WHALE SHARK GAZING AND CITIZEN SCIENCE: AN INTERVIEW WITH DR. BRAD NORMAN

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Australian marine biologist Brad Norman founded ECOCEAN to protect and conserve whale sharks. Despite being the world's largest fish, little was known about them. ECOCEAN developed software to identify individual animals based on their unique patterns from photographs and its Whale Shark Photo-Identification Library has collected more than 47,000 photographs and 22,000 sighting records of whale sharks sent by citizen scientists from around the world. In 2006, Norman received the Rolex Award for Enterprise, and in 2008 National Geographic Society named him an Emerging Explorer.

In November 2012, Brad Norman was in Delhi to attend that year's Rolex Awards ceremony where Janaki Lenin interviewed him.

How big a role did citizen science play in how much you've learned about whale sharks?

It has and continues to play a really important role. As a scientist, I can only be in one place one day of the year. But now we are finding these whale sharks are distributed around the world from the input of the citizen scientists. Currently, using the photo identification library we've developed, people in 54 different countries participate by sending photos or information about the whale sharks that they may have seen in, say, Mozambique, Philippines, or Mexico.

How do you identify whale sharks?

The spots are unique to each individual. So ECOCEAN

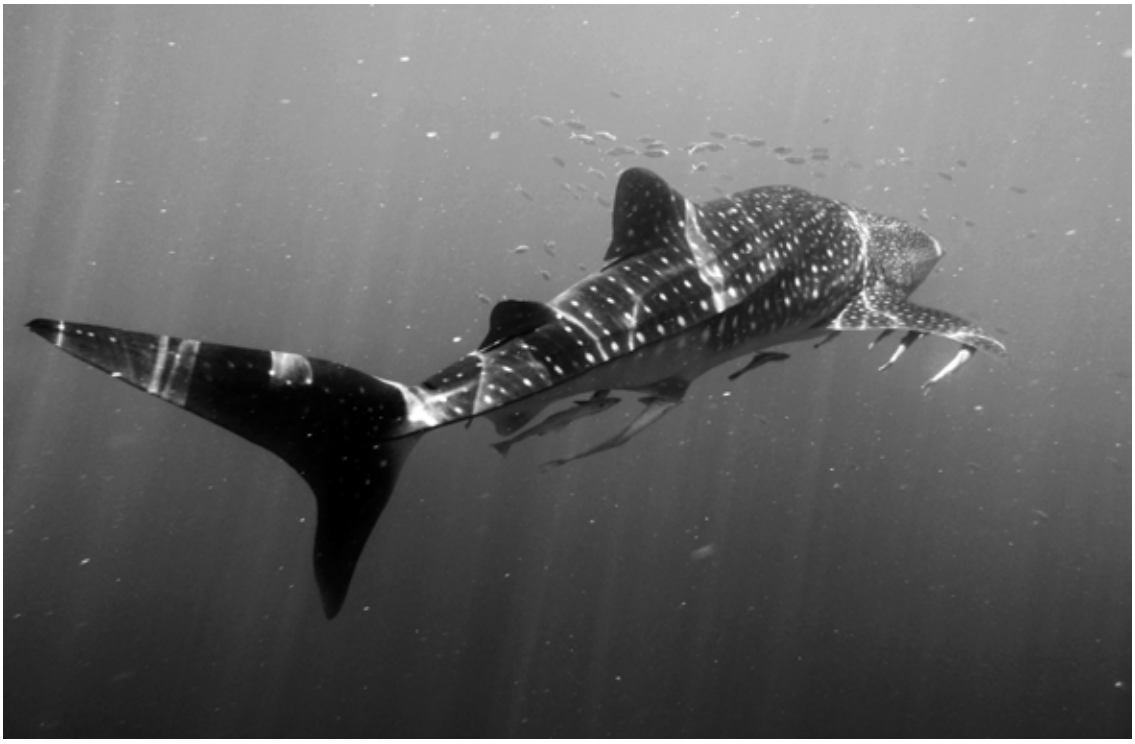

Figure 1. Whale shark.
Photo credit: Brad Norman

adapted an algorithm that NASA scientists use in the Hubble Space Telescope to map stars in the night sky to map the spot pattern on the skin of the whale sharks. We scan the photo that you took of a shark today against the thousands of other photos in the library to see whether the shark has been previously identified. We're finding that some sharks have been seen in the same location, especially at Ningaloo Reef in Western Australia where I work. I first swam with a whale shark in 1995; I saw that shark again in 2012. And we can prove that using this software. He's called A-001. It's an unexciting name, but he's also called Stumpy because a part of his tail is missing. He's got a Facebook page now called 'Stumpy Whale Shark'. Stumpy posts a different news story every day, and encourages people to learn more about the marine environment and the species within.

You started the citizen science program in 1995. How many people have participated in this?

There are a lot of members of the public that have contributed, but so have many researchers and conservationists from around the world. There are 3600+ individual people who have participated by sending whale shark identification sighting data and photographs. But tens of thousands of more people have received the ECOCEAN whale shark public awareness brochure or learnt about the sharks through various media we have produced.

Are these animals getting killed anywhere?

Very much so. That's part of the reason I started my long-term commitment to whale sharks and continue to push for their international conservation. There's still a lot of hunting in China mainly for their fins. In India, in the Philippines, in some other parts of the world, historically there was a lot of hunting going on. ECOCEAN has worked with various stakeholders to secure protection under federal legislation (Australia), and especially under international agreements, like CITES and Convention on Migratory Species (CMS). Many local groups continue to work hard to get whale sharks protected in their individual countries.

Whale sharks are listed as Threatened (Vulnerable to Extinction) under the IUCN Red List of Threatened Species. In fact, I was asked to prepare the report which succeeded in upgrading their official conservation status. Prior to this, the whale shark had been listed as Data Deficient.

There are places in the world where they are still being hunted. As an alternative, we've tried to promote ecotourism. Ecotourism, if done well, can actually be economically as well as ecologically positive, and a sustainable alternative to unsustainable hunting. We've proven that many of these whale sharks come back to the same location each year; they are a renewable resource rather than the once-only value of a dead shark for fins. There might be a small amount of money in hunting, but if you do tourism and if people keep coming back every year, a whale shark has a high value. In some countries such as the Philippines, it's not very expensive to go swimming with whale sharks. It can cost less than US$50 per person to go swimming with the whale sharks. In Mexico, it's a similar situation, although it appears over-exploited because the regulation and ability to monitor is limited. In fact, more than 100 vessels take people swimming with whale sharks. It's far from ideal, but fortunately, there are so many whale sharks there.

But in Australia, where whale shark ecotourism was first initiated, the industry is very well-regulated, with a very limited number of licenses, and a very high-quality tourism experience. There's a maximum of 15 licensed vessels, of which sometimes only 6 or 8 boats go out per day. There's a lot less pressure on animals. But the cost of swimming with whale sharks is almost AU$400 per person per day. And people are really prepared to spend the money for a unique but well-regulated tour. There is however a very real risk of killing the goose that laid the golden egg if whale shark ecotourism is not regulated properly. So we need to establish that if whale shark ecotourism is to go ahead, it should be done in a way that does not over-exploit the species and ensure it has very minimal impact: no touching or grabbing hold of the shark, and not too many people in the water. That's why I helped to establish some guidelines in Australia, which we are constantly testing. The evidence is showing that the management and current situation in Australia is having a positive effect on the numbers - which is very good.

The tourists get to swim with them, see the beauty of these sharks, but also learn more about them. We try to do that with the information brochures we distribute and the public awareness work we undertake, and try to get people to feel a sense of understanding and even involvement with the whale sharks. And a little bit of ownership too. That's why we use the photo identification program, so that members of the public can play a strong role in a citizen science project to help us scientists and conservationists to monitor whale sharks and also understand their numbers in the wild: whether the same ones are coming back, whether their numbers are still in decline as they are a threatened species, whether numbers are stabilizing or even increasing because of the protection that's been brought in around the world.

In recent times, it's worked very well. There

are a lot of people participating in the photo-identification citizen science project. So we're really lucky it's becoming a good way of getting people involved, to learn about the biggest fish in the sea.

The problem in Gujarat, India, was they were killing whale sharks to use the oil.

That was one of the situations that was understandable because it was to waterproof the wooden boats up there. But there is a very high market for fins in the East Asian market, and there was a lot of export for a couple of years before there was a big furor and the Indian government brought in protection. There's an amazing story of how the fishermen who used to hunt the whale sharks were encouraged to protect them. It's a good initiative launched by the Wildlife Trust of India in collaboration with the Forest Department and local authorities. If whale sharks are caught in a net, the fishermen quickly try and release them. If they had kept hunting the whale sharks at the numbers they were taking – it was suggested that one year up to a thousand whale sharks were killed – there'd be few left within years. The species is really long-lived, and although unknown for sure, it's believed that they can potentially live up to 100 years, and they probably don't mature until around 30 years old. Most of the sharks at Ningaloo Reef are males (usually about 85%). Most of these are immature. But they are not there to breed – just hanging out like teenagers and eating a lot!

How do you know when you see a whale shark that it's an immature male? Are they sexually dimorphic or do you have to examine them?

Our work is predominantly non-invasive. In order to determine if it's a male or a female, you have to swim underneath. It's very obvious if a whale shark is a male; their sexual organs (two claspers) are underneath the pelvic fin. In a female, the claspers are absent. In a mature male, these claspers are elongated, they are hanging down a little bit, they are calcified and you can tell they are ready to mate. An immature clasper is thin and smooth and tucked up against the belly. But we don't very often see the old boys. There are a small percentage of mature males at Ningaloo and that's provided me the opportunity over many years to determine at what length and age the males become mature. We don't know at what size or age the females are mature. In order to do that, you have to cut them open and look at their ovaries to check for maturity. And we don't want to do that. It's possible they mature at a smaller size but so little is known about them.

Are you analyzing dead specimens from locations where whale sharks are still being hunted?

Many countries have stopped hunting whale sharks - and that's good. In other countries where hunting continues (e.g. China), there is very limited data available. If whale sharks are ever found washed up on a beach, they are often in isolated locations, and by the time the authorities get to them, they are already decomposing. So it's rarely possible to do any analysis.

What's the longest distance a whale shark has traveled?

It's hard to say. Using the photo-identification library, we've identified sharks moving within a small area but between four different countries: between USA Gulf coast, the Yucatan in Mexico, Honduras, and Belize in Central America. This shows the outreach or the potential of this library. So four different groups of tourists or researchers in four different countries have taken a photo of a shark, sent it into the central database which is at whaleshark.org, and we've been able to prove several animals moving between those four countries, four different jurisdictions. We do believe these whale sharks are long distance migrators, and we really want to do some more work with satellite tags. But it's quite an expensive undertaking.

We've tagged several whale sharks but the tags have stayed on only two or three months at a time. And as a not-for-profit group, we have in the years past stayed away from spending $3000-4000 per tag. Recently, however, we tagged a couple of whale sharks using a different technique, a different attachment mechanism. Hopefully with minimal impact but maximum output. So we did a test case, with a mechanism timed for release after four weeks. One shark traveled about 600-700 kilometres. We plan to ramp up our efforts next year, funds willing. Hopefully, we can get these tags to stay on for over a year. We've yet to track a whale shark for a complete annual migration.

How many young do they have?

We still don't know where they breed or how often they breed. Up until a few years ago, we didn't know how they actually bred – whether they really were live bearers or not. But there was a whale shark caught in a fishery in Taiwan, back in 1995, and it still is the only pregnant female that's ever been found. They cut her open and she had 300 near-term embryos. I was involved in a genetic study a couple of years ago, published in 2010, showing those embryos were at three different stages of development. Some were between 35-40cm, some were between 45-50cm, and some were between 55-60cm. At this size, they are very vulnerable when they are born. But how

often they breed, where they breed, we still don't know. These are intriguing mysteries we hope to solve soon.

Were the embryos in three different breeding cycles?

We aren't sure. Our genetic study, led by Professor Jennifer Schmidt (University of Illinois), aimed to establish whether these embryos were fathered by different dads. It turned out that they were all from the same dad. What we believe is the female has the ability to store sperm and fertilize the eggs at different stages, and maybe push out 100 babies at a location this month at a certain time, another 100 next month and another 100 the month after to maximize the chances of survival. That's the first and last time we've had a pregnant female. We don't know what the gestation period is: Is it a year, 18 months? Do they breed once a year or once every three years? We don't know.

I've recently travelled to the Galapagos at the invite of a local NGO and the Charles Darwin Research Station to train local stakeholders in the use of newly developed tags for whale sharks. The sharks there are unusually big, up to 12-13 metres. They are all females and they are quite big in the uterine region. So we believe they are pregnant. We really hope to establish whether this is in fact a breeding location - which currently remains unknown.

These animals can get up to 18 metres in length, the biggest of all the fish in the oceans. At most locations where they are observed around the world, their average size is usually between four and eight metres. The males don't seem to become mature until at least eight metres in length. So most of the whale sharks we get to see are immature.

If you say that a lot of the animals you are seeing are immature but they keep coming back to the same location, are they coming back for seasonal feeding?

Correct.

Are they social? Do you see numbers together?

They don't usually interact. There's one place in the world where you do get a lot of sharks and that is the Yucatan in Mexico. They are not necessarily interacting with each other, but congregating at a feeding hotspot. However, at most sighting locations, the whale sharks are usually swimming alone, not so social unlike whales or dolphins.

They seem to be found in both, clear and turbid waters.

Whale sharks can dive down as deep as 2,000 metres that we know. But as filter feeders, they are always looking for food pulses or areas where there is a high concentration of food. And the thing is, a lot of the time when you do see them, they are feeding and where they are feeding, the water is full of plankton.

It's rare that you find them in really clear waters, but when you do, it's wonderful as there's great visibility. Ningaloo Reef is one of those locations. Most of the time we see them, the water is quite clear in that area between 10 and 20 metres visibility even when there is a food pulse. They are known to feed at Ningaloo Reef around dusk, when the plankton comes up to the surface and congregates, enabling the sharks to take advantage of that. There are certain places around the world, including Ningaloo and a few others where this happens. It's allowed us to learn so much more about this cryptic species.

The most important thing in a scientist's career is data. With a creature like this, it seems like you spend a long time gathering itsy-bitsy pieces of data. How do you survive as a scientist?

It's actually a little difficult sometimes. And I also run a non-profit called ECOCEAN which compounds the situation. But we are very lucky to have great volunteers. We do it because we love it, and because we are passionate. You don't do it to bank a million dollars. In fact, I'm not even on a proper salary and 'keeping the wolf from the door' is sometimes a challenge. I love these animals and I want to make a difference – and this provides me with a very positive feeling. We do get a few small grants along the way. The Rolex Award for Enterprise I received a few years ago was the biggest kick I've ever got in my life. It enabled us to bring this project to many countries around the world, which was fantastic.

Why would anyone worry about whale sharks? It's just a fish. It's not a predator in the true sense of the word.

One of the things about whale sharks is they have an important niche in the environment. We believe they may be an indicator of ecosystem health. They could be a bit like the canary in the coal mine. Because they are dependent on small organisms, they are dependent on productivity. If whale sharks that have been coming to a spot every year don't come one year, we can take a look and ask, "What's going on?" It might be pollution, habitat degradation, over-exploitation, or something we are yet to identify.

We obviously want to use a lot more high technology to be able to understand their movements, behaviour, habits, and

migration. These animals don't lend themselves to doing this kind of study because they live in isolated areas, they can dive to a couple of thousand metres, and it's expensive. For an NGO that has to work hard to find funding just to keep the lights on in the office, it can be a challenge. But we are cracking new ground all the time, so it's very positive.

Whale sharks were only first discovered in 1828, even though they have been around for millennia. Up till the late 1980s, there were only 320 confirmed sightings of whale sharks around the world. It's testimony to their rarity. But there's still more we don't know about them than we do. They are not out of the woods yet.

Is it possible to say if they are recovering in any part of the world?

Ningaloo is probably the best place in the world to study these animals because there is so much data being collected. Ningaloo Reef is bucking the trend in whale shark decline. The most recent stock assessment available using the photo-id program has shown not only has the decline stopped, but whale shark numbers have stabilized and even slightly increased – likely attributable to good management and minimal impact ecotourism. If we use a similar design, we may be able to show recovery in other parts of the globe also.

Postscript: In May 2013, fishermen released a newborn whale shark tangled in fishing net off the coast of Gujarat, the first evidence the species may be breeding in Indian waters. ■

A DEEP DIVING OLIVE RIDLEY IN THE BAY OF BENGAL

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Sea turtles are known to dive fairly deep, but the deepest dives are generally attributed to leatherback turtles who have been recorded to depths of 1000m and below (Houghton *et al.*, 2008). Not much is known about dive profiles of olive ridley turtles, but they have been recorded to dive to depths of about 150 to 200m on a regular basis (Whiting *et al.*, 2007, Macmahon *et al.*, 2007). A maximum depth of about 200m was recorded for olive ridley turtles in northern Australia (Macmahon *et al.*, 2007), but typically, dives were between 10 and 20m during inter-nesting periods and 30 to 60m post-nesting (Hamel *et al.*, 2008). In a study of sea turtles hooked in the Hawaiian long-line fishery, Polovina *et al.*, (2003) reported that olive ridleys frequently dived to 150m and below, with one dive recorded at 254m. Swimmer *et al.* (2006) also reported dive depths of over 250m for olive ridleys caught on longlines.

There is limited information about dive depths of olive ridleys turtles in the northern Indian Ocean. Two post-nesting females from Masirah Island, Oman, in the northwestern Indian Ocean, displayed dives of <40m depths (Rees *et al.*, 2012). These two animals remained in relatively shallow waters while being tracked, and thus their dive depths were constrained by their habitat. On January 20, 2013, a photograph was taken from a Remote Operating Vehicle in the Bay of Bengal, 40-50km offshore, south of Kakinada on the Andhr Pradesh coast (east coast of India) by Paul McCaffrey (Figure 1). The photograph was taken at a depth of 225m. The information reached us via Meghan Koperski of the Florida Fish and Wildlife Conservation Commission. This record adds to our knowledge of the poorly understood dive behaviour of the olive ridley turtle, and is the deepest dives recorded, to date, for the species in the Northern Indian Ocean.

Literature cited

Hamel, M.A., C.R. McMahon & C.J.A. Bradshaw. 2008. Flexible inter-nesting behavior of generalist olive ridley turtles in Australia. *Journal of Experimental Marine Biology and Ecology* 359: 47-54.

Houghton, J.D.R., T.K. Doyle, J. Davenport, R.P.