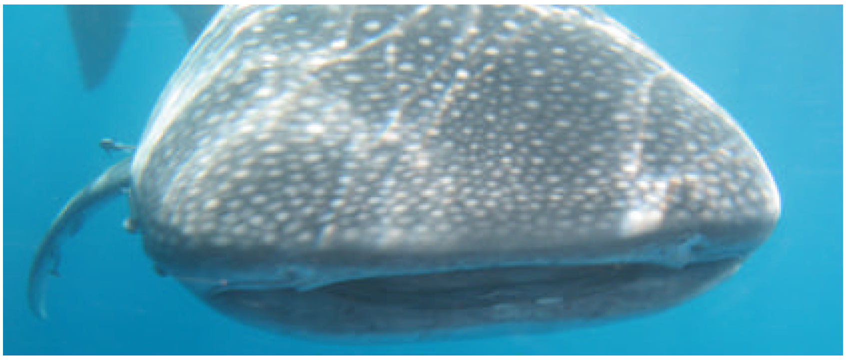
Whale Shark Photo-Identification Project, Sogod Bay, Philippines

March 24-30, 2006



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1 Background and Objectives

1.1 Coral Cay Conservation

Effective coastal zone management, including conservation of coral reefs, requires a holistic and multi-sectoral approach, which is often a highly technical and costly process and one that many tropical countries cannot adequately afford. With appropriate training, non-specialist, self-financing volunteer divers have been shown to be able to provide valuable data for coastal zone management at little or no cost to the host country (Mumby *et al*., 1995). This technique has been pioneered and successfully applied by Coral Cay Conservation (CCC), a British not-for-profit organisation.

Founded in 1986, CCC is dedicated to '*providing resources to protect livelihoods and alleviate poverty through the protection, restoration and sustainable use of coral reefs and tropical forests*' in collaboration with governmental and non-governmental organisations within a host country. CCC does not charge the host country for the services it provides and is primarily self-financed through a pioneering volunteer participatory scheme whereby international volunteers are given the opportunity to join a phase of each project in return for a financial contribution towards the project costs. Under the guidance of qualified and experienced project scientists, the volunteers undergo an intensive training programme in marine life identification and underwater survey techniques, prior to assisting in the acquisition of data. Finances generated from the volunteer programme allow CCC to provide a range of services, including data acquisition, assimilation and synthesis, conservation education, technical skills training and other capacity building programmes. CCC is associated with the Coral Cay Conservation Trust, the only British-based charity dedicated to protecting coral reefs.

The Coral Cay Society runs mini-expeditions, where society members who cannot spare the time to join a full 1 month CCC expedition can join specifically tailored "mini-expeditions". One of CCC's marine scientists accompanies each of these trips, giving lectures on marine science, species identification and/or surveying techniques, as appropriate to the needs of the society members.

1.2 Southern Leyte, Philippines

The Philippine archipelago of approximately 7100 islands forms part of the Wallacea Triangle, an area renowned for its high terrestrial and marine biodiversity. Some 499 hard coral species (Chou, 1998) and more than 2500 fish species (Leiske and Myers, 2001) have been recorded to date. The coastline is fringed with approximately 25,000 km^2 of coral reefs, about 10% of the land area of the whole archipelago (Spalding *et al*., 2001).

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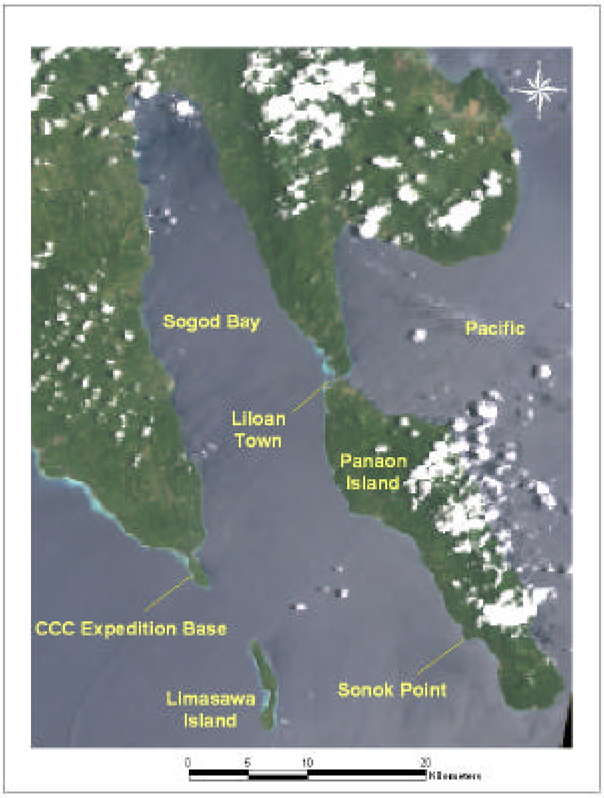
Southern Leyte, one of the six provinces of Eastern Visayas, is bounded in the north by the Province of Leyte, in the south by Mindanao Sea, in the east by the Pacific Ocean and in the west by the Canigao Channel. Sogod Bay (10° 12' N, 125° 12' E) is surrounded by 131.67 km of coastline and encompasses the islands of Panaon and Limasawa (Map 1).



Map 1 Sogod Bay, Southern Leyte

The coral reefs of Southern Leyte remain some of the least disturbed and least researched habitats in the Philippines. Sogod Bay is an important fishing ground and the area is rich in tuna, flying fish, herrings, anchovies, shell-fish, and mackerel. The Bay has been targeted by the Fisheries Sector Program of the Department of Agriculture as one of the country's ten largest bays in need of assessment and management (Calumpong *et al.*, 1994). Sogod Bay is also a feeding ground for charismatic mega-fauna such as pilot whales, melon-headed whales, dolphins, and whale sharks.

The topography of the coast surrounding Sogod Bay is characterised by steeply sloping hills. The western side of the bay has a flatter topography than the eastern coast, where steep hills often slope straight into the sea. The seabed is steeply sloping, providing the bay with a minimal coastal shelf and a deep, narrow central channel. There are two major rivers entering the north of Sogod Bay: the Divisoria River in Bontoc and the Subang Daku River in Sogod.

1.3 Whale Sharks:

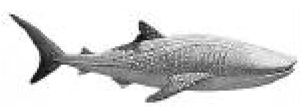
Despite the fact that the sharks and the 'true fishes' (bony fishes, jawless fishes, coelacanths etc) do not share a discreet common ancestor, they are often grouped together in common parlance as 'fish', a grouping referred to as a 'grade' by taxonomists. The whale shark, *Rhincodon typus* (Smith, 1828), is the largest member of this grade; its extraordinary maximum size of over 12m frequently earns it the moniker "the largest fish in the world". In fact, some researchers suspect that they may even reach sizes of 20m[1]. Along with the rays, skates and chimaeras, sharks belong to the class Chondricthyes, distinguished by the fact that they all have a skeleton made of cartilage rather than bone. In total, there are nearly 1000 species within this class. Sharks, skates and rays are grouped together in the sub-class Elasmobranchii, with the whale sharks being further segregated into the order Orectolobiformes, the carpet sharks. It is the only member of its family, Rhincodontidae, and thus its genus, *Rhincodon*. Its scientific name, *Rhincodon typus*, translates as 'rasp-tooth' 'type'.

Inhabiting most of the world's tropical oceans, whale sharks are cosmopolitan animals, and are known to undertake long migrations[2]. Tagging and DNA sampling have indicated that males tend to migrate further than females, the latter habitually returning to their place of birth (Froese and Pauly, 2006). However, very little else is known about their movements, mating or lifestyles. They can often be found near river estuaries or upwelling areas, where increased levels of nutrients in the water encourage the growth of microscopic algae, which in turn promotes the growth of the tiny planktonic animals, such as krill and small fish, which feed on these algae. Whale sharks graze the oceans for such animal plankton, straining seawater through their modified gills in order to feed. Their feeding appendage has evolved to allow them to actively 'suck' water into their mouths, permitting them to remain motionless in the water whilst feeding, should they so choose. They can often be seen to move their heads from side to side as they feed, and even to lift their heads partially out of the water (Clark and Nelson, 1997). It is from their feeding methods and their size that they have earned them their common name.

Although solitary animals are often encountered, large aggregations of over 100 individuals are also not unusual (Compagno, L.J.V., D.A. Ebert and M.J. Smale, 1989), and despite their enormous body size, they are not aggressive towards humans. In a number of areas of the world, tourism initiatives have begun to capitalise on these characteristics, offering visitors the chance to see these remarkable creatures in the wild. Their gentle nature even makes it possible to swim with them when they approach the surface of the sea.

However, these very same characteristics also make them vulnerable to human exploitation from hunting with harpoons. The flesh can be eaten and their fins sold for high prices to the Asian restaurant industry for soup; their

[1] Florida Museum of Natural History
[2] IUCN Red List of Threatened Species



cartilage is used in spurious anti-cancer 'medicines', based on an erroneous belief that sharks don't get cancer; the oil from their liver is used in the waterproofing of wood; their offal is ground up to make fish meal. Although it is hard to estimate the populations of these animals, the threat posed by such exploitation was considered sufficient to have them listed under Appendix II of the Convention on the International Trade in Endangered Species (CITES) in November 2002. Pre-empting this move, the Maldives protected whale sharks in 1995, and the Philippines followed suit in 1998[3].

The legal protection of whale sharks within the Philippines has raised the profile of the animals, and has facilitated the development of tourism initiatives based around the sustainable exploitation of the animals. On the island of Donsol, for example, the arrival of the sharks in the late 1990s created the opportunity for such an industry. The Local Government Units and community members teamed up with WWF Philippines to define and install management initiatives, with outstanding success. Since 1998, over 8000 visitors have snorkelled with the whalesharks in Donsol, and the 4.2 million pesos that have been generated through the payment of user fees have created numerous jobs within the town. Time magazine have gone as far as to describe Donsol as the best place in Asia for an animal encounter[4]. This success has paved the way for other fishing communities within the country to see the whale shark as a resource that can generate sustainable livelihood income, rather than one that should be fished for a once-off payment.

Within the Province of Southern Leyte, whale sharks have visited Sogod Bay for longer than living memory (Neil Pretencio, pers. comm.). However, there is as yet no formal structure for the development and management of a tourism industry based on these animals. The majority of sightings of the sharks are on the eastern side of the bay, possibly as a result of the peculiar current patterns created by the channel at the town of Liloan, with most of the sightings taking place between February and April (Neil Pretencio, pers. comm.). This year, the animals have been mostly sighted further south than usual, near the town of Sonok (Tony Exall, pers. comm.); this is the fist year that they have consistently visited Sonok Point (Mayor of Pintuyan, pers. comm.) although the reasons for this remain unclear. However, a lack of long-term datasets on the number of individuals sighted, the movements of the animals within the bay makes it impossible to make robust scientific observations regarding their population dynamics.

In order to begin to address this issue, the Coral Cay Society teamed up with the diving support and survey vessel, DSV Discovery, to undertake a preliminary whale shark survey in order to photo-identify as many of the individual animals as possible. For seven days in March 2006, teams of surveyors visited Sonok Point, recording images for submission to the Shark Trust (UK) and the Ecocean Project (Australia), as detailed below. It is

3 The Shark Trust
4 Worldwide Fund for Nature (WWF)

hoped to repeat this survey at the same time of year in 2007 in order to ascertain whether any of the individual animals have returned to the area.

2 Methods

Large nomadic pelagic animals, such as sharks and marine mammals, are frequently and increasingly vulnerable to a variety of anthropogenic threats. Unfortunately, they are also difficult and expensive to study, leading to a paucity of data on their population dynamics (migrations, breeding patterns etc), thus hampering the management and conservation of such animals. Satellite tracking is cost-prohibitive for the widescale study of such movements, and the effectiveness of 'tagging' with markers is inhibited by a variety of factors, such as a lack of persons who are capable of (or, indeed, motivated to) report sightings of tagged individuals, and the variable in situ longevity of the tags themselves. Animals are sometimes identified by scars on their bodies, but these markers are often susceptible to dramatic variation as the tissue heals over time, rendering the markers increasingly less useful. The further accumulation of more 'obvious' recent scars also tends to distract subsequent observers' attention from the older scars, with the individual often being mistakenly identified as a new animal rather than a resighting.

However, the increasing popularity of tourism associated with such animals creates an opportunity: if individual animals can be identified in a reliable and cost effective way from photographs obtained by tour operators and customers, databases can be created, logging sightings of individuals over space and time. This approach has been successfully pioneered for whalesharks (*Rhincodon typus*) by the Ecocean Project (www.ecocean.org), which has developed a database in conjunction with astronomers from the Universities Space Research Association and NASA's Goddard Space Flight Centre in Maryland, USA. Zaven Arzoumanian (an astrophysicist), Jason Holmberg (a software specialist), and Brad Norman (a marine biologist) have created a system whereby computer technology can be used to accurately identify whale sharks from appropriate photographs taken by non-specialists, such as those within the tourism industry.

The software package that has been adapted was originally designed for identifying portions of the night sky from photographic images, such as those obtained by the Hubble Space Telescope. The package consists of a database containing information about the spatial relationships between visible celestial objects, such as stars and galaxies. As the precise composition of the spatial relationships contained within any single image will be unique to the area of the cosmos photographed, this allows the system to analyse a new image and then to consult the database for matching patterns, determining the exact portion of the cosmos contained in that image. The researchers have been successful in applying the technique to the spotted patterns that are peculiar to the lateral ('side') surface of whalesharks (Arzoumanian *et al*, 2005). As Arzoumanian explained to *Astronomy* Magazine, "The contrast of white whale-shark spots on darker skin is well suited to a machine vision technique known as 'blob extraction,' which measures the locations and dimensions of pixel groups of a single colour. The spatial relationships between these groups form the basis for a unique identifier for each shark."

In the UK, The Shark Trust is also collating whale shark images for The Whale Shark Project (www.sharktrust.org/whalesharkproject/index.html). Once a sufficient number of images have been collected in this database, they will undergo computer-assisted Photo-ID to identify and catalogue each individual shark.

In order to facilitate such computer-assisted Photo-ID, these databases require images that have been obtained of specific body areas of the animals. For both databases, images of the area behind the gills are suitable (figure 1 – area A). The Shark Trust also collects images of the dorsal fin area (figure 1 – area B).

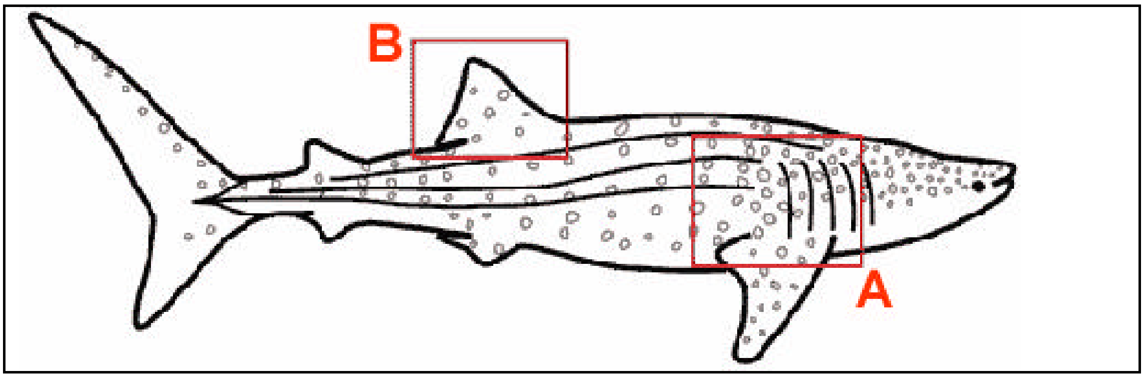


Figure 1: Photo-ID target areas
Image: The Shark Trust (www.sharktrust.org)

In order to ensure the safety both of the surveyors and the whale sharks, the Code of Conduct endorsed by The Shark Trust was followed (figure 2). Once a shark had been sighted, the area was approached in one of the small support boats that accompany the DSV Discovery. Surveyors then entered the water with snorkelling equipment and cameras. Surveyors maintained a distance of at least 3m from the animal (4m from the tail). The animals were never touched and no flash photography was used.

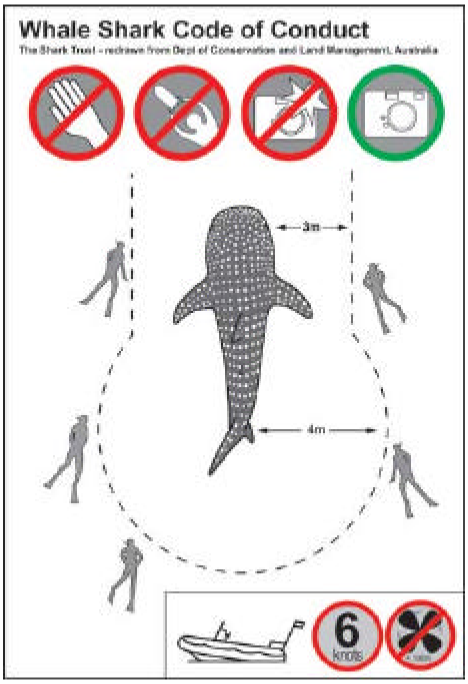


Figure 2 - Whale Shark Code of Conduct
Image: The Shark Trust (www.sharktrust.org)

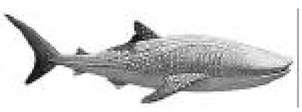
3 Results

3.1 Photo-ID Images

Over the 7 days of the project, a minimum of 18 and a maximum of 24 individual sharks were sighted (it was not possible to determine with a sufficient level of certainty whether six of these were new sharks, or were resightings of previously observed animals).

As many of the sighted sharks were not observed at the surface but were swimming deeper, the use of snorkelling technique limited the number of animals that could be photographed appropriately for the Photo-ID method, with accurate photos of some animals only possible from directly above rather than from the side.

However, appropriate images were obtained for 9 individual animals, with multiple images obtained of most subjects. In table 1, these images are presented, along with their Ecocean ‘encounter number’. To view the images, log on to http://www.shepherdproject.org/overview.jsp and enter the appropriate encounter number where indicated on the web page. Photographic credits are given on the site.



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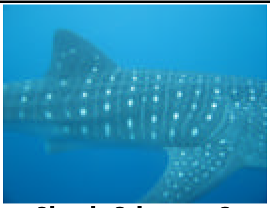
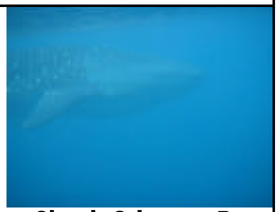
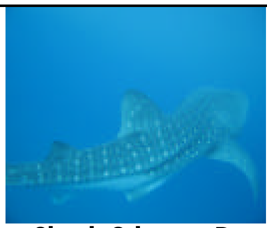
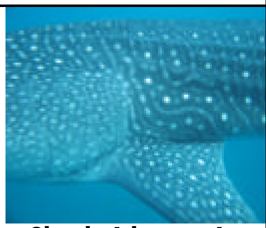
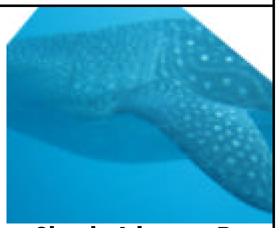
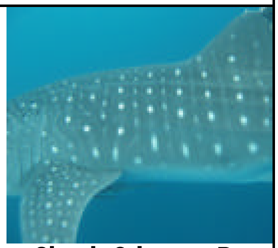
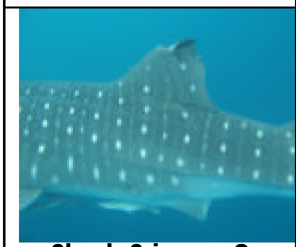
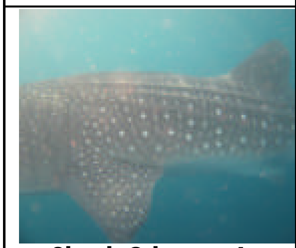
 Shark 2 image C 95200692129	 Shark 2 image D 95200692129	 Shark 3 image A 95200692839	 Shark 3 image B 95200692839
 Shark 3 image C 95200692839	 Shark 3 image D 95200692839	 Shark 4 image A 9520069380	 Shark 4 image B 9520069380
 Shark 4 image C 9520069380	 Shark 5 image A 95200694314	 Shark 6 image A 9520069480	 Shark 6 image B 9520069480
 Shark 6 image C 9520069480	 Shark 7 image A 95200695159	 Shark 7 image B 95200695159	 Shark 7 image C 95200695159
 Shark 8 image A 95200610359	 Shark 9 image A 952006101043	 Shark 9 image B 952006101043	 Shark 9 image C - tip of tail damaged 952006101043

Table 1 Photo-ID Images submitted to The Shark Trust and Ecocean. Listed codes are Ecocean encounter numbers (http://www.shepherdproject.org/overview.jsp)

3.2 Size observations:

78% of the 18 observed animals were between 4.5 and 7m (figure 3), with an overall mean length of 6.1m (? = ±1.3m).

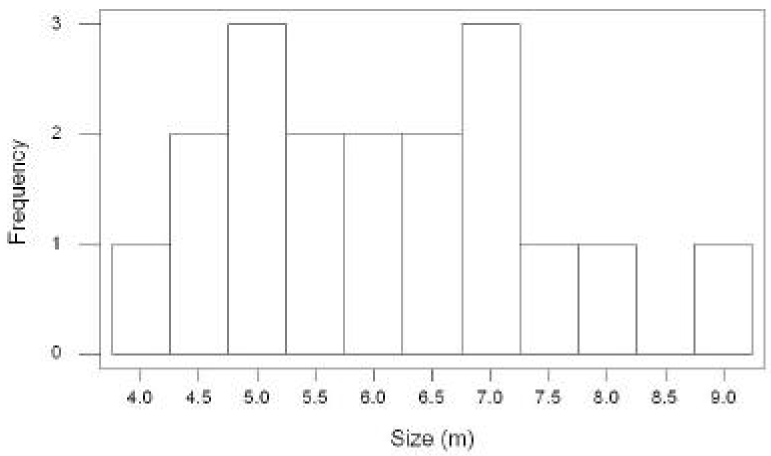
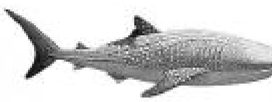


Figure 3 - Frequency of size observations (n=18)

3.3 Sex Observations:

The sex of whale sharks is readily indicated by the presence or absence of two large sex organs called 'claspers', located in the posterior ventral region of males. These claspers are modified fins, and are used during mating.

Of the 18 confirmed individual sightings at Sonok Point, 13 were sexed and all were found to be female.



3.4 Time of sightings:

The majority of sightings were either in the morning before 09:00 (58%), or in the evening after 16:00 (30%) – figure 4.

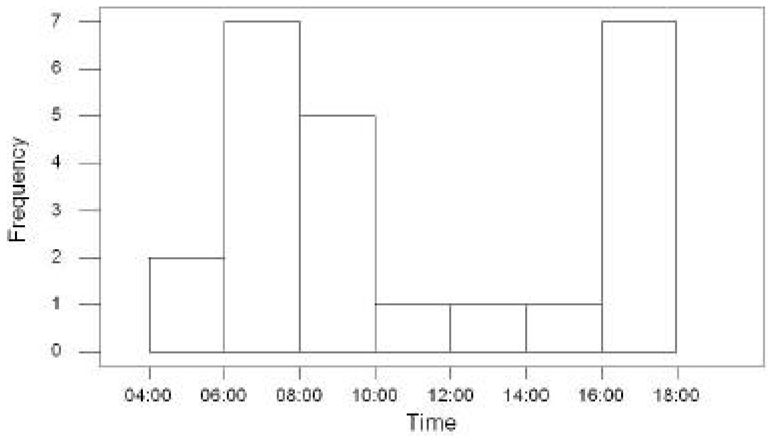


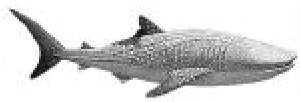
Figure 4 – Frequency of time observations (n=24)

4 Discussion

Sexual maturity in whale sharks may not occur until the animal is at least 9m in length[5], achieved at around 25-30 years of age (Taylor, 1994). The data suggest, therefore, that all of the observed sharks were younger than this, and were thus sexually immature. 13 of the 18 confirmed individuals were female, and this skewing also implies a prevalence of females within the bay at this time of year, although the dataset is too small and of too limited a timeframe to make statistically confident observations in this regard. Further data should be gathered in order to augment this dataset, and to facilitate longitudinal studies of the sharks' population dynamics.

As represented in figure 4, the time of sightings was heavily skewed towards the early morning and late afternoon. This may be linked to the "diel vertical migration" of plankton, which often approach the surface layers of the ocean in the evening, and then descend again the following morning. As the whale shark feeds on such plankton, it is likely that it may ascend and descend in tandem. This hypothesis is corroborated by anecdotal evidence from fisherfolk in Sogod Bay, suggesting that the sharks are often seen feeding at the surface at night near the town of Liloan (Map 1), even if they have not been previously sighted during daylight hours. At the end of the rainy season (November – February), terrigenous runoff from the steep sides of the bay may be partly responsible for the visible plankton blooms that

[5] Florida Museum of Natural History



occur in the early months of the year. The fact that whale sharks are most commonly sighted in the bay at this time implies a link between the presence of the animals and the seasonal abundance of food.

Although the sharks have annually visited Sogod Bay for generations, this is the first year they have been sighted at Sonok Point in such abundance (Vice Mayor of Pintuyan, pers. comm.). This was also the situation in Donsol, when the sharks began to arrive in 1997. Since then, the numbers of sharks visiting Donsol has increased, and this may also prove to be the case in Sonok. If this is so, the Municipality of Pintuyan is keen to develop an ecotourism initiative, modelled on Donsol, and is in the process of creating plans for a series of cabanas, plus a visitors' educational centre. This could prove to be of enormous benefit, both to the local community and to the whale sharks: if a resource has a tangible 'livelihood' value, then local communities are far more likely to be committed to the sustainable management of that resource.

It is hoped that this piece of research may be a baseline to the collection of long-term datasets on the population dynamics of whale sharks within the bay, to better understand the movements of these mysterious and magnificent animals, and thus to facilitate the most appropriate management of them as a livelihoods resource.

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