Boat trips	61	175	266	574	-	1,076
Revenue generated	-	-	15,050	31,272	48,316	94,634
LGU	-	-	2,832	6,487	10,692	20,011
Direct service providers	-	-	12,218	24,785	37,623	74,626

[a] Exchange rate – US$1 = Php 52
[b] Exchange rate – US$1 = Php 53
[c] Exchange rate – US$1 = Php 54

4. Discussion

4.1 Feasibility of whale shark ecotourism in Donsol

The distribution records based on the results of the whale shark survey were characterized by highly seasonal appearances, with aggregations of whale sharks appearing for several months. Food is an important factor for the growth, migration and abundance of whale sharks in time and space (Colman, 1997). The animals are commonly observed in areas where their planktonic food is abundant as a result of regular fish or invertebrate spawning events (Fowler, 2000). However, ecological research is necessary to confirm specific ecological events in the municipal waters of Donsol that contribute to the availability of food for whale sharks in the area. Although whale sharks are observed to be present in all 13 sampling sites, the probability for success of ecotourism based on whale shark viewing was thought to be higher in Donsol due to the animal's seasonal but regular presence in the area, local initiative and government support in terms of legislation and technical assistance, and the positive response of the community to establish an ecotourism program. Basic preconditions for

community-based ecotourism are: a) landscapes or flora/fauna which have inherent attractiveness or degree of interest to appeal either to specialists or more general visitors; b) ecosystems that are, at least, able to absorb a managed level of visitation without damage; c) a local community that is aware of the potential opportunities, risks and changes involved, and is interested in receiving visitors; d) existing or potential structures for effective community decision-making; e) no obvious threats to indigenous cultures and traditions; f) an initial market assessment suggesting a potential demand and an effective means of accessing it, and that the area is not over supplied with ecotourism offers (Denman, 2001).

Ecotourism operations based on whale shark viewing have started in many parts of the world; in Donsol the industry has proven to be far more valuable than whale shark fisheries and its potential to contribute to community development and economic growth has been realized. Whale shark ecotourism has brought visitors to Donsol from all over the Philippines and around the world. Visitor arrivals have been increasing over the past five years and this upward trend is predicted to continue in the coming years. As a result, income, investment and employment opportunities have been created and made more available for the LGU and the local community. National and local legislations strengthen the promotion of whale shark ecotourism as a form of non–consumptive use of the species. It is also viewed as sustainable alternative to whale shark fishery (Yaptinchay *et al.*, 1998; Yaptinchay and Alava, 2000). The activity led to community development through economic benefits, local pride and increased opportunities and capacities in terms of livelihood, employment, projects, and businesses.

4.2 Planning for the establishment of the whale shark ecotourism program

Although not prepared to take part in full-scale tourism, the Donsol community recognized the opportunity to embark on whale shark ecotourism because of political and social events that occurred and decided to embrace whale shark ecotourism to serve economic interests. Time was inadequate for social preparation and this inadequacy, that is, the absence of management and business skills, community awareness about ecotourism, among other things, resulted in subsequent program shortcomings. The planning process is crucial in establishing an ecotourism program (Ong, 1999). Planning requires ample time to involve diverse stakeholders who hold varying views and aspirations about how the activity should be developed in their area (Garrod, 2003).

4.3 The involvement of multiple stakeholders

All the identified stakeholders expressed an overwhelming interest to support the ecotourism program and agreed whale shark conservation was key. However, as a well-defined collaborative mechanism was absent, significant uncertainties and persistent conflicts among the stakeholders arose as the program began operating. The institutional arrangement over the management of the whale shark ecotourism venture was seriously challenged. The LGU hastily created the Donsol Municipal Tourism Council (DMTC), a local non-government organization, and vested the body with overall authority to manage and control all ecotourism programs in Donsol. It assumed some LGU functions such as accreditation, collection of fees, and imposition of fines/penalties; this eventually raised some serious legal concerns. The DMTC failed to provide ways and means to address the conflicts between stakeholders. Often the lack of capacity on the part of local planners and the inappropriate participatory mechanism resulted in poor performance of stakeholders in the planning and in the integrated decision-making process (Garrod, 2003).

The expertise and knowledge of various partners were shared during project implementation process but due to failure to foster effective leadership among the local stakeholders, genuine and full local participation of stakeholders in the planning and implementation processes was not achieved.

4.4 Threats to whale sharks and the marine resources of Donsol

Despite the strength of the whale shark ecotourism industry in Donsol as a form of non-consumptive utilization of the resource, major threats to whale sharks and their habitats, such as disturbance brought about the tourism activities themselves, illegal fishing activities and degradation of coastal resources, still exist. Regulatory measures are in place to control human interactions with whale sharks but difficulties in compliance and monitoring interaction activities are still reported. With tourist arrivals projected to steadily rise in the future, there is imminent danger of exceeding the carrying capacity of the whale shark resource base. Research on carrying capacity for whale shark interaction and other tourism-related activities is needed in order to develop precautionary management measures and the need to review existing policies and guidelines is emerging.

Illegal fishing activities, such as the operation of large commercial purse seines, are a serious threat in this area, not only to the habitat of whale sharks, but also to the livelihood of fisherfolk. Food security is the underlying principle of the Philippine Fisheries Code of 1998 (Congress of the Philippines, 1998). Thus, law enforcement is considered as a means to guarantee the sustainable use and continuous availability of resources in the Philippine waters.

4.5 Economic transfer of tourism-generated revenues

Ecotourism has transformed the coastal town of Donsol into an increasingly vibrant economy. It has provided economic benefits to the people of Donsol in terms of generation of employment, creation of new economic activities, improvements in household income, increase in economic activities and generation of local government revenues. Improvements in the nominal earnings were observed in various beneficiaries, such as BIOs, boat crew, spotters and restaurant and resort employees, in varying degrees and magnitude. The provision of the whale shark interaction tour and home stay services remains a monopoly of local residents. With the expectations of continued tourist influx, many local and external investors have purchased beach front property near the Visitor Center. As a result, the price of land along the coasts has increased tremendously, indicating to some extent the relative health of the local economy.

The tourism revenues realized by Donsol, however, are only a small fraction compared to the revenues generated by the Ningaloo Reef in Australia and by Belize. At Ningaloo, the estimated whale shark tourism revenues for a two month season amounted to AU$12 million or US$7.8 million (2004) (Norman, 2005). In Belize, the estimated value of whale shark tourism for 6 weeks was US$3.7 million nationally and US$1.35 million to the Gladden Spit Marine Reserve (2002) (Graham, 2005). These figures also show that wildlife is highly valued in developed countries where conservation and environmental consciousness are high. This may be different for a developing country, where conservation of wildlife and environment is given less priority. Nevertheless, it is clear that whale sharks are Donsol's natural capital. These animals will continue to contribute to the economic development of Donsol for as long as their health is secured and their habitats are protected and conserved.

4.5.1 Creating local incentives for whale shark conservation through ecotourism

The social and economic considerations of stakeholders, particularly the fishing communities who rely on coastal resources for their livelihood, are integral in sustaining conservation efforts in the area. Conservation measures, therefore, need to shift from species-based to ecosystem-based management, that is, expand from the conservation of whale sharks to include management and rehabilitation of the entire coastal ecosystem on which the livelihood of fisherfolk depends.

The LGU of Donsol now faces the challenge of achieving financial sustainability of conservation efforts, specifically, generating sufficient revenues to cover short and long-term expenditures associated with the implementation of coastal resource management activities including resource assessments, monitoring and enforcement, among others. In addition, the LGU must ensure that ecotourism activities and other whale shark related economic activities actually and sustainably benefit the local community. Adequate pricing mechanisms are important to ensure that recreational opportunities contribute to biodiversity conservation (Drumm, 2003). In Donsol, while ecotourism has demonstrated its potential to become a major local revenue contributors, the current cost of whale shark experiences are under-priced and inefficiently administered. Presently, earmarking funds to address threats to whale sharks and coastal resource management is not a priority of the LGU, which prioritizes volume over value, thus making it difficult to generate funds for impact monitoring and improved educational opportunities for tourists.

4.6 Challenges encountered and lessons learned

The process of establishing the whale shark ecotourism venture experienced difficulties in terms of social processes, policies, research and financing, specifically:

- Persistent conflicts among stakeholders led to subsequent program shortcomings,
- Institutional arrangement over the management of ecotourism was seriously challenged,
- There were limited resources to undertake species-focused and related studies,
- There was institutional conflict on policy development,
- There were difficulties in channeling economic benefits to conservation.

Building on challenges encountered, valuable lessons were generated:

- A feasibility study of a tourism product is essential in determining the success of a community-based venture,
- It is important to choose the correct form of business organization for a community-based venture that fits the situation in the community and the market,
- Careful design of a participatory planning mechanism is crucial for effective social process as it defines the nature of collaboration among diverse stakeholders. The lack of capacity on the part of local planners and an inappropriate participatory mechanism results in poor performance of the stakeholders in planning and integrated decision-making processes,
- Effective leadership in terms of collective ability to direct participatory planning improves and reconciles the different views and aspirations of the various stakeholders,
- Ecotourism must be pursued under a larger package of economic benefits to ensure the genuine participation of stakeholders. Economic and social considerations are integral in sustaining conservation efforts,
- Adequate pricing mechanisms are important to ensure that recreational opportunities contribute to biodiversity conservation. In this manner, the costs and benefits are equalized.

5. Conclusion

The community-based whale shark ecotourism in Donsol was able to demonstrate that the non-consumptive utilization of the resource is able to support community development, conservation and the tourism industry. It is recognized here that attention to social and decision-making processes is crucial in community-based ventures such as ecotourism. Good governance, leadership, open communication channels and cooperation should be further fostered among local residents to strengthen sustainable self-management and to allow genuine community participation. A long-term financing mechanism is necessary to direct funds to conservation works to sustain the resource base for ecotourism. The operational framework of integrated resource management is essential in pursuing ecotourism to address other pressing concerns relating to direct and indirect impacts to the whole ecosystem. The animal interaction program of Donsol, Philippines still has a long way to go before it could truly be labeled as an ecotourism activity. While the influx of tourists into Donsol is unchecked, the standard operating procedure in whale shark interaction is not fully enforced. The challenge now is to encourage and guide the local community to focus attention from the whale shark to the coast itself.

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Industry trends and whale shark ecology based on tourism operator logbooks at Ningaloo Marine Park

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Abstract

The Western Australian Department of Conservation and Land Management, now known as the Department of Environment and Conservation, together with the Ningaloo whale shark tourism industry have been closely involved with monitoring whale sharks at Ningaloo Marine Park through industry logbooks since 1995. Data from tour operator logbooks has proven useful in gaining an understanding of trends in the whale shark industry. Based on logbook data, the total number of whale shark interactions has reduced by around 27% from 1996 to 2004. The whale shark interaction success rate for tours has declined slightly, averaging approximately 83%. Analysis of observed whale shark length estimates over the last nine years indicated a 1.5m reduction in mean length. Whale sharks observed showed a trend for direction of travel along the north-south gradient with a greater northward bound favour. Analysis of spotter plane logbooks for the last three seasons indicated a shifting peak of whale shark observations to outside of the traditional whale shark tourism season into the months of June and July. It was recognised that log book data has limited scientific validity in the absence of related credible survey data especially in relation to search effort. Anecdotal reports that whale shark numbers are declining are not supported by an analysis of the aerial spotter plane data for the last three years from 2002-2004.

Keywords: Department of Conservation and Land Management, CALM, Ningaloo Marine Park, operator logbook, search effort, ecotourism, whale shark

1. Introduction

Whale sharks (*Rhincodon typus*) are the largest living fish in the ocean attaining sizes up to 12 m length, and have a tropical and warm-temperate global distribution (Last and Stevens, 1994). In spite of their size and large geographical range, little is known about the basic biology and ecology of whale sharks (Colman, 1997a). Ningaloo Reef in Western Australia hosts an aggregation of whale sharks in coastal waters from March to July each year, coinciding with an increase in productivity associated with mass synchronous coral spawning events after the March and April full moons (Simpson, 1991; Taylor, 1994; Colman, 1997a). The predictable arrival of whale sharks has led to the development of a lucrative ecotourism industry, with whale shark interaction tours operating in Ningaloo Marine Park since 1989. Until 1992 the scale of these activities was relatively small, however by 1993, increased national and international attention caused significant growth of public and commercial interest in interacting with these animals (Colman, 1997b).

The Western Australian Department of Conservation and Land Management (CALM) was established under the *Conservation and Land Management Act 1984* to fulfill a number of functions including responsibility for the conservation and protection of whale sharks whilst facilitating the development of sustainable tourism (Coleman, 1997b). In 1993, CALM initiated a trial system of management controls for commercial whale shark interactions in response to the increasing public interest, to ensure that this nature-based tourist activity was being managed equitably and sustainably (Colman, 1997b). These controls included the licensing of all existing charter vessels operating whale shark tours within the Ningaloo Marine Park. In consultation with the industry, statutory interaction guidelines were developed and implemented to minimise any potential negative impacts of the interaction on the whale sharks.

Ningaloo is recognised around the world as a primary location for whale shark interaction and a model of effective marine wildlife interaction tourism. CALM recognised that appropriate wildlife tourism can help educate and inform visitors, leading to a greater understanding and awareness of the natural environment (Coleman, 1997b).

CALM's whale shark operator logbook was introduced during the 1995 Ningaloo Reef whale shark paying season, which is the period 1 April to 31 May where whale shark licenses incur fees. At the time of development, it was recognised that the log sheets had a number of limitations due to the subjective nature of the data collection process, the collection of data by untrained observers and variation in the quality of the data recorded (Colman, 1997b).

In this paper, some results of the analysis of whale shark operator log book data from 1996 to 2004 and whale shark spotter pilot data from 2002 to 2004 are presented for discussion. The purpose of the log books was to record information on the size and status of the industry and to monitor the impact of tours on whale sharks for management purposes. The log books were also intended to provide feedback to commercial operators on tour and passenger information. Analysis of behavioural response data occurred in 2001 (Chapman, 2002) and resulted in a change of the behavioural data collected. Subsequently, insufficient behavioural response data is available for scientific analysis at this time.

2. Methods

The logbook system was introduced by Western Australia's Department of Conservation and Land Management (CALM) in 1995 and reviewed in 2002. Initially, logbook data was collected during the paying season only, the period of 1 April to 31 May when whale shark licenses incur fees of AUS$20 per adult and $10 per child. As these funds are directed to whale shark research and management, passes are issued to paying participants during this time to acknowledge their contribution. In 2004, CALM placed a greater focus on the requirement to collect logbook data for the entire whale shark season, hereafter referred to as the "full season", rather than just for the "paying season". This was due to the number of whale shark sightings from spotter planes in June and July 2003 being similar to those in April and May, thus indicating that peak abundance of whale sharks did not necessarily correspond with the peak tourist season for whale sharks.

Since 2004 logbook data has been collected in the following way:

- During the paying season data log sheets must be completed for every day whether a tour was conducted or not.
- Outside of the paying season log sheets must be completed for tours only.
- Logbooks must be completed from the first interaction tour conducted to the last tour conducted.
- Log sheets must be submitted to CALM every two weeks throughout the full season.

Logbooks are issued annually to tour operators by the local CALM office. Fortnightly submission of log sheets allows errors/issues that may arise in data recording to be dealt with reasonably promptly in order to maintain data quality standards and data is entered immediately into the CALM whale shark interaction database. Since 2003, failure to submit log sheets results in follow up action, with potential legal ramifications.

Following the collection of seven seasons of log book data from 1995 to 2001 inclusive, a review was commissioned to assess the effectiveness of logbooks, and to modify the log sheet design to ensure the data collected can be used to meet management objectives in subsequent paying seasons (Chapman, 2002). As the logbook format was changed slightly from 1995 to 1996, some data for analysis from 1995 has been omitted to maintain consistency. Following the review process, a new log sheet design was introduced for the 2002 paying season. The method of recording information on tour duration and the number of passengers carried per tour remained the same. Subjective information, such as records of dive quality and markings on the shark, were eliminated from the log sheets and the recording of shark behaviour was categorised.

Data collected in logbooks included information on passenger numbers, information relating to the whale sharks, and swimmer/whale shark interactions, see appendix for a sample whale shark interaction log sheet. Each log sheet has a unique identification number (Whale Shark Log, WSL), the date, and start and finish time of the tour. Passenger information collected included the number of adult and child paying passengers and the number of Free of Charge (FOC) passengers. FOC passengers were mainly passengers on a repeat trip as part of the operators' no encounter policy, which ensures a free second trip if the customer did not encounter a whale shark. Pass numbers, given only to paying passengers, were also recorded on the log sheet.

Shark information and observations recorded onto log sheets included the following: GPS location, water depth to seabed (recorded off operator vessel acoustic depth sounder), time of first encounter, estimated size of the shark, its sex and direction of heading. In addition, the whale sharks response to swimmers was recorded; operators

were advised to only record its principal or overall reaction to the snorkellers, allowing for up to five response records per swimmer group interaction. The information on whale shark behavioural responses when interacting with swimmers is not presented in this paper.

The recorded swimmer and whale shark interaction information included the number of swimmers, time per interaction and whether a whale shark was shared with another vessel, termed "handballed". During the paying season, if a tour was not conducted a log sheet is still required providing a reason why no tour occurred such as no bookings, poor weather or a day off from tours.

For every season since 1995, the size of each whale shark that swimmers interacted with was estimated to the nearest half meter by tour operators during the months of April and May, the paying season. Depending upon the number of sharks spotted on any day, multiple tour operators may utilise the same shark for swimmer interactions, resulting in replicate length estimates in the datasets. Analysis of length data therefore needs to consider replicate values and overall accuracy due to a likely large intra- and inter-observer error, estimated to be at about ±1.5 metres (Mau and Wilson, pers. obs.).

A preliminary analysis of this data was undertaken to determine the impact of these replicate length estimates. Replicates were removed from the length data for 1996 to 2001 (six seasons) and the mean length data for each season was compared with the original length data means using the Pearson Product-Moment Correlation Coefficient ($r_{[0.01,4]}$=0.9172, $r_{[calc]}$=0.9533), showing a significant linear relationship between the two datasets. Furthermore, the replicate record exclusive means of the dataset were all well within the standard error of the replicate record inclusive means dataset (furthest variation was 0.3 metres for paired mean of 6.77m with a standard error of 1.9m). Based on this analysis, and the time and difficulty involved in accurately identifying these replicate records retrospectively for removal, the data inclusive of replicate measures was deemed sufficient for comparative length data analysis across seasons reducing the administrative effort otherwise required for removal of replicate records.

Whale shark interaction vessels do not search for whale sharks but rather utilise aircraft to conduct searches and guide vessels to positions of whale sharks via radio communications. Due to administrative issues, data from spotter planes was only available for analysis from 2002. Spotter pilots record information for company records and provide a copy in kind to CALM. Records include information on the pilot, flight times and the vessels interacting with whale sharks. The number of whale sharks sighted is also recorded per flight along with locality, time of day, reaction to divers, abnormal behaviours, environmental conditions and other marine life.

The spotter plane data provided information on the total number of sharks sighted as opposed to the number of encounters recorded in vessel log sheets, this is advantageous as some sharks dive before a vessel arrives or swimmers have an opportunity to interact with it. Spotter plane data also excludes multiple recorded encounters of the same shark by different vessels. The spotter plane data also allowed the amount of effort required to find individual sharks within a season (intra-seasonal) and between seasons (inter-seasonal) to be calculated.

3. Results

3.1 Whale shark interaction data

The total number of whale shark interactions that occurred during booked trips had reduced by around 27% from 1996 to 2004 while there was an overall increase in the number of tours in that period by 58% (Fig. 1). The percentage of tours with successful whale shark interactions averaged 81.6% over the 9 year period, with an overall decrease from 89.5% in 1996 to 79.4% in 2004.

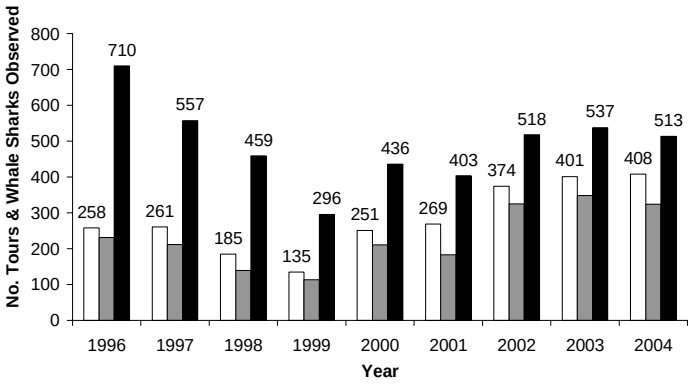

Figure 1. Number of whale shark experience tours □, number of tours with whale shark interactions ■ and total number of whale shark interactions ■ during the paying season (1st April to 31st May) from 1996 – 2004

From 1996 to 2004, the average number of interactions per tour had reduced continuously from 2.6 to 1.2 interactions per tour (Fig. 2). The actual time spent by a swimmer in the water with a whale shark per interaction had reduced from an average of 27 minutes and 24 seconds in 1996 to 7 minutes by 2004, however 1999 and 2001 remained high (Fig. 2). The average number of swimmers involved in each whale shark interaction remained fairly constant from the beginning to end of the nine year period, with a minimum of 7.5 and a maximum of 11.9.

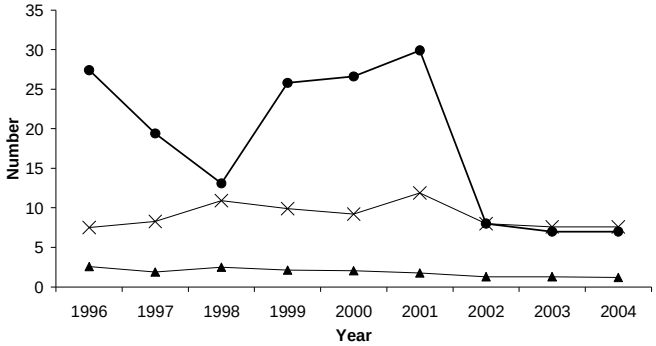

Figure 2. Average number of: ▲contacts per tour; • minutes per contact; and × swimmers per contact

3.2 Whale shark logbook length data

The average length of whale sharks decreased by 1.5 metres from 1995 to 2004 (Fig. 3), from a mean of 6.9 ± 1.84m (n=365) to a mean of 5.4 ± 1.45m (n=456). While there was no significant difference between the size of male and female whale sharks in each year, both sexes followed the same trend of reduced size over the study period.

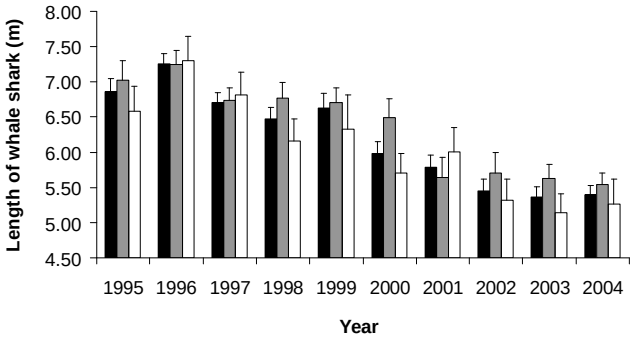

Figure 3. Average whale shark size with 95% confidence interval from 1995 to 2004 from Industry Logbook data (■ combined; ■ males; □ females)

3.3 Direction of travel

Clear trends become apparent when the logbook data for direction of travel of whale sharks is plotted and compared across years (Fig. 4). There is a significant trend for travel along the north-south gradient with a greater northward bound favour.

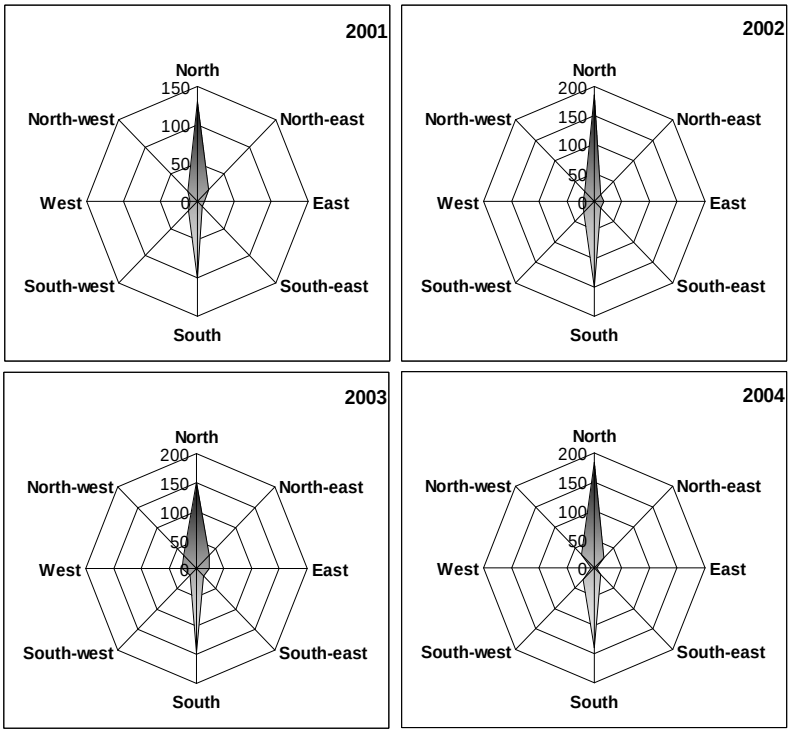

Figure 4. Webs depicting the pre-dominant direction of whale shark movement in 2001 – 2004.

3.4 Whale shark search effort by spotter plane

Based on data recorded in spotter plane logbooks, the ratio of sharks sighted to the number of spotter plane hours flown (i.e. search effort) was calculated to determine the search effort per sighting (Table 1).

Table 1. Flight time per whale shark sighting (hr:min)

Year	# Sharks Observed	Hours Flown	Flight Time per Sighting*	
			Paying Season	Full Season
2002	362	847	02:15	02:20
2003	615	986	03:30	01:40
2004	326	462	01:40	01:25

* Data rounded to nearest 5 minute interval

The 2004 full season recorded the lowest total number of shark sightings of the three years analysed (Table 1), this most likely reflects that this was also the year in which the least hours were flown, with less than half the time flown compared to the 2003 full season. However, 2004 was also the year in which whale sharks were most readily observed, with the least search time required for both the paying and full seasons. This is also evident in Figure 5, which shows the greatest ratio of whale sharks sighted per unit effort was recorded over the full 2004 season.

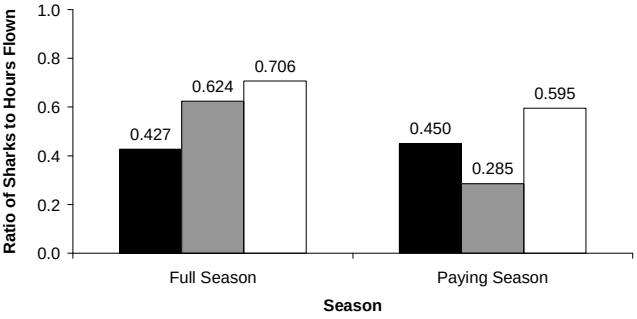

Figure 5. Comparison of whale sharks per unit effort (spotter flying hours) for the full season and paying seasons only (■ 2002; ■ 2003; □ 2004)

The 2003 paying season recorded the lowest ratio of whale sharks per unit effort for the three years analysed (Fig. 5). Conversely, the 2003 full season recorded the highest total number of shark sightings. The 2003 season was unusual in that a large proportion of sightings were recorded outside the paying season, with less than one third of sharks observed during this time, albeit the number of hours flown in the paying season was the highest recorded in the three years studied.

4. Discussion

Since the introduction of logbook monitoring in 1995, tourists participating in the Ningaloo Reef whale shark experience has steadily increased, with the exception of reduced numbers in 1999 likely attributed to the impact of severe tropical Cyclone Vance (Category 5) in March 1999. Participation numbers have more than doubled in nine years from 1996 to 2004, reaching a peak of 5835 for the 2003 paying season.

In recent years, long term whale shark operators have expressed concern over a perceived decline in whale shark numbers available for interaction and a lack of large individuals when compared to pioneering days in the 1980s. Based on the logbook records, there is a decrease in the total number of whale sharks observed based on interactions, especially when considering the increase in the number of tours conducted (Fig. 1). The whale shark interaction success rate, the percentage of tours with successful whale shark interactions, has reduced from 90% in 1996 to 79% in 2004, but was at 87% for 2002 and 2003 indicating a relatively minor trend towards a declining success rate.

However, these figures must be analysed with caution as changes in commercial operations and search effort from spotter planes over the seasons has not been included. Until 1997, most tour operators used their own spotter plane, resulting in greater search effort. In addition, whale shark tour operators were spread further south than at present to secure their own area of operation. In 1998 when operators began to cooperate and plane sharing became a common practice, handballing of individual whale sharks became more prevalent.

Furthermore, the logbook data analysed is limited to the paying season only, 1st April to 30th May, and whale shark interactions occur outside this period. For example, in 2003 the number of whale shark interactions in June and July were greater than in April and May, indicating that the peak numbers of whale sharks did not necessarily occur in the paying season.

When assessing possible causes for reductions in interactions it is important to consider the search effort by spotter planes applied each season. Anecdotal reports that whale shark numbers are declining are not supported by an analysis of the

aerial spotter plane data for the last three years from 2002-2004 (Fig. 5). Daily vessel activity time or vessel days are not indicative of search effort as they are not involved in actively searching for whale sharks and only very occasionally come across whale sharks while in transit. Rather, changes in the inter-seasonal aerial survey effort may be a causal factor for the apparent reduction in whale shark abundance. In addition, aerial search effort data indicated a considerable intra-seasonal variation in whale sharks per unit search effort.

Taylor (1996) indicated a reduction of relative abundance of whale sharks at the northern end of Ningaloo Reef and suggested that this may have been linked to a decline in coral cover from *Drupella damicornis* outbreaks prevalent at that time. Taylor and Pearce (1999) noted a relationship between the presence or absence of the Ningaloo Current and the aggregation of whale sharks at the northern end of the reef, with low whale shark abundances in years when there was little evidence of the Ningaloo Current (Wilson *et al*., 2001).

The possible decline in the size of whale sharks at Ningaloo Marine Park continues to be a much debated issue. Whale shark length has always been estimated by industry staff for logbook records and therefore analysis of size data must be treated with caution due to several potential sources of error. Logbook records showed a high level of inter-observer variability for length of the same sharks encountered. This data also represents the total number of encounters, as it does not take into account multiple encounters with the same shark by different vessels, either on the same day or on different days. Practical and accurate methods to determine the lengths of whale sharks by industry staff need to be developed in order to confirm this declining trend with confidence.

The results of this study suggest the mean length of whale sharks has decreased by 1.5m from 1996 to 2004. Some evidence suggests sexual maturity in both sexes may not occur until the sharks are between 8-9m in length (Norman and Stevens, 2007). As the whale sharks at Ningaloo Reef had a mean length of 5.4m in 2004, with a range of 2.5m to 10m, the majority of whale sharks encountered are likely to be immature.

This decreasing trend in size could support the increasing frequency of smaller individuals found in photo identification studies by Meekan *et al*. (2006) indicating a long term change to the population structure of the Ningaloo aggregation. Individual whale sharks return to Ningaloo over successive years and if a few large individuals were being repeatedly recorded and increasing numbers of smaller individuals were appearing, average length estimates would be affected. Using photo-identification at Ningaloo, one individual whale shark was recorded 13 times within a season and in three successive seasons (A. Richards, pers. comm.). Such individuals may be habituated to interaction thus skewing log book records towards its size class.

Since 1996, logbook records show the majority of whale sharks encountered at Ningaloo have been male with a sex ratio ranging from around 2:1 to 3:1 male to female. This trend is supported by other research which reported a male bias from photo identification studies at Ningaloo Reef (Meekan *et al*., 2006; Norman and Stevens, 2007). Logbook gender data must also be analysed with caution as it has similar potential sources of error as discussed for length data, with the additional possibility of misidentification of immature males for females.

Logbook data shown here portrayed a very strong trend for direction of travel along the north-south gradient, supporting anecdotal observations by industry members and tagging studies that whale sharks travel and aggregate further north along the Ningaloo Reef as the season progresses, before heading offshore to other waters (Wilson *et al*., 2005). The circulatory movement of water, driven by the currents, may be important for retaining planktonic biomass within the Ningaloo ecosystem (Taylor and Pearce, 1999). Additional studies by Taylor (1996) and Wilson *et al*. (2001) found that the seasonal southerly movement of warm water masses down the coast of Western Australia (the Leeuwin current) has been shown to influence the occurrence of whale sharks at Ningaloo Reef. However, Taylor (1994) described how whale sharks appear to follow these currents, generally travelling from north to south, in order to exploit abundant food sources. Additionally, recent studies by Wilson *et al*. (2005) showed that tagged sharks at Ningaloo travelled north-east into the Indian Ocean following their visit to the area.

Tour operator logbook records have also shown a decrease in the contact time each swimmer spends with a whale shark, whilst the number of whale sharks with which contact is made per tour and the number of swimmers per contact have remained relatively stable. This would appear to indicate that participants are spending less time in the water with each whale shark interaction. This trend is possibly a result of two changes, the data

recording method and operational arrangements. Firstly, changes in the logbook recording method in 2001 eliminated the ability of discretional summing of the total swim time by the operator. Secondly, increased tourist participation rates and the introduction of a guarantee scheme allowing swimmers a free second trip if unsuccessful has lead to economic pressure for all operators to ensure all their passengers successfully swim with a whale shark so they do not return as free of charge passengers. This pressure can lead to shortened overall individual interaction times during the first interactions of the day to ensure all participants get at least one swim should the shark dive sooner rather than later. A study to consider the implications of this practice on visitor satisfaction of the whale shark experience was commissioned for the 2005 season (Catlin, 2005).

5. Conclusion

CALM licensed whale shark operator logbook data represents an extensive data set for the last nine years of government and industry collaboration. Data from tour operator logbooks has proven useful in gaining an understanding of trends in the whale shark industry. However, it was recognised that the log sheets had a number of limitations due to the subjective nature of the data collection process, the collection of data by untrained observers and variation in the quality of the data recorded.

CALM cautions any researcher wishing to derive statistically valid results from the logbook data set to familiarise themselves first with the sources of data errors. The logbooks were not intended to provide stand alone scientifically rigorous data but rather were developed to primarily reflect industry trends. Little effort has been spent in the past to either train recorders or verify that data recording is occurring with accuracy and consistency. Further reviews of the logbook data and collection method are in progress to ensure that data accuracy is improved and refined to be useful to scientists and decision-makers involved in the conservation management of the whale sharks of Ningaloo Reef and meaningful involvement of the whale shark industry in this process is essential.

Appendix

A whale shark interaction log sheet which makes up the logbooks.

WSL

DEPARTMENT OF Conservation AND LAND MANAGEMENT *Conserving the nature of WA*

WHALE SHARK INTERACTION LOG

DATE

Vessel	Start Time	Number of Passengers	Paying		Other (F.O.C.)	Whale Shark Experience Pass	Pass Number	
Recorder	Finish Time		Adults	Children			From	To

SHARK	Position							Shark Observations									Contact Information											
	Latitude			Longitude			Depth	Time	Size	Sex	Dir	Response to swimmers					Contact Number	1	2	3	4	5	6	7	8	9	10	H/ ball
	Deg	Min	Sec	Deg	Min	Sec						i	ii	iii	iv	v												
A																	Minutes											
																	Swimmers											
B																	Minutes											
																	Swimmers											
C																	Minutes											
																	Swimmers											
D																	Minutes											
																	Swimmers											
E																	Minutes											
																	Swimmers											
F																	Minutes											
																	Swimmers											

The vessel did not sail today due to:

☐ No Bookings ☐ No Sharks ☐ Poor Weather ☐ Day Off ☐ Other, please specify _____

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Aerial surveys of whale sharks (*Rhincodon typus*) off the East Coast of Southern Africa

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Abstract

From 1993 to 1998, the Shark Research Institute conducted aerial surveys of whale sharks (*Rhincodon typus*) along the coast of KwaZulu-Natal, South Africa. Three types of aircraft were used: two different Cessna fixed-wing aircraft and a delta-wing microlight. The microlight proved to be the better choice for this survey due to its slow flight speed, manoeuvrability, portability, and low cost of maintenance and fuel. During 114 survey flights of the entire KwaZulu-Natal coast over 5 whale shark seasons, a total of 452 whale sharks were observed. These individuals were predominantly swimming in a south to north direction, often along the clearly defined perimeter separating clean water from that discoloured due to siltation by rivers. The aerial survey indicated that the sector north of Cape Vidal, with no major rivers discharging silt into the sea, was the most suitable for a tagging study of whale shark that was ongoing during this period.

Keywords: aerial survey, whale shark, abundance, distribution, South Africa, Indian Ocean

1. Introduction

The whale shark (*Rhincodon typus,* Smith 1828) is a filter-feeding, coastal and oceanic orectoloboid shark, found in all tropical and warm-temperate seas (Compagno, 2001). This shark was first reported from Table Bay, Western Cape, South Africa (Smith, 1828) but was eventually recorded from the southwest and east coasts of southern Africa to Mozambique and northward to East Africa (Barnard, 1925, 1935; Fowler, 1941; Bigelow and Shroeder, 1948; Smith, 1949; Bass *et al.,* 1975; Compagno, 1984, 2001; Bass, 1986; Wolfson, 1986; Compagno *et al*. 1989). The occurrence of whale sharks off the KwaZulu-Natal province on the east coast of southern Africa is a seasonal phenomenon that has been sporadically investigated and documented. This has resulted in limited data regarding the annual abundance and movements of this species in the area based on records of strandings, diver surveys, aerial surveys, and surface sightings (Bass *et al*., 1975; Beckley *et al*. 1997, Compagno, 1999).

Starting in December 1993 and ending 30 April 1998, the Shark Research Institute (SRI) initiated, developed and implemented an aerial survey program of whale sharks in order to support their ongoing whale shark tagging program (Gifford, 1994, 1995, 1997, 1998). Further information about this tagging program is given in Gifford *et al.* (2007). Surveys were conducted from Port Edward (31º02'5"S, 30º13'6"E; 158 kilometres southwest of Durban) to Kosi Bay (26º41'60"S, 32º53'60"E, 392 kilometres northeast of Durban) covering the KwaZulu-Natal coastline (Fig. 1). Anecdotal reports from divers and sport fishermen, suggested the area north of Cape Vidal was routinely visited by large numbers of whale sharks. Thus, one objective of this study was to confirm these observations, and possibly locate other areas suitable for the tagging program. It was also anticipated that data collected from the survey might prove useful in the development of local management plans of the species.

2. Methods

Aerial surveys were conducted along the KwaZulu-Natal coast of South Africa between December 1993 and January 1999 (Fig. 1). Reconnaissance flights were conducted randomly throughout the winter months, and no whale sharks were observed. Each year, the study period began when the sharks appeared off the KwaZulu-Natal coast, and ended when the sharks left the area, thus the study seasons were as follows: 31 December 1993 to 14 April 1994; 3 December 1994 to 30 April 1995; 1 October 1995 to 30 April 1996; 1 October 1996 to 30 April 1997; and 1 October 1997 to 30 April 1998.

Each survey flight encompassed the coast of KwaZulu-Natal from Kosi Bay in the north to Port Edward in the south (Fig. 1). In order to determine

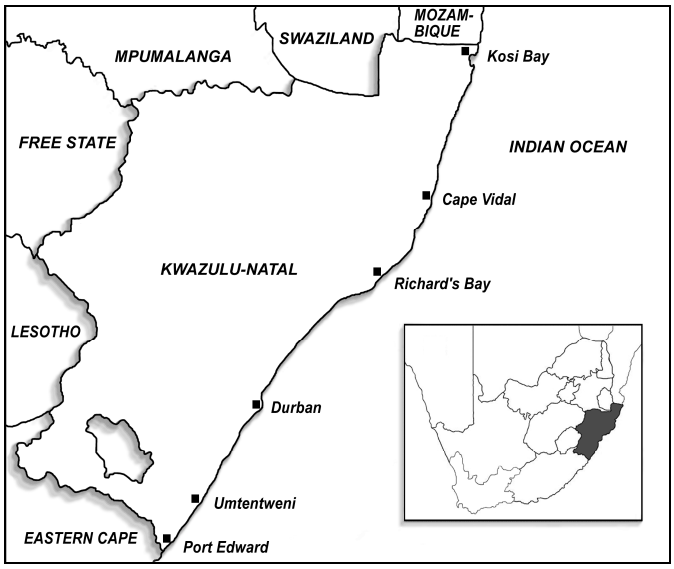

Figure 1. The study area off the KwaZulu-Natal coast in South Africa.

the optimum flight level for observation, test flights were flown at heights of 500, 750, 1000 and 1500ft above sea level. It was determined that flight levels between 500 and 850ft were the most productive relative to the wind direction and velocity, haze, and glare from the sea surface.

Three types of aircraft were used during the survey period (Table 1). During the 1993/1994 whale shark season, surveys were conducted using a Cessna 182; it facilitated three dedicated observers in addition to the pilot and was able to travel the entire survey area without refuelling. However, to reduce costs, a Cessna 172 was used for two of survey flights. The disadvantages of a reduced number of observers and limited fuel capacity outweighed the economical savings. In addition, the cruising and stall speeds of both Cessna aircraft were too high and their respective safe turning circles too wide to ensure that all whale sharks were counted. In order to accommodate the highly specialized needs of the tagging project, a Solo Wings delta-wing microlight aircraft was bought into service in October 1994. Although only capable of carrying the pilot and one observer, its speed and manoeuvrability proved ideal and the lack of any fuselage structure made visibility from the aircraft almost unlimited. A single pilot flew all Cessna surveys, while this and one additional person alternated as pilots of the microlight throughout the study.

Due to the prevalence of choppy sea conditions and reduced visibly resulting from sunlight reflecting off the sea surface, aerial surveys were performed as often as sea and weather conditions permitted rather than on a fixed schedule. On each survey flight, the aircraft was flown above the backline of breaking waves at 500 to 850 feet above sea level for the entire length of the KwaZulu-Natal coast. Whale sharks were counted only in one direction of each survey flight, the direction dependent on the sun's glare from the sea surface. A minimum of two experienced observers were deployed on each Cessna flight, one at port and one starboard, and whenever possible a third person recorded data. The microlight aircraft accommodated only one observer who also recorded data. The shallow sandy bottom of the coast and the use of low-altitude aircraft ensured whale sharks were easily observed and recognised.

On each flight, standard flight charts were used with a plastic overlay for recording the position and direction of travel of each whale shark. This information was transferred in a master log for each season.

Table 1. Evaluation of aircraft used in whale shark aerial surveys.

Aircraft	Engine	Cruising Speed (km/h)	Stall Speed (km/h)	Range (km)	Capacity *	Cost (US$/hr)
Cessna 182	Single	244	92	1600	3	45
Cessna 172	Single	205	92	860	2	32
Microlight Trike	Single	65-100	40-50	400	1	7

* in addition to pilot

3. Results

The greatest number of whale sharks sighted in a single day was on 15 January 1994 when 95 individuals were observed between Durban and Umtentwini on the south coast of KwaZulu Natal, a distance of 110km; this was during the season using Cessna aircraft. During the course of conducting the aerial surveys, it was found that the majority of whale sharks were swimming alone as fairly wide-spaced individuals. Occasionally a pair was observed, and only once were more than two seen together, when on 15 January 1994 five sharks were recorded in close proximity off Turton on the south coast.

Significantly more whale sharks were seen during the initial survey season using Cessna aircraft compared to subsequent seasons utilising microlight aircraft (Table 2). Overall 452 whale sharks were observed during the 114 flights of the entire KwaZulu-Natal coast. The 30% of coastal

Table 2. Results of aerial surveys along the KwaZulu-Natal coast, South Africa.

Season	No. Flights	No. Flights in S to N Direction	No. Flights in N to S Direction	Total Flight Time (hr)	Total No. Whale Sharks (550 km)	% Whale Sharks Durban to Port Edward (169 km)	% Whale Sharks Durban to Kosi Bay (381 km)
1993/1994	12	5	7	25.33	184	63.6	36.4
1994/1995	10	6	4	19.67	31	19.4	80.6
1995/1996	36	9	27	82.17	79	19.0	81.0
1996/1997	42	10	32	96.30	93	29.0	71.0
1997/1998	14	8	6	40.25	65	29.2	70.8
Total for Microlight	102	33	69	238.39	268	25.0	75.0
Total for All Surveys	114	38	76	263.72	452	40.7	59.3

length south of Durban contained 25.0% of the whale sharks observed on microlight surveys and 40.7% of all whale sharks for 5 seasons. This increase when including Cessna surveys is due to the majority of whale sharks observed in the 1993/1994 season being in this southern region compared to the opposite for all other seasons. For the 4 microlight survey seasons it is apparent that a relatively proportionate number of whale sharks were seen north and south of Durban.

The average number of whale sharks observed per flight for all seasons was 4.0, however this reduced to 2.6 when excluding the Cessna surveys of 1993/1994 (Table 3). The average number of whale sharks per flight was relatively consistent throughout the seasons of similar methodology. An average of 1 whale shark per 100km coastline was observed for all 5 seasons (Table 3).

During the five year survey period in KwaZulu-Natal, the directions of travel of each individual shark was recorded and the results are summarized in Table 4. Almost all whale sharks were swimming along the South African coastline rather than heading east or west. In all but the final year of study, the majority of individuals were heading in a south to north direction.

Aerial surveys revealed that the area south from Port Edward to Durban, a length of 169km, suffers from seasonal reduced water visibility due to silt discolouration resulting from swollen rivers that discharge directly into the sea, particularly after the summer rains. Observations showed that the whale sharks tended to avoid this turbid water and were often seen swimming along the clearly defined perimeter that separates the clean from the silt discoloured water.

Table 3. Mean number of whale sharks per flight and per kilometre of coastline in KwaZulu-Natal, South Africa.

Season	Whale Sharks per Flight	Whale Sharks per 100km Coastline
1993/1994	15.3	2.79
1994/1995	3.1	0.56
1995/1996	2.2	0.40
1996/1997	2.2	0.40
1997/1998	4.6	0.84
Microlight Surveys	2.6	0.55
All Surveys	4.0	1.00

Table 4. Direction of travel of whale sharks.

Season	South to North	North to South	West to East	East to West
1993/1994	59%	36%	4%	1%
1994/1995	68%	32%	--	--
1995/1996	61%	37%	2%	--
1996/1997	54%	46%	--	--
1997/1998	48%	52%	--	--

4. Discussion

Ideally, an aerial survey would be most useful if a set number of flights could be flown at the same dates and times each season, but the reality is that an aerial survey is dependent on weather and sea conditions. Thus it is not possible to assess the impact of adverse weather and sea conditions, if any, on the abundance of whale sharks during the study period. Although recorded and shown in table 2, the hours flown are not relevant to the objectives or results of this survey because headwinds and tailwinds vary with each flight and

may slow the aircraft or increase its speed, and the objective was not to fly a specific number of hours but to record the numbers of whale sharks per kilometre of coastline. A better indicator of whale shark abundance is the number of individuals observed per flight of the coastline or the number per 100km of coastline as given in Table 4. These results show significantly more whale sharks seen in the 1993/1994 season using Cessna aircraft compared to subsequent seasons which used microlights. It may be that there were more whale sharks during this season, but given the change in methodology analysis must be cautious.

Since the completion of this 5 year survey, a study was conducted from 2001 to 2005 by Cliff *et al.* (2007). This research surveyed the northern 350km of the KwaZulu-Natal coast by light aircraft. Over the seasons the sighting rates of flights varied from 0-4.35 whale sharks per 100km coastline with seasonal means ranging 0.21-0.69 sharks per 100km. These figures are comparable to the average number of whale sharks per 100km coastline for each season assessed by microlight aircraft in this survey. Additionally, in the surveys by Cliff *et al.* (2007) the majority of whale sharks were seen in the northern most 150 km of the KwaZulu-Natal coast. This contrasts the work shown here in which numbers of whale sharks were found along the entire coastal length.

South of Durban 34 rivers empty into the sea. Of these, the mouths of eight rivers are always open, and another five are open more than 80% of the year. Along the 209 km from Durban to St Lucia Estuary which is located 32 km south of Cape Vidal, 18 rivers or estuaries empty into the sea. Of these, five rivers or estuaries are always open and another three rivers are open 80% or more of the year. However, no major rivers empty into the sea between St Lucia Estuary and Kosi Bay, a distance of 172 km (Jackson and Lipschitz, 1984). As the whale shark distribution is relatively even along the coastline north and south of Durban (Table 2), no particular area was better for the Shark Research Institute's whale shark tagging program in regard to this. However, as the SRI's tagging program was to utilise divers to attach the tags, good underwater visibility was essential, and thus the area north of Cape Vidal was considered suitable for such work. Additionally, the beaches from Cape Vidal to Kosi Bay are generally wide and flat, making them conducive to take-off and landings of microlight aircraft used to support the tagging program.

No whale shark fisheries existed along the coast of East Africa during the course of this study. However, it was considered possible that the decrease in sightings from 1993/1994 to 1994/1995 might be related to the whale shark fishery then operating to the north in the Arabian Sea (Sreenivas, 1999; Hanfee, 2001). In 2000 and 2001, in efforts to determine if the sharks observed during this study period, including those tagged by the Shark Research Institute, were among those harvested at Gujarat on the Saurashtra coast of India, researchers from SRI visited the whale shark fisheries and processing plants at Veraval, India (Patil, 2002). Posters were distributed in Hindi, Gujarati and English, depicting the tags placed on whale sharks along the South African coast and offering a substantial monetary reward for the return of a tag. However, no tags were recovered.

5. Conclusion

Based on the continued sightings of whale sharks and the generally good water visibility in the area north of Cape Vidal, it was decided to concentrate the efforts of the tagging program in those areas with aerial support from microlight aircraft.

At the conclusion of this study period, an aerial study was commenced in KwaZulu-Natal by South Africa's Marine and Coastal Management using fixed-wing aircraft. Their results were presented at the Whale Shark Conference at Perth in May 2005.

Acknowledgements

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Satellite remote sensing as a tool to determine whale shark distribution

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Abstract

Whale sharks (*Rhincodon typus*) are known to be highly migratory, with their movements and aggregation influenced by phytoplankton biomass, associated fauna and changes in temperatures of water masses. One of the major requirements for the growing whale shark tourism industry is to identify potential areas of aggregation for human interaction activities; remote sensing of oceanographic conditions may potentially aid this. Monthly composite phytoplankton biomass fields derived from SeaWiFS data were analysed for three years (1998-2000) to observe variations in phytoplankton biomass in space and time correlating with whale shark distribution and abundance in the continental shelf region of Gujarat, India. In addition, NOAA-Advanced Very High Resolution Radiometer (AVHRR) derived sea surface temperature (SST) maps were generated to determine the optimum temperature range based on whale shark aggregation. The study shows that oceanographic conditions favourable to whale sharks of high phytoplankton concentration and a temperature range between 23-25 ºC coincide with the sighting and exploitation of large numbers of whale sharks in the area.

Keywords: whale shark, remote sensing, chlorophyll, sea surface temperature, SeaWiFS, India

1. Introduction

The whale shark (*Rhincodon typus*) is the world's largest fish and its inclusion on Appendix II of the Convention on International Trade in Endangered Species (CITES) in 2002 reflects global concern for the conservation status of the species (CITES, 2002). In India conservation concerns centered on intensified threat from increased incidental and targeted fishing of whale sharks, contributed mainly from the Gujarat region (Pravin, 2000). By the mid 1980s, the whale shark had become a regular targeted fishery off the coast of Gujarat, in the northeastern Arabian Sea, due to the high export value of meat, fins and liver (Hanfee, 1997; Pravin, 2000). Following concerns of overfishing, the hunting of whale sharks in India was prohibited on 28 May 2001 when it was placed under Schedule I of the Indian Wildlife (Protection) Act of 1972 (Wildlife Protection Act, 2003).

The ban on whale shark fishery resulted in a need to find an alternate source of income for those local fishermen who lost their livelihood. Many other locations across the globe have embraced whale shark ecotourism resulting in economic and conservation advantages, for example Donsol, Philippines (Quiros, 2007) and Seychelles (Rowat and Engelhardt, 2007). The regular occurrence of whale sharks in the waters off Gujarat, India during the winter monsoon season every year suggests the possibility of a viable ecotourism venture based on whale sharks. For any such attempt, baseline information on occurrence of this species is essential to assure the ability to locate whale sharks for interaction with tourists.

Whale sharks are widely distributed in oceanic and coastal warm tropical waters worldwide, excluding the Mediterranean, usually between latitudes 30ºN and 35ºS (Norman, 2000; Chen and Phipps, 2002). Various studies suggest that these sharks prefer areas where the surface temperature is 21 to 25ºC (Iwasaki 1970; Colman, 1997; Pravin, 2000; Duffy, 2002; Pravin *et al*., 2002a). The species is highly migratory, with a tagged whale shark known to have traveled a distance of 13,000 km from the Gulf of California, Mexico, to near Tonga over 37 months (Eckert and Stewart, 2001). Additionally, their movements within a region may be precisely timed to coincide with localised productivity events and/or behavioural changes in their prey that allow for more efficient feeding (Taylor, 1994; Norman, 2000; Wilson, 2001).

Satellite remote sensing is the only window into the synoptic state of large continental areas of the ocean, and this tool has the potential to be used to identify areas where whale sharks may occur. This work uses satellite derived ocean parameters of chlorophyll *a* (Chl *a*) and sea surface temperature (SST) to evaluate whether oceanographic conditions typically considered favourable to whale

sharks occur in the continental shelf waters of Gujarat, India at the time of known whale shark presence. If found successful, this concept can be expanded to develop a technique for whale shark sighting based on Chl *a* and SST images.

2. Methods

2.1 Study area

Based on available data of the whale shark fishery, which indicated significantly greater reporting of whale sharks in Gujarat than other Indian states (Hanfee, 1997; Pravin, 2000), the region from the continental shelf up to the coast between Okha and Diu in the state of Gujarat was identified as the study area (Fig. 1). The continental shelf of Gujarat, in the northeastern Arabian Sea, is an area regularly visited by whale sharks, where they have been observed in the area for hundreds of years (Rao, unpublished; Vivekanandan and Zala, 1994; Pravin, 2000; Hanfee, 2001; Pravin *et al*., 2002a; Pravin *et al*., 2002b).

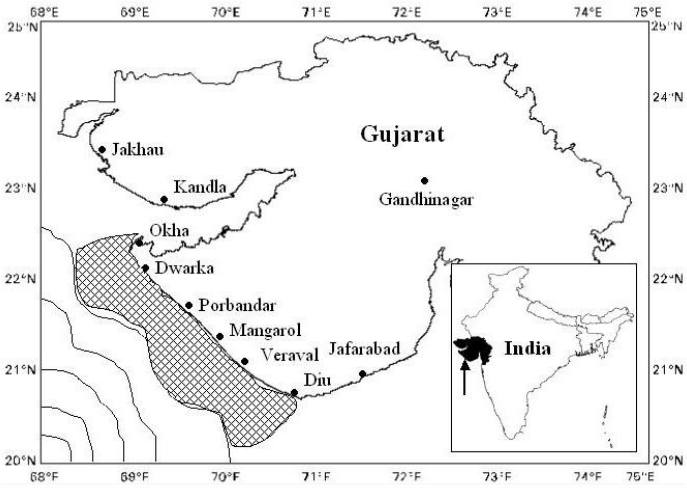

Figure 1. The coastal belt of Gujarat, India indicating the study area (hatched).

2.2 Methodology

Remotely sensed phytoplankton biomass fields at 9 km pixel resolution were obtained using SeaWiFS Level 3 monthly composites of the Arabian Sea from Goddard Distributed Active Archive Center (http://daac.gsfc.nasa.gov) for a period of three years (1998-2000). Monthly sea surface temperature (℃) data of the same period, measured by Advanced Very High Resolution Radiometer (AVHRR), was obtained from the National Oceanographic and Atmospheric Administration (NOAA) satellite archive (http://www.saa.noaa.gov) at the same pixel resolution. The standard NASA algorithm (OC_4 version 4.3) was used to produce global maps of phytoplankton biomass concentration parametrised in terms of chlorophyll *a* distribution. The algorithm is shown to retrieve chlorophyll concentrations within ± 35% of *in situ* concentrations in accordance with the goal set by SeaWiFS mission.

Due to the lack of scientific research on whale sharks in the area, distribution and abundance information could only be inferred from published literature and capture, incidental landing and sighting data from non-government organisations. It is important to note that as the fishery industry in India is generally unregulated and unmonitored (Pravin, 2000) this information of whale shark abundance cannot be considered complete. This study is confined to the annual period of February/March for 1998 to 2000 as a reasonable number of whale sharks were reported in the Gujarat area during this time. The number of whale sharks observed or exploited for these times is shown in Table 1.

Monthly chlorophyll *a* and sea surface temperature data corresponding to the study period have been used to study the distribution pattern of phytoplankton biomass and sea surface temperature.

Table 1. Total number of whale sharks sighted/ exploited/ incidental capture in the continental shelf region of Gujarat, India during February - March for 1998 to 2000.

Period	# Whale Sharks	Source
February – March 1998	140	Pravin (2000)
February – March 1999	123	Hanfee (2001)
February – March 2000	73	Hanfee (2001)

3. Results

The chlorophyll *a* images in the study area extending from the continental shelf region up to the coast demonstrate very high chlorophyll *a* values ranging from 0.7-7.9 $mg.m^{-3}$ in the month of February 1998 and 0.79-7.8 $mg.m^{-3}$ during March 1998 (Fig. 2). Chlorophyll *a* concentrations of greater than 2 $mg.m^{-3}$ were observed along the coast within 100 m depth zone from Porbander to Veraval during February and March 1998.

High phytoplankton biomass accumulations greater than 0.8 $mg.m^{-3}$ were observed in the open ocean areas of the northeastern Arabian Sea adjoining the continental shelf during February 1999 and 2000 (Fig. 2). In contrast, in February 1998 high concentrations of phytoplankton biomass were observed within the shelf only, with adjacent open ocean areas having moderate concentrations of approximately 0.5 $mg.m^{-3}$. The distribution patterns of chlorophyll *a* during March 1999 and 2000 followed a similar pattern as the previous month for each year (Fig. 2).

Sea surface temperature maps for the months of February and March 1998-2000 demonstrate values ranging between 23-25ºC in the entire continental shelf region of Gujarat and warmer temperatures greater than 26ºC outside the shelf (Fig. 3).

4. Discussion

The Arabian Sea is connected to the warm, highly saline waters of the Persian Gulf and the Red Sea, and experiences unique features and events. The semi-annual reversal of monsoon winds blowing from the northeast during December-February and from the southwest during June-September drive strong currents, produce complex eddy fields, deepen the mixed layer and induce both coastal and open ocean upwelling (Shetye *et al*., 1994). These physical changes directly affect primary production processes and consequently influence the abundance, distribution and diversity of fishery resources (Banse and McClain, 1986; Brock and McClain, 1992; Yoder *et al*., 1993; Bhattathiri *et al*., 1996; Yoder *et al*., 2001). Whale shark migration to the northern areas of the Arabian Sea during the winter monsoon could thus be linked to phytoplankton availability.

During the winter monsoon (December - February), seasonal cooling and convective mixing in the northern Arabian Sea injects nutrients into surface layers, triggering primary production and a phytoplankton bloom (Bhattathiri *et al*., 1996; Prasanna Kumar and Prasad, 1996). The seasonal migration of whale sharks in a south to north direction from near Maldives to the west coast of India (Pravin *et. al.*, 2002a) at this time appears to coincide with these events. Figure 2 illustrates this high phytoplankton biomass for the three year study.

NOAA-AVHRR derived sea surface temperature images indicated cooler temperatures in the range of 21-24 °C along the continental shelf region of Gujarat and the northern areas of open ocean during the winter monsoon (Fig. 3), this is the optimum temperature range for whale sharks (Pravin, 2000). In addition to the preferential temperature range, the high concentration of phytoplankton over a large area (Fig. 2) coincides with aggregation of whale sharks in the shelf-coast region of Gujarat during the periods of February and March for three consecutive years (1998-2000).

Further analysis and development of a tool to predict whale shark distribution may provide evidence that intensity, timing and variations in the spatial distribution of the phytoplankton bloom from year to year, determined by variations in the atmospheric and oceanic physical processes, accounts for the variations in whale shark aggregation in the shelf-coast region.

5. Conclusion

The seasonal visit of whale sharks to the coast of Gujarat, India during the winter season every year generates a scope for the development of an alternate source of income for the fishing community by means of a whale shark ecotourism industry. To be able to utilise the resource in this way, predictability of whale shark presence is necessary. Satellite remote sensing of ocean colour and temperature is our only window into the synoptic state of the pelagic ecosystem and offers the potential to identify areas where oceanographic conditions suitable for whale sharks occur. Based on knowledge of optimum physiological conditions for whale sharks we have identified such conditions exist on the coast of Gujarat at the time of known whale shark aggregations. A more detailed study of whale shark movement, distribution and abundance in this area combined with validated oceanographic observations of satellite derived chlorophyll *a* and sea surface temperature is needed to confirm any direct correlation between whale shark distribution during the winter season off Gujarat.

Acknowledgments

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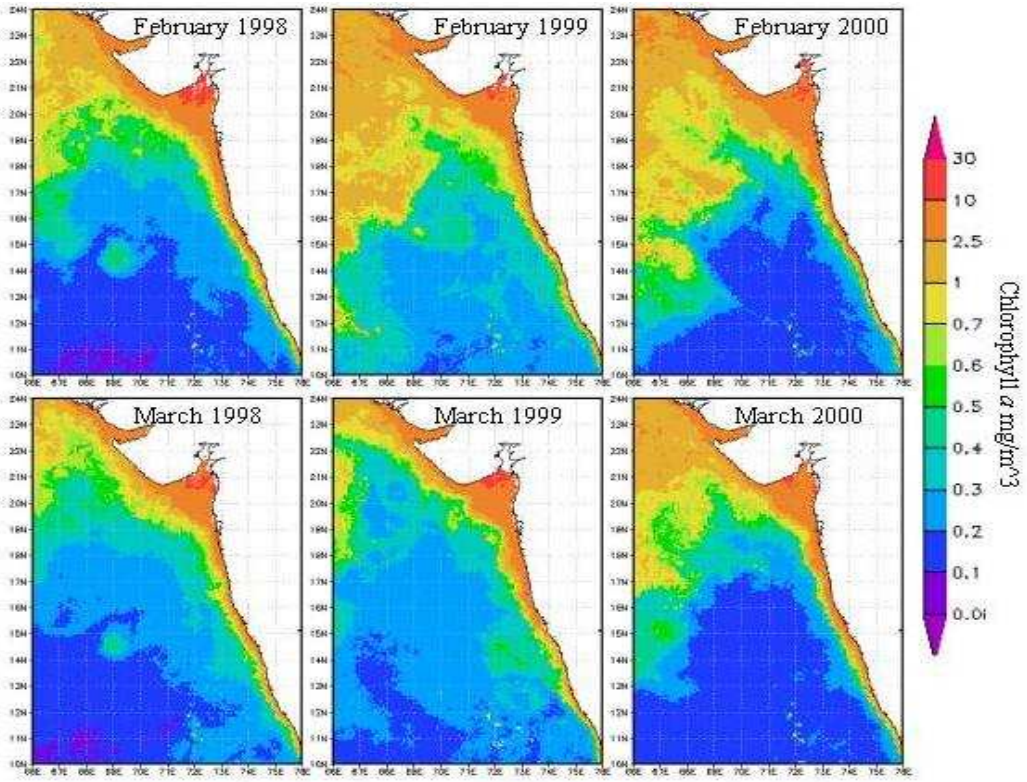

Figure 2. Interannual comparison of SeaWiFS derived chl-*a* variation during February-March, 1998-2000.

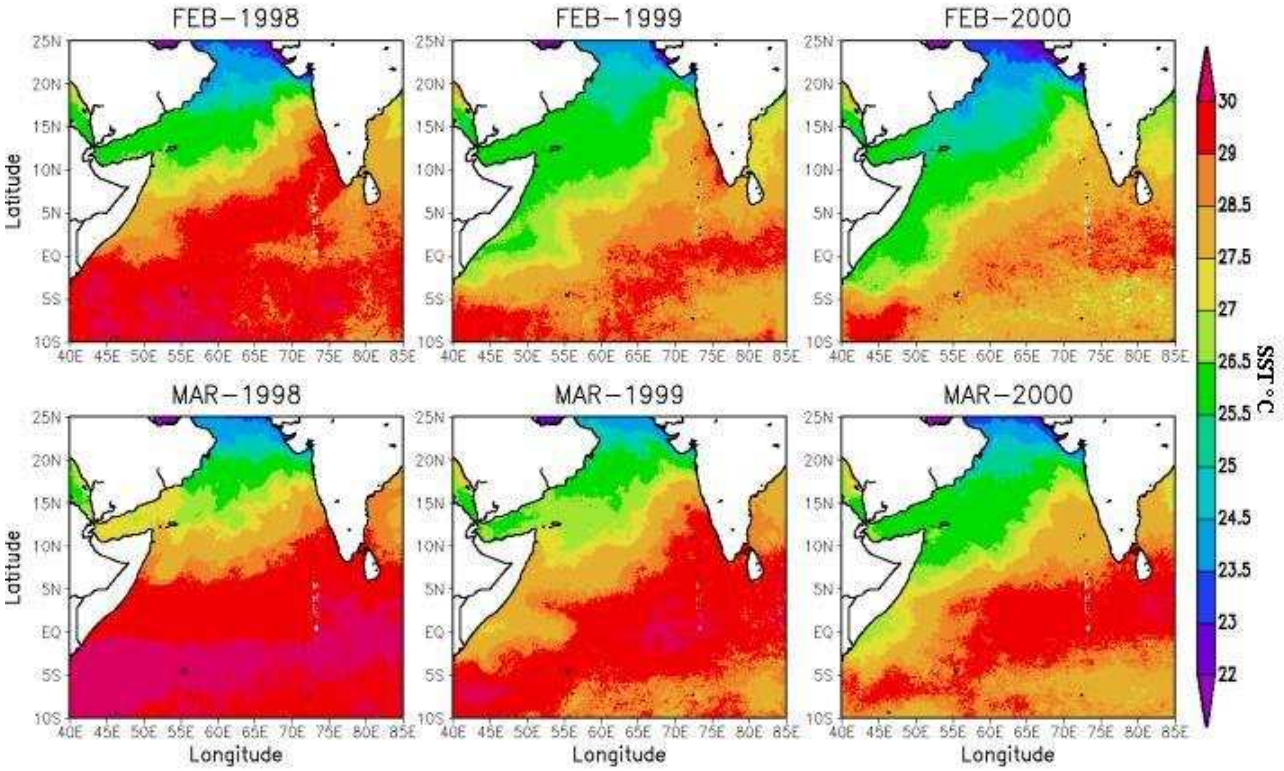

Figure 3. Interannual comparison of NOAA AVHRR derived SST variation during February-March, 1998-2000.

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PART I. SCIENCE

Whale shark (*Rhincodon typus*) biology and ecology: A review of the primary literature.

J.D. Stevens.

In the 160 years since Andrew Smith described the whale shark in 1828, two people devoted much of their scientific lives to whale sharks. This period of research mainly comprised documenting the known sightings, captures and strandings of this species. Dr Eugene Gudger collected reports of whale sharks from all over the world and published 47 papers on these sharks in 40 years. Dr Fay Wolfson also documented whale shark records from all over the world and published a bibliography on the species as well as a paper summarising all the known (320) occurrences from published records and verified reports up to 1985. However, life history information during this period was scant.

In the succeeding 20 years from 1986, there has been a huge increase in recreational diving and boating activity around the world that has led to discoveries of whale shark aggregations in various places. Together with increased demand and prices for whale shark products this has led to considerable conservation and marine ecotourism interest in the species that has provided the impetus for a number of studies. However, while some further understanding of whale shark reproduction and age and growth has resulted, our knowledge of the species biology and ecology is still poor. Over the last 10 years several tagging and tracking studies have been initiated on whale sharks in various parts of the world. Despite the relatively recent increases in demand for whale shark meat driven by the Taiwan market, there are still few good data in the primary literature from existing fisheries.

A review of behavioural ecology of whale sharks (*Rhincodon typus*).

R. Aidan Martin.

Behavioural ecology of whale sharks is very incompletely known. Recent rapid development of whale shark-based ecotourism at several widespread localities risks deleterious impacts on the behaviour, habitat, and ecology of the target species. Available information on behavioural ecology of whale sharks is synthesised from the published literature (including inferences from related species) and personal observations. This information is reviewed within the unifying framework of theoretical behavioural ecology, revealing opportunities to fill in critical knowledge gaps. Topics covered include: sensory biology, movements, anti-predator behaviour, feeding behaviour, social behaviour, reproductive behaviour and interactions with humans. Data collected by whale shark ecotourists and operators could help fill in some of the knowledge gaps about the behavioural ecology of this species.

Satellite tracking of whale sharks using tethered tags.

Andrew Gifford, Leonard J.V. Compagno, Marie Levine and Alex Antoniou.

Aggregations of whale sharks, *Rhincodon typus*, occur each year off South Africa (Indian Ocean) and in the waters surrounding Utila, Bay Islands, Honduras (Caribbean Sea), where they form the basis of a whale shark ecotourism industry. In 1998 and 1999 the Shark Research Institute deployed tethered satellite tags on five whale sharks in an effort to gather information on their diving profiles and both long-term and short-term movements. Satellite tags were attached to the sharks by divers using tag anchors placed in either the skin or musculature of the shark, and tethers from 1.5 to 7 m were used with varying degrees of success. Tethered tags provide real-time data about the habitat use and diving profiles of whale sharks, and may be recovered if they detach prematurely from the host animals. An unexpected finding was that the sharks dived regularly to depths of >320 m, which may have contributed to premature detachment of the tags due to drag and, as result, the hydrodynamics of the tag were refined. Sharks tagged off the coast of KwaZulu-Natal, South Africa, travelled northwards. One shark tagged off the coast of Utila Bay Islands, Honduras, travelled to the Swan Islands, then moved along the Yucatan Peninsula and into the Mexico Basin, while the second shark tagged off Utila travelled to the coast of Belize. This study confirms that tethered satellite tags are effective tools in monitoring travel paths and habitat use of whale sharks when real-time data is needed.

Satellite tracking of juvenile whale sharks, *Rhincodon typus*, in the Northwestern Pacific.

Hua-Hsun Hsu, Shoou-Jeng Joung, Yih-Yia Liao and Kwang-Ming Liu.

Four juvenile whale sharks, *Rhincodon typus* were tagged using SPOT2 (Smart Position and Temperature Transmitting) satellite tags (Wildlife Computers Ltd.) during 2002 and 2004. Transmissions from three males (4.0-4.5 m total length) were successfully received via the Argos satellite system. Two sharks tagged in April had similar routes after being released. They spent the most time in open sea suggesting that it is an important period in the life history of juvenile whale shark in the Northwestern Pacific. In addition, they generally occupied areas where the water temperatures were between 23 and 32℃. Another shark tagged in November moved above the sea ridges in the first month after being released then migrated along the eastern and northern coastal waters of Taiwan during winter. This shark stayed in the Kuroshio Current region where the water temperature was between 25 and 29℃, then moved to the edge of the China Coastal Current region where the temperature was low (14-21℃) and remained there. In the last 15 days of the tracking, the shark shifted to the coastal waters of Taiwan where the temperature was between 17 and 24℃. Three individuals dive deep into waters where the temperature was 6℃. The average swimming speed was between 28.3 and 34.6 km per day. They could accelerate to 11-13 km/hr for a very short time period. Their movement patterns appeared to be related to boundary currents which may bring abundant prey, and sharks stayed in waters with higher plankton densities for a longer time. These results provide important information on migratory routes of whale sharks in the Northwestern Pacific, and can be used as a reference for the conservation and management on the world's largest fish.

Regional scale horizontal and local scale vertical movements of whale sharks in the Indian Ocean off Seychelles.

D. Rowat and M. Gore.

Little information on the movements and use of habitat by whale sharks is available. We present data on regional horizontal and local vertical movement of juvenile whale shark from waters off Seychelles into the Indian Ocean, as recorded by satellite telemetry. Tracking data show that the direction of travel in three sharks was influenced by the prevailing geo-strophic currents. The temperature distribution frequencies recorded show that the sharks spent the majority of time in waters of 25 ˚C to 35 ˚C. However, short exposures to very cold waters, below 10 ˚C were recorded and these are consistent with dives to deeper depths. Depth recordings show that up to 53% of the time was spent in water shallower than 10 m, but dives to depths of 750 m to 1000 m were also recorded. These results are discussed in relation to diel patterns and diving behaviour in a similar planktivore, the basking shark. The marked preference of the whale sharks for swimming in relatively shallow water may indicate the importance of this range with respect to their foraging activities and has implications for their management and conservation.

Aerial census of whale sharks (*Rhincodon typus*) on the northern KwaZulu-Natal coast, South Africa.

Geremy Cliff, Michael D Anderson-Reade, Andrew P. Aitken, Graeme E. Charter and Victor M Peddemors.

A project was initiated to assess the potential for dedicated whale shark diving on the northern KwaZulu-Natal (KZN) coast of South Africa. Between October 2001 and September 2002 12 aerial surveys were conducted along 350 km of the coastline immediately south of the South Africa/Mozambique border. Only eight whale sharks were seen, with a sighting rate of 0.21 sharks per 100 km of coastline. Another thirteen surveys were completed during the summers of 2003/4 and 2004/5 and a total of 30 sharks were sighted, with a mean sighting rate of 0.69 sharks per 100 km of coastline. The density of sharks was highest in the far north where it averaged 1.05 sharks per 100 km between January and May but this value is considered too low to support dedicated whale shark diving. Local dive operators and light aircraft pilots confirmed the scarcity of whale sharks in the region. The mean sighting rate from three flights along 950 km of southern Mozambique coastline in March was 5.6 sharks per 100 km of coastline. Reasons for the marked regional differences in shark density are not apparent but the paucity of sharks in northern KZN waters may be linked to a recent increase in sightings off the Kenyan coast.

Foraging ecology of whale sharks (*Rhincodon typus*) within Bahía de los Angeles, Baja California Norte, México.

Jonathan D. Nelson and Scott A. Eckert.

The presence of whale sharks (*Rhincodon typus*) in Bahía de los Angeles, Baja California Norte, Mexico, is a seasonal phenomenon, occurring during the months of June – November, with highest abundance from August – October.

The foraging ecology of whale sharks in Bahía de los Angeles was studied from July 28 – October 26, 1999. During this period, 19 individual whale sharks were identified, including 9 males, 3 females, and 7 whose sex was not identified. Feeding by whale sharks was observed on 132 out of 190 sightings. Approximately 80% of the feeding events occurred in areas with ≤ 10 m bottom depth, (mean ± SD = 7.0 ± 5.5 m), and were concentrated primarily in the southernmost region of the bay. The highest numbers of feeding events occurred between 1200 – 1600 h. Mean (± SD) sea surface temperature during these events was 29.7 ± 1.1 ^{o}C. Three feeding behaviors, "active", "vertical", and "passive", and one non-feeding behavior, "cruising", were characterized. Analysis of plankton samples collected beside feeding sharks revealed that zooplankton, primarily copepods (~ 85% of total zooplankton abundance) appeared to be the primary prey source in the bay. Although whale sharks were observed feeding among large schools of baitfish (sardines, anchovies), whale sharks were never observed directly preying upon these fish. Whale sharks may target baitfish to locate zooplankton, as these fish can be indicators of plankton rich patches. Zooplankton abundance was significantly different among the three feeding behaviors, suggesting that prey abundance may influence which feeding technique was utilized. Feeding was not observed when the minimum density of zooplankton was less than ~ 10.0 x 10^3 individuals m^{-3}. Whale sharks may be following oceanographic cues (physical and biological) both within the bay as well as throughout the Gulf of California that are favorable for increases of prey resources. Because whale shark ecotourism is rapidly increasing in Bahía de los Angeles, it is important to identify and manage ecologically important areas utilized by whale sharks within the bay to ensure the continued integrity of the habitat that supports whale shark presence.

Ram filter-feeding and nocturnal feeding of whale sharks (*Rhincodon typus*) at Ningaloo Reef, Western Australia.

J. Geoff Taylor.

The paper reports feeding behaviours of whale sharks (*Rhincodon typus*) at Ningaloo Reef, Western Australia that have been observed during field trips over a period of 23 years. Two distinct feeding behaviours have been observed, namely passive feeding, which resembles the ram filter-feeding of the basking shark (*Cetorhinus maximus*), and active feeding at the surface, as previously described in the literature. Nocturnal surface feeding behaviour is reported. The targeted prey species were specific to the different feeding techniques and times. Contrary to previous reports, the gills of the shark moved actively in a rhythmical fashion during both of the observed feeding modes. The principal prey species identified at Ningaloo have been the euphausiid *Pseudeuphausia latifrons*, portuniid megalopa, stomatopod larvae, copepods, chaetognatha, and schools of small fish. The diurnal appearance of whale sharks at the surface and the passive feeding witnessed during daylight hours, suggests that the whale shark is searching for localised aggregations of plankton that persist at the surface in the weeks following the reef spawning.

Assessing the size, growth rate and structure of a seasonal population of whale sharks (*Rhincodon typus* Smith 1828) using conventional tagging and photo identification.

Rachel T. Graham and Callum M. Roberts.

Population size and structure of whale sharks (*Rhincodon typus*) remain unknown despite their economic importance to targeted tourism and fisheries and their 2002 listing on CITES Appendix II. Here, we present results from the first whale shark population study in the Western Hemisphere and describe the inherent difficulties of assessing populations using catch-independent methods in free-ranging sharks. From 1998 to 2003 we identified 106 whale sharks using their distinctive scars and spot patterns following 521 encounters at a predictable seasonal aggregation on the Mesoamerican Barrier Reef linked to snapper spawning aggregations at Gladden Spit, Belize. Encountered sharks measured a mean total length of 6.3 m ± 1.7 m SD and a range: 3.0 m to 12.7 m (n = 317). Sexual and size segregation is suggested: 31% of encountered sharks (n = 162) were sexed, of which 86% were immature males. Between 1999 and 2002, 70 sharks were tagged with 72 conventional tags and measured sharks (n = 63) possessed a mean length of 6.0 m ± 1.6 m SD (range 3.0 m to 9.7 m). Growth rates for three resighted sharks ranged from an estimated 0.03 m to 0.70 m $year^{-1}$. Resightings of tagged sharks elsewhere on the Mesoamerican Barrier Reef indicate that the population is not resident at Gladden Spit and is shared with two other sites possessing seasonal aggregations: Isla Contoy, Mexico and Utila, Honduras. Monitoring whale shark populations at Gladden Spit and the other aggregation sites on the Mesoamerican Barrier Reef underpins the region's lucrative and burgeoning whale shark tourism and is key to their local and international conservation.

Size and maturity status of the whale shark (*Rhincodon typus*) at Ningaloo Reef in Western Australia.

Bradley M. Norman and John D. Stevens.

Between 1995 and 1997, 360 observations of whale sharks at Ningaloo Reef revealed that approximately 85% were males (4-12 m TL). Based on the external morphology of claspers, all males <7 m TL were immature. Only 9.3% of males between 7 and 8 m TL were found to be mature, compared to 36.6% of those between 8 and 9 m TL. All but one of the 79 male whale sharks >9 m was considered mature. A logistic equation fitted to the percentage of mature males in each size class predicted a length at first maturity (L_{50}) of ~8.0 m TL, while 95% (L_{95}) of males were mature by ~9.0 m TL. Female whale sharks at Ningaloo Reef during this study were generally smaller and ranged in length from 4 to 8 m TL. The small size and general absence of female whale sharks from Ningaloo Reef suggest that the region may be important for feeding rather than breeding.

Variations of the mitochondrial control region sequence in whale sharks (*Rhincodon typus*) from the Gulf of California, Mexico.

Dení Ramírez-Macías, Ricardo Vázquez-Juárez, Felipe Galván-Magaña, Adrián Munguía-Vega.

A highly variable fragment of the mtDNA control region of the whale shark was sequenced to investigate genetic population structure at three localities in the Gulf of California. We found high levels of variation with 14 haplotypes among 36 individuals ($\underline{h}$ = 0.90, π = 0.005). AMOVA analysis did not detect significant structuring among Gulf of California whale sharks ($\underline{P}$ > 0.12, Φ_{ST} 0.029), which indicates a single, highly mobile population. Genetic analysis, along with field observations, suggests natal philopatry of female whale sharks in the Gulf of California.

PART II. CONSERVATION & MANAGEMENT

Occurrence of whale shark (Rhincodon typus) in the Indian Ocean: a case for regional conservation.

David Rowat.

From the first whale shark (*Rhincodon typus*) described in 1828 from the Indian Ocean, the region continues to be one of the most important areas for whale shark sightings. However, the species has been the subject of several targeted fisheries and thus sustained massive, rapid declines in population numbers.

The known range of occurrence and targeted fisheries for whale sharks in the Indian Ocean are discussed, along with stated national conservation measures in the range states. The results of a preliminary survey of 16 regional cooperative partners from 11 of the Indian Ocean range states are presented for whale shark occurrence, monitoring, perceived threats and realized conservation measures. These data are already proving valuable by facilitating cooperation between organizations regionally.

The current international conservation framework is briefly described and suggestions made as to possible linked regional conservation initiatives, such as under the auspices of the Convention on Migratory Species.

Tourist compliance to a Code of Conduct and the resulting effects on whale shark (*Rhincodon typus*) behavior in Donsol, Philippines.

Angela L. Quiros.

This study examines tourist compliance to the Code of Conduct for whale shark (*Rhincodon typus*) interactions and assesses impacts of tourists on whale sharks in Donsol, Philippines. Whale sharks feed in Donsol's nutrient rich waters between November and June, drawing up to 7,100 visitors annually. Tourist, tour operator, and whale shark behavior were examined during human-whale shark interactions (n=777) on 117 boat trips (March, April and May) in 2004, and on 76 boat trips in 2005 (n=620). Average compliance to Code of Conduct regulations in 2004 and 2005 was 44% for the minimum distance kept; 82% for no touching, no path obstruction and a maximum of 6 swimmers per whale shark; 89% for a maximum of 1 boat per shark, 99% for no flash photography and no SCUBA, scooters, and jet-skis. Significant predictors of whale shark's directional changes were path obstruction and proximity of swimmer to whale shark, while for whale shark's dive response it was first-time sighting and whale shark feeding. The significant predictor of a violent shudder behavior was touching. Generalized linear modeling evaluated change in direction, dive response and violent shuddering variables, and found that touching, flash photography, and swimmer diving towards the whale shark significantly affected the magnitude of disturbance. Tourism impacts on whale sharks can be minimized through adaptive management that monitors tourism and alters interaction regulations to reflect tourist and tour operator actions that have detrimental effects on whale sharks.

Seychelles: A case study of community involvement in the development of whale shark ecotourism and its socio economic impact.

David Rowat and Udo Engelhardt.

Whale sharks (*Rhincodon typus*) have long been known to the local community of Seychelles, especially the fishers, but the sharks have never been exploited there as a food resource. The growing interest in the species by visitors to the islands prompted a more pro-active management approach in response to an initial pilot monitoring programme.

The stakeholder driven process involving dive and boat operators, conservation organizations and governmental agencies that instigated a nation wide monitoring network is described and the feedback to the public and stakeholders is illustrated. The development and adoption of a code of conduct for whale shark encounters to enable the sustainable use of whale sharks as an ecotourism resource is described.

Published estimates of the worth of whale sharks as an ecotourism resource in Seychelles forecast a potential value of up to US$4.99m for a 14 week season; these are reviewed and compared to actual revenues realised by the fledgling whale shark ecotourism activities. The direct links and spin-offs of these commercial activities to the on-going research programme and the mutual benefits are discussed.

Community-based management through ecotourism in Bahia de los Angeles, Mexico.

Nirari Cárdenas-Torres, Roberto Enríquez-Andrade and Natalie Rodríguez-Dowdell.

In some places around the world, whale shark ecotourism has become an important economic activity. Specific cases are present in Mexico, the most important being Bahia de los Angeles, Baja California; Bahia de La Paz, Baja California Sur, both in the Sea of Cortes and near Holbox and Contoy Island, Quintana Roo in the Caribbean Sea. Observation and swimming activities with whale sharks in Bahia de los Angeles have been offered for approximately 14 years, although these activities have only recently become more popular. Several studies have been carried out since 2001 to present economic alternatives for the people living in this coastal community based on whale shark aggregations. This bay is one of the very few known and accessible places around the world where whale sharks congregate on a regular and predictable basis. However, human-related activities, including tourism pressure may also affect the behavior of individual sharks and consequently, have a negative impact on the industry. The present study led to the implementation of a “Code of Conduct” for interaction activities with whale sharks so they could ensure a safe, enjoyable experience for participants and to prevent the animals from being harmed or disturbed. Also, it enabled the establishment of a continuous data set collected directly by the tour operators, which is updated each year in collaboration with independent researchers. The guidelines within this “Code of Conduct” have formed the basis of similar management practices in other places of Mexico, and are enforced to reduce the chance that the animals will be negatively affected through human interaction. It is concluded that community-based projects are important for long term conservation.

Property rights based management: Whale shark ecotourism in Bahia de los Angeles, Mexico.

Natalie Rodríguez-Dowdell, Roberto Enríquez-Andrade and Nirari Cárdenas-Torres.

Predictable and long-term whale shark (Rhincodon typus) aggregations can be observed in few locations around the world. In some places where this occurs the use of the species through ecotourism has become an important economic activity. Bahia de los Angeles, Mexico is an important habitat for whale sharks for up to seven months per year. Based on their presence, ecotourism activities with the species have become more popular among the local community in recent years. Whale sharks and their habitat represent an important form of natural capital with high potential to produce economic value; however this has not translated in an improvement of the local communities’ quality of life due to several limitations that the activity, resource and users confront. The most evident threat is free access, carrying with it a potential loss of economic benefits due to resource saturation and when external groups use the resource or tourists observe the species without having to hire local tour operators. It is recognized that property right regimes are fundamental because they define the rights and obligations for the use of natural resources and the rules by which these rights and obligations are implemented. The present study recommends the implementation of a strategy for the sustainable management of whale sharks based on property rights; taking into account both the characteristics of the resource and the social context where it is used. Through the opinion of a consultant panel comprised of representatives from federal, state and municipal governments, as well as academics, non governmental organizations and local users of the resource, three different options are analysed - free access; a limited number of permits for local users; and a

concession of the area in favour of the group of local users- by means of four qualitative criteria (efficiency, equity, transaction costs and acceptance) and a quantitative criterion (duration), using Multicriteria Analysis. The evaluation concludes that the scenario which is the most efficient, equitable, with lower transaction costs and more acceptable is a concession of the area in favour of the group of local users.

SHORT COMMUNICATIONS

Whale shark landings in Indonesian artisanal shark and ray fisheries.

William T. White and Rachel Cavanagh.

Comprehensive surveys of the chondrichthyan catches landed at various localities in eastern Indonesia were conducted between April 2001 and October 2005 to obtain detailed catch composition data from local, artisanal fisheries. A total of 144 chondrichthyan species representing 36 families were identified in this study, including the whale shark *Rhincodon typus*. Of the 270 individual surveys conducted, only one specimen of *R. typus* was recorded, at the fish landing site of Kedonganan in southern Bali in April 2004. A further four whale sharks were caught by the fishers at this site in the three subsequent months. All of these sharks were finned at sea and the carcasses not retained. Three other whale sharks had been landed by shark processors at this same site in Bali and one was landed near the fish landing site of Tanjung Luar in east Lombok in August 2005. It is highly likely that whale sharks are also landed, albeit irregularly, by the numerous other artisanal fish landing sites throughout Indonesia. However, calculating an approximate number taken on an annual basis within Indonesia would be very difficult, if not impossible to determine.

Occurrence of whale sharks (*Rhincodon typus*) in Madagascar.

Mananjo Jonahson and Simon Harding.

Whale sharks are known to occur in Malagasy waters although very little research has been completed to further document the species. In order to increase the current national knowledge of the species, it is planned to conduct whale shark surveys in Madagascar. An initial investigation based on interviews of local fishers and dive operators was completed to establish the logistical baseline for such surveys. It was found that whale sharks are present around the majority of the Madagascar coastline but most known sightings have occurred along the north-western coast. In Nosy Be, it appears whale sharks occur all year round, particularly during planktonic blooms. Plans for further assessment involving a combination of boat based observations, photo identification, and acoustic and satellite tagging are described.

Conference Presentation Abstracts

Volker BASSEN

The East African Whale Shark Trust

The regional situation:

The earliest whale shark sightings on record occurred in the Indian Ocean. Most of the whale sharks along the Kenya coast are males. It is not unusual to see them in groups of up to 20 during November to March, whale shark season. Females are seen between March and November. The big groups are most likely to be seen during neap tide. It is currently a mystery where they go at other times; a mystery which may be easier to solve when the East African Whale Shark Trust buys an ultra light! Their size varies from 3m to 20m but the average is around 8-10m. They are seen most often near the surface quite close to the reef which is 100m from the beach. The EAWST is the first whale shark conservation project of its kind along this coast. It aims to raise awareness and promote protection in various ways.

Present threat:

The local community and the fishing industry pose a real threat to the whale shark. Fortunately, because their arrival is relatively recent, most people have not caught on to their value on the international market. Fishermen use oil from whale shark liver to protect their boats from rot. Fins are a delicacy, and fetch between $80-130 per kilo (dried). Sadly the shark trade carries on unchecked here and it is all too easy to catch a whale shark then sell off the fins. I found a dead whale shark early this year and have amazing footage of its massacre and the stolen parts being sold.

The way forward:

Research - the big question for the research department will be the reason behind the increase in whale sharks, perhaps linked to the surge of mantis shrimps or congested shipping lanes. Research will be carried out in conjunction with Universeum and Chalmers University, both based in Sweden. Satellite tag design is to be incorporated into the relevant doctorate programme which will be of great significance to our monitoring of the whale sharks here.

Education projects will be accredited and cater for different groups – school children, students and tourists.

Community-based projects - to work with the local villages to give the trust long-lasting meaning for the people who have lived for centuries along the coast.

Eco-tourism - whale shark friendly eco-safaris incorporating diving or snorkeling, BBQ lunches and camping.

Volker Bassen

East African Whale Shark Trust, PO Box 933, Ukunda 80400 Kenya

Nirari CARDENAS-TORRES

Community-based management through ecotourism in Bahia de los Angeles, Mexico

In some places around the world, whale shark ecotourism has become an important economic activity. Specific cases are present in Mexico, being the most important Bahia de los Angeles Baja California; Bahia de La Paz, Baja California Sur, both in the Sea of Cortes and near Holbox Island, Quintana Roo in the Caribbean Sea. Swimming with whale sharks in Bahia de los Angeles has been carried out approximately for 14 years, although it is until recent that it has become more popular. Several studies have been carried out since 2001 to present economic alternatives for the people leaving in this coastal community based on whale shark aggregations. This bay is one of the very few known and accessible places around the world where whale sharks congregate on a regular and predictable basis. However, human-related activities, including tourism pressure may also affect the behavior of individual sharks and as consequence, have a negative impact on industry. The present study proposes a series of recommendations based on the implementation of “Code of Conduct” at the bay to ensure a safe, enjoyable experience for participants and to prevent the animals from being harmed or adversely disturbed. Also, it enabled the establishment of a continuous data set collected directly from the tourist operators, which updated each year in collaboration with independent researchers. The guidelines within this “Code of Conduct” have formed the basis of similar management in other places of Mexico, and are enforced to reduce the chance that the animals will be negatively affected through human interaction. It is concluded that community-based projects are important for long term conservation.

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Lisa CARNE

Whale shark tourism at Gladden Spit Marine Reserve, Belize, Central America

(Poster Presentation)

Gladden Spit was declared a marine reserve in May 2000 because of the spawning fish aggregations and the whale sharks attracted there to feed, but it wasn't until 2002 that Friends of Nature, a young NGO formed from a grassroots community organization, began co-managing the area with the Belize Fisheries Department. Based on a series of community and stakeholder consultations in 2003, whale shark tourism guidelines and regulations were created and then implemented in 2004.

Whale shark tourism at Gladden Spit Marine Reserve in Southern Belize has grown from one tour operator in 1996 to 26 operators in 2005. Meanwhile the likelihood of a whale shark sighting during the peak season (March –June) has dropped to less than 20% in 2004 from over 80% in 1999. The maximum number of whale sharks in one aggregation has also reduced to just six in 2004 from 13 in 1997.

Tour guides, visitors and researchers unanimously agreed these regulations needed to be revisited, and stricter guidelines are being enforced for 2005. No more than four boats are allowed on the site at once, with 90-minute time slots assigned by lottery. But questions remain: Four boats is 56 people, is this crowd still too large? Is SCUBA diving having a negative effect on the spawning aggregations and/or whale sharks? Are researchers and their monitoring efforts interfering? Should the site be closed to tourism and/or fishing for an indefinite period? Or has the global population of whale sharks been significantly reduced, thus affecting the number of whale sharks sighted at Gladden Spit Marine Reserve?

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Geremy CLIFF

Aerial census of whale sharks on the northern KwaZulu-Natal coast, South Africa 2001-2005

This project was initiated in 2001 to assess the potential for dedicated whale shark diving on the northeast coast of South Africa. Between October 2001 and September 2002 13 aerial surveys were conducted between Ballito and the South Africa/Mozambique border, a distance of 375 km and only ten whale sharks were seen. This represents a sighting rate of 1 shark per 460 km These extremely low sighting rates clearly cannot support a dedicated whale shark diving industry.

An additional nine surveys were completed during the summers of 2003/4 and 2004/5 over the same stretch of coastline and 25 sharks were sighted, with a mean sighting rate of 1 shark per 135 km of coastline. Although this represents an increase on the sightings from 2001/2, numbers are still low. Anecdotal reports from dive operators at Sodwana Bay and light aircraft pilots have also indicated that whale sharks continue to be scarce in the region. By contrast at least 58 sharks were sighted in the Tofo region of southern Mozambique on a flight in March 2004.

The low sightings in South African waters may simply reflect an extended period in which few whale sharks entered KZN waters from the north. On the other hand the low sightings come at a time when there is increasing global concern as to the status of whale sharks. Heavy fishing pressure in certain parts of the species' range may well have resulted in a decline in numbers.

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Julien COLOMER

Australian Government conservation and management of whale sharks

The whale shark is listed as vulnerable under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Australian Government's jurisdiction over the whale shark extends 3 nautical miles from shore to the outer edge of Australia's Exclusive Economic Zone (EEZ). The Australian Government is also responsible for Australia's international obligations with regard to whale sharks.

The presentation will focus on the Australian Government's roles and responsibilities in the conservation and management of the whale shark as defined by the EPBC Act and relevant International agreements, including threat-based recovery planning and domestic and international recovery actions.

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Claire DAVIES

Christmas Island – Ecotourism and research

Christmas Island (CI) is listed as a 'critical habitat' for the whale shark due to the aggregation of whale sharks in the area between October to April coinciding with the food pulse produced by the spawning of the red land crabs.

The first rains in October/November trigger the start of an amazing natural phenomena that culminates in the aggregation of whale sharks in the waters of CI. Millions of endemic red land crabs migrate from the island forest plateaus to the ocean edge to breed, releasing up to 100,000 eggs per female into the sea. It has been observed over several years that the arrival of whale sharks at CI coincides with the spawning of the red crabs.

There are two dive operators, Indian Ocean Diving Academy (IODA) and Wet 'n' Dry Adventures (WDA), on CI that run trips to dive / snorkel with the whale sharks during the whale shark 'season'. Due to the small scale of the tourist industry at present, combined with the isolated location of the island, planes are not available for spotting the whale sharks. Tourists either interact with whale sharks while on SCUBA at depth or, when spotted from the boats, while on snorkel. Stakeholders at CI are beginning to realise the importance of this phenomena and have increased marketing efforts to make CI a premier eco-tourism destination.

Whale shark sighting numbers have varied over the years, with 2005 the best for 4-5 years. In 2005, there have been sightings of up to eight whale sharks together at dusk, apparently all feeding. A dedicated plankton study coordinated through Parks Australia North and ECOCEAN has begun to investigate the links between whale shark aggregation and food pulses at CI.

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Mariana DIAZ

The importance of cross scale institutional arrangements for whale shark conservation and management: the experience from two coastal communities in Mexico

Whale shark ecotourism has expanded rapidly in the last few years and Mexico is no exception to this trend. Two of the main areas where these big fishes come into sight and where whale shark ecotourism is taking place are Bahia de los Angeles, Baja California (Baja California Peninsula) in the north-west of Mexico and Holbox Island, Quintana Roo (Yucatan Peninsula) in the south-east. The industry has rapidly developed especially in the Holbox region where in a period of three years the activity has become an important source of income for the community in general.

Both in Bahia de los Angeles and Holbox Island the communities and the whale sharks have been affected by social, cultural, ecological and economically-driven changes. This is partially because of the economic vulnerability of the communities and their dependency on marine resources and tourism for survival. But, also, the adoption of marine ecotourism as an alternative source of income has caused other issues related to social conflicts and diverse social interests. All of these issues affect the communities and may well negatively impact on long-term conservation of the whale shark. Given this situation the present study aims to determine the necessary horizontal (across space) and vertical (through levels of organisations) linkages of institutional arrangements to conserve the whale sharks while constantly determining how this will help to increase the social, economic and ecological resilience of the communities.

This study draws on the rationale that for the conservation of whale sharks to be successful it is vital to understand the role of the users of the resource and their livelihoods. Therefore, the people-centred Sustainable Livelihoods (SL) approach was used as a theoretical framework. The SL framework was utilised as a tool to understand the main components that affect people's livelihoods in rural areas and the linkages among these. The study concentrates mainly on three aspects of the SL. The components are social capital, natural capital and institutions which were all analysed in detail. Qualitative research methods were used extensively on a cross case study in the two communities in Mexico where whale shark ecotourism has been developed on a community basis. The experiences, although very different in nature (different socio-economic context, geographical locations, etc.), permitted the analysis of strengths and weaknesses, therefore providing useful insights.

The 'widely held' view that ecotourism is good for developing communities and the natural capital (whale sharks in this case), is questioned in this paper. First, where the natural capital has not previously been exploited 'ecotourism' can, if not carefully managed through appropriate institutional and other arrangements, impact on the resource being 'exploited'. Thus, and second, institutional arrangements, both in horizontal and vertical contexts, are vital management ingredients. Existing institutional arrangements, even if acceptable in theory, can be put under enormous pressure when the ecotourism activity is

expanding rapidly and the pressures on the social capital of the affected communities are too great to allow an adequate response. The lessons from these Mexican studies indicate a need to focus first on the natural capital (because without it the social capital and institutional arrangements will be superfluous), and then on recognition that 'management' of the social capital will influence the success of institutional arrangements for this and other natural resources in the affected areas.

Mariana Diaz

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Leonel ESPINOSA DIAZ*

The whale shark (*Rhincodon typus*): Proposal of fishing regulatión in cuban waters

A synthesis of the main biological characteristics and the state of exploitation of the whale shark in international waters, is offered. Evidences of severe reductions of populations in Asia, are pointed out. The whale shark is included in the Appendix Ii of CITES since 2002 Most of the specimens observed in Cuban waters presented sizes between 4-8 m, which are likely young immature. The main objectives of this paper are the followings: 1. To present a list of sightings of the species through the Cuban platform since 1984 and 2. To propose the ban of fishing and trading this species in Cuban waters to contribute to its protection.

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Ben FITZPATRICK*

Quantitative analysis of scarring frequency in whale sharks and implications for adult survivorship

Discovery of a number of whale shark aggregation sites during the past few decades are gradually facilitating increased scientific understanding of their life history. Photographic databases and collection of associated morphometric data from Ningaloo Reef has revealed the shark is slow growing and does not mature until about 30 years of age (Taylor unpub data). Analysis of growth rings in vertebrate samples suggests whale sharks live to over 100 years (Winter 2000). Capture and dissection of a mature, pregnant female revealed they give birth to hundreds of young which combined with the discovery of juvenile whale sharks in the guts of marlin and mako sharks suggest high juvenile mortality rates (Joung et al 1996, Coleman 1997, Kukuyev 1996). Tagging studies show they migrate long distances through international waters with the same sharks returning to the same location year after year (Meekan et al, etc, Press et al in press, Eckert and Stewart 2001). It also appears specific cohorts of whale sharks aggregate at different locations across the globe with mature females for example aggregating off India and immature males aggregating off Ningaloo Reef (Taylor 1994). These life history traits suggest a species whose populations are slow to recover and vulnerable to overexploitation. As yet no empirical studies into sources of adult whale shark mortality have occurred. This is despite the fact that records from photographic databases suggest scarring consistent with shark bite marks and boat strikes is common in sharks frequenting Ningaloo Reef and the Seychelles (Taylor, Rowat, Press et al in press). A fatal attack on an adult whale shark by killer whales recorded in the Gulf of California together with a recent example of a predatory shark attack on a whale shark at Ningaloo Reef suggests despite their immense size, adult whale sharks experience significant predatory pressures (Fitzpatrick et. al. in press). One of the first retrieved whale shark carcasses was taken off the bow of an ocean liner after a collision and recently a fatal boat impact on a whale shark was recorded in Seychelles (Rowat unpublished data). Whale sharks also encounter entanglement hazards as highlighted by another example from the Seychelles where a badly decomposed whale shark carcass was found in a discarded fishing net (Rowat unpublished data). Fishing pressures are increasing and have already caused significant declines in whale shark aggregations adjacent the Philippines and India (Refs). This paper outlines an analysis of scaring frequency in whale sharks from photo databases collected at Ningaloo Reef and the Seychelles. This data is used to quantify the relative risk to adult whale shark populations from common impacts. The implication this has on adult survivorship is analysed and the likely long-term impact on populations projected.

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Sonja FORDHAM

International conservation of whale sharks

For decades, the popularity and public appeal of whale sharks has fuelled the shark conservation movement and thereby enhanced the status of less appreciated sharks worldwide. The charisma of this flagship species has helped earn it protection in at least 11 countries and the distinction of the first shark species to be listed under the Convention on Migratory Species (CMS) and the Convention on International Trade in Endangered Species (CITES). While this relatively well-protected shark offers lessons and hope for conserving myriad less appealing shark species, whale sharks remain at serious risk for overexploitation. Gaps, inadequacies and lack of enforcement associated with existing whale shark protections must be addressed in order to ensure effective conservation. This presentation will review the process, hurdles and implications associated with securing international protection for whale sharks as well as progress since CMS and CITES listings were implemented. Relevant activities associated with implementation of the United Nations Fish Stocks Agreement and International Plan of Action for the Conservation and Management of Sharks will also be discussed. The presentation will include an outlook for future efforts to curb international trade in whale sharks and conserve the species on a global scale.

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Otto GADIG

Occurrence, distribution and conservation of the whale shark in the western-south Atlantic

(Poster Presentation)

This contribution intend to presents a revisionary data on the occurrence of the whale shark along the western South Atlantic coast, based literature and original information, discussing several aspects related to their distribution. There are about 50 records of whale sharks in this area coast, most of them made from sighting of alive specimens, but there are some representative data on stranding animals. The occurrence of *Rhincodon typus* along the western South Atlantic continental shelf may be explained by the intrusion of the South Atlantic Central Water (SACW) over the continental shelf of Southern Brazil. This penetration allows a remarkable high primary productivity, creating trophic conditions adequate to the occurrence of these sharks and *mobulid* rays, which are associated to highly productive areas. Recommendation for future procedures for conservation of this species in Brazil will be presented, including public education and actions together government agencies.

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Rachel GRAHAM

Patterns of diving whale shark over variable time scales and in relation to a predictable food source

Using satellite pop-off archival tags, we investigated the diving patterns of whale sharks over different time scales and in relation to a predictable food source, the seasonal spawn of aggregating snappers. Satellite tags deployed over periods of 14 days to 206 days provided dive data on four male whale sharks. All four individuals recorded dives of over 1000 m to depths with temperatures of less than 8.5^0C, with one shark withstanding ambient water temperatures of 4.35^0C and possible dives to below 1500 m. All sharks displayed diel oscillatory diving behaviour, with shallow diving taking place at night and deeper dives taking place during the day. Similar to marine mammals, whale shark ascents are significantly faster than descents during directed dives over 500 m. The recovery of a satellite tag from a shark (S4) provided the first set of continuous fine-scale archival data for a whale shark. The tag recorded data every 60 seconds for 206 days to show that whale sharks are superlative divers, descending over 1000 m and tolerating temperature ranges of 26.4^0. We used frequency domain analysis of time-series data to demonstrate that free-ranging whale sharks display diel and circa-luna diving behaviour. Diving patterns are influenced by a seasonally predictable food source.

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Rachel GRAHAM

Iterative planning and adaptive management of whale shark tourism in Belize: global implications of lessons learnt from 1998 to 2004

Whale shark encounter tourism is a lucrative and high profile activity displaying rapid global growth, particularly along the Mesoamerican Barrier Reef where at least three known seasonal

aggregations exist. In Belize's Gladden Spit and Silk Cayes Marine Reserve, where sightings are seasonally predictable, whale sharks congregate in large numbers to feed on spawn produced by an aggregation of reproducing snappers. This phenomena, which to date remains unique has led to a three-fold increase over seven years in the number of tour operators providing whale shark tours to the site and a substantial increase in revenue for stakeholder communities. Higher visitation was expected following the "discovery" of Gladden Spit, prompting the declaration of Gladden Spit as a marine reserve in 2000 and the development of whale shark tourism guidelines, including a tour-guide course oriented towards the provision of low-impact sustainable whale shark encounters. Belize further passed laws protecting whale sharks within the reserve in 2000 and within the country in 2003. Yet, a decrease in daily and seasonal whale shark sightings coupled with increased visitation from 2002 and 2004 prompted reserve managers to undergo iterative planning prior to whale shark seasons followed by post-season adaptive management. Management of the phenomenon and those viewing it was articulated as a set of guidelines in 2000 that relied primarily on compliance until 2004. Continued declines in whale shark sightings and apparent changes in spawning fish behaviour coupled catalysed a change in management strategy with a move away from compliance towards greater restrictions and enforcement in 2004. The once open access site and its seasonal aggregation of whale sharks have now become closed access resulting in conflicts between stakeholders. The continued downward trend in sightings in 2004 coupled with the need to generate funds for marine reserve management under the country's new framework for protected areas has led managers to tighten restrictions and tour-operator requirements for 2005. By comparison, lessons learnt from Belize were applied to the management of tourism at Mexico's Yucatan whale shark aggregation limiting the need for large management shifts. Lessons learned in Belize have broad implications for the health of predictable aggregations of whale shark population and the development of whale shark tourism globally.

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Rachel GRAHAM

Estimating a global population of whale sharks: pitfalls and opportunities

Whale sharks are large highly migratory fish listed as *Vulnerable* in the IUCN's Red List and recently listed on CITES' Appendix II due to their *K*-selected life history characteristics and susceptibility to targeted fisheries. Estimating local, regional and even a global population size to promote whale shark management and conservation has been hampered by their wide-ranging nature and geographically discrete efforts to characterize populations. However, discrete efforts are the main building blocks of global assessments and characterising Belize's whale shark population provides a basis to examine many of the pitfalls and opportunities for defining a global whale shark population. In Belize, data taken during encounters made at a predictable seasonal aggregation linked to the spawning of snappers coupled with photo identification and conventional marker tagging enabled us to identify 106 individual whale sharks as transient visitors to Gladden Spit, Belize, between 1998 and 2003. A minimum of 521 encounters with whale sharks was recorded. Seventy sharks were tagged with conventional marker tags between 1999 and 2002. Resightings of Gladden Spit's tagged sharks throughout the Mesoamerican Barrier Reef coupled with satellite and acoustic tag data indicate that the population is not resident to Gladden Spit and is shared with two other sites hosting known seasonal aggregations: Holbox, Yucatán in Mexico and Islas de la Bahía, in Honduras. Over 80% of Gladden's sexed sharks were juvenile males. Signs of recent mating on a mature male individual suggests that whale sharks reproduce on the Mesoamerican Barrier Reef and that Gladden Spit's aggregation is not representative of the regional population. The Belize-based study highlights the need to look closely at aspects such as demographics, ontogenetic and sexual segregation, prey preference, migratory behaviour, seasonality, anthropogenic pressures, cooperative agreements, scientific collaborations, funding availability and conservation initiatives in the quest for defining a global population of whale sharks.

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Fahmida HANFEE

Transition from whale shark harvesting to protection in India

Veraval, a small coastal town in Gujarat, a western state of India, suddenly came into the limelight earlier in the year 2001, when a massive trade in Whale Sharks (*Rhinocodon typus*) was revealed showing excessive exploitation of a vulnerable species that could be facing extinction

unless urgent measures for better management are introduced.

The study consisted of literature reviews as well as interviews with various fisheries experts, research institutes and local fishermen. The report showed that Whale Sharks that were once considered commercially unimportant have gradually become the victims of extremely lucrative, targeted fishing.

A preliminary survey of the trade in shark and shark products had already been carried out by TRAFFIC-India over 1996-1997. This study found that in Gujarat, Whale Shark fishing had gathered considerable prominence in recent times. With very little information on the species as well as on the trade, a survey was initiated to study the impact of the trade along Gujarat's coastline, which is the longest among Indian states, stretching to some 1,640 km.

The study revealed that Whale Sharks, which occur in the fishing areas off Veraval during March-June, are harvested for its meat, fins, liver, skin and cartilage. Demand for Whale Shark liver seems to have already existed in the 1950s, primarily to extract oil that was then used for waterproofing boats. However, until the beginning of 1990s, the Whale Shark never caught much attention as a profitable catch. By 1992, however, it was hunted for almost all its parts.

It was found that the boom in Whale Shark fishing in India resulted partly from bans imposed elsewhere on Whale Shark fishery (such as in the Philippines and Maldives).

The study urged greater international collaboration in research and information gathering on India's Whale Shark stocks and its basic biology. It also called for alternative sources of revenue for fishers on the coast of India. For example, 'dive tourism' is considered to have good potential for revenue generation for local fishers as an alternative income to returns from the Whale Shark fishery.

It was concluded that national and international protection needs to be urgently provided and that the Whale Shark be listed in the Wildlife (Protection) Act, 1972 and CITES Appendix-II.

As a consequent development that was welcomed by conservationists and in line with the above recommendation, the Government of India included Whale Sharks in Schedule-I of the Wildlife (Protection) Act, 1972 on 28 May , 2001. This provides Whale Shark with the highest protection under the national law of India and makes its fishing and trade in its all forms illegal.

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Jason HOLMBERG

An astronomical pattern-matching algorithm for automated identification of whale sharks (*Rhincodon typus*)

We describe the development and implementation of a novel technique for identifying individual whale sharks through numerical pattern-matching of their natural surface “spot” colorations. Together with scarring and other visual markers, identifications have in the past been made, by eye, using spot patterns found on whale shark flanks. We have automated this process by adapting an algorithm originally developed in astronomy for the comparison of star patterns in images of the night sky. In tests using a set of previously identified shark images, our method correctly matched pairs of images exhibiting the same pattern in more than 90% of cases; from a much larger library of previously unidentified images, it has to date produced nearly 100 new matches. Our technique is robust in that the incidence of false positives is low, while failure to match images of the same shark is predominantly attributable to projection effects in photographs not ideally oriented with respect to the shark’s flank. We describe our implementation of the pattern-matching algorithm, tests of its efficacy, its incorporation into the new Web-based ECOCEAN Whale Shark Photo-identification Library, and prospects for its further refinement.

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Hua-Hsun HSU

Satellite tracking of young whale shark (*Rhincodon typus)* in the Northwestern Pacific

Four young whale sharks, *Rhincodon typus* have been tagged and released by using SPOT2 (Smart Position and Temperature Transmitting) satellite tags (Wildlife Computers Ltd.) during 2002 and 2004. Transmissions from three individuals (male; 4.0-4.5 m TL) were successfully received via the Argos satellite system. Two sharks tagged in April had similar route after being released. They spent most time in the open ocean suggesting that it is an important period in the life history of young whale shark in the Northwestern Pacific. In addition, they generally occupied areas where the water temperatures were between 24 and 30℃. Another shark tagged in November moved near the small islands in the first month after being released then migrated along the eastern and northern coastal waters of Taiwan

throughout the winter. This shark stayed in the region where the water temperature was between 25 and 28℃ then moved to lower temperature (14-20℃) after 44 days and stayed in the layer. In the last 15 days of tracking, he shifted to the waters where temperature was between 18 and 24℃. His movement patterns appeared to be related to boundary currents. Sometimes the three individuals could dive to deep and cold waters where temperature was 6℃. The average swimming speed of them was between 14.8 and 18.7 nautical miles per day. They could speed up to 6 or 7 knots for a very short time period. These results provide important information for the conservation and management on the world's largest fish. More such tagging researches and further stock assessment are required.

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Robert HUETER

Biological studies of large feeding aggregations of whale sharks (*Rhincodon typus*) in the southern Gulf of Mexico

Whale sharks (*Rhincodon typus*) are known to inhabit nearshore waters in the southern Gulf of Mexico and northeastern Caribbean Sea off the Mexican and Cuban coasts, but little research has been conducted on the sharks in this area. Biological studies of these sharks began off the northeast coast of Quintana Roo, Mexico in August 2003, and are continuing. Using a combination of aerial and on-water surveys, oceanographic sampling, tagging and tracking, genetic sampling and collaborations with local fishermen and guides, we are investigating the number, distribution, behavior and migration of these whale sharks and their relationship to conspecifics observed in other parts of the Gulf, Caribbean and other regions. In Mexico around the northeast coast of the Yucatan Peninsula, the sharks begin to appear in the area in mid-April and are found there more or less continuously through September, feeding on plankton associated with a summer upwelling. Several hundred sharks may be present in this area each summer. Estimated sizes range from 3 to 13 m in total length with both sexes represented at a ratio of approximately 3:1 males:females. Mature and immature animals are present. We have tagged nearly 200 individuals in the area with conventional external tags, attached satellite PAT tags to three sharks and acoustic transmitters to five, tracked one animal actively for 4.5 hr, and obtained genetic tissue samples from 15 sharks. Resightings of tagged animals are being reported. On the northwest coast of Cuba only 200 km to the ENE, whale sharks are reported by tuna fishermen and biologists to be present in the fall months. Biological studies of the sharks in these waters have been initiated to determine their relation to the Mexican shark complex. This region may contain one of the most important population centers for whale sharks in the Gulf of Mexico and Caribbean region.

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Whale shark (*Rhincodon typus)* occurrence in Bangladesh

This huge pelagic filter feeder is not well known in fishermen community in Bangladesh and not poses fishing interest like other sharks and fishing species. Occurrence of incidental capture and offshore records by fishermen predict the presence of whale shark in Bangladesh marine territory. There is no available information regarding the whale shark occurrences and migration in our territorial water since no study and continuous monitoring of existence country water Bay of Bengal area. But according to fishermen from St. Martin island during the winter October to February every year whale shark occur in the offshore areas of south west zone from last land mark of the St. Martin island at a distance of 50-60 kms which approximate location would be N20.02140 E92.15676. The Cox's Bazar and Chittagong deep-sea fishermen informed whale shark sighting at the coordination at about N21.73517 E89.44088 to N19.32809 E91.37721 in the Bay of Bengal. They have been sighted solitary and also in schooling of several individuals.

The incidental captures of whale shark during 1996-2004 recorded along the coast of Cox's Bazar, Teknaf, St. Martin Island and at Chittagong fishery landing centre. 11 individuals have been recorded from the incidental capture of which the size ranges were 16 – 23 ft. (n=11); color dark grey to black, ventral portion whitish;

* Registered but unable to attend conference

majority spots are brown. Although this magnificent animal is not a target species they are accidentally caught in large drifting gill net of strong filament. Once entangled, fishermen try to get them to shore and sold to a middlemen by 2000-20000 Taka local currency which is approximately 35 – 350 US $ in equivalent. And finally processed into piece to make dry fish and fins are sold at high price (30 U$/kg) for export purposes. Like other sharks if captured whale sharks also consumed only by tribal people and some parts are exported. It is important to monitor occurrence in seasonality in the Bay of Bengal. Also movement pattern and migratory corridor should be explored to start conservation initiative and other related outcome activity of Whale shark based viz., ecotourism, and survey based volunteer watching program in season of availability. The major occurrence of the whale shark is assumed to be in the winter period of the zone according to my observation. Whale shark research still has to be initiated in Bangladesh and for that international cooperation is necessary.

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Mananjo JONAHSON

Methodological approach for whale shark (*Rhincodon typus*) observations on the North Western coast of Madagascar

A whale shark (*Rhincodon typus*) observation programme will be conducted for the first time in Madagascar as a result of demand for scientific information on this species in the country. The study site selected for this first survey is located on the North Western coast of the island that is known to be frequently visited by the species. It is even reported that these animals occur in the area all year round and mostly during planktonic blooms or when juvenile fish are abundant. This period corresponds to the summer season between October and February. In January 2005, a large group of whale shark was spotted by local divers around Nosy Iranja, an important tourist place in the Northern part of the country. A preliminary trip will be conducted there to interview local fishers and dive operators about the frequency and the potential sites of observation of the species. A satellite tag will be deployed if an individual is encountered during this first trip. The survey programme itself will start in November when the chances to see the animal are optimum. Using data from remote sensing, the sites where the planktonic blooms are found will be identified beforehand. Temporal and spatial variations of these blooms will be systematically collected and analysed to predict an eventual surface apparition of the animal. Then, the methods to be used during this expedition will be a combination of aerial survey and boat-based observation. One team will fly over a defined zone using a small aircraft and following a determined transect in order to spot an individual or a group of whale shark. The data to be collected from the aircraft are the number of individuals, the geographic position, the meteorological conditions and aerial photography will be taken. Another team will survey the same zone from a boat. The data to be collected are the geographic positions, the physical and chemical seawater parameters as well as photographic identification. Satellites tags will be deployed on some individuals. These tags will transmit the position of the individual as well as some selected seawater parameters for a defined period of time. Conditions permitting, underwater observations and photography may as well be conducted. Finally, to ensure a continuation of the survey, data sheets with date, site and number of individuals will be provided to local dive operators so that they can record any whale shark observation during the entire season.

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Dhiresh JOSHI

Campaign for whale shark conservation: Experiences from coastal Gujarat, Western India

The whale shark (*Rhincodon typus*) listed in the IUCN Red List of Threatened Species (IUCN, 2000) was being commercially exploited on a large scale in the western Indian Gujarat state, with 591 recorded killings between 1999 and 2000 (Hanfee, F. 2001). However, hunting of the whale shark was banned in India from May 2001, when it was placed in Schedule I of the Wildlife (Protection) Act, 1972.

A survey assigned by the Wildlife Trust of India to Taylor Nelson Sofres (tns) was conducted in Ahmedabad, an inland urban centre, and Veraval, an intermediate fishing port to assess the awareness levels and attitudes towards the whale shark among citizens, policy makers and fishermen in 2004. The broad results of the sample survey showed that while the “apparent” awareness about the fish was reasonable, there seemed to have been a confusion between whether the animal being referred to was a shark or a whale. The state was also largely unaware of the fact that the world’s largest fish came to their

shores, was commercially harvested, and that it was now a legally protected species. A large percentage also thought that the fish was dangerous to humans.

To dispel myths about the whale shark, and to spread awareness about the species and its legal status, a campaign was devised, which brought together, perhaps for the first time, a popular Hindu religious head, wildlife conservation NGOs, the government and the corporate sector on a common platform. The campaign relied on testimonials from the religious head, spread through traditional local street theatre and dance forms, with a life sized inflatable model of the whale shark, creating a carnival around the species. Policy makers, local enforcement agencies and administration were closely involved at all the events. Paintings, quiz competitions, games and talks were conducted in schools covering over 5000 children.

As the campaign moved over the state, four coastal towns and the capital of the state adopted the whale shark as the city's mascot. A special postal cover with the cancellation message of "Save the Whale Shark; Pride of Gujarat" was also released. This paper describes the ongoing campaign and experiences from using various indigenous campaign tools in coastal towns of Gujarat from January 2003 to March 2005

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Branka KING

The whale shark industry, Exmouth / Coral Bay - Western Australia

Our family owned and operated companies have been based in Exmouth for over 25 years. Father and son, George and Raymond King first swam with a whale shark in 1970 out of Coral Bay

My first swim was with a 10 metre whale shark back in 1987. The following years, we encountered many that were over 8 metres long. In the late nineties, up until now, we have been swimming with many smaller sharks.

Whilst seeing a whale shark is an important factor on a whale shark tour, it is essential that the service provided by the tour company is of a high level. The customer's interpretation of the experience is highlighted by this and through many years as one of Exmouth's longest standing owner/operators, we can testify to this fact.

CALM'S role in providing rules and regulations is essential and has proven to be successful in controlling the masses who snorkel with whale sharks each year. 10 people at a time in the water, interacting with a w/shark, is a ' comfortable ' number.

Exmouth and Coral Bay have been fortunate enough to date, to predict the annual return of the whale shark. What would happen if they disappeared and failed to return? Economically, the region would be in dire straits as the tourist revenue received from this activity runs well into millions of dollars. If they ceased visiting altogether, it would spell the end of an era for future generations who would have be interested in partaking in the whale shark experience.

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Sarang KULKARNI

Opportunities and challenges in research, conservation and management of whale sharks along the coast of Gujarat (India)

Whale sharks occur throughout the Indian Ocean and have been reported from the Maldives, Seychelles, Comores Islands, Madagascar, South Africa, Mozambique, Kenya, Pakistan, Sri Lanka, Thailand, Malaysia, Indonesia, Australia and India. The large congregation of Whale Shark was known from South Africa, Kenya, Belize and Ningaloo Reef of Western Australia until the whale sharks huge killings came in limelight from the coast of Gujarat, India. After studying the whale shark fishery in the past and its trade from the state, it has been estimated that approximately over few thousand whale sharks visits the coast of Gujarat every year and this estimation reveals that the coast of Gujarat provides very imperative habitat for the large whale shark population of the world. Since legal protection from 2001, till today there have been little or no studies on whale shark distribution, population dynamics and ecology for which would play very effective role in the management and conservation of the species. Perhaps the largest whale shark congregation along the Gujarat coast provides India an important and very vital opportunity to study the population and ecology of whale shark and play significant and active role in the conservation and management of Whale shark on global scale. However, there are also ample challenges to achieve the successful and effective conservation and management of whale shark in India due to lack of awareness among across the sectors and lack of infrastructure. Indian marine biological

scientific community lacks the expertise, long term vision, commitments and field marine biologist skills. Prior to the protection of Whale Sharks by law, there have been thousands of coastal families dependent on whale shark hunting. After the ban on its hunting, these families have lost their livelihood. The effective conservation of whale shark can only be achieved if there is involvement of local communities. Nonetheless, the unique opportunity of swimming with this gentle giant and perhaps the world's largest aggregation could result in the development of a unique, most popular, seasonal ecotourism industry along the coast of Gujarat and will not only help in providing alternative livelihood but also uplift lives of fishing communities. However these developments could follow only once the research on whale shark's population dynamics, distribution and ecology takes place. In present paper, the opportunities and challenges in the research, conservation and management of whale shark along with the proposed action plan for the coast of Gujarat are presented and discussed.

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Beena KUMARI

Role of remote sensing for strategic planning and conservation of whale shark: A case study in the Northern Arabian Sea

Whale shark, the biggest and harmless fish found in the ocean is facing severe threat from the mankind. In India, whale sharks were caught opportunistically for decades, because of high export value. It is distributed in the epipelagic oceanic and coastal waters of tropical and warm-temperate regions, often seen far offshore but sometimes seen the lagoons also. Aggregation behavior is a defining characteristic of whale sharks and is known to aggregate in the frontal region of an eddy for feeding purpose. It apparently prefers areas where the surface temperature is 21 to 25°C, and salinity of 34-34.5 ppt; these conditions are probably optimal for production of plankton and small nektonic organisms, all of which are prey of the whale shark. Whale sharks are apparently highly migratory, with their movements probably timed with blooms of planktonic organisms and changes in temperatures of water masses. They are often associated with schools of pelagic fish, especially scombrids. It is probable that, at least in the natural settings, trophic (feeding) biology is driving the aggregation behavior.

Food is an important factor influencing the growth, migration and abundance of whale shark in time and space. By identifying the feeding ground of whale shark, its sighting and conservation strategy can be refined. This study demonstrates the use of satellite derived ocean colour and SST images to monitor seasonal and interannual variability of phytoplankton distribution and other dynamical ocean features and highlights the potential application of this information to detect the highly valuable whale sharks in the Arabian Sea. The mechanism of bloom formation, the oceanographic characteristics of the bloom and the probability of whale shark aggregation are discussed.

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Peter LAKE

Ecotourism role in public awareness, research & community involvement

Whale shark ecotourism is a recent industry at Ningaloo Marine Park that has grown rapidly in the last decade and attracts large numbers of tourists. Being involved from the start as one of only two operators, Ningaloo Deep Charters have watched the industry grow and develop. Awareness of whale sharks and the area has been helped by working with many documentary makers from around the world. Involvement with research and education has always been a high priority, working with CALM and CSIRO and tagging programmes, and also participation with schools and the chance for students to study whale sharks. Industry can play a large role in public awareness, continuing research and community involvement.

Peter Lake
Ningaloo Deep Marine Tours, Exmouth

Ingo LANGE

German – European School in Singapore (GESS): Nature and conservation studies

(Poster Presentation)

The German European School in Singapore (GESS) does support a German education approach to motivate and connect young students with scientists giving them the opportunity to participate in real ongoing research projects. This initiative, called "NaT-Working", is meant to transport a message to the "youngsters" that their early creative involvement in science, technology and nature conservation issues is wanted and their early exposure towards science, facing real challenges as well as sharing responsibility, is

needed in modern society, see www.bosch-stiftung.de/natworking/ (in German language only).

One project at our school, which is still in an early stage, aims towards a more open and global approach in the field of marine research, focusing on the migration of whale sharks. Involvement of higher education in active research and conservation can be seen as a catalyst to bring international groups together which otherwise might not find "the critical mass" due to a lack of communication or a limited budgets (third world countries). To bring a regional team of students, teachers and scientists together in order to support a monitoring programme will be one of our next project tasks. With the learning experience for all students, teachers and researchers involved, that "higher goals in nature studies and conservation" can be achieved by bridging national and political borders and cultural differences, such a project can be valued as an isolated challenge and adventure for some, but it might turn out to be one key component to support scientists and research like the whale shark migration studies from an additional platform.

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Marie LEVINE

Aerial survey of whale sharks (*Rhincodon typus*) off the East Coast of Southern Africa from 1993 to 1998

From 1993 to 1998, the Shark Research Institute conducted aerial surveys of whale sharks along the coast of KwaZulu-Natal, South Africa. Three types of aircraft were used: two Cessna fixed-wing aircraft and a delta-wing microlight. The microlight proved to be the best choice for this survey due to its slow flight speed, manoeuvrability, portability, and low cost of maintenance and fuel. The aerial survey indicated that the sector north of Cape Vidal was the most suitable for a tagging study of whale shark that was ongoing during this period. In addition, the microlight provided aerial support for a number of fledging whale shark-based ecotourism ventures in that sector and in the Seychelles. The aerial surveys documented a significant decline in the whale shark numbers along the KwaZulu-Natal coast from the start of the 1994/1995 season and continuing to the end of the survey period.

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Marie LEVINE

Satellite tracking of whale sharks

Aggregations of whale sharks (*Rhincodon typus*) occur each year off South Africa (Indian Ocean) and in the waters surrounding Utila, Bay Islands, Honduras (Caribbean Sea), where they form the basis of an ecotourism industry. In 1998 and 1999 the Shark Research Institute deployed satellite tags on five whale sharks in an effort to gather information on their long term and short-term movements. Problems were encountered with the attachment of the tags to the sharks. Satellite tags were attached to the sharks by divers and different methods of attachment were used with varying degrees of success. This study confirms that satellite telemetry is an effective tool in monitoring travel paths and habitat use of whale sharks.

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Aidan MARTIN

Behavioural ecology of whale sharks (*Rhincodon typus*): Research opportunities and implications for ecotourism management

Behavioural ecology of whale sharks is very incompletely known. Recent rapid development of whale shark-based ecotourism at several widespread localities risks deleterious impacts on the behaviour, habitat, and ecology of the target species. Available information on behavioural ecology of whale sharks is synthesised from the published literature (including inferences from related species), anecdotes from reliable observers, and personal observations and experience in marine ecotourism. This information is reviewed within the unifying framework of theoretical behavioural ecology. This review reveals opportunities to fill in critical knowledge gaps and minimise negative ecotourism impacts. Topics covered include: evolution and phylogeny, distribution, habitat, swimming, migration, population structure, sensory biology, mortality, predators, diet and foraging, social behaviour, reproductive biology, life history, faunal associations, interactions with humans, and ecotourism threats. If carefully managed, whale shark ecotourism is probably sustainable, fostering continued research on and protection of the species as well as conservation of the local habitats where it aggregates predictably. Ecotourism operators and clients can assist

collection of basic behavioural and ecological data on whale sharks. Toward this goal, a standardised whale shark data reportage form is provided.

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Roland MAU

Involving tourism operators in whale shark monitoring and research - Opportunities and limitations at Ningaloo Marine Park

The Western Australian Department of Conservation and Land Management (CALM) and the whale shark tourism industry have been closely involved with monitoring Ningaloo's whale shark interactions since the 1990s. Direction for research and monitoring is provided through a departmental management program and includes standardised operators' logbooks, aerial survey data, photo-identification, and tagging. Some funds to support research and monitoring are collected through a fee for whale shark experience participants. In a review it was found that operator logbook data is useful to management in gaining an understanding of trends in the whale shark industry, but some parameters had limited scientific validity in the absence of search effort data. CALM is in the process of evaluating the application of photo-identification as a scientifically credible population monitoring tool. The benefits of such as a program to industry, science, management and tourists has not been fully realised to date. Although the primary goal for operators is visitor satisfaction, most operators are willing and able to participate in meaningful research and monitoring programs that can integrate with their operations as has been shown in past tagging projects. CALM will facilitate an increasingly collaborative approach involving industry in whale shark conservation management in Ningaloo Marine Park.

Roland Mau

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Keiran McNAMARA

Whale sharks in Ningaloo Marine Park – Conservation and sustainable tourism

The Government of Western Australia is developing a state-wide system of marine parks and other marine protected areas, to help conserve the marine environment and provide for its sustainable use. One of the best known of these is Ningaloo Marine Park, which is visited annually by whale sharks that have become the basis of a thriving tourism industry based on swimming with the whale sharks. A management program, including licensing of tour operators, is in place to ensure both the protection of whale sharks at Ningaloo and the sustainability of the tourism industry that depends on them. Research has shown that $127 million per annum of expenditure by tourists is directly attributable to Ningaloo and the adjacent Cape Range National Park, with whale sharks being one of the most significant symbols of the tourism attractions of the area. The future of whale sharks at Ningaloo and the economic value derived from them through tourism is dependent on international efforts extending well beyond Western Australian waters.

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Mark MEEKAN

The world's largest fish is getting smaller

The discovery of a decline in average size and relative abundance of the world's largest fish, the whale shark, at Ningaloo Reef in Australia suggests that increasing exploitation of whale sharks is driving the declines, even in parts of their range where they are protected.

Increasing exploitation of whale sharks threatens the future of these large pelagic animals. Continuous records of an aggregation of whale sharks at Ningaloo Reef, Western Australia show that mean shark length declined by nearly 2.0 m and relative abundance was reduced by approximately 50 % over the last decade. These reductions have occurred despite the total protection of whale sharks in Australian waters. As this species is highly migratory, such changes in demography probably reflect increasing fishing mortality in other parts of their range. Effective conservation of whale sharks will require international protection and collaborative tagging studies that identify and monitor the migratory pathways of these animals.

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Jonathan NELSON

Foraging ecology by whale sharks (*Rhincodon typus*) within Bahía de los Angeles, Baja California Norte, México

The presence of whale sharks (*Rhincodon typus*) in Bahía de los Angeles, Baja California Norte, Mexico, is a seasonal phenomenon, occurring during the months of June – November, with highest abundance from August – October. The feeding ecology of whale sharks in Bahía de los Angeles were studied from July 28 – October 26, 1999. During 54 days of field sampling, 19 individual whale sharks were identified (9 males, 3 females, and 7 unsexed). A total of 190 sightings were recorded, of which 132 were foraging events. Approximately 80% of the foraging events occurred in areas with $\leq$ 10 m bottom depth, (mean ± SD = 7.0 ± 5.5 m), and were concentrated primarily in the southernmost region of the bay. The peak foraging time was between 1200 – 1600 h. Mean (± SD) sea surface temperatures during foraging events was 29.7 ± 1.1 ^{o}C. Three foraging behaviors, active, vertical, and passive feeding, and one non-foraging behavior, cruising, were characterized. Analysis of plankton samples collected next to foraging sharks revealed that zooplankton, primarily copepods (~ 85% of total zooplankton abundance) appeared to be the primary prey source in the bay. Although whale sharks were observed foraging among large schools of baitfish (sardines, anchovies), whale sharks were never observed directly preying upon these fishes. As possible indicators of plankton rich patches, whale sharks may be using baitfish to locate prey. Zooplankton abundance was significantly different among the three foraging behaviors, suggesting that prey abundance may have been the driving force determining which feeding technique was utilized. Zooplankton abundance in samples collected during foraging (n = 22) was significantly greater than zooplankton abundance collected at 16 fixed sampling stations (n = 165) throughout the bay. Whale sharks may be following oceanographic cues (physical and biological) throughout the Gulf of California that are favourable for increases of prey resources. Because whale shark ecotourism is rapidly increasing in Bahía de los Angeles, it is important to identify and manage the ecologically important areas, utilized by whale sharks within the bay to ensure the continued integrity of the habitat that supports whale shark presence within the bay.

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Jonathan NELSON

Seasonal comparison of whale shark (*Rhincodon typus*) distributions within Bahía de los Angeles, Baja California Norte, México between 1999 and 2002.

(Poster Presentation)

Whale shark distributions within Bahía de los Angeles were compared from data collected during July 28 – October 26, 1999 and August 15 – October 24, 2002. A total of 54 days (568 hours of effort) were sampled in 1999 and 56 days (608 hours of effort) in 2002, resulting in 0.33 observations h^{-1} and 0.08 observations h^{-1}, respectively. A total of 190 sightings were recorded in the bay in 1999 and 50 sightings in 2002. In 1999, nineteen individual whale sharks were identified (9 males, 3 females, 7 unsexed). In 2002, six individual sharks were sighted including 4 males and 2 females. Total body length (TL) ranged from 3 – 10 m, with a mean (± SD) of 5.4 ± 1.2 m (1999) and TL ranged from 3.5 – 7 m, mean ± SD = 5.25 ± 1.6 m (2002). During both seasons, over 90% of the sightings occurred in water $\leq$ 10 m deep in the southernmost region of the bay. Most observations occurred between 1100 – 1600 h. The mean (± SD) sea surface temperature during whale shark sightings in 1999 was 29.1 ± 1.3^{o}C and 28.6 ± 1.2^{o}C in 2002. Of the sightings in 1999, 70% occurred during whale shark feeding episodes, compared to 47% in 2002. Although the number of sightings was significantly lower in 2002, when whale sharks were observed the physical parameters (water temperature, tidal cycle, time of day), foraging behaviors, and distributions were very similar to 1999. The primary differences observed in 2002 were 1) overall lower surface temperatures and 2) overall lower abundance of zooplankton. These data suggest that whale sharks may be following oceanographic cues (physical and biological) throughout the Gulf of California that are favourable for increases of prey resources. If whale sharks entered Bahía de Los Angeles and the conditions did not provide plentiful prey resources, it is likely that the sharks moved on from that bay to other locations in the Gulf. Since 1999 conservation efforts have been proposed to protect whale sharks in Mexican waters. In December 2000, a plan was officially launched to create a National Marine Park in the Bahía de Los Angeles area. Although a Reserve has not been officially established by the Mexican Government, the Autonomous University of Baja California, the Gulf of California Islands Wildlife Reserve, and local tourist operators have proposed a code of conduct for whale shark observations following guidelines implemented in 1997 by the Western Australian Department of Conservation and Land Management. Because whale shark ecotourism is

rapidly increasing in Bahía de los Angeles, it is important to identify and manage ecologically important areas utilized by whale sharks within the bay to ensure the continued integrity of the habitat that supports whale shark presence within the bay.

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Nimu NJONJO

Whale sharks in Kenya - Community initiative projects

History

There is a local legend that when God created the whale shark He was so pleased that He gave His angels handfuls of gold and silver coins to throw down onto its back and that is why it is called *papa shillingi* in *kiswahili*, which translates as a shark covered in silver shillings. The local dug-out canoes are not much bigger than the average whale shark and in the past these beautiful fish have been treated with a mixture of fear and respect particularly because of their size. Today however, it is well-known that they are harmless to humans and they are easy to catch, even in a dug-out canoe. There is an alarming trend among local fishermen and the fishing tycoons to fish even our most precious resources, and with the very high value placed on its fins the whale shark is at real risk.

Fishermen project – an overview

The project aims to educate as to the long-term value of the whale shark, highlighting the special part it plays in local folklore. For the young, this will be advertised as something cool, for the old as something of which to be very proud. Anyone who has swum with a whale shark will know that invariably these magnificent creatures sell themselves and that it is a uniquely humbling experience to be close to them. There will be a special emphasis on the fact that the local people have lived alongside the whale shark for centuries and that there is a great deal that they can teach the trust's researchers. Sighting and reporting, sale of whale shark carvings and work as whale shark guides will create direct revenue to the local fishermen. The trust will re-direct a proportion of its funds back into the local villages making it a community project.

Education project – an overview

Due to the range of visitors to the Kenya coast, the trust will offer different education programmes in an attempt to make them interesting for everybody.

Local schools: as part of the science curriculum including a field trip

Gap year students: including PADI whale shark specialty for divers and whale shark presentation

Tourists: ranging from a simple whale shark safari to a more intensive accredited educative session including the PADI specialty for divers

With the overall aim as regards the eco-tourism being to raise awareness and heighten consciousness towards the conservation of the whale shark.

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Brad NORMAN

Size, sex ratio, maturity status and occurrence of the whale shark (*Rhincodon typus*) at Ningaloo Reef in Western Australia

Between 1995 and 1997 approximately 85% of all whale sharks recorded at Ningaloo Reef, Western Australia were males whose total lengths (TL) ranged from 4-13 m. Based on level of clasper abrasion, all males <7 m TL can be considered immature, while 9.3 and 36.6% of males between 7 and 8 m TL and 8 and 9 m TL, respectively, were mature. All but one of the 79 male whale sharks >9 m that had their clasper morphology examined were found to be mature. A logistic equation fitted to the percentage of mature males in each size class predicted a length at first maturity (L50) of 8.05 m TL, while 95% (L95) of males were mature by 9.11 m TL. Female whale sharks at Ningaloo Reef during this study were generally smaller and ranged in length from 4 to 8 m TL. In each year of the study, whale shark occurrences at Ningaloo Reef correlated to coral spawning events. Similarly, at Christmas Island in 1996 and 2004, whale shark aggregations are related to the increased productivity associated with red crab mass spawnings.

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Brad NORMAN

The ECOCEAN whale shark photo-identification library: A centralized and scalable approach to whale shark data collection, management, and analysis

A comprehensive research program undertaken at Ningaloo Reef between 1995-1997 confirmed that the natural skin patterning posterior to the gill slits of each whale shark is unique, remained unchanged during this period and can be used to identify individual animals (at least) greater than 3m TL. Further research between 1997 and 2004 established that the pattern of spots and lines does not exhibit significant change over time (using analysis of matching photo pairs), and can be confirmed as stable on whale sharks sighted as many as 16 years apart by eye and up to 8 or more years apart using algorithmic identification (upper limit unknown). The study showed that although gross scarring on the body and fins of some sharks (possibly caused by predatory animals; boat damage etc.) can be used as in certain circumstances, secondary identifying characteristics, superficial scarring (e.g. scratches) exhibit rapid repair and cannot be used for identification purposes.

The ECOCEAN Whale Shark Photo-identification Library was established in 2002 as an interactive web-based global whale shark monitoring tool, encouraging input from researchers, videographers/filmmakers, and ecotourists throughout the world. The Library currently houses in excess of 660 individual whale shark encounter submissions from more than 20 separate whale shark range states. Many of the 300 whale sharks identified within the Library to date have been sighted on separate occasions, either within the same year and/or between years. This photo-identification technique is non-invasive and can be used as a 'natural tag' in mark-recapture studies, to establish estimates of population size and fluctuations on a temporal and spatial scale, while eliminating the possibility of tag loss using conventional tagging equipment.

The ECOCEAN Whale Shark Photo-identification Library was built from the ground up as a multi-user, "groupware" tool using a "pull" model, allowing for the collection and sharing of data from a global research and conservation community. Built-in functionality includes photo keyword searching, algorithmic searching based on natural spot patterning, encounter parameter search (sex, size, date, etc.), data export for tools such as Excel, Program Mark, and CAPTURE, and security and copyright protection functionality.

With increased uptake by the broad range of stakeholders already supporting this project, it will be possible to identify fluctuations in whale shark numbers at a range of locations and further understand whether this species remains in decline on a global scale.

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Brad NORMAN

Whale shark conservation: protecting 'critical habitats' and managing risks to the species

Although widely distributed and highly migratory, whale sharks are drawn to and dependant on habitats identified as 'critical' in their life cycle. Under Australian legislation (the EPBC Act 1999), important locations for feeding in Australian waters include Ningaloo Marine Park and Christmas Island. These and similar areas must continue to receive the highest levels of protection, while habitats critical for breeding for this species must be defined as a priority. The only location from where breeding activity for whale sharks has been confirmed is off the coast of the Peoples Republic of China (Taiwan). Whale shark hunting has declined there in recent years, although it remains as one of the few remaining locations where a targeted fishery for this species continues. As a consequence of declining catch levels, the annual Total Allowable Catch (TAC) of whale sharks in Taiwan has been reduced. There is evidence of increased interest in whale sharks for aquaria, although to date, 17 of 23 taken for display in one Japanese aquarium have not survived in the highly unnatural environment. A major conference in Taipei (April 2005) discussed the options for the sustainable and non-consumptive utilisation of the whale shark, particularly ecotourism. Whale shark ecotourism can be a significant contributor to whale shark conservation when undertaken appropriately. However, human activities can interfere with the natural behaviours of whale sharks. Boat strike is highly prevalent in certain areas. To minimise damage to sharks, it is argued that the use of protective propeller guards should be considered in areas of high whale shark abundance. Sustainable management requires 'indicators of disturbance' to be defined; appropriate 'risk assessments' to be undertaken; and changes to guidelines implemented as required to minimise any impacts on this threatened species.

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Ruel PINE

Lessons learned and challenges in setting-up a community-based whale shark ecotourism program: The case of Donsol, Sorsogon

In some parts of the Philippines, whale sharks are butchered for their meat and fins. This is not the case in Donsol, Sorsogon. Since 1998, when the local leaders and fisherfolks embarked on whale shark ecotourism program, the non-consumptive utilization of the species continues to gain support from the community, as led by the local government unit, and from different sectors of the national government agencies and private groups.

The case in Donsol provides lessons learned and insights on challenges in establishing a community-based whale shark ecotourism program. Foremost of the lesson is viewing whale shark ecotourism as a form of enterprise. Donsol was competitive from the very beginning and the activity continues to bring direct benefits to the community, which in effect, generate incentives to continue the current conservation actions. The local government and fisherfolks equitably share in revenues. The process is also essential as it defines the collaborative mechanism among and between diverse stakeholders and takes into consideration their different interests.

Partnerships need to be built so that expertise and knowledge of project implementation can be shared. Strong local government unit, national government agencies and private sector support was generated in terms of policy enactment, technical inputs, capacity development, and human and financial resource mobilization.

The downside during the early phase of implementation was the absence of unifying management framework for development and conservation in the coastal zone and ecotourism was rather pursued in isolation. Community uncertainties and conflicts still periodically arise as the community step up in running the program. Institutional arrangement over the management of ecotourism was also a serious challenge with various interests to be taken into consideration in the implementation. For a time, the appropriate form of business set-up in the management of ecotourism was not clear. Ecotourism in Donsol is projected to rise steadily which brings greater challenges in regulating efforts for tourism activities in Donsol. Regulatory measures are in place to control human interactions with whale shark but difficulty on strict compliance and in monitoring interaction activities is reported. The threat due to inadequate enforcement of interaction guidelines is still real and present. The potential impact of ecotourism operations on whale shark aggregations and behaviour is recognized but scientific data is wanting.

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Jeffrey POLOVINA

Investigating the ocean habitat of the Ningaloo Reef whale sharks

We begin with an introduction that illustrates several approaches that combine tracking data and satellite oceanographic data to describe how loggerhead sea turtles are using the pelagic habitat in the North Pacific. Then we move to Ningaloo Reef whale sharks. In 2003 and 2004 we deployed pop-up archival tags on 19 whale sharks at Ningaloo Reef. These tags show the whale sharks travel northeast from Ningaloo Reef. We use satellite oceanographic data including sea surface temperature (SST), surface chlorophyll, and sea surface height data to examine the ocean habitat in the Indian Ocean in the region our tags indicate whale sharks are traveling. Our data describe a variety of features including persistent large warm core eddies, seasonal coastal upwelling, chlorophyll blooms, and a fairly persistent coastal current. We discuss how these features might be important to Ningaloo whale shakes. Further we explore the use of SST to improve the light-based geolocation for one of the whale shark tags.

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Michelle PRESS

Photo identification of whale sharks

Photo-identification is a non-invasive and accurate tool that is commonly used to identify individuals within a given population. This method can assist in collecting fundamental information such as population size, dynamics and migration patterns. My study examined the applicability of this technique for biological studies of whale sharks (*Rhincodon typus*). Three independent photographic databases of whale sharks at Ningaloo Reef, Western Australia recorded

between 1992 –1996, 2002 and 2004 were analysed to determine if photo-identification techniques could be applied to these animals. Ratings of photographic quality and various methods to identify spot patterns and distinctive characteristics on each whale shark were compared and are discussed. A combination of spot and stripe patterns above behind the last gill slit and forward of the dorsal fin and distinctive scars and marks on the dorsal, caudal and pectoral fins were found to be useful for identifying individual whale sharks. These patterns appeared to be unique to individuals and distinctive markings could be recognized on some sharks for more than a decade. From 528 photographs, 276 individuals were identified. Of these, 69% were male, 14% were female and 17% were of indeterminate gender. This sex ratio did not vary among years or among months within the 2004 season of sampling. Photographed sharks ranged in size from 3-11m total length (TL). The size distribution of sharks was bimodal with a large peak at 5m and a smaller peak at 7-8m TL. A total of 61 individuals (22%) were resighted during the study. Of these, 35 were resighted at different times during the same year (sometimes on multiple occasions) up to 4 months after they were initially photographed and 25 were resighted in different years. The interval between resightings in different years was typically 1-3 yrs, however one individual was resighted after a period of 10 yrs and 2 were resighted after a period of 12 yrs.

Michelle Press

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Angela QUIROS

Monitoring whale shark tourism in Donsol, Philippines: Examining tourist compliance to regulations and the effects of tourism on whale shark behavior

This study aimed to assess effects of tourists on whale sharks, and to minimize negative impacts of tourism. In 1998, tourism was initiated to protect whale sharks and provide benefits to the Donsol community. Approximately 40 – 60 whale sharks feed in Donsol's nutrient rich waters between November and June, drawing 2,000 visitors annually. Between March and June 2004, an evaluation of community-based whale shark (*Rhincodon typus*) ecotourism was conducted in Donsol, a coastal fishing village in the Philippines. Human-whale shark interactions (n=785) were observed on 117 boat trips over 33 days (~10 days in March, April and May/June). Swimmers' effects on whale shark behavior, visitor compliance to regulations, and tourism management were examined by observing visitor, tour guide and whale shark behavior on tour boats. Logistic regression analyses modeled whale shark dive response and directional changes (banking), with indicators of human activity. Significant predictors of whale shark's directional changes were path obstruction and proximity of swimmer to whale shark. Significant predictors of a whale shark's dive response were first-time sighting, path obstruction, and whale shark feeding. Analysis of variance examined differences in whale shark sightings and environmental parameters across three months. Inappropriate boat approach, and boat and swimmer crowding caused stakeholder conflicts. Preliminary research in the Philippines as well as observations in Belize have shown that certain whale shark behaviors can be categorized as 'avoidance behavior' (e.g., dive response and directional changes). Using adaptive management for monitoring tourism and altering interaction regulations to be site-specific, we can minimize tourism impacts on whale sharks.

Angela Quiros

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Deni RAMIREZ MACIAS

Characterization of Molecular Markers for populational studies of the whale shark (*Rhincodon typus*, Smith 1828) of the Gulf of California

The whale shark (*Rhincodon typus*) is epipelagic with a circumtropical distribution. In the Indo-Pacific Ocean there is a small fishery on the whale shark. However their tourist attraction has grown worldwide. The whale shark has some special characteristics: 1) large size, 2) slow growth, 3) late maturation and 4) extended longevity, which probably limits their recruitment making it vulnerable to exploitation. It is a highly migratory organism, and the sustainable use of this species depends on our knowledge of its biology, ecology and behavior, which is very limited. In 2000 the whale shark was listed as vulnerable on the IUCN Red list and was included on the red list in Mexico in 2001 because of the population decline in the last years which could incite a negative effect on their populations. It is necessary to obtain population information that permits to determine the degree of vulnerability of the populations. The whale shark is known to aggregate seasonally in three main areas of the Gulf of California, México: Bahía de Los Angeles (BLA) in Baja California, Bahía de La Paz (BLP)

and Banco Gordo (BG) in Baja California Sur. A study with telemetry documented the geographic movements of whale sharks in the Gulf of California and into the north Pacific Ocean and they think that its probably that there is no inter region or inter ocean genetics differences among populations of whale shark. For that reason it is necessary an international species management. Such aggregations represent unusual opportunities to study some aspects of whale shark biology, allowing a more detailed study of their health and population structure (inbreeding depression, genetic variability) using molecular techniques. These results with the knowledge of sex proportion and photo identification would have important implications for conservation of this species. Therefore, our objective was to isolate and characterize molecular markers to develop such studies. We observed and obtained skin tissue from 40 sharks in the former locations in autumn of 2002, 2003 and 2004 (BLP), in summer (BG) and in autumn 2003 and 2004 (BLA). The animals were photo identified. So far we have 5 recaptures between 2003 and 2004 of BLA, and 2 recaptures between BLA and BLP in 2004, this indicates the movements and a small population size. We designed specific primers to amplified the mitochondrial d-loop and evaluate their polymorphism by means of automatic sequence.

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José REMOLINA SUAREZ

Domino project: Management strategies with local stakeholders participation in Yum Balam Mexico

(Poster Presentation)

For many years whale sharks (*Rhincodon typus*) swimming in small groups or singly have been sighted by fishermen within their fishing grounds on the northeast coast of the Yucatan Peninsula, Mexico. These sharks, however, have not been subject to capture for either consumption or as bait. As from 2002, interest to observe and swim beside these animals by local visitors and relatives of local residents of the area, initiated the tourist activity. Enlivenment of this activity generated an economic alternative to fishers by becoming tour guides. This also increased the consciousness of fishers who observing inappropriate behaviour of visitors approached the authorities of the Yum Balam protected area to initiate actions to ensure the conservation of these sharks. Workshops were held with fishers working as tour guides, hotel owners, non governmental organizations and environmental authorities. As result of these meetings rules and a code of conduct were created to providing basis for this species sustainable management. A project entitled Domino Project, considering aspects such as the biology and ecology, regulation and management of the Mexican Atlantic whale shark population initiated during second quarter of 2003. Results from this project give evidence indicating that this is probably one of the most important whale shark aggregations worldwide. Work has been focused to defining management and conservation strategies for the whale shark in this area off the coast of Mexico. Amongst other results of this project are: Draft of an Official Mexican Norm, elements to regulate the observation and swimming with whale shark activities by providing 52 four months boat permits in 2004, training and certification of 72 local guides considering the biology and ecology of the whale shark, first aid and aquatic rescue, snorkel and group management, and professionalisation of the service, enforcement and surveillance increased in the area as well as the level of compliance of all permit holders and guides regarding the conduct of code. Also, data gathering increased. Holders of permits provided important information, such as the morphological characteristics, area, and presence of tags. For this, maps were being distributed to register population area's distribution and permit holder's positions during the period of visit.

The most important lessons learned to make this process successful are that the following aspects have been taken into consideration: stakeholders' participation in the process, technical support, recuperation of traditional knowledge, preference to local community members and evaluation and feed back of the whole legal and regulatory aspects concerning this project

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Allison RICHARDS

Conservation through collaboration

(Poster Presentation)

This poster demonstrates how the model of an existing and successful species conservation

program can be applied to implement and develop similar conservation programs for other threatened species.

The key factors learnt from the very successful Ningaloo Turtle Program include:

1. Community / Industry volunteers
2. Coordinated locally
3. Strong partnerships and shared goals
4. Accepted and standardized method
5. Stakeholder involvement and feedback

These key factors can be applied to whale shark photo identification efforts on the Ningaloo Reef. Ningaloo Whale shark Watch is a locally driven conservation initiative, which aims to use the immense resources provided by the local ecotourism industry to methodically collect information regarding the whale sharks that visit the Ningaloo Reef. The program aims to encourage collaboration between whale shark guides, charter operators, management agencies, and researchers by providing a means to log and record information and images about local whale shark movements. This enables the provision of immediate feedback to charter operators and visitors about individual whale sharks and can provide complete and standardised data to the global photo identification scheme administered by Ecocean and to other research initiatives around the world.

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Natalie RODRIGUEZ-DOWDELL

Property rights based management. Whale shark ecotourism in Bahia de los Angeles, Baja California

Predictable and long-term whale shark (*Rhincodon typus*) aggregations can be observed in few locations around the world. In some places where this occurs, the use of the species through ecotourism has become an important economic activity. Bahia de los Angeles located in the oriental coast of Baja California is an important habitat for whale sharks for up to seven months per year. Based on its presence, ecotourism activities with the species have become more popular with the local community in recent years. Even though whale sharks and their habitat represent an important form of natural capital and the high potential the use of the species offers, this has not translated into a significant improvement of the communities quality of life due to several limitations the activity, resource and users confront. Possibly the most evident threat is free access with a potential loss of economical benefits when external groups use the resource or tourists observe the species without hiring local tour operators. It is recognized that property right regimes are fundamental for the use of natural resources, defining the rights and obligations in their use and the rules by which these rights and obligations are implemented. The present study proposes a recommendation based on property rights for a sustainable management of whale sharks, understanding both the characteristics of the resource and the social context where it is used. Through the opinion of a consultant panel integrated by representatives from Federal, State and Municipal Government, Academics, Non Governmental Organizations and local users of the resource three different alternatives are analyzed (free access, a limited number of permits for local users and a concession of the area in favor of the group of local users) in function of qualitative criteria (efficiency, equity, transaction costs and acceptance) and quantitative criteria (duration), using Multicriteria Analysis. The evaluation concludes that the alternative which is the most efficient, equitable, with lower transaction costs and more acceptable is a concession of the area for the group of local users.

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David ROWAT

Indian Ocean whale sharks: a case for regional conservation

From this first Whale Shark described in 1828 from the Indian Ocean, the region continues to be one of the most important areas for whale shark sightings. The species has been the subject of several targeted fisheries, however and massive, rapid declines in population numbers.

The known range of occurrence and targeted fisheries in the Indian Ocean are discussed, along with stated national conservation measures in the range states. The results of a preliminary survey of 14 regional cooperative partners from 9 of the Indian Ocean range states are presented for occurrence, realized conservation measures, monitoring and perceived threats. These data are already proving valuable by facilitating cooperation between organizations regionally.

The current international conservation framework is briefly described and suggestions made as to possible linked regional conservation initiatives, such as under the auspices of the C.M.S.

David Rowat
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David ROWAT

Regional scale horizontal migration and local scale vertical movements of whale sharks

Published literature has shown that whale sharks migrate across large distances but that many show a degree of site fidelity. Such movements within the Western Indian Ocean had been indicated by early tag re-sightings. Data on large scale horizontal trans-boundary movement of whale shark across the Indian Ocean as recorded by satellite telemetry are presented that show migrations from Seychelles to Tanzania, Somalia and Thailand.

On a local scale, data from pop-off archival satellite relayed tags are presented that confirm vertical movement patterns. Data indicate that the sharks spend the majority of their time in a very narrow range with respect to depth and temperature. That is, up to 85% of the time is spent in less than 100 metres and 90% of the time was spent in water between 25-35'C. This is discussed with relation to diel patterns and findings from studies on basking shark diving behaviour.

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David ROWAT

Seychelles: A case study of community involvement in the development of whale shark ecotourism and the socio-economic impact

Whale sharks have long been known to the local community of Seychelles, but they have never been exploited here as a food resource. The growing interest in the species by visitors to the islands has prompted a more pro-active management approach to the species, resulting in an initial pilot monitoring programme.

The stakeholder-driven process involves dive and boat operators, conservation organizations and governmental agencies. A nation-wide monitoring network is described and the feedback to the public and stakeholders is illustrated. The development and adoption of a code of conduct for whale shark encounters to enable the wise use of whale sharks as an eco-tourism resource is described and the code presented.

Published estimates of the worth of whale sharks as an eco-tourism resource in the Seychelles forecast a potential value of up to US$4.99m for a 14 week season. These estimates are reviewed and compared to actual revenues realised by the fledgling whale shark eco-tourism activities. The direct links and spin-offs of these activities to the on-going research programme and the mutual benefits are discussed.

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Jennifer SCHMIDT

Development of a DNA microsatellite panel for the study of whale shark (*Rhincodon typus*) genetics and population biology

Appropriate conservation management of any species requires knowledge of the behavioral ecology of that species. Whale sharks are a wide-ranging species that inhabit tropical and warm temperate waters around the globe, and are believed to undertake long migrations. Whale sharks' slow growth and late time to sexual maturity make them vulnerable to overfishing and habitat compromise, and likely slow to rebound from any population decline. The ability to use DNA analysis to generate unique genetic profiles for individual animals allows the study of the social structure and breeding habits of a species, and thus the design of appropriate plans for conservation. If such genetic information is combined with tracking data from tagged animals, it can be used to monitor geographic movements and distant interactions of these animals as well. Microsatellites are repetitive DNA sequences composed of varying numbers of dinucleotide or trinucleotide repeats. The repetitive nature of these sequences makes them prone to expansion or contraction of the repeat array during DNA replication, resulting in an increase or decrease in repeat number. This mutability of microsatellites means that a pattern of alleles across multiple repeat loci can be essentially diagnostic for individual animals and their close relatives, and any group of alleles is likely to be characteristic of an individual population.

In collaboration with the Shark Research Institute (SRI), a project was undertaken to use

microsatellite analysis to study the population genetics of the whale shark. As no whale shark microsatellites had been previously identified, a repeat oligonucleotide hybridization technique was employed to isolate microsatellite-containing sequences from whale shark genomic DNA. Hybridizing genomic fragments were cloned and sequenced to determine the nature of each particular repeat. Since microsatellite repeats are flanked on either side by unique sequence, PCR can be used to amplify each individual microsatellite from multiple animals. This analysis identified more than 25 different whale shark microsatellite repeat loci, with a repeat range of 6-27 units. These included simple sequence dinucleotide repeats, as well as more complex mixed repeats. Subsequent analysis has shown several of these microsatellites to be polymorphic for repeat length between different whale sharks, and these are being used for detailed genetic characterization of the animals. The data provided by this analysis will allow a first molecular look at whale shark population structure, breeding biology and migratory patterns.

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Jai SLEEMAN

The influence of oceanographic and atmospheric processes on whale shark abundance at Ningaloo Reef, Western Australia

A decade (1996-2004) of observations of the abundance and distribution of whale sharks recorded by eco-tourism boats off Ningaloo Reef were compared to regional and global oceanographic and atmospheric variables including SST, wind speed and direction, water depth, the Indian Ocean Dipole Mode index (DMI) and Southern Oscillation Index (SOI). These physical variables were derived from either empirical ground-based data or from remote sensing instruments. A Generalised Linear Modeling (GLM) and model selection approach was used to determine relationships between the numbers of whale sharks and individual and combined physical variables. The results indicated that the relative abundance of whale sharks was influenced by a combination of the SOI, SST and depth. The SOI had the highest weight of evidence, followed by depth and SST. There was a weak positive relationship between whale shark and SOI and SST. This indicates that more whale sharks are observed in weeks during La Nina conditions and higher sea surface temperatures that are associated with the stronger Pacific trade winds that drive the Leeuwin Current southward. These outcomes have implications in defining the environmental processes that characterize suitable whale shark habitat in the Ningaloo region.

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John STEVENS

Whale shark biology: a review of published literature

In the 160 years since Andrew Smith described the whale shark in 1828, two people devoted much of their scientific lives to whale sharks. This period of research mainly comprised documenting the known sightings, captures and strandings of this species. Dr Eugene Gudger collected reports of whale sharks from all over the world and published 47 papers on these sharks in 40 years. Like Gudger, Dr Fay Wolfson documented whale shark records from all over the world and published a bibliography of these sharks as well as a paper summarising all the known (320) occurrences of whale sharks from published records and verified reports up to 1985. However, life history information during this period was scant with a few observations on feeding and with conjecture over the species reproductive method.

In the succeeding 20 years from 1986, there has been a huge increase in recreational diving and boating activity around the world that has led to discoveries of whale shark aggregations in various places. Together with increased demand and prices for whale shark products this has led to considerable conservation and marine ecotourism interest in the species that has provided the impetus for a number of studies. However, while some further understanding of whale shark reproduction and age and growth has resulted, our knowledge of the species biology and ecology is still poor. Over the last 10 years several tagging studies have been initiated on whale sharks in various parts of the world. These have used both conventional and electronic tags to provide information on movements and behaviour. However, few results from these have so far appeared in the primary scientific literature. Despite the relatively recent increases in demand for whale shark meat driven by the Taiwan market, there are still few good data in the primary literature from existing fisheries.

John Stevens
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Brent STEWART

A large fish and a large puzzle: preliminary information on the population genetics of the whale shark (*Rhincodon typus*)

In recent years tagging studies, including satellite transmitters, have increased our knowledge of the migratory behavior of individual whale sharks. These findings reinforce the perception of a highly mobile species moving over thousands of kilometers in short time periods. Based on this high vagility it was hypothesized that inter-region or inter-ocean genetic differences may not be observed for whale shark populations. In this study we use mitochondrial DNA control region sequences to assess the genetic connectedness of whale sharks sampled from different oceans. We found 31 polymorphic sites resolving 16 haplotypes in complete mtDNA control region sequences from 23 whale sharks (6 from the Gulf of Mexico; 6 from the Sea of Cortez, Baja California; 3 from Ningaloo Reef, Western Australia; 3 from South Africa; and 1 each from Taiwan, the Maldives, and the Philippines). Due to the sharing of haplotypes among sampled locations, we found no significant genetic subdivision. This result is consistent with a single global population but our conclusions are conditioned by the small sample size so far. Nonetheless, differences observed among haplotypes, including nucleotide substitutions and gaps of 17 to 164 nucleotides, are considerable and indicate that sufficient variation exists in the mtDNA control region to detect any extant population subdivision. Because most samples were collected from feeding aggregations of whale sharks, a mixed population scenario where reproductively segregated populations co-occur on those sampled areas could explain the observed lack of phylogeographic signal. More sequencing data are being gathered to provide a more statistically rigorous analysis of the partitioning of variation among different geographic areas.

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Geoff TAYLOR

Whale sharks – the early history, and the Ningaloo phenomenon

The presentation will review some of the early history of the whale shark as reported in the scientific literature, and the early “history” of the Ningaloo Reef whale shark phenomenon.

An overview of early research conducted by the author at Ningaloo will be presented:

Reef spawning and whale sharks

Aerial surveys conducted 1990 -1992

Observations of feeding behaviour and sampling of plankton at Ningaloo

Development of the database, based on whale shark markings.

Geoff Taylor

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Surasak THONGSUKDEE

Whale shark in Thailand

(Poster Presentation)

Whale shark, *Rhincodon typus*, has been recorded in Thai waters since 1936. In general, the information of whale sharks has been obtained by the divers and tourists. Sighting areas occur in both coastlines, the Andaman Sea and the Gulf of Thailand. Main observations have been reported at Similan and Surin Islands, Phang-nga province and Tao Island, Suratthani province.

Although very few research activities have been carried out on this species, the whale shark lovers have been created the website for information sharing and conservation aspect since 2001, see www.whalesharkthai.com. Moreover in order to protect and conserve the whale shark, the Ministry of Agriculture and Cooperatives has issued a Ministerial Proclamation dated 28 March 2000 prohibiting catching and killing of whale shark in the sea of Thailand.

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Michel VELY

Whale Shark *(Rhincodon typus)* in Djibouti (Horn of Africa): Conciliation of Ecotourism Development, Conservation and Development of a Scientific Program

Whale sharks have been observed in djibouti for 40 years (Palandri A., *pers. Comm.*). Aggregations, which occur especially during winter months, have been notified since 20 years. But this led only recently to the promotion of the area as a potential whale shark ecotourism site. Aiming at developing a sustainable ecotourism and collecting scientific data on whale sharks in djibouti, the association Megaptera developed a

programme since 2003. Megaptera is an association working on marine mammals in the indian ocean since 1994. This programme has been developed in cooperation through capacity building with a newly created local association, the Marine Conservation Society Djibouti, and the djiboutian administration in charge of environment, under the impulsion and with the financial support of a local eco-tourism company, Dolphin Excursions. In 2004, using experience on whale-watching and marine mammals photo-identification, a 3 months survey in the gulf of tadjourah reported an important population of whale sharks, essentially solitary, observed on two sites (off arta beach and off ile des boutres). Individuals have been photo-identified (from the distinct colour patterns around the gills and the area around the primary dorsal fin). A data base is available on these photo-identified individuals. The first whale shark tagging programme in djibouti has also been conducted: 14 individuals were tagged using placard tags (Aquasing) according to indications of D Rowat (MCSS). The start of a formal monitoring and tagging programme will provide information on the whale shark population in the north eastern indian ocean, an area that up to this time has been largely un-studied. Djibouti would be a very interesting place to perform this kind of study both at a local and at a larger scale. In fact, at a local scale, aggregations of whale sharks are observed mainly in two locations of the tadjourah gulf during three months (November to January) but occasional sightings are reported all year long. Some observations even suggest there could be other aggregations near obock or seba islands archipelago in july-august. At the larger scale of indian ocean, it would be interesting to further investigate origin and population dynamics of these groups of sharks integrating spatial and temporal dimension (both at a seasonal and inter-seasonal scale). To achieve this goal the tagging programme could be reinforced by the use of satellite tags. This programme, if developed in cooperation with other teams conducting similar projects in indian ocean, will certainly help in developing a wider understanding of the range and migrations of the whale sharks in the indian ocean. Besides, our programme in djibouti aims at promoting the conservation of the marine environment in djibouti through development of a sustainable ecotourism through the implementation of observation and approach guidelines, public and local populations' awareness raising, scientific research and international collaborations.

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William WHITE

Whale Shark Landings in Indonesian Artisanal Shark and Ray Fisheries

(Poster Presentation)

Comprehensive surveys of the elasmobranch catches landed at five localities in eastern Indonesia were conducted between April 2001 and March 2005 to obtain detailed catch composition data from local, artisanal fisheries. A total of 146 chondrichthyan species representing 35 families were identified in this study, including the whale shark *Rhincodon typus*. Of the approximately 210 individual surveys conducted, only one specimen of *R. typus* was recorded, at the fish landing site of Kedonganan in southern Bali. A total of 4 whale sharks were caught by the fishers at this site over several months, all of which were finned at while at sea and the carcasses not retained. In the Manado area of North Sulawesi, two large high-wall trap-nets have been known to operate illegally in the pelagic migratory channel of Tangkoko Nature Reserve. The catches from these nets include large numbers of dolphins, whales, manta rays, whale sharks, other sharks, marlin, turtles and dugongs. It is likely that whale sharks are also landed occasionally by numerous other artisanal fish landing sites throughout Indonesia, but calculating the total number taken on an annual basis within Indonesia would be very difficult, if not impossible.

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Steve WILSON

Migratory movements and vertical behavior of whale sharks tagged at Ningaloo Reef, Western Australia

Feeding aggregations of whale sharks *Rhincodon typus* occur seasonally in coastal waters off Ningaloo Reef, Western Australia. We attached pop-up archival tags to 19 individuals (total length = 4.5-11.0 m) at this location in 2003-04 to examine their movement patterns. Horizontal movement data suggests that these whale sharks represent a local population that undertakes short distance seasonal migrations. They utilize both inshore and offshore habitats and make extensive vertical movements (0-980 m). Temperatures ranging from 4.2-28.7℃ were recorded and changes of up to 20.8℃ were experienced on dives. Conservation and management implications are also discussed.

Steven G. Wilson

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David WOOD

Socio-economics of tourism at Ningaloo and importance of whale sharks

In the early 1990s, Exmouth faced relegation to the ranks of another remote Western Australian declining country town when the United States Defence forces, Exmouth's raison d'etre, left town. The once booming service sector of the economy

was under threat including hotels, schools and health services and aging infrastructure threatened to fail with no rationale for replacement. The town's population declined by 25% and community meetings foretold possible closure of the town.

However, in the ensuing years, tourism replaced the defence economy riding, to a degree, on the notoriety of Ningaloo's whale sharks. Tourists flocked from around the world to swim with the leviathans of the reef and the activity was promoted by documentaries in Japan and Europe and later, in guide books, now the primary motivator of international tourism in Exmouth. Between 1990 and 2002, international tourism escalated from less than 10% of Exmouth's tourism numbers in April to more than 50%. During the same period, snorkelling replaced fishing as the primary activity for tourists and swimming with whale sharks was enjoyed by more than 40% of all tourists in Exmouth during the whale shark season contributing significantly to the local economy.

This paper describes the emergence of new tourism activities in Exmouth between 1990 and 2003 drawing on empirical longitudinal data collected by the author between 1997 and 2004 and that collected by others in the late 1980s to early 1990s. The paper illustrates the significance of swimming with whale sharks to local people and the local economy.

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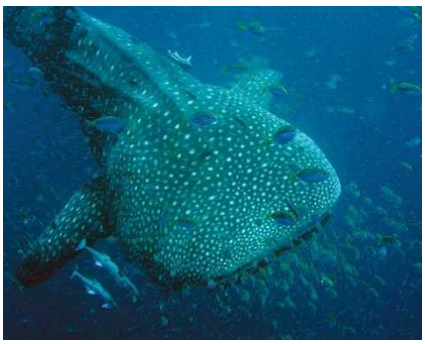

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