

Succeeding in sea turtle conservation: not just counting the decline

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ABSTRACT

Marine turtle conservation is complex and requires long-term interventions. Long-term projects require large investments in terms of finance, physical resources and human capital, and the decadal time-frames provide the opportunity for population loss even in the face of conservation action. Compounding this sea turtles evoke a range of personal responses from conservationists and scientists which often blur the objectivity of conservation initiatives, and projects and programmes across the globe frequently document the decline of turtle populations without implementing appropriate conservation action. Herein I reflect on the value and commonplace of documenting population downward trends, and use a non-exhaustive series of examples of effective measures with relatively rapid conservation outcomes as examples of what may be required for marine turtle conservation to succeed.

KEY WORDS: Sea turtles, conservation actions, population loss.

RESUMEN

Las acciones de conservación de tortugas marinas son complejas y requieren intervenciones a largo plazo. Los proyectos a largo plazo, a su vez, requieren grandes inversiones en términos económicos, de recursos materiales y capital humano. Los periodos decenales permiten constatar los declives en las poblaciones, incluso en actuaciones de conservación. Para agravar la situación, las tortugas marinas evocan una serie de respuestas personales de los conservacionistas y los científicos que a menudo pierden la objetividad de las iniciativas de conservación y los proyectos y programas en todo el mundo con frecuencia documentan la disminución de las poblaciones de tortugas, sin aplicar las medidas adecuadas para su conservación. En este artículo, se refleja el valor de documentar las tendencias de disminución de las poblaciones y el uso de las series no exhaustivas de ejemplos de medidas efectivas con resultados relativamente rápidos en cuanto a conservación, como ejemplos de lo que las tortugas marinas pudieran requerir para su éxito de conservación.

PALABRAS CLAVES: Tortugas marinas, actuaciones para la conservación, declive poblacional.

LABURPENA

Itsas dortoken kontserbaziorako ekintzak, konplexuak eta epe luzera begirakoak behar dute izan. Hau dela eta epe luzerako egitasmoek ere inbertsio ekonomikoa handia behar izaten dute, bai gizakiei baita ornigaiei dagokienez ere. Hamarkadek, populazioen gainbeherak ikus-teko aukera ematen dute baita kontserbaziorako egitasmoetako ekintzetan ere. Gainera egoera hau gehiago nabarmentzen da zientzilariei eta naturzaleek ikuspegi objektiboaz aldenitu eta kontserbaziorako neurriak hartu gabe gainbehera hauek azpimarratzen dituztenean. Artikulu honetan, itsas dortoken populazioen gainbeherarako joerak dokumentatzeak nolako garrantzia duen azpimarratzen du baina baita kontserbazioari dagokionez, beste neurri eraginkor batzuek izan dituzten emaitza azkarrak ere, itsas dortokek, beren kontserbaziorako beharko lituzketen neurrien adibide gisa.

GAKO-HITZAK: Itsas dortoka, kontserbaziorako ekimenak, populazioen gainbehera.

INTRODUCTION

Not so long ago I was in a country discussing the potential for sea turtle conservation with a group of people from various agencies when a well-known and respected local 'turtle' person exclaimed "But Nick, we have been working for twenty-seven years and yet our turtle populations continue to decline alarmingly! What should we do?" So I said "Whatever it is you're doing now, I'd stop. If it isn't working, there's not much point in continuing..." Looking back this seems a bit abrupt, but it got me thinking about what makes conservation approaches for turtles significant and of great impact while others simply continue to document population declines.

Numerous projects and programmes across the globe 'document the decline' of turtle populations without really taking appropriate conservation action. Malaysia documented the leatherback population decline in Terengganu

until it disappeared (CHAN & LIEW, 1996). Pakistan has seen their olive ridley population practically disappear and the green population substantially diminished (ASRAR, 1999; KABRAJI & FIRDOUS, 1984). I could go on... I would argue that counting turtles alone does not save them, and that bold and decisive measures, which often take considerable courage and determination to implement, can make a significant difference. I understand fully that many conservation measures take years to implement and show results. These programmes work in cases where the conservation resources are sufficient and available over long periods, and turtle populations are sufficiently robust to withstand continued threats until conservation measures have the intended effect. Meeting both requirements is often impossible: either resources dry up or turtles do. Sometimes what started out being the reason for initiating a conservation intervention stops being a priority, and other interventions are needed. Long-lasting programmes need continued reeva-

uation, both of their objectives and their outcomes, because often what was a problem one decade is no longer the next. I do not disregard or disrespect any of the protection measures and awareness programmes and beach monitoring programmes currently out there, although I will admit that the implementation of these seems at times arbitrary. Rather, I use a series of examples to highlight how conservation can be substantially accelerated through courageous, even audacious actions, decisions and/or programmes which have led to a well-documented difference. After reading of population declines, I thought it was time for some good news.

Here I look at some of what I call 'bold steps' that have been taken by individuals, agencies and organisations, which have had substantial immediate and long-term effects on turtle populations. I have no 'scientific' measure for what 'substantial' entails, but used the following criteria as my personal guideline: 1) turtle population(s) prior to the activity were declining, often at alarming rates and/or were under great threat; 2) the activity was clearly defined and recognizable for being a unique, stand-alone action rather than the result of cumulative and complementary activities; 3) subsequent to the action turtle population(s) enjoyed a reversal of trend(s) and were stable; and 4) today are recovered or recovering at a rapid rate. This paper is not a thorough examination of everything that has ever been done for sea turtles, and it is concerned more with processes than specific populations. I hope the examples I list herein provide impetus for individuals, agencies and organisations that face declining turtle population trends with ideas and (hopefully) catalyse a renewed approach to turtle conservation.

Marine turtles are highly valued marine species that arguably are essential to ocean health, and which have garnered the attention of conservationists, government officials, the public and the media. They support substantial aspects of many economies through tourism, they confer indirect benefits which ensure that local fisheries are sustained, and they aesthetically enhance coastal seascapes. They are also marine substrate engineers, and nutrient transporters (PREEN, 1996; BOUCHARD & BJORNDALE, 2000). Sea turtles and their products have been used by mankind for thousands of years as an important food source as well as a host of other uses. Sea turtles play valuable ecological roles in marine ecosystems as consumers and prey among other roles (LANYON *et al.*, 1989; BJORNDALE, 1996; BJORNDALE & JACKSON, 2003), and they are indirectly linked to seabed and fisheries stability (TELUCKSINGH *et al.*, 2010). They function as key individuals in a number of habitats, and can be indicator species of the relative health of habitats that have a tangible value to society. These habitats support commercial fish and invertebrates (found in seagrass beds, open oceans and coral reefs, among others) that are valued by mankind. For example, green turtles crop seagrasses and maintain the health of these important habitats. Seagrass beds can also be developmental grounds for shrimp and other larvae, which are the building blocks of economically-valuable shrimp and fin-fisheries industries. Today, turtles

also have non-consumptive uses such as tourism, education and research. They possess endearing qualities which evoke considerable passion amongst native peoples, conservationists and most people with whom they come in contact. In many parts of the world, sea turtles and humans share cultural links that can elicit deep-rooted reactions to conservation action (CAMPBELL, 2003).

Being long-lived (HEPPELL *et al.*, 2003) and of late maturation (MILLER, 1997) they face a multitude of threats over long periods of time. These threats include mortality in mechanized and artisanal fisheries, egg and turtle consumption, and habitat degradation and loss, amongst others (LUTCAVAGE *et al.*, 1997). Sea turtles are evolutionarily prepared to suffer high mortality rates in the early life stages, but their large juveniles and adults have substantially high reproductive and population maintenance value (CROUSE *et al.*, 1987, HEPPELL *et al.*, 2007). The loss of a small proportion of eggs or hatchlings may be compensated by their demography, but the loss of older animals can have substantial negative effects on population size (CROUSE *et al.*, 1987). Compounding this, population structure whereby turtles comprise distinct genetic stocks (MORITZ, 1994) or management units (WALLACE *et al.*, 2010) precludes substantial interaction of stocks and restricts gene flow. In practice this means that turtle populations that have been decimated are not about to rebound through massive immigration from outside populations. Hatchling sex is dependent on temperature during incubation, particularly during the middle of the incubation period (MILLER & LIMPUS, 1981; MILLER, 1985), a critical biological adaptation that often comes into play in conservation schemes. Additionally, hatchling sea finding and orientation are guided by visual stimuli (WITHERINGTON & BJORNDALE, 1990) whereby altered ambient lighting may disorient turtles and cause high levels of mortality. To complicate matters, hatchlings disperse into open ocean areas, adult turtles migrate great distances between foraging and nesting habitats, and juveniles and adults can occupy multiple foraging grounds at different stages of their life cycle (MUSICK & LIMPUS, 1997).

Given these biological characteristics and the myriad threats they face, conservation of sea turtles is a massive challenge. Management plans for marine turtle conservation and/or recovery run into dozens of pages and address hundreds of actions. Since the 'conservation awakening' for sea turtles by Archie Carr in the 1960s and thereafter (e.g. CARR, 1967; 1986a,b) and his pioneering work in Costa Rica, conservation programmes have struggled to meet the varied threats, and costs have grown exponentially. The challenges have been taken up across the globe and while some interventions have worked wonders, others have been left lacking.

DOCUMENTING THE DECLINE

Documenting the decline in populations is unfortunately a major part of modern science. Many turtle workers rally around beach monitoring programmes that faithfully count fewer and fewer turtles each year. The sea turtle

scientific literature is littered with scientific descriptions of population declines: Malaysia's decline of the leatherback is a good example (CHAN & LIEW, 1996), and the 90% decline of the green turtle in the early part of the 20th century in Sarawak (LEH, 1985) was equally alarming. BJORN DAL *et al.* (1993) report on the decline of hawksbill turtles at Tortuguero. WITHERINGTON *et al.* (2009) document the decline of loggerhead nests in Florida. Laura Sarti and colleagues recorded the early decline of the leatherback in Mexico (SARTI *et al.*, 1996), and SPOTILA *et al.*, (2000) summarise the precipitous decline of the leatherback across the Pacific. Luckily for turtles, these people know what to do with the information they gather to influence conservation. The documentation phenomenon is not only restricted to sea turtles – it is prevalent in a wide diversity of fields: KRYSKO & SMITH (2005) highlight how Kingsnakes *Lampropeltis getula* (Linnaeus, 1766) declined until disappearing completely from Florida. The Steller's sea cow *Hydrodamalis gigas* (Zimmerman, 1780) was hunted to extinction (ANDERSON, 1995) while hunters and scientists documented the dwindling numbers. The African manatee *Trichechus senegalensis* Link, 1795, was counted for years until it reached the brink of extinction (NAVANZA & BURNHAM, 1998), and WHITE (1995) describes how species after species of frogs disappeared from Australia amidst countless research programmes. GARBER & BURGER (1995) highlight a 20-year decline in wood turtles *Clemmys insculpta* (Fitzinger, 1835) as a result of human recreation, and BIESMEIJER *et al.* (2006) report on declines in pollinators and link this to declines in insect-pollinated plants, while LUNDMARK (2008) describes lessons learnt from declines in species diversity in forest studies.

I realise that this process drives subsequent conservation action in an area, but in many ways, documenting the decline is becoming synonymous with conducting wildlife research. Ben Rawson, a primatologist with Conservation International, commented in an interview in 2007 with Krista Mahr, a reporter from Time/CNN, that primate surveys in Southeast Asia had turned into a process of "documenting the decline of these species for science". But documenting a population decline should only be considered a catalyst to spring into action, not a conservation activity in itself. Assessment of population trends and threats are critical to understanding conservation needs and for forming conservation strategy. The problem lies when these are conducted exclusively, in the absence of any conservation action. In many cases, while beach patrol units are out there counting turtles, their numbers often just continue to decline, in need of some effective strategy to reverse the trend. More often than not, immediate impacts are needed to stem the declines before the populations collapse.

OFF-TARGET CONSERVATION APPROACHES

All too often I come across cases where the conservation activities being implemented are not addressing the key threats. I do not have a global overview of who does what, but my travels through the Indo-Pacific and many

other parts of the globe have left me in no doubt that while many projects and programmes work well, others are off-target. For instance, in one place where fisheries bycatch was an obvious threat (hundreds of shrimp trawlers sitting just offshore) erosion of the nesting beaches was being addressed. In another, a concern over egg poaching drove a massive egg-relocation effort when again fishery pressure was the key issue. In neither of the projects had anyone considered assessing fishery bycatch. Sometimes these off-target efforts, though well-intentioned, are linked to a basic lack of grounding in turtle biology, but often they are the 'low hanging fruit' option – the easier problem to tackle. Very often projects implement piecemeal efforts with no longer-term strategy, no link to data needs, or no clear cause-effect linkages. Some projects tag some turtles in a season, with no follow-up plans for monitoring recaptures. A simple look at recapture rates for long-term saturation tagging projects highlights just how many tags one would have to put out to hope for a realistic return rate. Other projects deploy satellite transmitters but never follow up with the country where their turtles end up. While still others relocate thousands or clutches of eggs to hatcheries when there are no major poaching or predator threats – or where these could be addressed through more efficient beach patrols or nest protection schemes. All too often the turtle populations at these sites continue to decline (there are a few exceptions!) suggesting to me that the piecemeal approach, of efforts here and there that are not necessarily aligned, and which often take decades to implement, is not the best recipe for turtle conservation, and that effective, and sometimes aggressive and audacious interventions are needed. Indeed, a look at some examples of these supports this claim.

THE BOLD AND THEIR CONSERVATION OUTCOMES

Given the criteria outlined above, I turned up a suite of what I would describe as bold initiatives, which can be categorised into three key groupings: 1) Major turtle-related policy shifts with long-lasting impacts; 2) Direct interventions by Governments or individuals; and 3) Simply trying something new, even when there were wide misperceptions about the chances of success.

In the 1950s, one of the forefathers of the modern-day turtle conservation movement, Dr. Archie Carr, came across a black sandy beach some 50 miles north of Limon, on the Caribbean coast of Costa Rica, where hundreds upon hundreds of green turtles laid their eggs. But local poachers had long been aware of the location of the site, turtles and eggs were a valuable commodity, and the population was in steep decline. Turtles were harvested, consumed and traded to international markets. Dr. Carr and the Caribbean Conservation Corporation (the organization Dr. Carr helped form to carry out the annual nest monitoring and protection program at Tortuguero) suggested to the Costa Rican government that all of Tortuguero beach be set aside as a National Park and that turtle hunting be banned in the country. And so, it was that with the help of a great many people and institutions, as well as the people of Tortuguero, these recommendations came to pass in 1975 (Law 5680) with

the creation of the Tortuguero National Park and in 1999 with the complete ban on turtle hunting in Costa Rica. Today, the Tortuguero green turtle colony (by far the largest remaining in the Western Hemisphere) has made a remarkable recovery. While foraging ground mortality still occurs (CAMPBELL & LAGUEUX, 2005) this does not seem to have impacted the steady growth in nesting numbers (BJORN DAL *et al.*, 1999), highlighting just how important it is to protect turtle nesting grounds. Tortuguero is one of the two largest remaining green turtle rookeries in the world (TROENG & RANKIN, 2005), thanks to key interventions by an inspirational leader, and his many supporters and collaborators that precipitated decisive action on the part of the government and people of Costa Rica.

On a remote beach in Tamaulipas, on Mexico's Gulf coast, once nested thousands upon thousands of Kemp's ridley *Lepidochelys kempii* (Garman, 1880) sea turtles. An amateur video in 1947 documented an *arribada* style nesting event, where tens of thousands of turtles crawled and bumped over each other to lay eggs at the same time. But by the 1960s Kemp's ridley nesting had declined by some 80% and showed no signs of stopping. The turning point came about when Mexico's Instituto Nacional de Investigaciones Biológico-Pesqueras started patrolling the beaches in 1966, and in 1977 when the key nesting beach was protected with armed guards to deter egg poachers (MARQUEZ *et al.*, 1999), with a concurrent prohibition of fishing in nearshore waters off the reserve. By declaring the area a national reserve and fiercely protecting the turtle nests and simultaneously reducing bycatch offshore, these activities prevented the extinction of the Kemp's ridley. Today the Kemp's ridley is staging an amazing comeback (MARQUEZ *et al.*, 2001; CROWDER & HEPPELL, 2011), and would likely have been lost to humanity if it were not for the timely and bold intervention of the Mexican people.

Pushing the boundaries even further, and in the face of widespread egg consumption and traditional uses, the 1990 complete ban on harvest of sea turtles and their eggs in Mexico was another bold and effective move by the Mexican government, in my opinion. In May 1990 the President of Mexico Carlos Salinas de Gortari announced a total and permanent ban on the capture and trade of all sea turtle species and related products in Mexico's waters (ARIDJIS, 1990). Working tirelessly behind the scenes to make this happen were countless inspiring individuals, among them Georgita Ruiz, Rene Márquez, Raquel Briseño, Daniel Rios, Alberto Abreu-Grobois, and many others. As a result, in La Escobilla, there has been a dramatic increase in olive ridley *Lepidochelys olivacea* (Eschscholtz, 1829) nests from 50,000 in 1988 to over 700,000 in 1994 to more than a million nests in 2000 (MARQUEZ *et al.*, 2002). If the government had waited until everyone was in agreement about such a ban, chances are we would still be waiting. With this decision in the background, Mexican conservation agencies added a legal foundation upon which to address bycatch, poaching and illegal consumption.

In the early 1970s populations of turtles in Malaysia were all suffering dramatic declines. In peninsular Malaysia turtles had crashed, with reported declines of up to 99%

(IBRAHIM, 1993). The Terengganu leatherback *Dermochelys coriacea* (Vandelli, 1761) was well on its way to local extirpation, the Sarawak green turtle *Chelonia mydas* (Linnaeus, 1758) egg harvest was drying up, the olive ridley, was fast disappearing from Malaysian shores. The turtles in Sabah were facing a similar fate. The government over there had tried closed seasons, purchasing eggs from the traders, and had enacted legislation to protect turtles, but nothing seemed to work. That was when the Sabah State government stepped in and purchased the islands outright from the local inhabitants and turned them into a protected area (BASINTAL & LAKIM, 1993). In its day this was a bold and very expensive move, but today the Turtle Islands Park boasts the only robust and growing population of turtles in all of Southeast Asia (SHANKER & PILCHER, 2003).

Cuba was once a willing partner in the trade in hawksbill *Eretmochelys imbricata* (Linnaeus, 1766) shell. With access to large tracts of the hawksbill's Caribbean range, Cuba amassed huge stockpiles of shell over the years (CARRILLO *et al.*, 1999). But when it first reduced, and then eliminated, all legal take of hawksbills, the impressive move contributed to strong population recoveries region wide. The Cuban turtle fishery was closed in 1994 at all but two traditional harvest sites (Isla de la Juventud and Nuevitas). A 2008 moratorium prohibited the catch in these last two sites, creating a nation-wide ban for an indefinite time. Concurrently, the main nesting and feeding areas for turtles gradually came under special protection, most of them as National Parks (e.g. Peninsula de Guanahacabibes, Jardines de la Reina, San Felipe Key and Cayo Largo). Genetics research by BOWEN *et al.* (2007), originally used to support arguments for the cessation of Cuban trade (MORTIMER *et al.*, 2007) link the Cuban hunting grounds with key nesting grounds throughout the Caribbean, and today these linkages are demonstrating how the Cuban end to legal harvests is helping regional nesting aggregations achieve astonishing comebacks. For example, at Mona Island in Puerto Rico, nesting numbers are up 700% in the last 20 years, and continue to rise there 10-20% annually (DIEZ & VAN DAM, 2006; DNER, 2010). Similarly over in the Yucatan peninsula, population recovery has been evident since then (GARDUÑO-ANDRADE *et al.*, 1999), and in Barbados (BEGGS *et al.*, 2007), and while the jury is still out on a definitive cause-effect relationship, Cuba's bold and very effective move is suggestive of great regional impacts, originally negative, and subsequently positive.

Similarly bold, Indonesia designated green turtles as a protected species in 1999 despite controversial use of green turtles in religious ceremonies and through cultural traditions in Bali, and historical take of adult turtles from both nesting and foraging areas across many parts of the archipelago. The sheer size and diversity of Indonesia poses a variety of challenges for turtle conservation: there are 33 provinces comprising over 17,000 islands covering spread over some 6 million km². National legislation is enforced at a provincial level, with varying degrees of autonomy and success. Massive exploitation of green turtle eggs took place since the 1900's, when turtle eggs were used as royal gifts (such as in the Derawan Islands), but

which later developed into large-scale, unregulated collection of eggs for commercial purposes. Based on records from the local office of Marine Affairs and Fisheries, some two to two and a half million green turtle eggs were collected at just about every island each year from 1985 to 2000 (ADNYANA, 2003). Prior to 2000, an estimated >30,000 turtles were traded legally in Bali alone using a quota system. But then all turtle species were protected by the Peraturan Pemerintah Republik Indonesia No. 7 & 8 passed in 1999 through which all forms of turtle trade are prohibited, and while there are still many hurdles to overcome, this decisive move set the legal scene for greater control and management than was ever possible previously in Indonesia.

Along the same lines, Hawaii's listing of its endemic green turtles in 1975 under State Division of Fish and Game Regulation 36 (BALAZS, 1976; BENNETT & KEUPER-BENNETT, 2008), a few years before green turtles were listed under the US Endangered Species Act (ESA), led to near-complete cessation of harvest, a bold move which was likely the main cause for the recovery of the Hawaiian green turtle stock. The Hawaiian green turtle population had been harvested in the 19th century during expeditions to the Northwestern Hawaiian Islands (AMERSON, 1971; BALAZS, 1980) and the pressure persisted at foraging grounds of the main Hawaiian islands until the mid-1900s. Commercial harvest began in the mid-1940s in part due to restaurant demand and tourism which increased significantly in the 1960s and early 1970s (BALAZS, 1980; WITZELL, 1994; CHALOUKKA & BALAZS, 2007). Compounding this there was additional unregulated traditional harvest by native Hawaiian and other Pacific Islander communities in Hawaii. By the mid 1970s, the Hawaiian green turtle population was over-exploited and reduced to approximately 20% of pre-exploitation numbers, but since the enactment of state and federal ESA protections in the 1970s the number of nesting green turtles has increased dramatically over the past thirty years with an estimated annual growth rate of 5.7% per year (BALAZS & CHALOUKKA, 2004; CHALOUKKA *et al.*, 2008). Despite the cessation of harvesting and protection under State and Federal laws, occasional illegal harvesting of green turtles still occurs in Hawaii, but this does not appear to be hindering population recovery.

A few bold moves that had indirect impacts on sea turtles are also noteworthy. The promulgation of the US Endangered Species Act (Public Law 93-205) in 1973 with its specific enforcement penalties was a critical step in providing legal protection to species, turtles included, and established the foundation upon which conservationists and government agencies grounded their turtle-related protection activities. Dr. Russell Train was appointed by President Nixon to draft the ESA, and he and his team incorporated new principles and ideas into the landmark legislation which transformed environmental conservation in the United States. Without the ESA, there would likely be no turtle excluder devices (TEDs), no lawsuits to close fisheries in which bycatch is an issue (such as the Hawaii longline closure), no nest relocation in the face of natural and anthropogenic threats (such as during the recent Gulf of Mexico

oil spill), nor any restrictions on harvests and domestic trade (as noted earlier for Hawaii). The ESA was very bold move to comprehensively address wildlife conservation, and unfortunately and surprisingly, not all turtle range countries have anywhere near such stringent legislation.

Turtles require several key habitats to survive. They need beaches to lay eggs, but they also need vast expanses of marine habitats in which to feed and grow. So it was bold indeed when farther across the Pacific, the establishment of the Great Barrier Reef Marine Park by the Commonwealth of Australia (Great Barrier Reef Marine Park Act 1975), created the then largest marine park in the world spanning 344,400 km² in a tremendous step that resulted in the protection of vast tracts of turtle nesting and foraging habitat. This was further supported by the Park's World Heritage listing in 1981 (sea turtles were a specific value identified in the WH listing process). Today the park, located in the Coral Sea off the coast of Queensland in northeast Australia, is managed by the Great Barrier Reef Marine Park Authority to ensure that it is used in a sustainable manner through a combination of zoning, management plans, including co-management plans with indigenous peoples, permits, education and incentives, all of which have helped turtle populations flourish.

A commonly raised cause for concern with sea turtles is the ubiquity of plastic in our oceans. With alarming frequency sea turtles mistakenly ingest plastic bags because they resemble sea jellies (MROSOVSKY, 1981) and hard plastics when fouled and disguised by goose barnacles and macro algae (WITHERINGTON, 1994). More than a million birds, tens of thousands of whales, seals and turtles and countless fish worldwide are killed by ingesting plastic rubbish every year (LAIST, 1997). So it is bold indeed when countries take drastic moves and ban the use of plastics entirely. In March 2002, Bangladesh declared an outright ban on all polyethylene bags after they were found to have been largely responsible for the floods that submerged two-thirds of the country by choking the drainage systems in 1988 and 1989. On the 4th of March 2005, the President of Eritrea announced a full ban on plastics of any kind in the country, citing blocked gutters, choked farm animals and marine wildlife, soil pollution and aesthetic reasons. In 2009 Papua New Guinea joined the fray, and the import, manufacturing, sale and use of non-biodegradable plastic shopping bags was banned. On the 5th of January 2011, Italy followed suit, even though it received a wave of backlash by critics who were worried it could not be done. To date, at least Australia, Belgium, Bhutan, Botswana, China, Eritrea, Ethiopia, Germany, India, Ireland, Italy, Japan, Kenya, Malta, Maui (US), Papua New Guinea, Philippines, Samoa, San Francisco (US), Singapore, Somalia, South Africa, South Korea, Sweden, Turkey, Uganda, and Zanzibar (Tanzania) all have some form of plastic bag ban in place. These bans are bold indeed, and surely a good move for sea turtles.

Over the years, it has been interesting to see people try something new, bold and even audacious even, where concerns over the novelty and viability were ignored and from which exciting new approaches to conservation evolved. The Seychelles islands host one of the five largest re-

maining populations of hawksbills in the world, although in the latter half of the 20th century their numbers declined alarmingly (MORTIMER, 1984, 1998). Confronted with this, the Seychellois government gradually implemented all the right measures: stopping people from killing turtles on the beaches, revegetation of nesting beaches, implementing an artisan compensation and re-training scheme for those involved in the shell trade, honouring its international commitments (such as to CITES), providing legal protection and conducting thorough monitoring and research programmes to inform decision-making. But it was probably the 1998 public burning of its stockpile of raw hawksbill shell during the 1998 Miss World Pageant that got the world's attention. From the late 1960s to the early 1990s, most of the nesting females had been killed at the nesting beaches, often before laying any eggs (MORTIMER, 1984). The turtles were slaughtered for their shell, destined for the curio markets in Japan. In 1993 the government banned the sale of hawksbill shell products, and some 2.5 tons of raw hawksbill shell were purchased from local artisans (COLLIE, 1995). Then, in November 1998, in conjunction with the Miss World Pageant, the government publicly burned the stockpile to demonstrate it felt the turtles had far greater value as live animals than as dead shells (MORTIMER, 1999). The government was of the opinion that live hawksbills would bring more revenue to Seychelles (as a tourist attraction), and had made a public demonstration that poaching of hawksbills would not be tolerated. Turtle conservationists were of two minds as to the value of the event and the loss of the shell stockpile, but one thing is for sure: it was different, it was bold, and it got everyone's attention.

By the late 1970s the Kemp's ridley population at Rancho Nuevo was down to an estimated <500 nesting turtles and while beach protection was underway on key beaches in Mexico, the population continued to decline. So a US and Mexican team comprising the Instituto Nacional de la Pesca of Mexico, the U.S. Fish and Wildlife Service, the National Park Service, the National Marine Fisheries Service and the Texas Parks and Wildlife Department designed an audacious and controversial headstart project, which incubated eggs and reared the hatchlings until they were a year or so old. The idea back then was to allow the turtles to grow beyond a size at which natural mortality decreased substantially. Some 20,000 eggs were brought up by plane over ten years from Mexico to Padre Island, Texas, and then the hatchlings were imprinted on the beach and in nearshore waters at South Padre before being reared in tanks (KLIMA & MCVVEY, 1982; MANZELLA *et al.*, 1988). The small juveniles were then tagged as they were released, in the hopes of documenting the establishment of a new nesting colony. While some argued the project had no way of determining success and others that it was a mitigation measure for existing threats, one thing is for sure: the headstart project was bold and ingenious for its time, and spurred greater research and conservation efforts for the Kemp's ridley along the way (BYLES, 1993). It took some creative thinking to put it together, and trialed a relatively small number of eggs (minimal risk) in the hopes of devising a strategy to rapidly repopulate depleted turtle populations (maximum

returns). The jury is still out on how successful the project was at a population level, but today there are more and more headstarted Kemp's ridley turtles nesting on Padre Island (SHAVER, 1996; SHAVER & RUBIO, 2007).

Similarly alarming further south in the Americas, Brazil's turtle populations in the 1970s were all undergoing precipitous declines. But the creation of Projeto TAMAR-IBAMA, which involved local communities as key protagonists in conservation activities and expanded the protection of key nesting beaches to some 1100 km of the coastline, was a bold stroke of genius. Prior to the 1970s conservation of coastal and marine natural resources in Brazil was nonexistent, and nearly all loggerhead *Caretta caretta* (Linnaeus, 1758) eggs and nesting females along the Brazilian coast were taken (MARCOVALDI *et al.*, 2005). Turtles were threatened by marine debris (BUGONI *et al.*, 2001) and coastal gillnet and pelagic longline fisheries (SOTO *et al.*, 2003; KOTAS *et al.*, 2004). Turtles in Brazil faced an uphill battle. TAMAR needed to design an approach that generated buy-in from low-income coastal communities with few alternatives, and that relied on egg collection for consumption and sale. They did this by creating a collaborative and all-inclusive system that included direct employment; environmental and public outreach campaigns including educational and health-related projects; research; internships; work at visitor centres, shops and museums; production of handicrafts; development of ecotourism guides, and participation in cottage industries, sports activities, kindergartens, community vegetable gardens, provision of technical assistance to various fisheries, as well as a suite of other local activities. TAMAR was not a just turtle conservation project, it was a complete livelihoods package using sea turtles as flagship species. Each year some 14,000 turtle nests are protected along Brazil's mainland and islands, and hundreds of turtles are released alive from fishing gear, a massive endeavor lead successfully by local fishers and other stakeholders (MARCOVALDI *et al.*, 2005). Today in Brazil, all four species are recovering, and likely would have been locally extirpated without the intervention of TAMAR and its visionary leaders.

The Grupo Tortuguero de las Californias network took a truly bold approach to address turtle poaching and bycatch at Mexico's Baja California peninsula, an important foraging and nesting area for five turtle species. When by the mid 1990s Mexico's ban on sea turtle harvest had had little effect on the isolated Baja California peninsula, the Grupo Tortuguero transformed turtle poachers into turtle protectors by celebrating their considerable turtle knowledge, and together they assessed turtle population trends through a standardised regional monitoring network. Lifelong turtle hunters alienated by the ban found positive outlets for their considerable hunting prowess, and dozens became proud leaders of turtle conservation in their communities. By assembling turtle hunters and other stakeholders through festivals and annual regional meetings plus engaging fishermen in participatory research, the network has greatly reduced sea turtle traffic, consumption and bycatch. To address loggerhead bycatch, the network took

the ostensibly outrageous approach of convening a series of tri-national fishermen's exchanges, uniting delegations of Japanese, Hawaiian, and Mexican fishermen to share bycatch solutions. The exchanges inspired a large contingent of Mexican fishermen to switch to turtle friendly gear in 2007, sparing 100s to 1000s of loggerheads each year since (PECKHAM *et al.*, 2011). The exchanges also led to bycatch mitigation solutions for the Japanese poundnet fishery through demonstration trials involving fishermen, fisheries managers, gear manufacturers, academics and public media. Largely through the Grupo Tortuguero's work and partnerships, loggerheads at two critical habitats in the Pacific are today the focus of effective conservation strategies. Other networks in Baja California have since ensued, addressing the same issues throughout the ranges of their turtles – following green turtles to mainland Mexico and loggerheads to their Japanese nesting sites. Bold was initially bothering at all when experts said the turtle populations were already hopelessly depleted, then involving supposedly worthless poachers, followed by facing down corrupt officials with quiet tenacity and facts.

SOME FINAL THOUGHTS

Clearly, there are many good stories to tell. My research on the subject has left me in no doubt that these steps were amongst those responsible for the turnaround of not only the individual turtle (and human) populations at stake, but also for the global reversal of sea turtles' fortunes. I am convinced that the bold moves I present above (used as a group of representative examples rather than a comprehensive register) set the scene and can provide the encouragement and impetus for the development of countless other great initiatives that have made huge differences across the globe. From the early days, when Archie Carr led a delegation to Mexico to discuss bans on the slaughter of turtles with industry leaders – recounted in his famous "Encounter at Escobilla" piece in the MTN (CARR, 1979), and the informal discussions amongst prominent turtle conservationists in the 1980s with the Japan Bekko Association to find solutions to the hawksbill shell trade (MTSG, 1993), there have been, and continue to be, some very charismatic people and some very important personal linkages that have made a difference.

Policy changes, as a result of research into mortality factors, have also come along strongly: the requirement to use circle hooks in the U.S. Atlantic pelagic longline fishery and the Hawaii shallow-set fishery for swordfish, the net ban on the east coast off Florida and Georgia, and the Queensland government's complete protection of Mon Repos, the major rookery for loggerheads in the South Pacific, are great examples. Novel thinking and a willingness to try something new, even in the face of public opposition, continue to emerge: an electric fence to keep pigs from leatherback nests in West Papua (SUGANUMA, 2005), or the culling of thousands of feral pigs from north Queensland to reduce predation on flatback *Natator depressa* (Garman, 1880) and ridley turtles (QUEENSLAND GOVERNMENT, 2010), come to mind.

Legal instruments, multi-national institutions and greater access to funding have all contributed to turtle wellbeing and recovery efforts. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) had a massive impact on international trade starting in the 1980s, and was largely responsible for the halt in the decline of hawksbills, then heavily traded for their shell (MEYLAND & DONNELLY, 1999). The creation of the Marine Turtle Conservation Fund through the Marine Turtle Conservation Act (Public Law 108-266) in the US has created a stable and growing funding platform for countless small-scale conservation projects across the globe, by providing financial resources for projects that conserve the nesting habitats, marine turtles in those habitats, and other threats to the survival of marine turtles. A few of these projects are described within this report.

The Wider Caribbean Sea Turtle Network (WIDECAST) brought together 43 countries to actively collaborate on sea turtle conservation, much to a suite of detractors in its early days. Over the years it has been successful in engaging all countries in dialogue, getting laws changed, habitats protected, trade stopped, turtles saved, people involved, training imparted, funds raised, and inspiration imparted at a large regional scale (around the entire Caribbean sea) fraught with political complexity. WIDECAST has linked scientists, conservationists, resource managers, resource users, policy-makers, industry groups, educators and other stakeholders together in a collective effort to develop a unified management framework, and brought the best available science to bear on decision-making. The network has been instrumental in creating conservation models, encouraging community involvement, and raising public awareness, and in sharing this approach with other regions of the world, to broader benefit (WIDECAST, 2010).

Protection of turtle habitat is crucial. Without this protection, we would have said goodbye to many turtle populations a long time ago. Today, critical habitats have been protected that have set the scene for tremendous population recoveries. For instance, nesting beaches have been protected in La Réunion (BOURJEA *et al.*, 2007), in South Africa (HUGHES, 1993), in Turkey (WHITMORE *et al.*, 1990), in the Seychelles and in Mexico and in Malaysia and throughout the Caribbean, as noted above, and just about everywhere turtles exist.

A common link amongst many emerging successful conservation programmes of today is partnership with local communities. Papua New Guinea has a very successful community-based conservation programme, as do Sierra Leone, Australia, Costa Rica, Mexico, and loads of others. In Papua New Guinea the use of finance incentive schemes to promote community buy-in has been a particularly effective strategy (PILCHER, 2007). These grassroots projects are becoming the mainstream conservation initiatives of the 21st century.

So it should come as no surprise that I feel turtles have fared well given all this attention. I know that most conservation initiatives make gradual impacts over long periods of time. But turtles may not have the luxury of that timeframe,

and for this reason I think that stepping out of the ordinary and trying something new, which can accelerate the recovery of turtle stocks, should still be recognised for what it can do.

As to how one tops the examples listed above, I'm sure there are still loads of opportunities. One might contemplate some level of sustainable take as a way of balancing human and turtle needs and promote greater buy-amongst communities, or use novel financial measures to influence conservation behaviour, such as micro-credit schemes, payments for ecosystem services, incentive mechanisms that drive behavioural change. I imagine even green or blue carbon credits all have their place in turtle conservation of the future. And I think that we should not be so quick to dismiss something new and untested, so long as the foundations upon which it is designed have been carefully thought out, researched and grounded in the best available science, and it does not threaten recovering wild populations. I look forward to this turtle conservation future.

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