Domino Project
Technical Report

2003 - 2008

Rafael de la Parra

Biol. Rafael de la Parra Venegas

October 2008.

Index

Foreground

Abstract

A seasonal whale shark population on the northeast corner of the Yucatan Peninsula, Mexico, is subject to non-extractive use. A tourism industry has developed over the past years involving local community members in accordance with corresponding environmental regulations. Co-management between all stakeholders has been sought from the start. Much information has been received from tourism operator's logbooks regarding the whale shark population. Important lessons have been learned in the process. Domino Project, The Mexican Atlantic Whale Shark Project, started during 2003 season, providing important information to this scarcely known species. Tagging and recapture, telemetry tracking, genetic relationship, behavior, growth, distribution, and population dynamics, are involved into this multidiscipline and international collaborating project.

Keywords: Mexico, whale shark, management, community participation, population dynamics, ecotourism, genetic, telemetry.

Resumen

El aprovechamiento no extractivo de una agregación de tiburón ballena, al noreste de la península de Yucatán en México, durante los últimos años, ha dado como resultado el desarrollo de una industria turística importante para las comunidades locales. El manejo y la reglamentación de las actividades, ha involucrado a los diferentes actores desde un principio, mediante la colaboración de los prestadores de servicios turísticos y las autoridades ambientales principalmente. Muy valiosa información ha sido proporcionada, mediante las bitácoras y reportes de avistamientos de los permisionarios. Hoy se reconoce la importante contribución al conocimiento de la especie, a partir del inicio del Proyecto de Estudio del Tiburón Ballena del Atlántico Mexicano, conocido como "Proyecto Dominó" desde 2003 a la fecha. Marcaje y re avistamiento, telemetría acústica y satelital, variabilidad genética, alimentación y nutrición, comportamiento, crecimiento, distribución y dinámica poblacional, ecología e hidrobiología, son tema de estudio en este multidisciplinario e internacional proyecto de colaboración.

Palabras clave: México, Yucatán, tiburón ballena, manejo, participación comunitaria, dinámica poblacional, ecoturismo, genética y telemetría.

Introduction

Under Mexican law, there are two technical terms to describe the utilization of wild fauna: extractive use, referring to the removal of animals from their environment by means of hunting or capture and non-extractive use describing the means by which animals are admired or used without removal from their environment, such as tourism (e.g. observation, swimming and diving).

Other Mexican law categorizes whale sharks as vulnerable species under the NOM-059-SEMARNAT-2002. While the proposed NOM-029-PESC-2000, prohibits whale shark extraction.

In Mexico, as in other countries where whale sharks aggregate, such as Australia, Belize, Philippines and Seychelles, ecotourism activities are offered for tourists to interact with these iconic sharks.

The presence of whale shark in Mexico, distribute along most of the coast line. In particular off the coasts of the Baja California Peninsula (Sea of Cortez, Pacific Ocean) and Yucatan Peninsula (Caribbean Sea, Atlantic Ocean) they can be easily located during certain seasons. In the northeast corner of the Yucatan Peninsula, where the waters of the Caribbean and the Gulf of Mexico come together, there is an up welling with very cold water masses rich in nutrients which causes dramatic increments in the amount phytoplankton and zooplankton production.

This oceanic fertility triggers the whole food chain's activity to increase; thus we find large groups of fish, sea birds, sea turtles, manta rays, dolphins and several shark species, including the whale shark. In addition, this site is located between two natural areas protected by the Mexican Government, Yum Balam and Contoy National Park.

Objective

To obtain through proper management, effective conservation and sustainable tourist use of the whale shark (*Rhincodon typus*), preserving the species and its habitat in Mexican Atlantic waters.

Specific objectives

To contribute on the management of the observation and swimming activities, based on monitoring programs.

Encourage the standardization in gathering information during the activity.

Promote environmental education in local communities involved in whale shark observation activities.

Increase local participation in the species management and monitoring programs.

Methodology

In order to obtain population estimations, useful in management determination, the following strategies are recommended:

Tagging – Recapture
This handy tool, allow mathematic use in modeling statistically, an open population; tagging conventionally with an easy to identify tag on subsequent recaptures (re sighting actually).

Photographic Identification
Used whereas the seawater transparency enables to be the best method, will be used to corroborate the previous one.

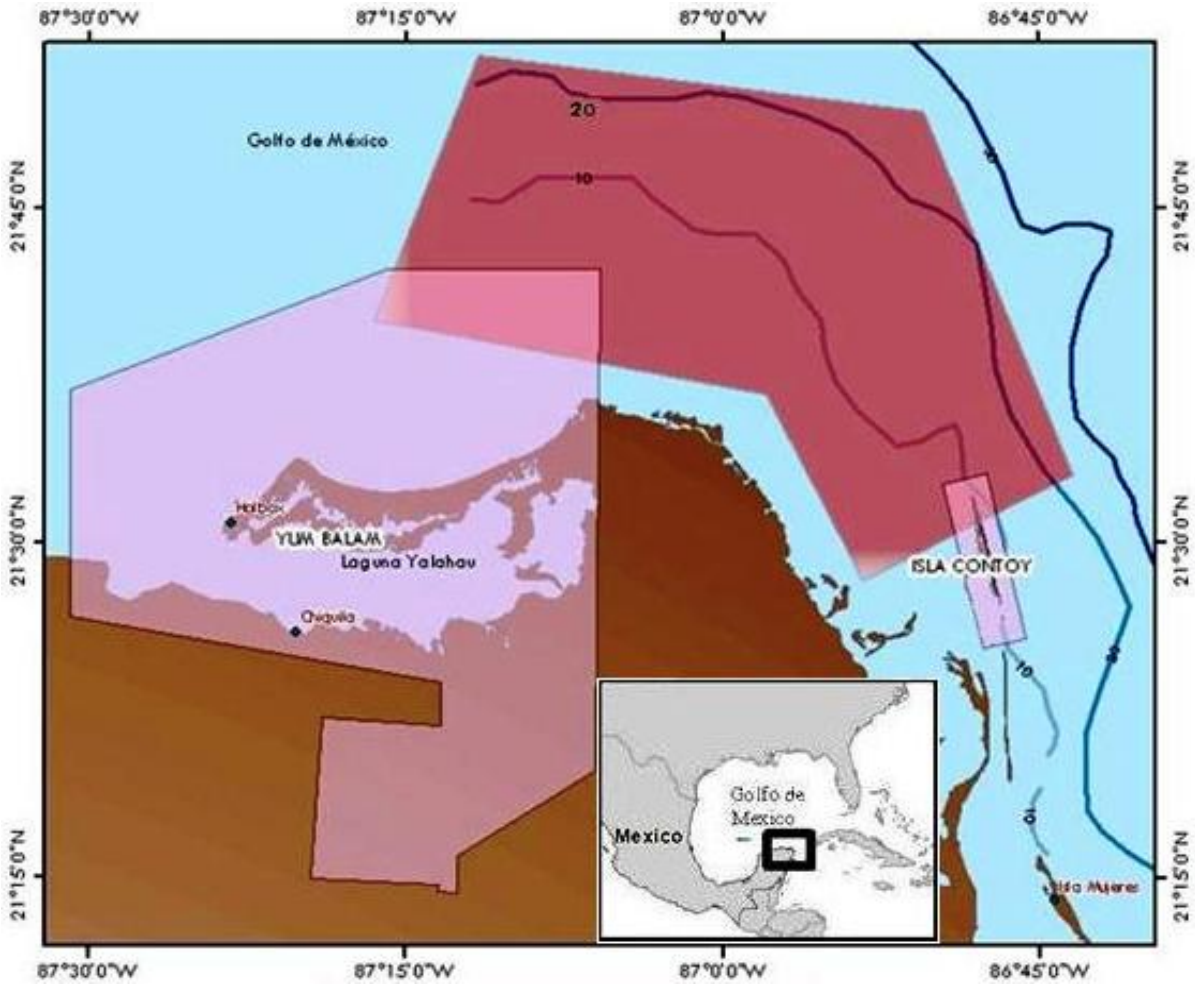
On both cases, the following information would be registered:
Date, time, location (geo positioned), maximum length, sex (gender), maturity, peculiar characteristics, behavior, weather and oceanic conditions.

Aerial Censuses
Weekly aerial counts, allow to geo positioning individuals, tracking movements and other dynamic population changes in the study area.
This is another comparable tool to the preceding ones.

Telemetry
Acoustic and satellite telemetry methodologies, due to their inherent complexity, are being realized in collaboration with external experienced colleagues.
Support and supervising this technology is very important.

Genetics, Feeding, Physiology, Behavior, Pollution
Adjacent studies like these ones would produce valuable knowledge, regarding management tendencies, therefore logistic support is advised.

Location



by Montserrat Trigo

Participants

Natural Resources and Environmental Secretariat (SEMARNAT)*
Natural Protected Areas National Commission (CONANP)*
Environmental Federal Protection Attorney (PROFEPA)*
Sustainable Development Education and Training Center (Cecadesu)*
Conanp Yucatan Peninsula Regional Area Direction*
Conanp Geographic Information Subdirección*
Yum Balam Flora and Fauna Protected Area*
Contoy Island National Park*
Tourism Secretariat (SEDETUR)*
Navy Secretariat (SEMAR)*
National Polytechnic Institute (IPN)*
Research and Advanced Study Center (CINVESTAV)*
Marine Science Interdisciplinary Center (CICIMAR)*
National Autonomous University of Mexico (UNAM)*
UNAM Material Research Institute*
(Sisal-UNAM) Research and Academic Multidisciplinary Unit*
Science and Technology National Council (Conacyt)
Norwest Biological Research Center (CibNor)*
World Wildlife Fund, México
Pronatura, Yucatán*
Renewable Energy Society (Ser de Quintana Roo)*
Adventure Tourism and Ecotourism Mexican Association
United Nation Development Program (UNPD)*

Gerogia Aquarium*
Mote marine Laboratory*
Center for Shark Reseach*
University of South Florida*
Smithsonian Institute*
The Nature Conservancy*
Wildlife Conservation Society*
Marine Meganet*
Utila Whale Shark Research*
Whale Shark and Oceanic Research Center

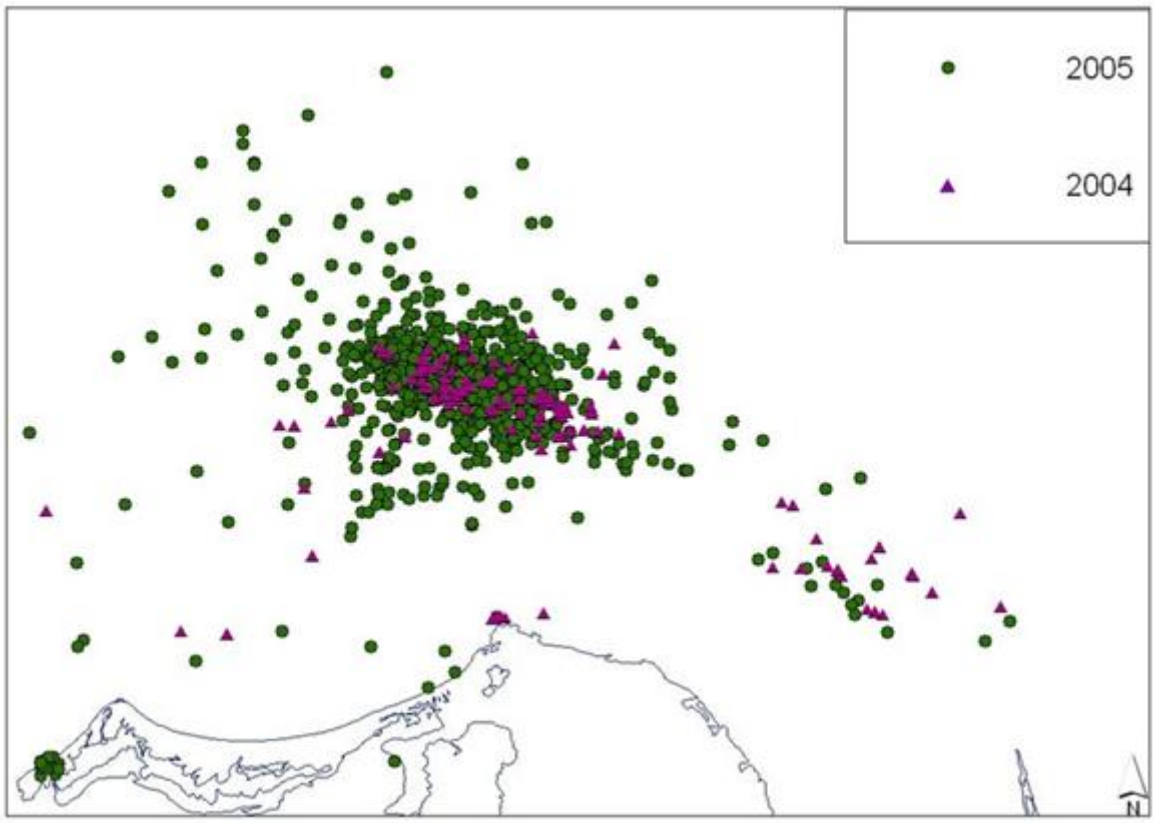
*(to date collaborating)

Social Participation and Development

Holbox Island and Chiquila

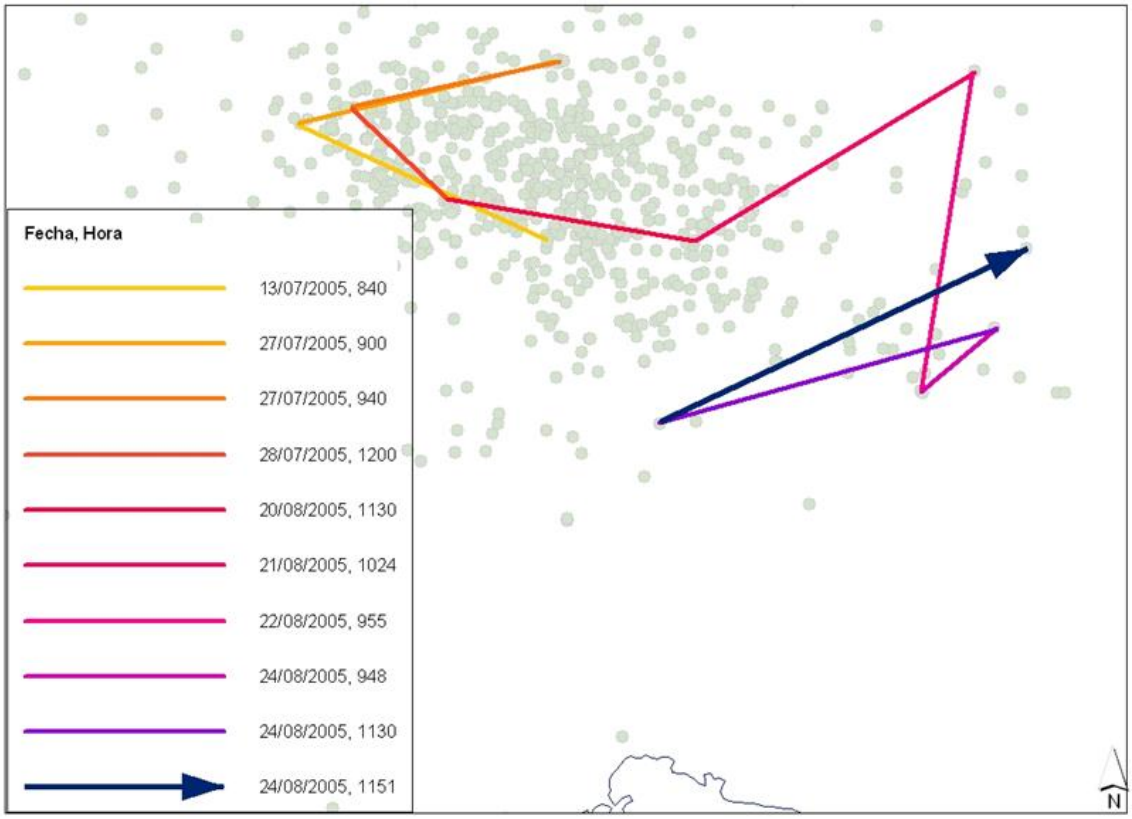
Locally generated, the whole project is a consequence of a social movement, in the quest for alternate incomings, and in order to manage wisely this potential resource, they were willing to participate, of course there's still certain reluctance to share valuable and tradition knowledge.
At first they only share sighting approximation sites, even tricking…
Little later they become involved in information generation about numbers, sizes, groups, sex, behavior, visitor numbers, but still location is kind of an issue….

Sightings reported by tour operators



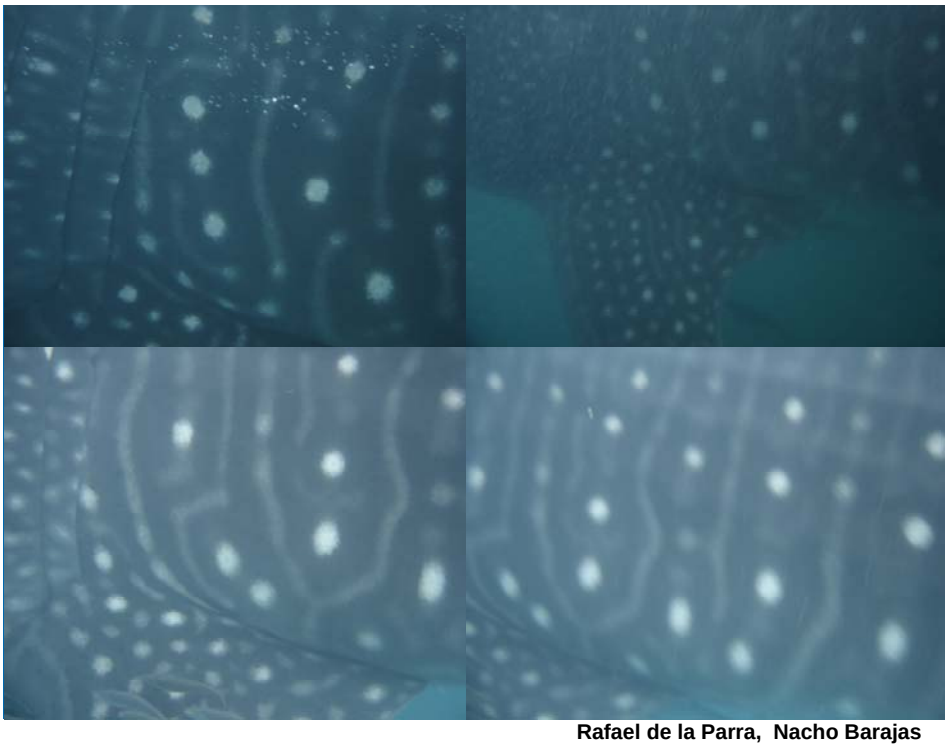
By Montserrat Trigo

However, they are providing precious individual movement's information:

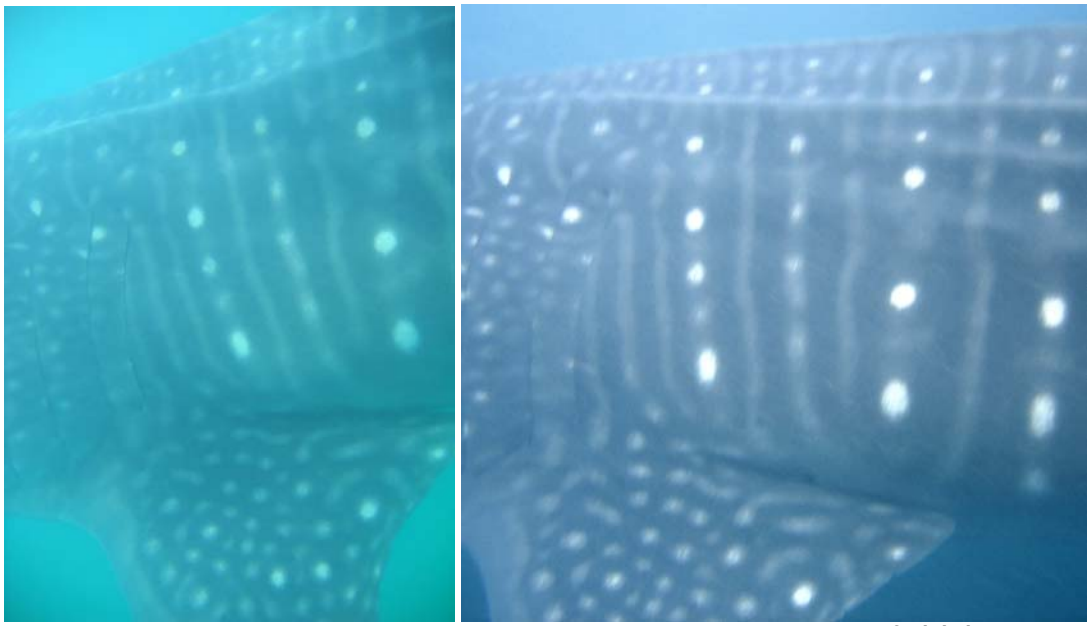


By Montserrat Trigo

Sharing our outcomes and information, as well as starting a Photographic Identification Program, providing them with disposable cameras, in order to achieve and share images, keeping a credited digitalized record and giving them back their photos, has helped a lot.



Rafael de la Parra, Nacho Barajas

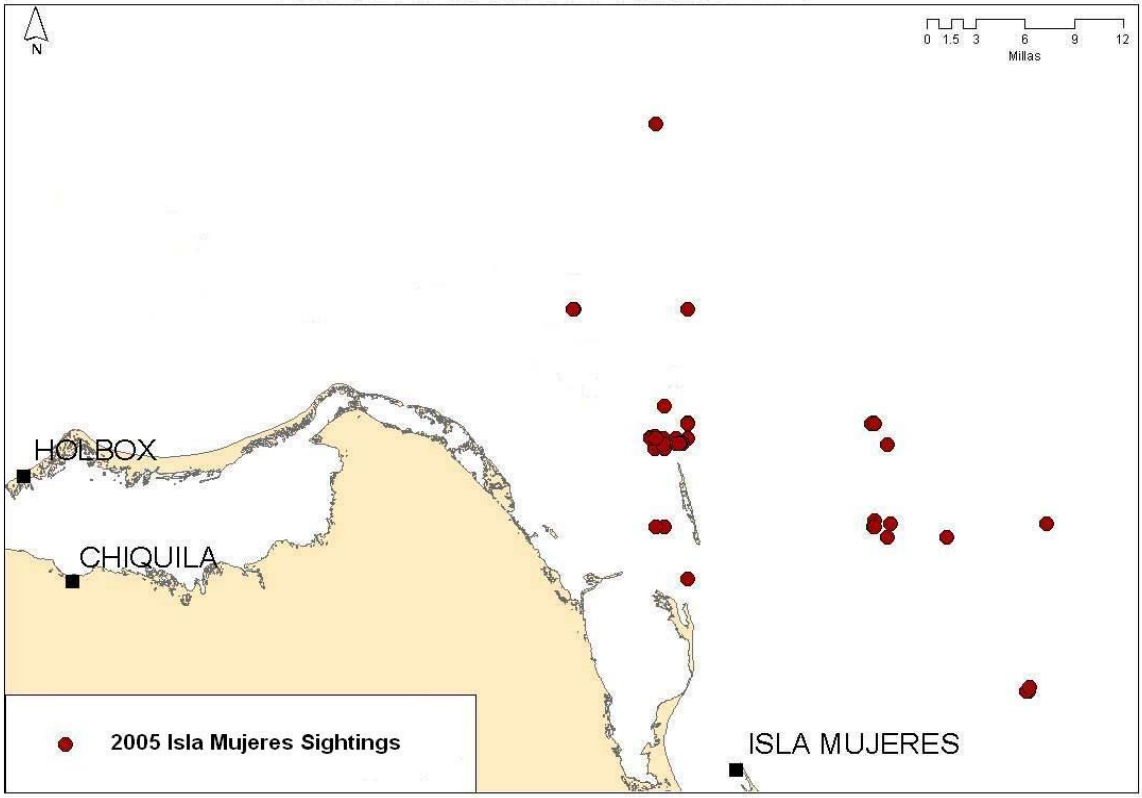


Rafael de la Parra

July 2006 August 2007

Isla Mujeres

Now Isla Mujeres participation seems to be fundamental, as they are finally sharing and showing their own knowledge:
There's an important part of this aggregating population outside, outside our estimated major presence borders….



By Montserrat Trigo

Guidelines, rules, laws…

In order to preserve a valuable resource, when they become aware that harassment and bothering, produced an evasive behavior, asked for help! Searching everywhere to obtain a guideline to establish a respectful way to interact with these animals, they look for whale and dolphin watching experiences, and then looking how other Whale Shark Tourism operations manage, they shape an ethic code.
Identifying the following points of concern:

Tourist misbehaves.
Increase in whale shark related activities.
Increasing requests by tour providers to carry out the activity.
Lack of inspection and monitoring.
Unclear legal status.
No information on the natural history of the species and its habitat, needed for decision making.
Possible conflicts with other groups in the area, such as fishermen.

This has been the core for permits, management, rules and laws.
In Mexico, it is a matter of time, to have congress approved laws, about this whole interaction with whale sharks.

Ethic Code

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

- activities may only be conducted during daylight hours, beginning half an hour after sunrise and finishing by half an hour before sunset
- boats must be less than 10 meters in length
- maximum boat speed within the whale shark observation zone is 3 knots
- a minimum distance of 100 m is to be kept between boats
- the number of tourists per boat would not exceed a maximum of six people plus two crew members
- boats will remain at a distance of at least 5 m from the whale shark
- only one boat is to be associated with each whale shark, for a maximum interaction of 30 minutes
- only two visitors with a guide are permitted in the water at any given time
- only snorkeling and swimming are permitted (no SCUBA)
- swimmers must maintain a minimum distance of 5 m around the shark at all times
- the use of safety vests is mandatory
- the use of non-biodegradable sunscreens and suntan lotions are not permitted
- the use of any apparatus that produces noise that could disturb the sharks are not permitted
- inspection and monitoring must be implemented to assure that the code is followed
- collaboration in research and monitoring is recommended

- chasing or harassing elusive whale sharks is not permitted
- extreme care with any garbage should be observed, and residues and waste will be properly kept until disposing on land containers
- training is to be provided to improve the service given by tourist operators and guides in order to certify them as specialized guides

Following the 2003 whale shark season, a second workshop took place in October 2003, to upgrade the code content, based on observed results. Two amendments were made to improve the activity and decrease risks to the sharks. Firstly, as the plankton can be incredibly dense, resulting in poor visibility (less than 3 meters), the distance kept by swimmers was reduced from 5 m to 2 m. Secondly, the number of tourists per boat, would depend on the boat size. Boats of 24 ft or less are allowed to carry 5 tourists, this increasing 1 passenger per additional foot length to a maximum of 10 tourists on 29 ft boats or longer.

Activity numbers

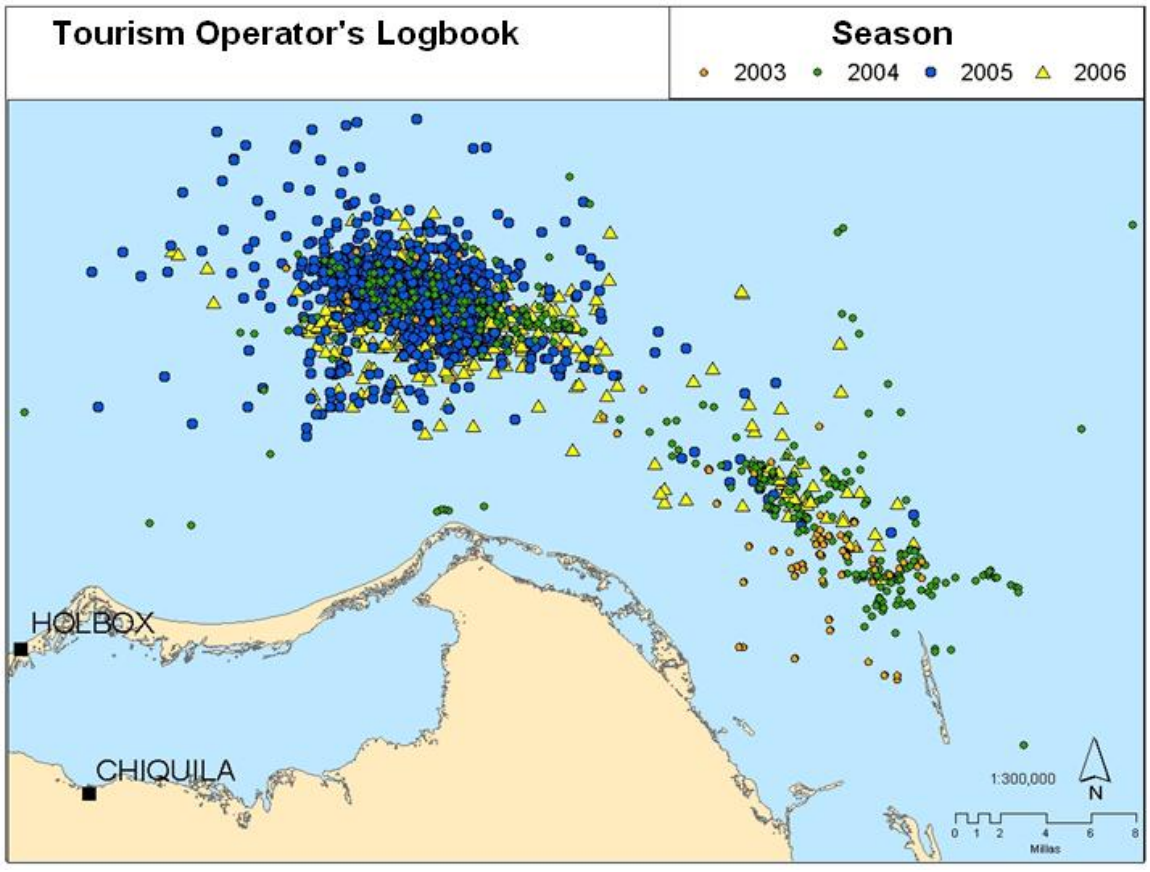
Year	Permits	Guides	Visitors*	Season
2002	0	10	1500	Not established
2003	42	24	3000	24 jun – 30 sep
2004	53	72	6593	13 may – 30 sep
2005	122	71	9100	1 jun – 15 sep
2006	147	79	12900	17 may – 15 sep
2007	142	95	16000	8 may – 15 sep
2008	140	150	17600	30 may – 15 sep

***Chiquia and Holbox only**

Tourist Operator Participative Research

Following graphs and tables are based on information provided by TOP (Tourist Operator Providers), this knowledge is invaluable and at the same time skeptical matter…

	2004	**2005**	**2006**
Total sightings	507	1627	1124
Individual reports	302	1427	893
Groups reports	205	245	231
Male:Female ratio	1:1	1:1	1.3:1
Average size	7.3	8.0	8.2
Minimum size	2	1.2	2
Maximum size	13	18	14
Sightings with known location	268	1224	828



By Montserrat Trigo

Official Research

Tagging

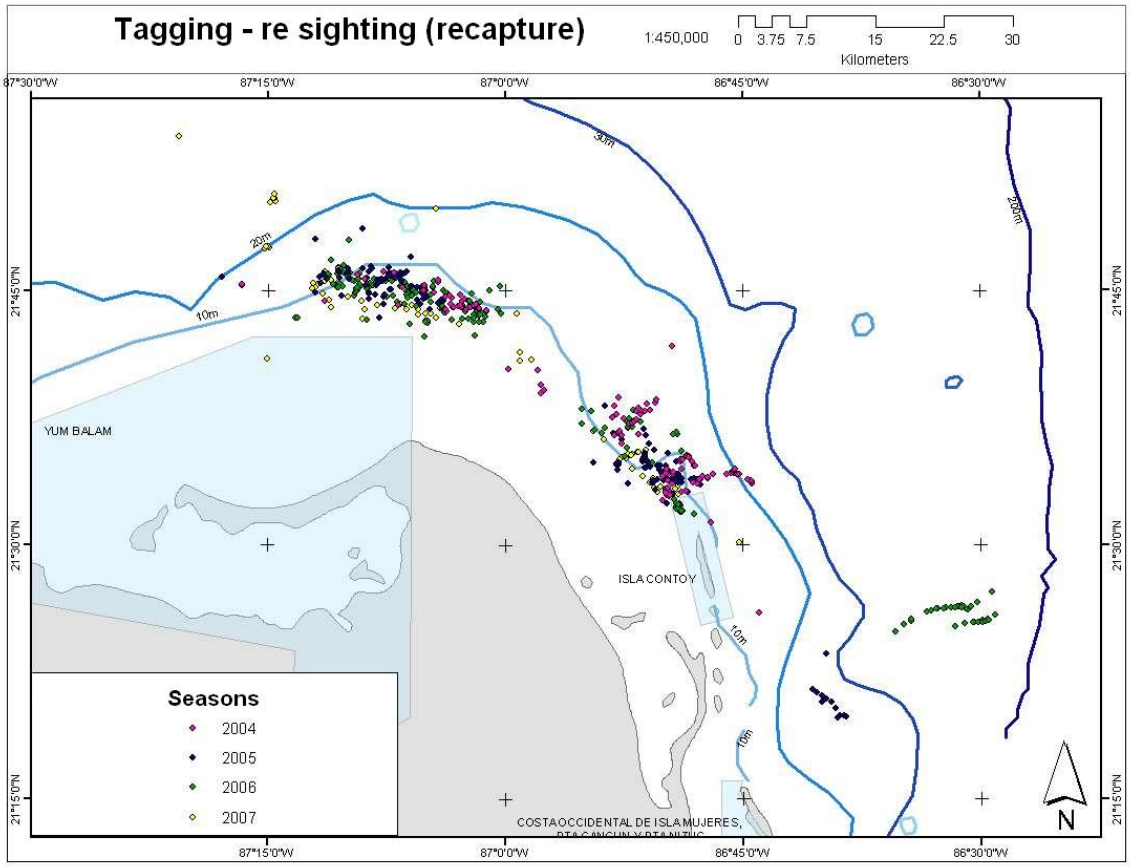
Tag and recapture methodology, has been widely used on open population studies, re sighting (recapture) of any previously tagged animal, can provide population estimates as well as movement indications. Long distance reports confirm that some tagged whale sharks are sought also in Honduras, Belize and United States coasts. Re sighting individuals tagged on previous years, can provide useful information about growth and phylopatry (site fidelity).

Rafael de la Parra

	2003	2004	2005	2006	2007	2008	Total
Tagged	17	172	164	201	63	99	716
Re sightings	5	14	34	70	10	47	180
Male:Female ratio	1.8:1	3:1	2.1:1	2.69:1	2.93:1	3:1	2.58:1
Minimum total lenght		3.5	3	2.5	3.5	3.5	3.2
Maximum total lenght		10	9	9.5	8	9	9.1
Average total lenght		6.5	5.5	6.2	5.53	6.4	6.02
Photographed Individuals	3	26	132	171	54	164	570*

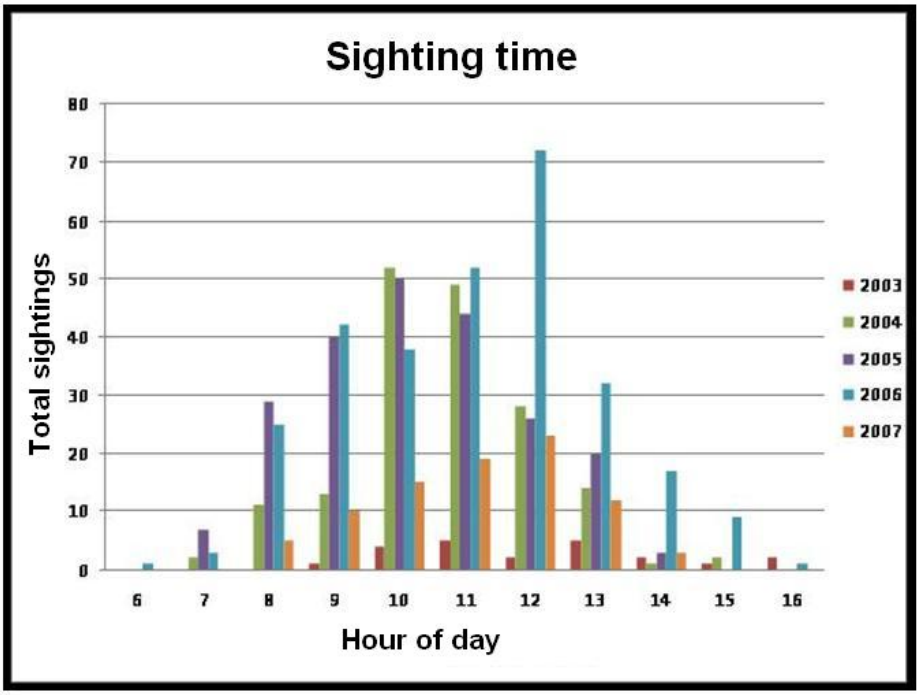
*includes non tagged ones.

Conventional tagging and recapture efforts have provided enough information to produce the following map:



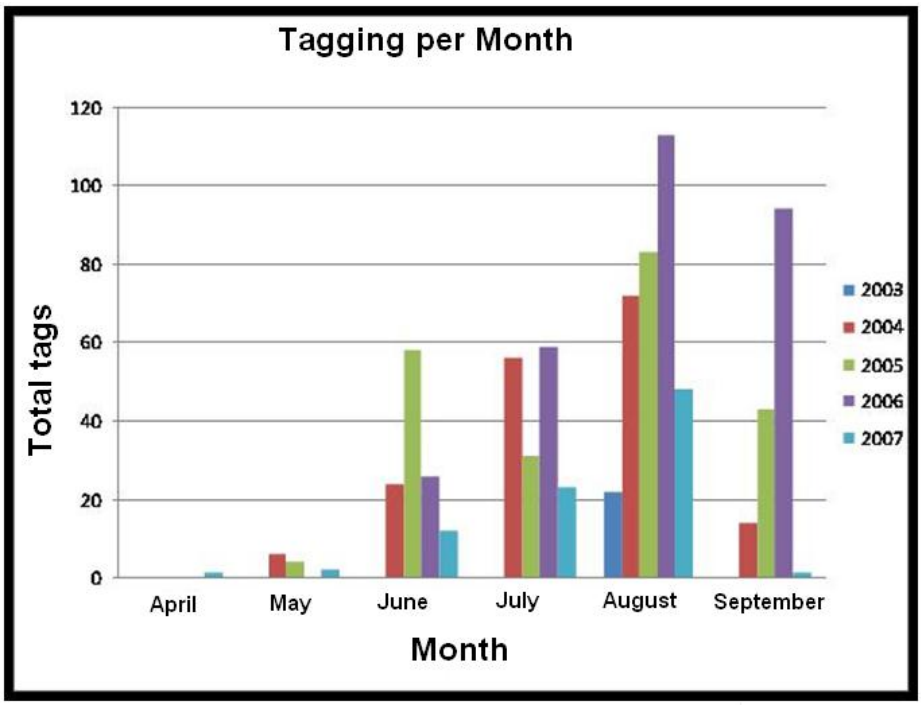
By Montserrat Trigo

Sightings occur mostly in the morning, therefore tagging effort has been conducted also in the morning, but often they stay on the surface afternoon, or they come back, rising to the surface again. Their surface presence is associated with feeding on plankton, it is very probable that plankton vertical movements are correlated with whale shark surface presence, anyway weather and oceanic conditions should play an important role too.



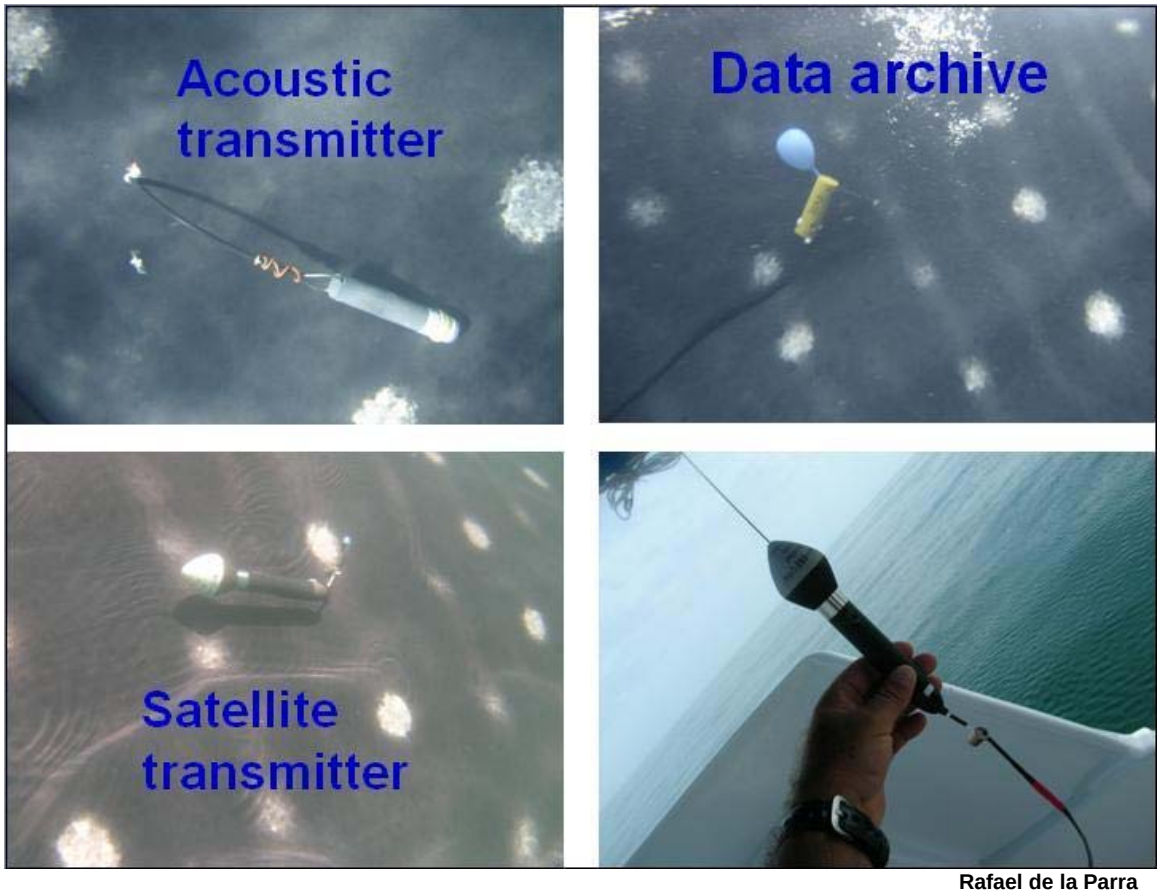
By Montserrat Trigo

Whale shark arrival starts on April, increasing until reach a maximum peak on August, and then decrease through September. This is observed during tagging activities. Variations may follow diverse causes, like atmospheric reasons and tropical storms, which appear to intensify during “Niña” years, like 2005.



By Montserrat Trigo

While conventional yellow Id tags are placed into dermis, on the left side beneath the first dorsal fin, all other devices like data archive, acoustic or satellite transmitters are deployed on the right side, beneath first dorsal fin too.



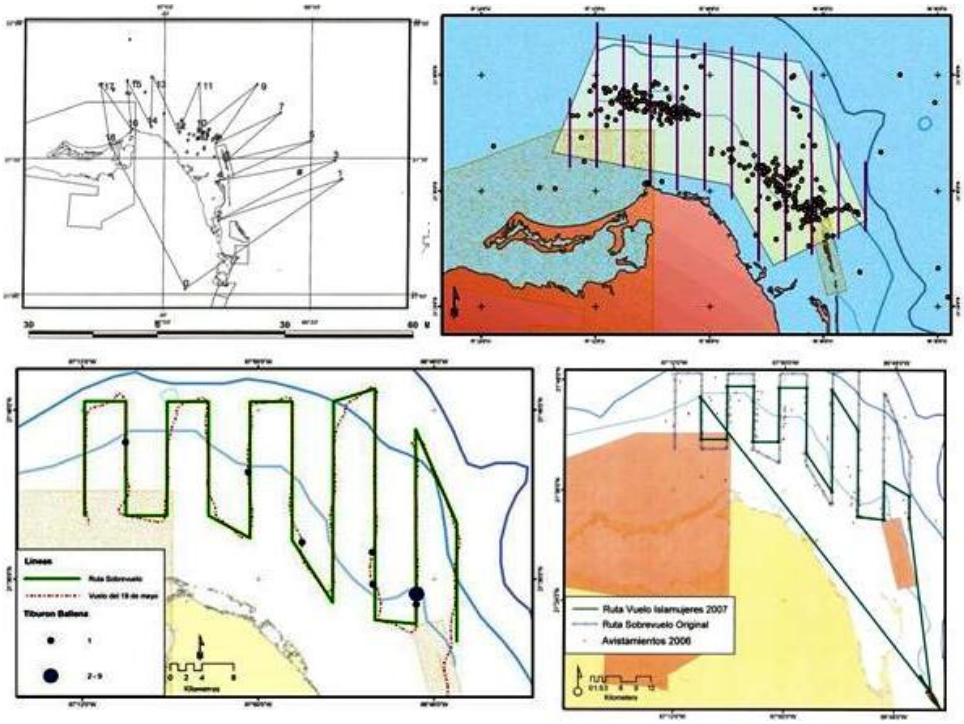
Rafael de la Parra

Aerial Census

On 2004, several survey flights were conducted in order to locate whale sharks and estimate group numbers. Cessna 207 airplanes were used for.

Rafael de la Parra, Lilia González

Based on “surface” information, a transect for aerial survey was designed, using valuable experiences on marine mammals aerial censuses:

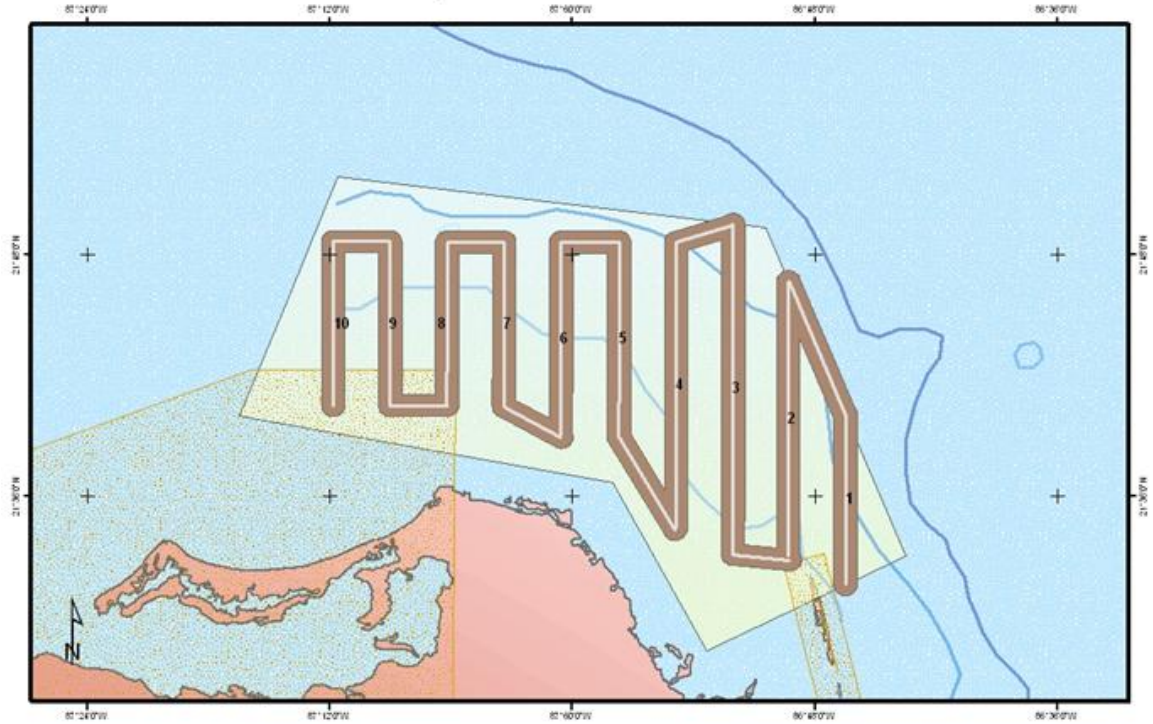


By Montserrat Trigo and Rafael de la Parra

It has been adapted and modified according to results and equipment used, because on 2006 an ultralight plane was used too:

RPV, Oscar Reyes, Lilia González

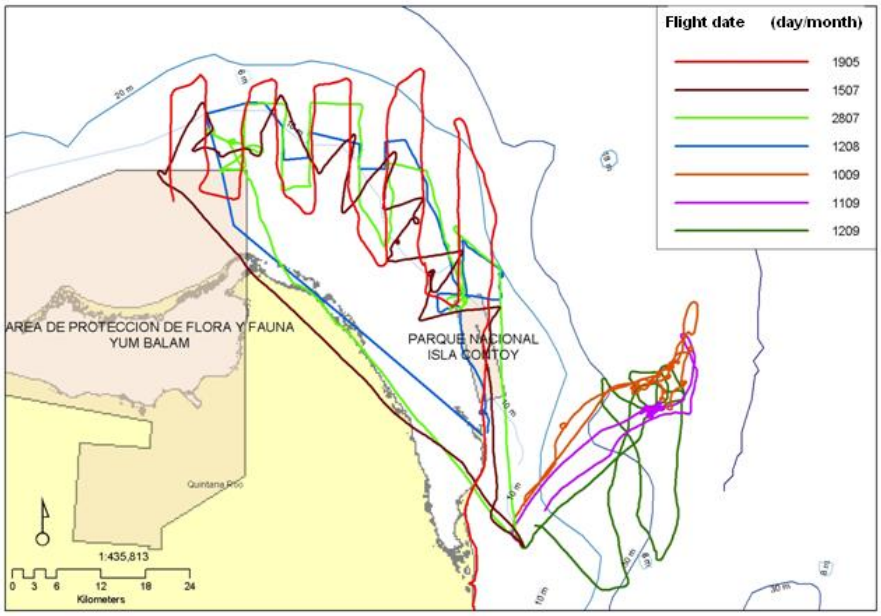
Confident 500 m visibility on each side was obtained at 250 m altitude, 14.5% coverage of the total study area:

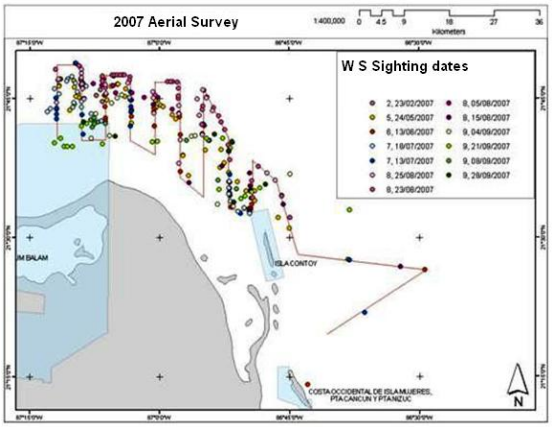


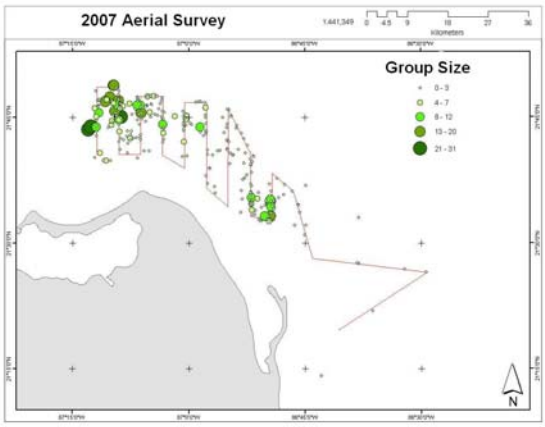
By Montserrat Trigo and Rafael de la Parra

After processing the information obtained during 2006, when a huge group was located several miles east Contoy Island, 2007 survey stretched to monitor this zone. Whale sharks registered by date and group size are represented in the following maps.

2006 Flights

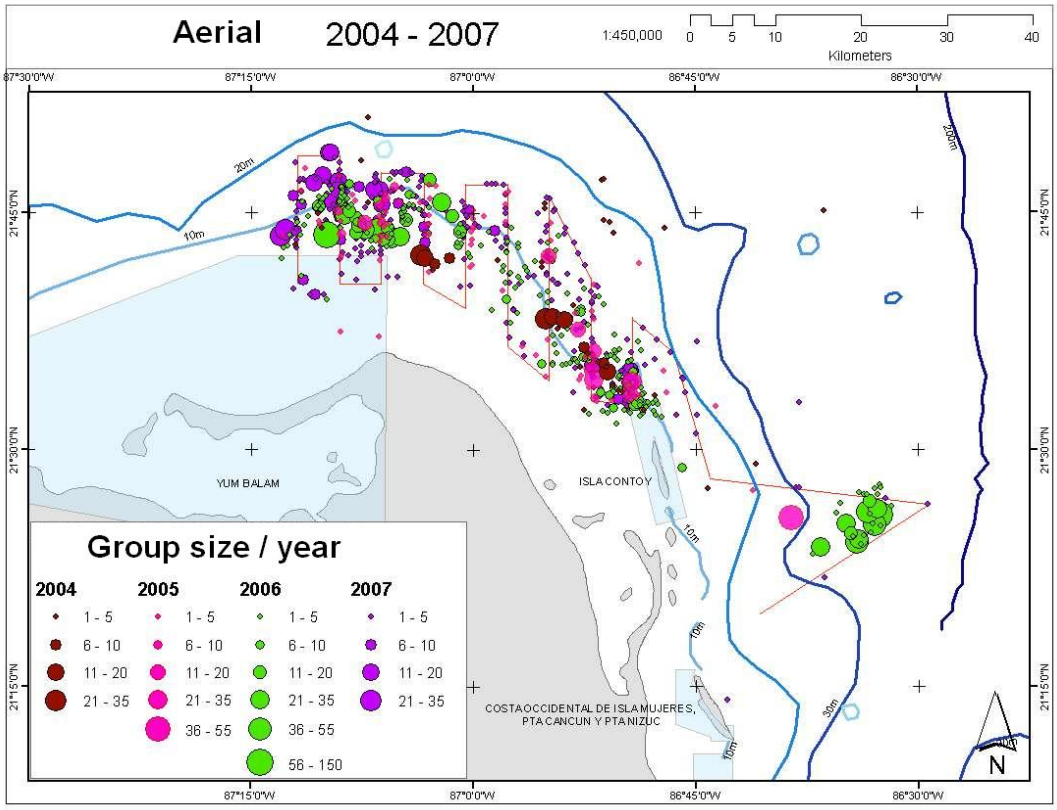






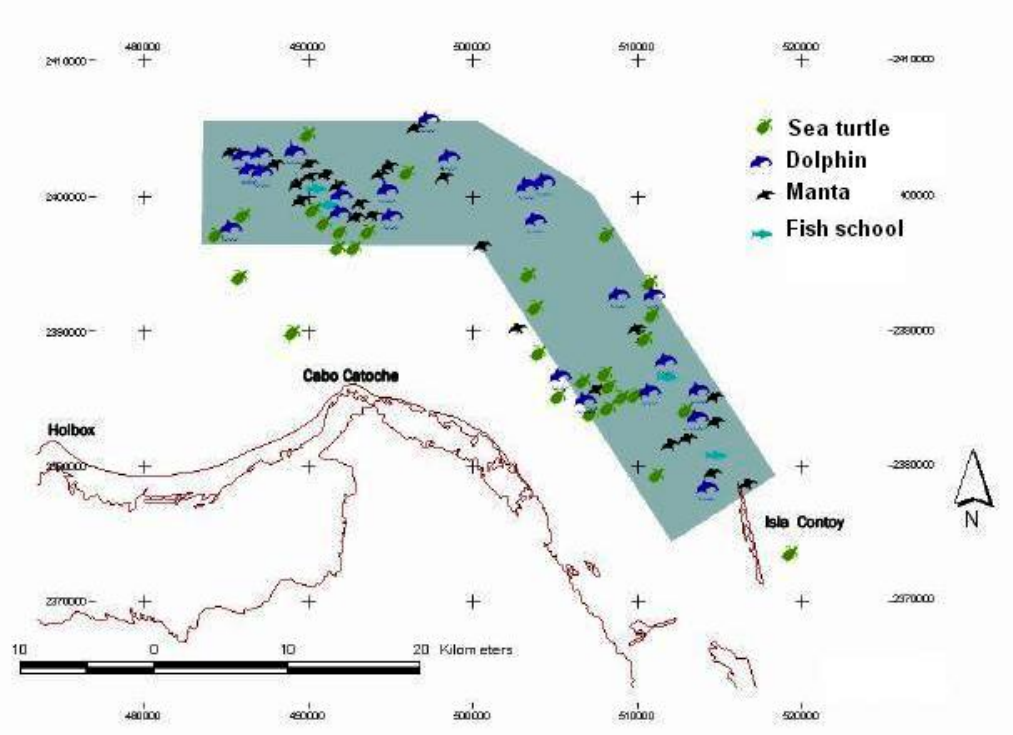
By Montserrat Trigo and Rafael de la Parra

Cumulative information registered from 2004 to 2007 flights is shown, represented in group sizes per year.



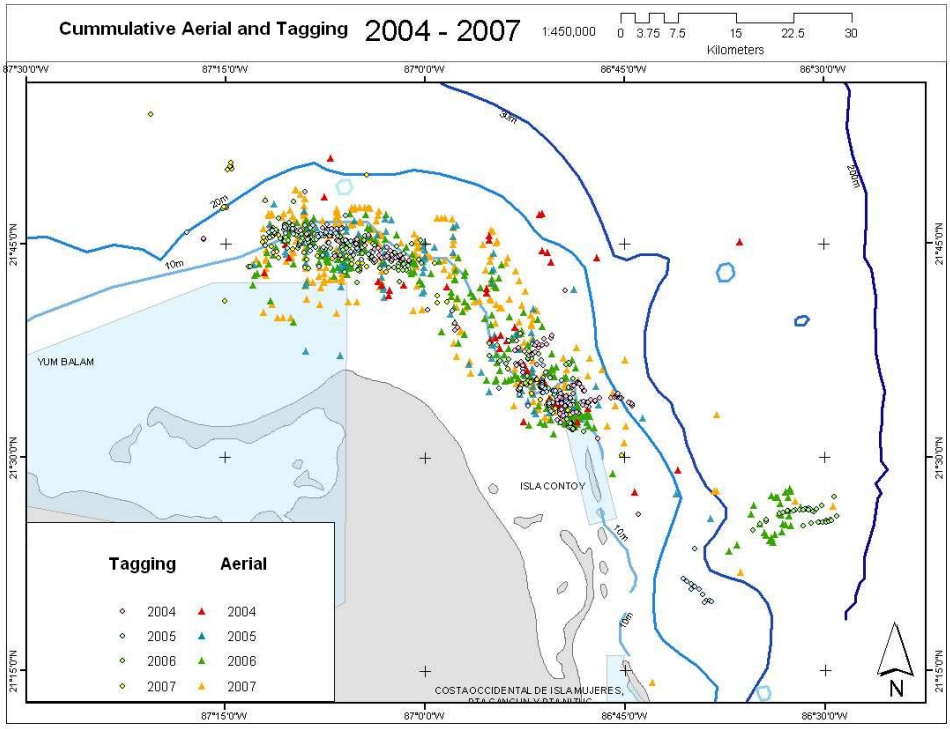
By Montserrat Trigo and Luis de la Parra

Other species, like sea turtles, dolphins, rays, mantas and fish schools are also registered



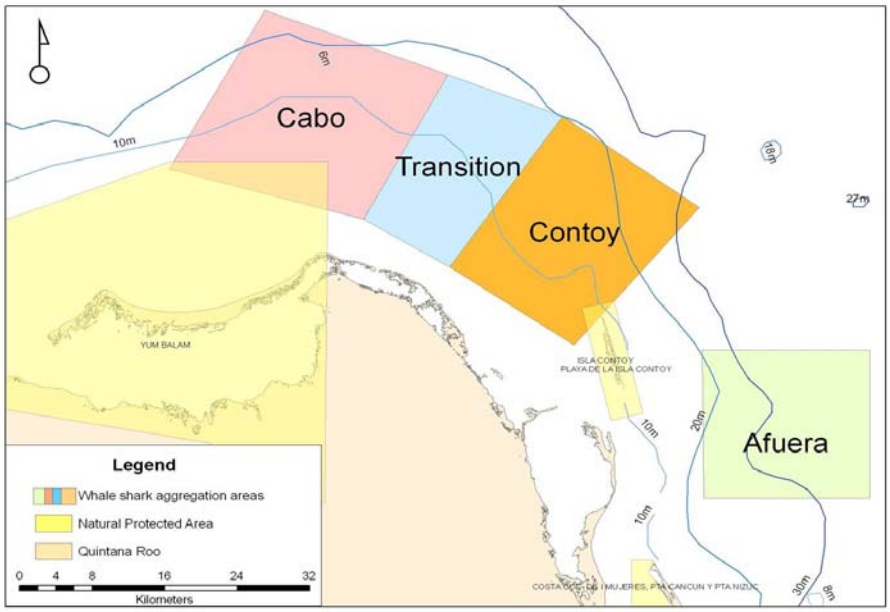
By Natalí Cárdenas

The following map was constructed by overlapping aerial and tagging geographical information:



By Montserrat Trigo

Considering these results, three zones can be distinguished in the study area, plus a fourth one offshore:

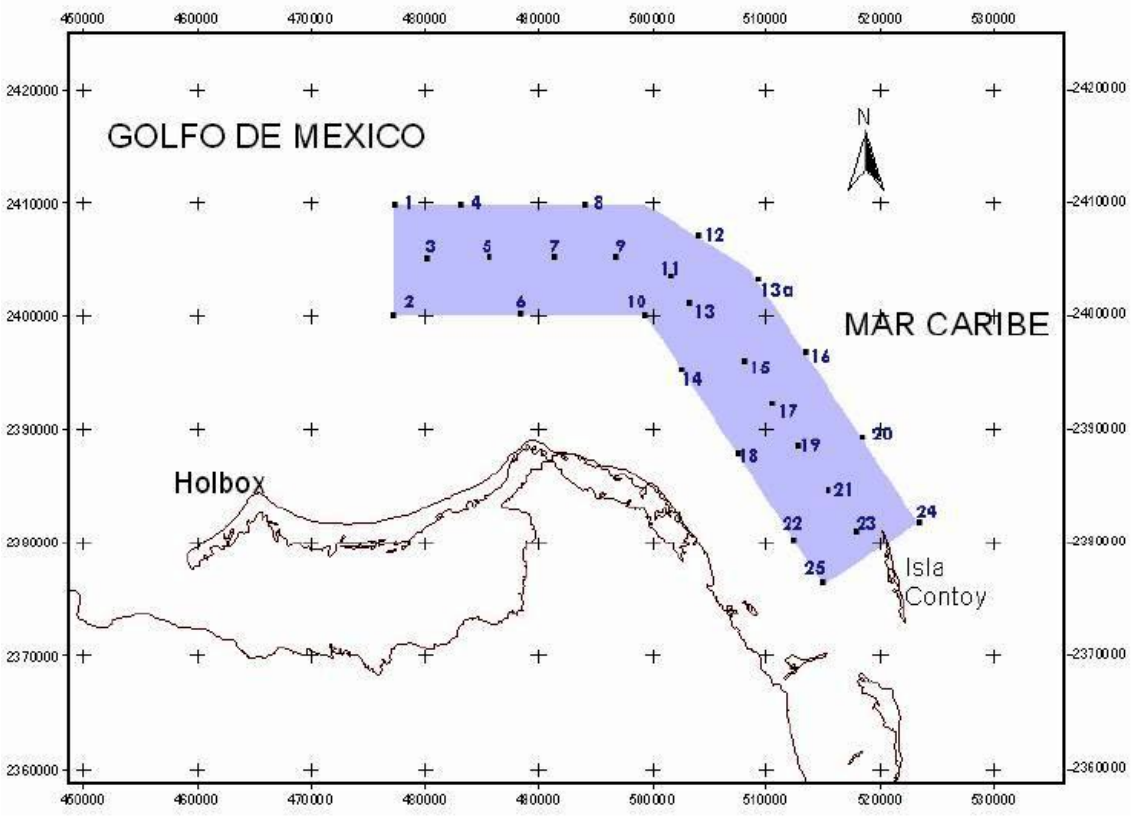


By Montserrat Trigo

After a population methodology workshop, using two different models resulted on ***1410 Whale sharks***, as population size estimation in the study area.

Hidrology and Plankton

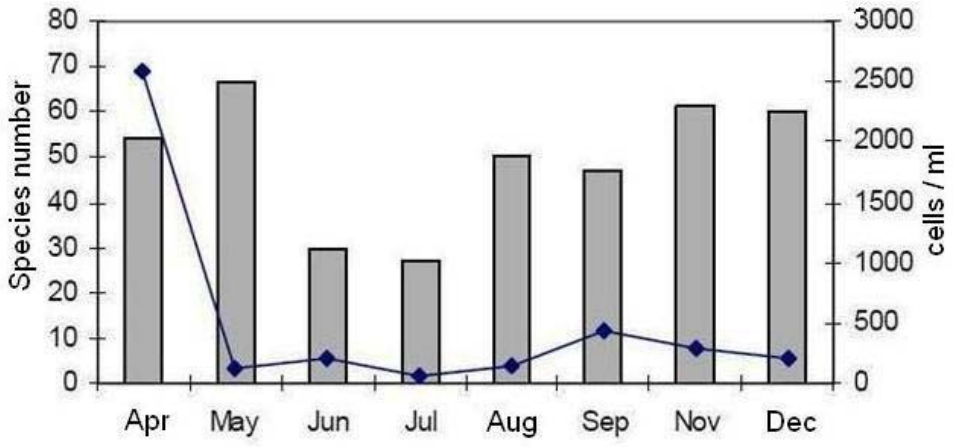
Cinvestav colleagues determined a total of 26 point pattern (stations) to collect information, while continuous flow analyzed some parameters, other were measured on surface at each station, while the water column was evaluated only on the “intermediate” stations (3, 5, 7, etc.)



Oscar Reyes, Natalí Cárdenas

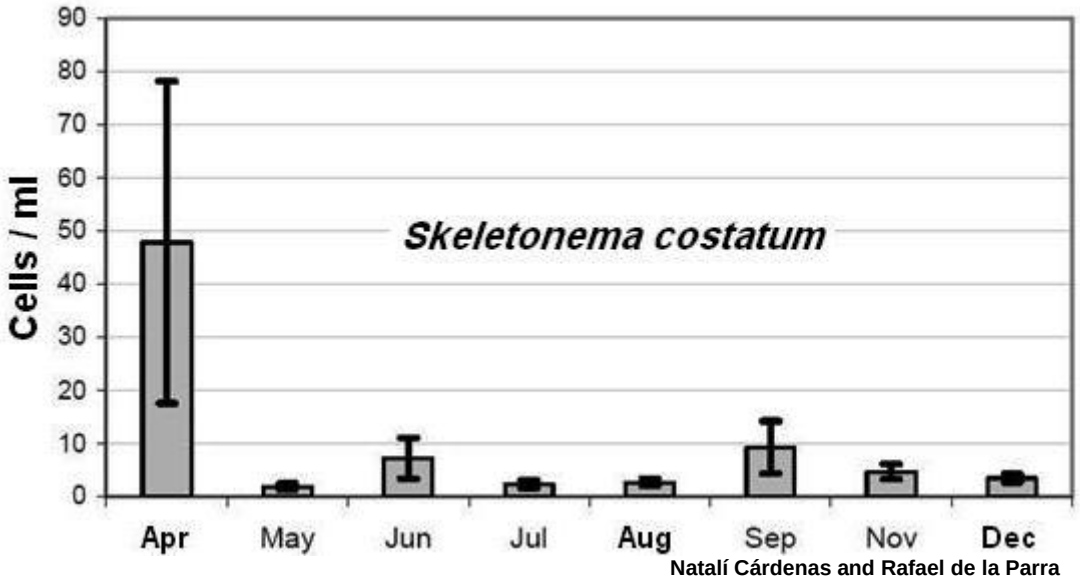
Light, Temperature, Salinity, Dissolved Oxygen, Phosphates, Silicates, Dissolved Inorganic Nitrogen and Chlorophyll were analyzed on 8 sessions from April to December 2005, to continue along 2006, 2007 and 2008.
During processing analysis, physical, chemical and biological parameters were correlated.

Plankton diversity and time variation is represented in this graph:



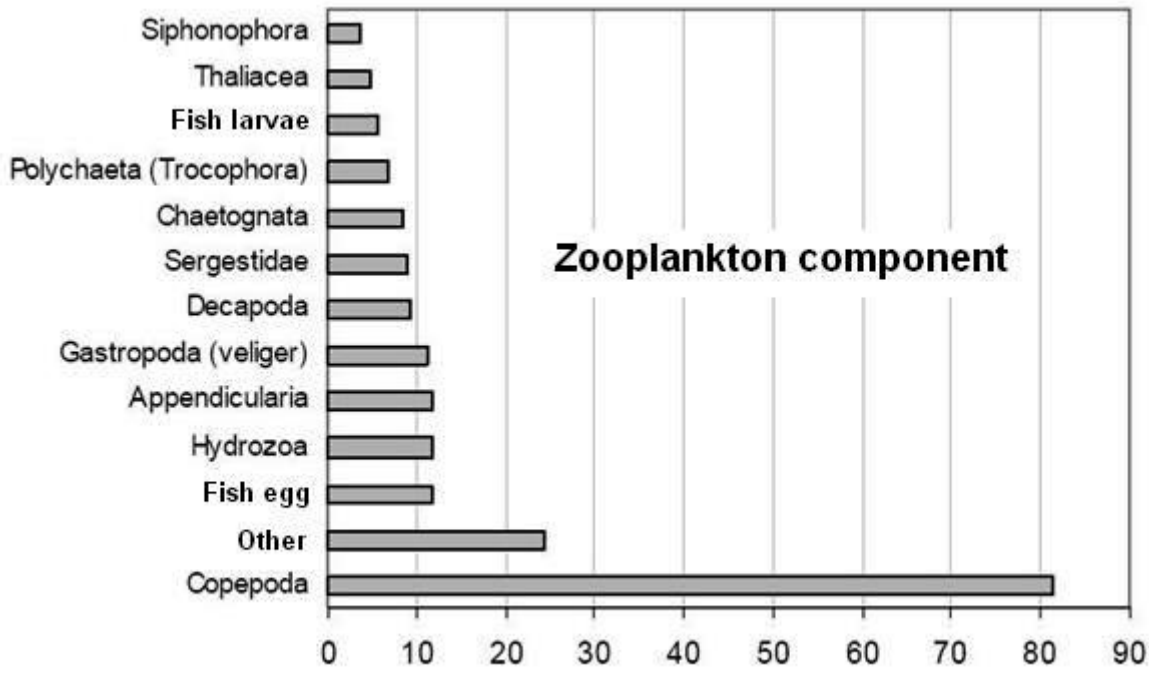
Natalí Cárdenas

Upwelling indicative species presence became a confirmation when deep water diatoms were collected.



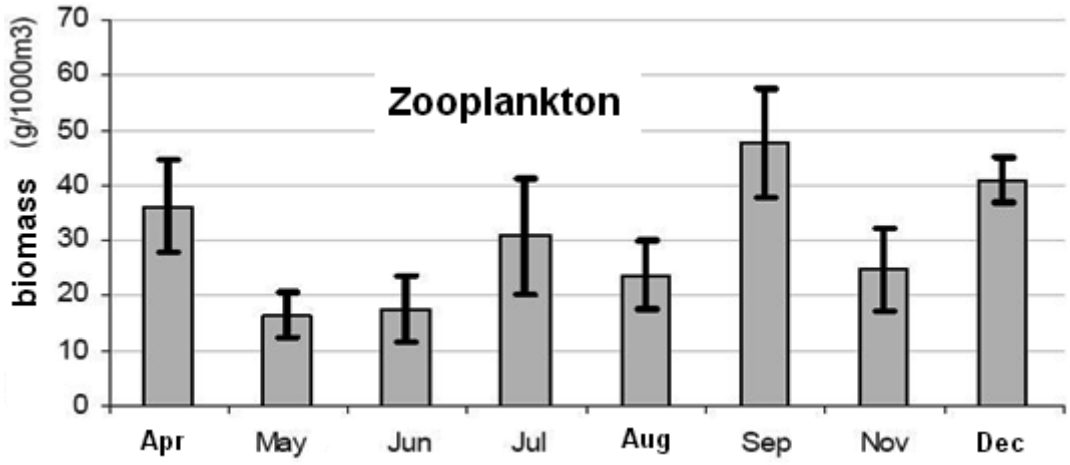
Natalí Cárdenas and Rafael de la Parra

Zooplankton Group collected:



Natalí Cárdenas and Rafael de la Parra

And the biomass per month:



Natalí Cárdenas

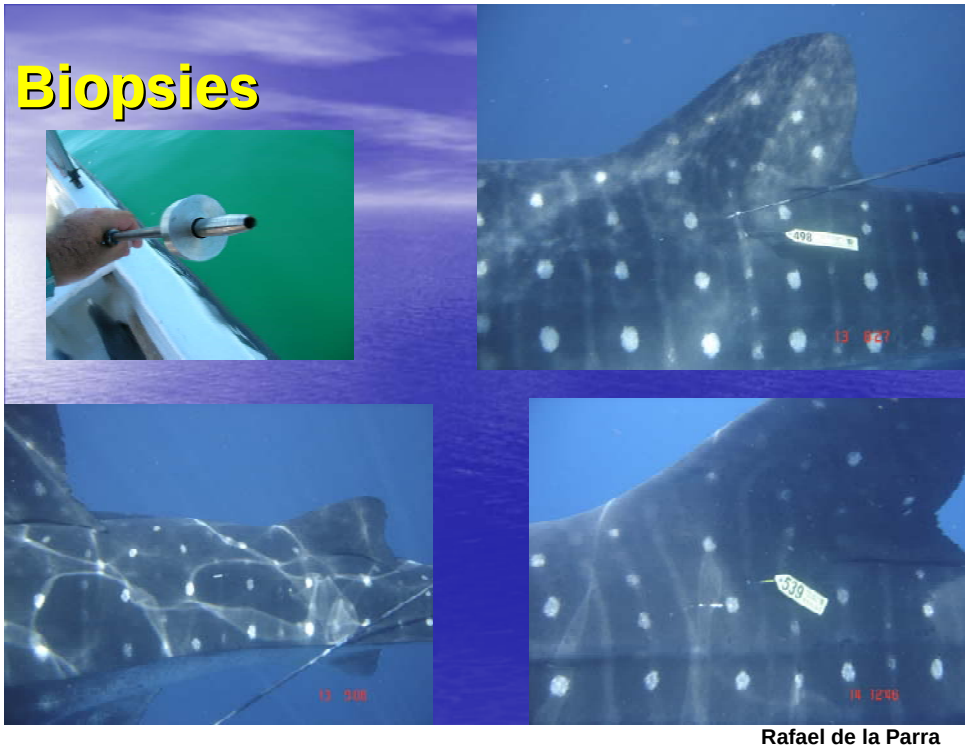
Genetics

The hypervariable region, from the DNAm region, was amplified and secuencied, in order to analyze the genetic structure from two oceanic isolated areas: Baja California Gulf (Sea of Cortez) and the Mexican Caribbean.
35 haplotypes. 23 found on Baja and 15 on Holbox, therefore higher haplotype diversity was observed on Baja than on Holbox.
Now analyzing which polymorphic microsatellites could be used to provide valuable knowledge on the population structure on both zones.
CibNor and **Cicimar**, are conducting this studies and they may confirm which appears to be philopatry too.

Dení Ramírez

Stable Isotopes

This study correlates nutrient ratios, (carbon – nitrogen) found on plankton collected in situ with those found into Whale Shark skin tissue biopsies, processed at **CibNor – Cicimar**, trying to determine, where specific individuals or a group of them, has been feeding on.



Rafael de la Parra

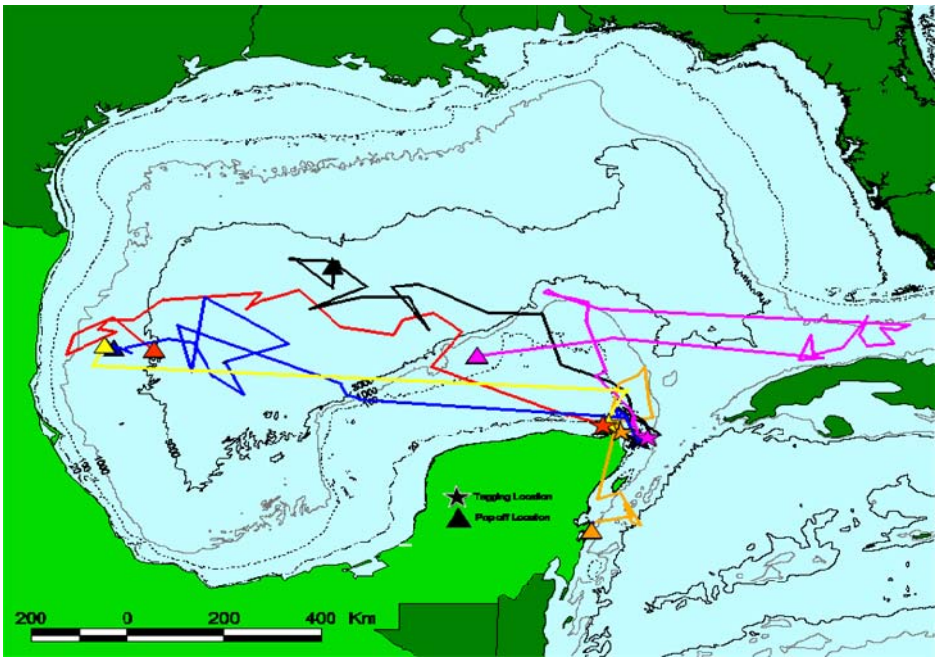
Satellite Telemetry

Pop up satellite archive transmitters (PSAT), are been deployed by the **Center for Shark Research, Mote Marine Laboratory** colleagues. 11 animal tracking information is being processed (which geographic position is calculated through crepuscular light levels), including water temperature and depth. Detachment is previously programmed, thus obtaining very valuable knowledge on vertical and horizontal movements and behavior.

Satellite transmitter deployed summary

2004	2005	2006	2007	2008	Total
2	4	6	3	6	21

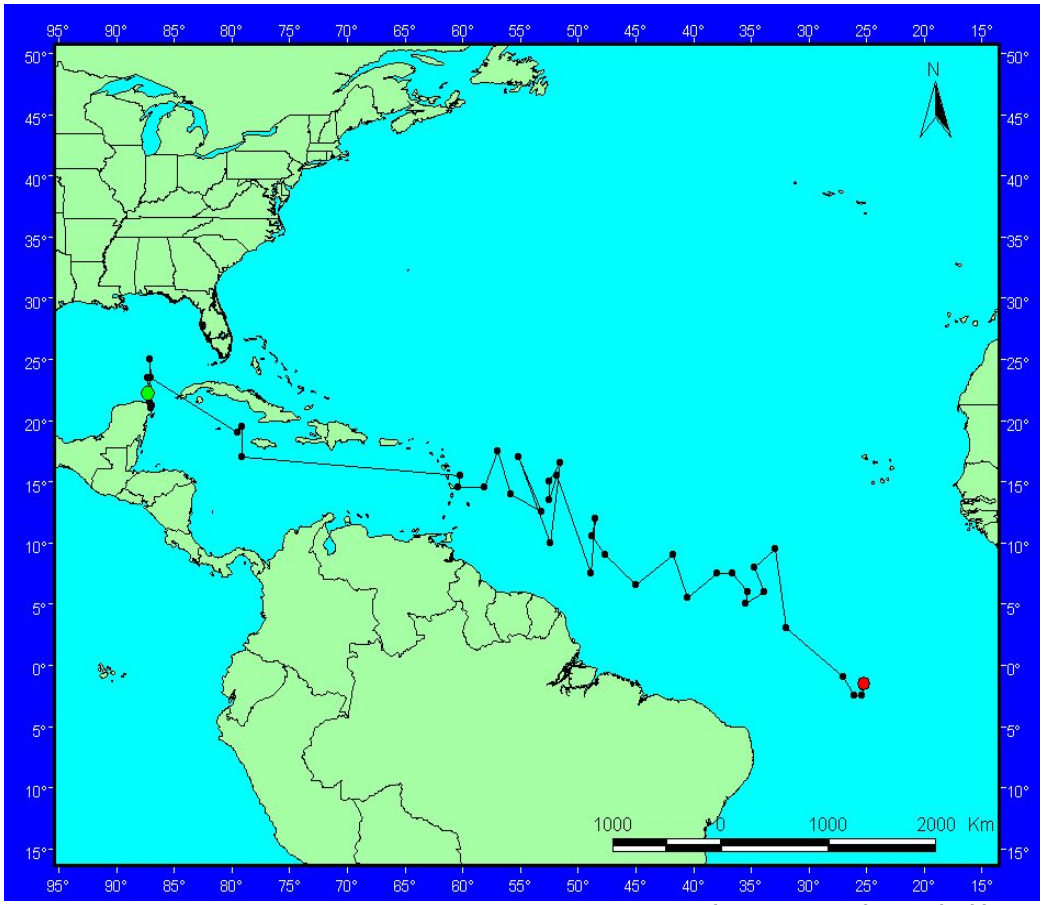
Four Whale Shark movements are shown here:



Robert Hueter, John Tyminski

Some individuals swim inside the Gulf of Mexico, some prefer to go east, near Cuba, while others travel south into the Caribbean.

On August 2007, a satellite transmitter was deployed on a 7.5 m female, north of Quintana Roo, five months later the transmitter began to send information from the southern hemisphere, between Africa and Brazil. Over 7,200 Km in a straight line from the deploying site.
Dive recording, shows up to 1700 m depth, where water temperature is barely 4°C.

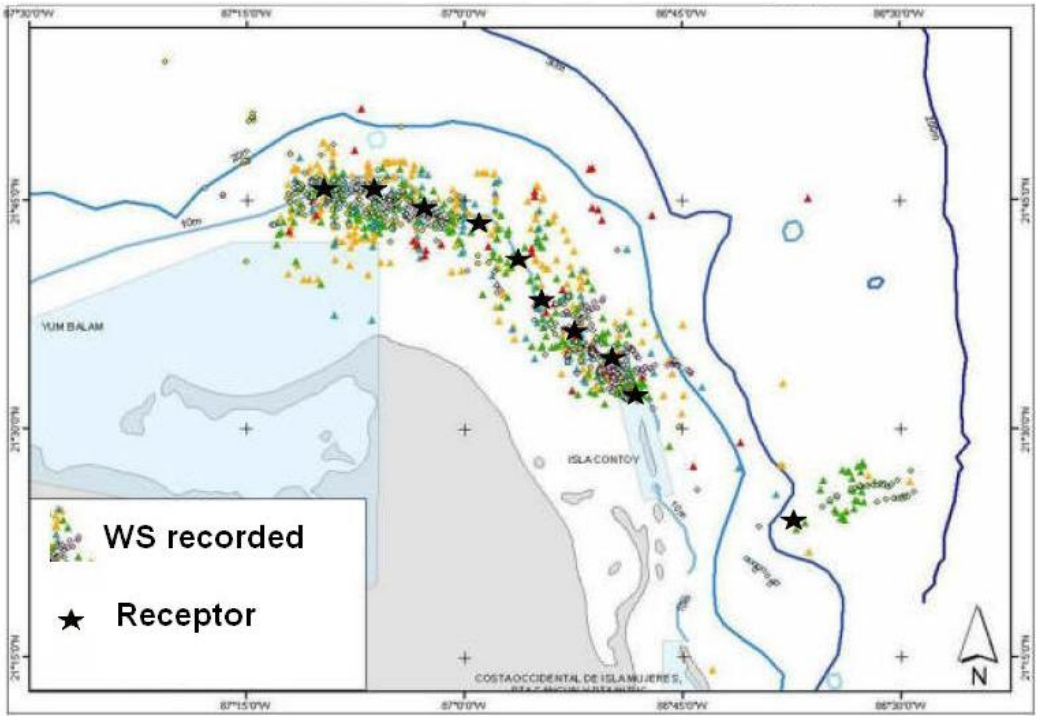


Robert Hueter, John Tyminski

Acoustic Telemetry

During 2007 attending an invitation to collaborate with an International Acoustic Array, recently started on Belize and Honduras, led to conform **Marine Meganet**, which now also involves Cuba, United States and Brazil; with **Wildlife Conservation Society** participation.

Over 53 acoustic transmitters have been deployed on 53 whale sharks and 9 acoustic receptor underwater stations are collecting data in the study area, animal movements between stations as well as non surface behavior is expected to be recorded.



Montserrat Trigo and Rachel Graham

Nutrition and Feeding

An enormous quantity of data and careful calculations, obtained processing photographic, video and watching information is being conducted by **University of South Florida** scientists, swimming speed and mouth size estimations are been the input to calculate the water passing through whale shark filtering structures. Simultaneously zooplankton net tows are realized by **Smithsonian Institute** collaborators, to collect and quantify the available biomass and to identify zooplankton component groups and its nutritional content.

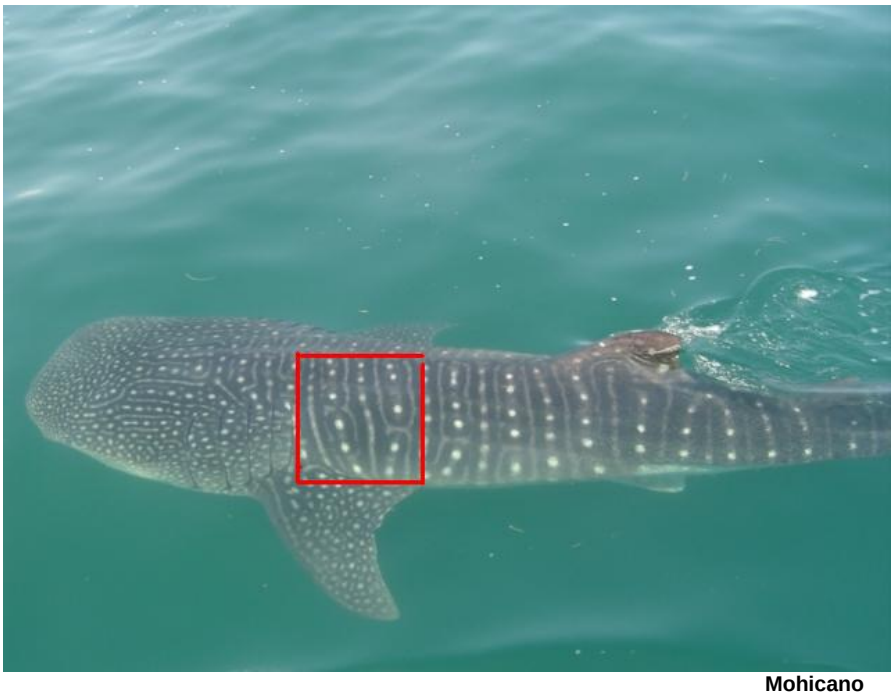
Rafael de la Parra

Photographic Identification

Starting a photographic catalog since 2004 field studies, has allowed to identify very particular individuals, but today's tools involving complex algorithm like Groth and i3S have facilitate to know more accurately whether an individual is a re sighting or a "new" visitor.

At least three different software programs have been developed to scan for recorded ones from a database.

Efforts to connect authors in order to look for compatibility are under process. **Ecocean** is today's largest library in the world, and the catalog is being uploaded. Several individuals have been reported to visit Honduras, Belize, Cuba, the Gulf of Mexico, Florida coast and Mexico. In the mean time the project is using another program too.



Mohicano

Photography is also a useful tool to determine the damage acceptance limit:

Rafael de la Parra

Heavy Metals

Mexico National University **UNAM**, has conducted heavy metal studies on sea grass in the area, therefore whale shark skin samples are been analyzed, in order to determine if Cadmium, Lead or Mercury are present, without positive or conclusive results.

Total tagging, telemetry, genetic and photography summary

Registered sharks	**946**
Tagged (conventional)	**716**
Recaptures (re sightings)	**180**
Satellite transmitters	**18**
Data archive tagged	**5**
Acoustic transmitters	**53**
Genetic, nutrition and heavy metal biopsies	**259**
Photographed	**570**

*** 2003 a 2008**

Tagging and Aerial activities

	2003	2004	2005	2006	2007	2008	Total
Field trips	2	20	27	25	19	27	120
Flights	0	5	7	20	12	18	62

Training

Local communities are participating from the beginning. Holbox, Chiquila and Isla Mujeres attendance to training courses, workshops and interchange programs:

Rafael de la Parra

Four course processes are basic to obtain official specialized guide certification:

Group managing
Rescue and snorkel
First aid and CPR
Whale shark habitat, biology and ecology

Collaboration on monitoring whale sharks and its environment is a result of specific workshops too.

By 2008 training involves:

Course – Workshop	**92**
Total hours	**1070**
Attendance	**761**
Instructors	**16**

School lecture, presentation and environmental education course – workshop:	
Elementary, High School and College	**32**
Teachers as promoters on WS knowledge	**5**
Environmental education for NGOs	**3**
Attendance	**934**

Rafael de la Parra

International participation

Perth, Australia
Ensenada, BC. Mexico
Belize City, Belize. PST
Antigua Guatemala. TNC
San Pedro Sula, Honduras. TNC
Belize City, Belize. TNC
Placencia. Belize. TNC
Utila, Honduras WSORC
La Paz, BCS. Mexico
Utila, Honduras. UWSR
Belize City, Belize. GCFI

Perspectives

Batimetric and oceanic current studies
Photographic catalog
Parasitology
Hallometric studies
Satellite telemetry in actual time
Related species studies like Manta ray

Publications

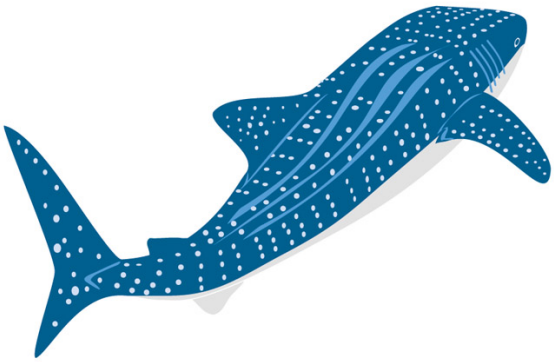
Participation on the First International Whale Shark Conference held on Perth, Australia, with the poster:

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

On 2006, the Mexican conservation and biodiversity magazine ***Especies***, published "***Tiburon Ballena, el mayor pez del mundo***".
The photographic catalog is the following publishing goal, while three papers are under review to be submitted for publication.

On 2005 Domino Project uploaded on line:
www.domino.conanp.gob.mx

And the official logo was designed:



DOMINÓ
Proyecto del
Tiburón Ballena
del Atlántico Mexicano

@IMPI registration pending