
International
WhaleShark
conference
9-12 May 2005 Perth Western Australia

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CONFERENCE PROGRAM

A **Welcome Function** **(or 'Icebreaker')** will be held on

Sunday 8 May 2005 from 6.30 pm -8:30 pm at the conference venue: The Holiday Inn Perth Hotel, 788 Hay Street Perth in the private cordoned-off area on the ground floor.

(Please follow the signs in the foyer and go to the Registration Desk when you arrive).

The **Conference Dinner** will be held on

Thursday, 12 May 2005 from 7.00 pm to 10.00 pm at the conference venue: the Holiday Inn Perth Hotel**.**

Please follow the signs in the foyer to the upstairs to the Mezzanine Level of the Hotel where you will be greeted.

Both events are included with your registration.

The Registration Desk will be open as follows:

Sunday 8 May 2005 Located on the Ground Floor	**5.30 pm to 8.30 pm** *(please follow the signs in the foyer).*
Monday 9 May 2005 * Located on the Ground Floor	**7.30 am to 9.00 am** *(please follow the signs in the foyer).*
Monday 9 May 2005 * Located on the Mezzanine Floor	**9.00 am to 5.30 pm** *(please follow the signs in the foyer & go up the staircase to the main Conference Room).*
Tuesday 10 May 2005,] **Wednesday 11 May 2005,]** **Thursday 12 May 2005]*** Located on the Mezzanine Floor	**8.00 am to 5.30 pm** *(please follow the signs in the foyer & go up the staircase to the Conference Room).*

* ***Please note that from Monday through to Thursday, the Registration Desk will also be open during all session breaks.***

Sunday 8 May 2005

A **Welcome Function (or 'Icebreaker')** will be held on

Sunday 8 May 2005 from 6.30 pm -8.30 pm at the conference venue:

Holiday Inn Perth Hotel,
788 Hay Street, Perth Western Australia

in the private cordoned-off area on the ground floor. *

* ***(Please follow the signs in the foyer on the ground floor and go to the Registration Desk when you arrive).***

Day 1. -PROGRAM DETAILS – Monday 9 May 2005

Time	SPEAKER
0800 - 0900	**Registration**
0900 - 0920	**Opening Ceremony** Welcome John Keesing (Australia) Official Opening – Hon Dr Judy Edwards MLA Minister for Environment and Science
0920 - 0950	**Conservation Plenary Session** – Chairman John Keesing Keiran McNamara (Australia) Whale Sharks in Ningaloo Marine Park – Conservation and Sustainable Tourism
0950 – 1010	Sonya Fordham (USA) International Conservation of Whale Sharks
1010 – 1030	David Rowat (Seychelles) Indian Ocean whale sharks: a case for regional conservation
1030 – 1100	**Tea/Coffee**
1100 - 1120	**Conservation Theme continues** – Chairman Sonya Fordham Julien Colomer (Australia) Australian Government conservation and management of whale sharks
1120 - 1140	Brad Norman (Australia) Whale shark conservation: protecting 'critical habitats' and managing risks to the species
1140 - 1200	Zahirul Islam (Bangaldesh) Whale shark *Rhincodon typus* occurrence in Bangladesh
1200 - 1220	Michel Vely (Djibouti) Whale Shark *(Rhincodon typus)* in Djibouti (Horn of Africa): Conciliation of Ecotourism Development, Conservation and Development of a Scientific Program
1220 - 1240	Lionel Espinosa-Diaz (Cuba) The whale shark (*Rhincodon typus*): Proposal of fishing regulatión in cuban waters
1240 – 1340	**Lunch**
1340 - 1410	**Ecotourism Plenary Session** – Chairman Brad Norman Rachel Graham (Belize) Iterative planning and adaptive management of whale shark tourism in Belize: global implications of lessons learnt from 1998 and 2004
1410 - 1430	Ruel Pine (Philippines) Lessons Learned and Challenges in Setting-up a Community-Based Whale Shark Ecotourism Program: The Case of Donsol, Sorsogon
1430 - 1450	Angela Quiros (Philippines) Monitoring Whale Shark Tourism in Donsol, Philippines: Examining tourist compliance to regulations and the effects of tourism on whale shark behavior
1450 - 1510	Claire Davies (Christmas Island, Australia) Christmas Island – Ecotourism and Research
1510 - 1530	Nirari Cardenas-Torres (Mexico) Community-based management through ecotourism in Bahia de los Angeles, Mexico
1530 - 1600	**Tea/Coffee**
1600 - 1610	John Keesing (Australia) Information session on developing a Conference Communique
1610 - 1650	**Special Ningaloo Session** – Chairman Jennie Cary Geoff Taylor (Australia) Whale sharks – the early history, and the Ningaloo phenomenon
1650 - 1710	Peter Lake (Australia) Ecotourism role in public awareness, research and community involvement.
1710 - 1730	Branka King (Australia) The Whale Shark Industry, Exmouth / Coral Bay - Western Australia
1730 - 1800	**Workshop Convenors meeting**

Day 2. -PROGRAM DETAILS – Tuesday 10 May 2005

Time	SPEAKER
0800 - 0840	**Registration**
0840 - 0910	**Science Plenary Session** – Chairman Rachel Graham John Stevens (Australia) Whale shark biology: a review of published literature
0910 - 0930	Brent Stewart (USA) A large fish and a large puzzle: preliminary information on the population genetics of the whale shark (*Rhincodon typus*)
0930 – 0950	Jennifer Schmidt (USA) Development of a DNA micro satellite panel for the study of whale shark (*Rhincodon typus*) genetics and population biology
0950 – 1010	Deni Ramirez-Macias (Mexico) Characterization of Molecular Markers for populational studies of the whale shark (Rhincodon typus, Smith, 1828) of the Gulf of California
1010 - 1030	Mark Meekan (Australia) The World's Largest Fish is Getting Smaller
1030 – 1100	**Tea/Coffee**
1100 - 1120	**Science Theme continues** – Chairman Mark Meekan Rachel Graham (Belize) Patterns of diving whale shark over variable time scales and in relation to a predictable food source
1120 - 1140	Steve Wilson (USA) Migratory movements and vertical behavior of whale sharks tagged at Ningaloo Reef, Western Australia
1140 - 1200	Robert Hueter (USA) Biological studies of large feeding aggregations of whale sharks (*Rhincodon typus*) in the southern Gulf of Mexico
1200 - 1220	Jonathon Nelson (USA) Foraging Ecology by Whale Sharks (*Rhincodon typus*) within Bahía de los Angeles, Baja California Norte, México
1220 - 1240	Jeffery Polovina (USA) Investigating the ocean habitat of the Ningaloo Reef whale sharks
1240 – 1340	**Lunch**
1340 - 1400	**Science Theme continues** – Chairman Steve Wilson Jai Sleeman (Australia) The influence of oceanographic and atmospheric processes on whale shark abundance at Ningaloo Reef, Western Australia
1400 - 1420	Huahsun Hsu (Taiwan) Satellite tracking of young whale shark, *Rhincodon typus* in the North - western Pacific
1420 - 1450	David Rowat (Seychelles) Regional scale horizontal migration and local scale vertical movements of whale sharks
1450 - 1510	Marie Levine (USA) Satellite Tracking of Whale Sharks
1510 - 1520	Monanjo Jonahson (Madagascar) Methodological approach for whale shark (*Rhincodon typus*) observations on the North Western coast of Madagascar
1520 - 1550	**Tea/Coffee**
1550 - 1610	**Science Theme continues** – Chairman David Rowat Rachel Graham (Belize) Estimating a global population of whale sharks: pitfalls and opportunities

1610 - 1630	Brad Norman (Australia) Size, sex ratio, maturity status and occurrence of the whale shark (Rhincodon typus) at Ningaloo Reef in Western Australia
1630 - 1650	Geremy Cliff (South Africa) Aerial census of whale sharks on the northern KwaZulu-Natal coast, South Africa 2001-2005
1650 - 1710	Marie Levine (USA) Aerial Survey of Whale Sharks (*Rhincodon typus*) off the East Coast of Southern Africa from 1993 to 1998
1710 - 1730	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 – Mezzanine Floor	
1730 - 1830	**Lisa Carne** (Belize) Whale Shark Tourism at Gladden Spit Marine Reserve, Belize, Central America **Otto Bismarck Gazzano Gadid** (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 **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. -PROGRAM DETAILS – Wednesday 11 May 2005

Time	SPEAKER
0800 - 0840	**Registration**
0840 - 0910	**Socio-Economics Plenary Session** - Chairman Rod Quartermain David Wood (Australia) Socio-Economics of Tourism at Ningaloo and Importance of Whale Sharks.
0910 - 0930	David Rowat (Seychelles) Seychelles: A case study of community involvement in the development of whale shark ecotourism and the socio-economic impact
0930 – 0950	Fahmida Hanfee (India) Transition from Whale Shark harvesting to protection in India.
0950 – 1010	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
1010 - 1030	Wairumi Njonjo (Kenya) Whale Sharks in Kenya
1030 – 1100	**Tea/Coffee**
1100 - 1120	**Special Whale shark Recognition/Observation Session** – Chairman John Stevens Roland Mau (Australia) Involving Tourism Operators in whale shark monitoring and research - Opportunities and Limitations at Ningaloo Marine Park
1120 - 1140	Brad Norman (Australia) The ECOCEAN Whale Shark Photo-identification Library: A Centralized and Scalable Approach to Whale Shark D Collection, Management, and Analysis
1140 - 1200	Jason Holmberg (USA) An Astronomical Pattern-Matching Algorithm for Automated Identification of Whale Sharks (Rhincodon typus)
1200 - 1220	Michelle Press (USA) Photo identification of whale sharks.
1220 - 1240	Ben Fitzpatrick (Australia) Quantitative analysis of scarring frequency in whale sharks and implications for adult survivorship
1240 – 1330	**Lunch**
1330 - 1400	**Management Plenary Session –** Chairman Nick D'Adamo Natalie Rodriguez-Dowdell (Mexico) Property rights based management Whale shark ecotourism in Bahia de los Angeles, Baja California
1400 - 1420	Otto Gadig (Brazil) Occurrence, Distribution and Conservation of the Whale Shark in the Western South Atlantic
1420 - 1440	Dhiresh Joshi (India) Campaign for Whale Shark Conservation: Experiences from Coastal Gujarat, Western India
1440 - 1500	Sarang Kulkarni (India) Opportunities and Challenges in Research, Conservation and Management of Whale Shark along the coast of Gujarat
1500 - 1520	Volker Bassen (Kenya) The East African Whale Sharks Trust
1520 - 1540	Jose Suarez (Mexico) Promoting International Collaboration in Whale Shark Conservation, Science and Management
1530 - 1600	**Tea/Coffee**
1600 – 1730	**Special Session** – Chairmen John Keesing and Denis Beros. Discussion and Drafting Session on developing a Conference Communique
1730 - 1800	**Workshop Convenors meeting**

Day 4. -PROGRAM DETAILS – TWO CONCURRENT WORKSHOPS

TIME	UPSTAIRS CONFERENCE ROOM	DOWNSTAIRS CONFERENCE ROOM
0800 - 0900	Registration	
0900 - 1030	**CONCURRENT WORKSHOP *1*** **Workshop 1 (Science)** Convenors : Mark Meekan and John Keesing Morning session includes presentation by Bill Erb, Intergovernmental Oceanographic Commission on Global Ocean observing System (GOOS) network as a useful model for international cooperation and collaboration	**CONCURRENT WORKSHOP 2** **Workshop 2 (Conservation)** Convenors : Nick D'Adamo and Paul Gamblin
1030 - 1100	Tea/Coffee	Tea/Coffee
1100 - 1230	Concurrent Workshop 1 continues Including determining priorities and mechanisms for global research collaboration.	Concurrent Workshop 2 continues
1230 - 1300	Lunch	Lunch
1300 - 1400	**Release of Conference Communiqué by Hon Dr Judy Edwards MLA Minister for Environment and Science**	
1400 - 1530	Concurrent Workshop 1continues Afternoon session includes breakout groups for planning regional projects eg. Indian Ocean Rim, Pacific, Atlantic	Concurrent Workshop 2 continues
1530 - 1600	Tea/Coffee	Tea/Coffee
1600 - 1700	**Closing Session**	
1700 – 1900	**Free Time**	
19.00 - onwards	**Conference Dinner** **at the Holiday Inn Perth Hotel** **788 Hay Street, Perth Western Australia**	

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.

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Nirari CARDENAS-TORRES

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

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Key words: whale shark, conservation, management, ecotourism, community.

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 *(Poster Presentation)*

Whale Shark Tourism at Gladden Spit Marine Reserve, Belize, Central America

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.

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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.

Key words : whale shark, synthesis, state of exploitation, update situation, fishing regulation.

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Ben FITZPATRICK

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

Ben Fitzpatrick, Mark Meekan, Dave Rowat, Geoff Taylor, Cory Bradshaw

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

Sonja Fordham and Brad Norman

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 ***(Poster Presentation)***

Occurrence, Distribution and Conservation of the Whale Shark in the Western South Atlantic

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

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Key words: whale sharks, rhythmicity, oscillatory diving, satellite tags

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^{0}C, with one shark withstanding ambient water temperatures of 4.35^{0}C 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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Iterative planning and adaptive management of whale shark tourism in Belize: global implications of lessons learnt from 1998 and 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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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)

Z. Arzoumanian, J. Holmberg, B. Norman

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

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Keywords: whale shark, tag, satellite tracking, conservation, Taiwan, 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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Biological studies of large feeding aggregations of whale sharks (*Rhincodon typus*) in the southern Gulf of Mexico.

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ABSTRACT: 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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Mohammad Zahirul ISLAM

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; 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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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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Campaign for Whale Shark Conservation: Experiences from Coastal Gujarat, Western India

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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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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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Opportunities and Challenges in Research, Conservation and Management of Whale Shark 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

Beena Kumari and Shailesh Nayak

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.

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Ingo LANGE *(Poster Presentation)*

German – European School in Singapore Nature and Conservation Studies

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. (http://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

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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

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(keywords: whale sharks, satellite telemetry, Indian Ocean, Caribbean Sea, Argos)

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

Keywords: swimming performance, foraging strategy, mating system, interaction guidelines

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.

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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

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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

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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 ***(Poster Presentation)***

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

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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 ≤ 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 °C and 28.6 ± 1.2 °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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Wairimu NJONJO

Whale Sharks in Kenya

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

B. Norman and D. Morgan

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

B. Norman and J. Holmberg

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

Brad Norman

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

Ruel Pine, Moonyeen Alava, Arnel Andrew Yaptinchay

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

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Steve Wilson, Hubbs-Sea World Research Institute, San Diego

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.

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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.

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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.

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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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Allison RICHARDS *(Poster Presentation)*

Conservation through Collaboration.

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

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Key words: whale sharks, property rights, efficiency, equity, transaction costs, multicriteria analysis

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.

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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

David Rowat and Udo Engelhardt

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

Jennifer V. Schmidt and Marie Levine, The University of Illinois at Chicago, Chicago, IL and the Shark Research Institute, Princeton, NJ.

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

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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.

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

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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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Jose SUAREZ

Domino Project: Management Strategies with Local Stakeholders Participation in Yum Balam, Mexico

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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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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.

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Surasak THONGSUKDEE *(Poster Presentation)*

Whale shark in Thailand

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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 <www.whalesharkthai.com> since 2001. 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.

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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 ***(Poster Presentation)***

Whale Shark Landings in Indonesian Artisanal Shark and Ray Fisheries

William T. White, Fahmi and Dharmadi

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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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°C were recorded and changes of up to 20.8°C were experienced on dives. Conservation and management implications are also discussed.

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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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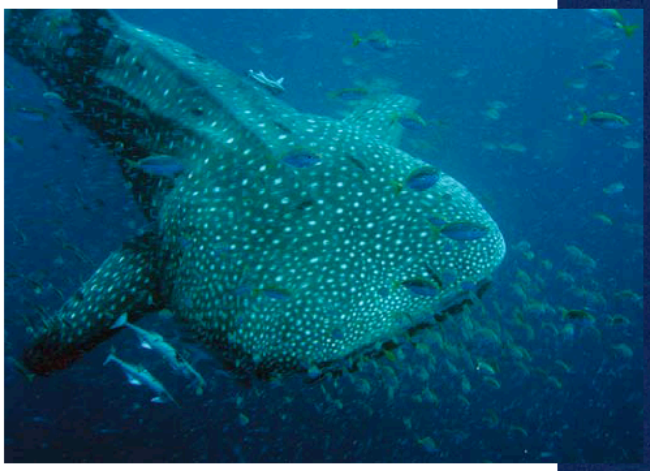

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