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ORAL PRESENTATIONS

POSTER PRESENTATIONS

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HISTORICAL REVIEW OF RELATIONSHIPS BETWEEN SEA TURTLES AND HUMAN IN JAPAN : RECOGNITION OF THE IMPORTANCE OF LOCAL RESEARCH AND MANAGEMENT COORDINATOR (LRMC)

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After birth in Africa 300 thousand years ago, *Homo sapiens* expanded the distribution to the world, one of them branched into three routes and came to Japan. The oldest *H. sapiens* in Japan is from Ryukyu Okinawa and it is about 20 thousand years ago. At that time, of course, the sea turtle was living. From that time on, *H. sapiens* have used sea turtles as food. If it did not have a sea turtle, *H. sapiens* might not have come to Ryukyus. *H. sapiens* eating sea turtles can be known from the fact that the excavated ruins contain sea turtle bones. Bones of the sea turtle are excavated from Ryukyu and the mainland Japan as well as from the ruins of Hokkaido. Especially for those on isolated islands where mammals as food do not live, the sea turtle must have been an important food. This relationship between people and sea turtles in the early stages is hardly recorded in the literature, but you can catch a glimpse of folk customs and rituals left in various places.

There is a settlement called Takezaki in the south of Tanegashima island, Kagoshima. There was a ceremony to capture loggerhead turtles coming to mate only once a year, and sharing meat with all the inhabitants. The important factor here is that they caught turtle only once a year. This rule restricted excessive capture and led to the protection of loggerhead turtles. In Fukuoka there is a dish called Gameni which is made only once when the New Year approaching every year.　When winter comes, the green turtle from the Japan Sea moves to avoid cold. It is said that people caught it and cooked. Of course they have been using chicken instead of turtles now. On the Ie Island Ryukyu, people captured and ate the green turtle. Adult residents gathered children when they cook turtles. Then they held the kitchen knife in front of the turtle's eyes and showed tears flowing from the eyes. The children ate turtles, but their tears could not be forgotten. Like this, until around 1950, humans used turtles, but naturally acquired a way to protect their resources. This was symbiosis in a sense.

It was modern technology and money economy that destroyed this symbiosis between humans and turtles. The freezer was most affected. By keeping the turtle meat in the freezer, the meat lasted long. And even if humans do not eat it, they can change it to money. People caught more turtles than consumption, and turtles began to decrease. In addition, the modernization of the fishing gear began to kill turtles not needed by bycatch. Modernization influenced the eggs of the sea turtle. In Fukiagehama beach, Kyushu, inhabitants could only collect half of sea turtle eggs under unwritten local law. However, as the transport network developed, eggs were brought to Tokyo, it became possible to sell higher. Then the mafia and gang came from downtown to collect all the eggs, and the collection of eggs was completely banned by law. And the ideal symbiotic relationship between humans and sea turtle is over.

As the era of overexploitation continued, volunteer inhabitants who tried to protect turtles, eggs and environments of each nesting beach appeared in the 1950s and 1980s. For example, Mr. Yasuo Kondo (Hiwasa), Mr. Ichiro Yamauchi (Kamoda), Mr. Yoshiro Kawarazaki (Omaezaki), Mr. Hiroshi Takeshita, Mr. Yoshito Nakajima (Miyazaki), Mr. Kazuyoshi Omuta　(Yakushima)、Mr.。 Osamu Uemura, Mr. Kiyoshi Goto (Minabe), and Mr. Masamichi Samejima (Satuma) etc. They responded to all the problems related to the sea turtle at each nesting sites. Specifically, count of nesting, tagging, protection of eggs and hatching, education for local children, guidance of visitors, law-making with administration, and the like adjustment of the mass media. Although their work is volunteering, they have contributed significantly to the protection of sea turtles and the development of the local area. Their existence was internationally unique to Japan and was very important. I would like to call them with this special role as a Local Research and Management Coordinator (LRMC).

Scientists also became interested in sea turtles when it is known that sea turtles lay eggs throughout Japan. Apart from Dr. Saburo Nishimura's work that revealed that a sea turtle spawning in Japan is *Caretta caretta*, the team of Kyoto University, led by master course students Mr. Katsufumi Sato and Mr. Yoshimasa Matsuzawa, stayed on the Minabe Senri beach and started research. While playing a role as LRMC with Mr. Kiyoshi Goto, they made remarkable achievements in research on ecological research of sea turtles. The cooperation between LRMC and young scientists was a very desirable relationship in the management of sea turtle's nesting site.

However, this team is an exception, and most scientists need to conduct rational research. They can not do long-term and labor-intensive work on the nesting beach. And young students tried to raise research results without fulfilling the role of LRMC. Genetic and tracking researches without long-term stay in the field were consistent with their rational research policies.

The relationship between LRMC and scientists is getting closer recently in Japan. LRMC may be weakened by an increase in scientists. However, when considering the future of the sea turtle, what is most needed is LRMC rather than scientist. People who are interested in sea turtles must make and support the LRMC that understands the various elements of the local area and manages the sea turtle and the environment. In order to conserve the sea turtle from now on, it is most important to establish the position of LRMC and increase them globally.

THE NORTH PACIFIC LOGGERHEAD: A BRIEF HISTORY OF SCIENTIFIC RESEARCH, CONSERVATION, AND NEW DISCOVERIES

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The North Pacific loggerhead is an amazing animal that inhabits the largest ocean basin in the world. From the time hatchling loggerheads depart their nesting beaches in Japan, until some 30 years later when they return as adults, each individual will have traveled tens of thousands of kilometers, interacting with countless habitats, and dodging a myriad of human threats. Today, loggerheads in this region are among the most well-studied sea turtle populations in the world. From nesting beaches in the west to foraging areas in the east, loggerhead research has touched the farthest stretches of the North Pacific. However, it wasn't always this way. For many years, North Pacific loggerheads were an enigmatic species: Individuals were recorded in eastern Pacific, but their origin was completely unknown. Gradually, through flipper tagging studies and genetic research, we learned about the trans-Pacific movements of loggerheads. Our understanding about their ecology was further established with satellite telemetry and stable isotope analysis, and the cumulative research helped portray the amazing life history of North Pacific loggerheads. Our knowledge about loggerheads was possible because of the exhaustive efforts of biologists and conservationist across the Pacific, especially on the nesting beaches of Japan where researchers and turtle enthusiasts alike have been studying and protecting loggerheads for many decades. In this talk I will chronicle the history of research on North Pacific loggerheads, discussing three eras of scientific inquiry, including the ages of discovery, knowledge integration, and mechanistic investigation. I will also share recent findings about loggerhead biology in the eastern Pacific and describe how holistic conservation efforts are helping reduce human impacts. There is still much to learn about Pacific loggerhead biology, and many hurdles remain for their protection. Nevertheless, we are at an exciting time in the history of Pacific loggerhead research and conservation. The wealth of new knowledge and signs of population increases at the nesting beaches after decades of decline are encouraging. These gains can be attributed to a combination of long-term nesting beach protection as well as efforts to minimize impacts on turtles at sea. Together these advances are all rooted in the goodwill and commitment of hundreds of communities and individuals across the North Pacific who have united to study and save this species.

A LONG WAY FROM 'HOME': JUVENILES IN THE EASTERN PACIFIC

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During their long juvenile stage, North Pacific loggerheads venture far from their natal beaches in the western Pacific and make a living in the vast North Pacific. Similar to their counterparts in the North Atlantic, most of these juveniles embark on a transoceanic journey, and their survival depends on them locating suitable foraging habitats. Decades-worth of satellite telemetry have identified core-use areas for juvenile loggerheads in the Central North Pacific (CNP), showing them to have high fidelity to particular thermal bands and relatively productive oceanic convergence zones. In addition to spending time in the western Pacific and the CNP, tens of thousands of juveniles are known to congregate at a foraging hotspot off the coast of Mexico's Baja California Peninsula (BCP) in the eastern Pacific. It remains unclear what determines where juveniles spend most of their time, and whether or not they recruit to the eastern Pacific. Yet it is clear that these habitats, the oceanic CNP and more nearshore areas in the eastern Pacific, contrast sharply, especially with respect prey quality, movement and energetic requirements, and bycatch-related mortality rates.

In the CNP, high seas longlining is a known threat to turtles; while in the eastern Pacific, smaller-scale fishing in the Gulf of Ulloa along the west coast of the BCP is a known source of fisheries-related bycatch for turtles. Years' worth of beach surveys adjacent to the Gulf of Ulloa showed that these foraging turtles suffer one of the highest-documented rates of bycatch globally, where at its worst, thousands of turtles were being killed each year along the BCP. Meanwhile, research utilizing samples from these many dead stranded turtles revealed information about the demographics of the turtles in the eastern Pacific. Juveniles can spend over 20 years in the eastern Pacific, and the potentially long stage duration in the eastern Pacific could have staggering effects on the survivorship for juvenile loggerheads. What brings the juvenile turtles to eastern Pacific is still unclear, but it may be related to oceanographic conditions, with warmer water inviting loggerheads closer to North America. Indeed, juvenile loggerheads are also encountered off the coast of the U.S., especially during periods of warmer water. These more northerly turtles, initially thought to be wanderers from Mexican waters, originate from the CNP. The implications of this variable habitat use, in the context of continuing climate change and extreme ocean conditions (i.e. the Pacific warm water blob of 2013-2016), warrant continued monitoring of this population in the eastern Pacific, now, and into the future.

Acknowledgements to the many, many dedicated researchers and partners who have helped shine a light on the North Pacific loggerheads' juvenile "lost years" in the eastern Pacific.

PUBERTY LIFE OF LOGGERHEAD TURTLE IN THEIR NATAL WESTERN PACIFIC

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The breeding habitat of North Pacific loggerhead turtle is restricted in the western end of the ocean basin and hatchlings migrate and distribute from their natal waters to the central and eastern North Pacific nursery ground. This is the cause of the absence of young juveniles from the western North Pacific and recalling that the western North Pacific is an important habitat for adults. However, the occupancy of adults among the individuals (n=1392) that appeared on a migratory corridor along the Kuroshio Current was 10.6%, and the majority was a subadults that accounted for 75.9% followed by larger juveniles (13.5%). The sub-adult mentioned here refers to individuals in a maturing state from the onset of the secondary sex characteristic to the sexual maturity. The dominance of sub adults indicates that the western North Pacific is the important habitat not only for breeding adults but also for maturing sub adults. As a note, sub adults showed female biased sex ratio (1 male to 1.6 female) and the ratio would represent actual wild sex ratio in the habitat. By the way, when did they return to their natal western Pacific? How long have they spent here before being adults? The skeletochronology gave us an answer. Although there was a very large individual differences in mature age and estimated to be wide from ca. 20 to 60 years old, it was estimated to be 37 or 43 years old on average. Similarly, skeletochronology and SCL size of their return indicates age at come back to the natal western North Pacific as 18-31 years old. From the SCL size distribution, catch-curve analysis estimated an annual survival rate of sub adults as 0.857. This survival rate is similar with immature in South Pacific and higher than juveniles in North Atlantic and Mediterranean. If we assume the age at maturity and return was 37 and 24–25 years old on average, respectively, loggerhead turtle in North Pacific needs 12.5 years after return to natal western North Pacific until reaching maturity. This indicates 14.5% of sub adult loggerhead turtles survive until maturity.

TWO DRAGON PALACES: MIGRATORY AND LIFE-HISTORY POLYMORPHISM IN A LOGGERHEAD TURTLE POPULATION

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Japanese people are familiar with the folktale of URASHIMA Taro, i.e., Taro was brought to a dragon palace by a turtle that he had saved. Literature including this tale first appeared in the 8th century. The motif is also used for the logo of this symposium. However, based on recent scientific findings, there should be two dragon palaces to which Taro was potentially brought; if Taro saved a small turtle, he should have been brought to a dragon palace located in the oceanic Pacific, whereas if Taro saved a large turtle, he should have been brought to another dragon palace located in the neritic East China Sea. The story of URASHIMA Taro may need to be updated in the 21st century.

In contrast to the traditional view of loggerhead turtle life history, satellite telemetry and stable isotope analysis have revealed that, within some loggerhead turtle populations nesting in Japan, small females, as well as juveniles, tend to forage on planktonic animals in oceanic waters, whereas large females tend to forage on benthic animals in neritic waters. This phenomenon does not mean that small adult females become large and shift from oceanic to neritic habitats with age, because female loggerheads grow little after reaching sexual maturity. Similar size-related foraging dichotomy was also seen in male loggerheads. The lack of significant differences in allelic and haplotype frequencies between oceanic and neritic foragers at 5 microsatellite loci and mtDNA sequences suggested that their foraging dichotomy does not have a genetic basis. The 2.4-fold difference in offspring quantity and the similarity in offspring quality between oceanic and neritic foragers suggested that their fitness is unequal, which is consistent with the results from DNA analysis. Therefore, their alternative life histories are strongly suggested to be environmentally maintained. Phenotypic plasticity may have enabled sea turtles to survive during their evolutionary history of >110 million years.

NORTH PACIFIC LOGGERHEAD CONSERVATION - A STORY OF TRINATIONAL COOPERATION

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With the increased understanding of how North Pacific loggerheads (*Caretta caretta*) use habitats across the Pacific Ocean, has come the increased collaboration between scientists and conservationists. These collaborations have included scientific exchanges and fishermen to fishermen exchanges. This has laid the groundwork for government-to-government exchange on the conservation status of North Pacific loggerheads over the last decade. In 2016, the Japanese, Mexican and American governments agreed to work to together to develop a Trinational Recovery Plan for North Pacific loggerheads. This is the first trinational recovery plan for North Pacific loggerheads. The recovery team, is composed of government and non-government representatives from Japan, Mexico and the United States. The team has worked to identify and assess the threats to North Pacific loggerheads and the needed recovery actions. In mid-2018, a draft recovery plan will be available for public comment. While the recovery team is developing a recovery plan for North Pacific loggerhead conservation, it will take a diverse set of non-governmental and governmental actors to implement it.

NASA KENNEDY SPACE CENTER: CONTRIBUTIONS TO SEA TURTLE SCIENCE AND CONSERVATION

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The National Aeronautics and Space Administration (NASA) is a United States (US) federal agency that oversees US space exploration and aeronautical research. NASA’s primary launch site, Kennedy Space Center (KSC) is located along the east coast of Florida, on Cape Canaveral and the western Atlantic Ocean. The natural environment within KSC’s large land boundaries, not only functions as an extensive safety buffer-area, it performs simultaneously as a wildlife refuge and a national seashore.

In the early 1960s, NASA was developing KSC for rocket launches and the US was establishing an awareness of, and commitment to protecting the environment. The US began creating regulations that required the consideration of the environment when taking action on federal land or with federal funds. The timing of the US Endangered Species Act (1973), the US National Environmental Policy Act (1972), coincided with the planning and implementation of the US Space Shuttle Program. This resulted in the first efforts to evaluate the impacts of space launch operation operations on waterways, air quality, habitats, and wildlife.

The first KSC fauna and flora baseline studies were predominantly performed by University of Central Florida (then Florida Technological University). Numerous species of relative importance were observed and sea turtles were receiving regulatory review and protection as surveys by Dr. L Ehrhart (UCF) from 1973-1978 described turtles nesting along the KSC beaches and foraging in the KSC lagoon systems. These data were used in the first NASA Environmental Impact Statement for the Space Transportation System (shuttle program) in 1980.

In 1981, work by Dr. Archie Carr, University of Florida (UF), Dr. Ehrhart at KSC, Ross Witham for the state of Florida, and Fred Berry for the US National Oceanic and Atmospheric Administration, created a wave of interest and concern in these threatened and endangered species. In 1981, in Jacksonville Florida, the Florida Department of Natural Resources organized the first “sea turtle workshop” which ultimately gave rise to the International Sea Turtle Symposium.

In 1982, NASA began a long term ecological monitoring program with contracted scientists on site. This included efforts to track sea turtle status and trends at KSC and maintain protective measures for these species. Many studies and collaborations have occurred on KSC over these last 45 years with agencies (USFWS, NOAA, NAVY), students, and universities (UCF, University of Toronto, Texas A&M, UF). This presentation will review the various studies and collaborations on sea turtles at KSC that include: nest distributions and success, stranding network development, aerial survey testing for nest counts, predator control assessments, the earliest baseline blood chemistry health determinations on nesting females, stress hormones in nesting females, multi-year study of hatchling sex ratios, genetics, species composition, abundance and distribution of in-water juveniles, turtle cold stun response, exterior lighting impacts and control, and satellite tag tracking of post-nesting turtles in the vicinity of near shore shoals and sand mining sites.

Through these studies, monitoring, and recommendations, KSC has provided excellent stewardship and protection of the local environment. While conducting its space program mission, KSC has also made significant contributions of information for agencies charged with the conservation and management of these species.

SPACE, TECHNOLOGY, AND MARINE TURTLE RESEARCH

Mark Hamann
James Cook University

All fields of research have benefited from advances in technology. Some of these advances have made research less time consuming and more accessible to research groups around the world, and some advances open new fields of research. Our ability to track the movements and behaviour of marine turtles has benefited from several advances in technology over the past 40 years and now we have a diverse range of tags that can deliver accurate locations via phone or internet connections. The challenge now is to make better use of existing tracking data, and then use tracking data to develop a stronger understanding of the links between behaviour and habitat. In this talk I will explore the advances in the way marine habitats are being mapped using satellites or drones, and how current and new tracking technology can be coupled to improve our understanding of how turtles are using marine habitats.

ARGOS SYSTEM: IMPROVEMENTS AND FUTURE OF THE CONSTELLATION

Sophie Baudel | Yann Bernard | Stephan Lauriol | Alexandre Tisserant
CLS | CLS | CLS | CLS

Argos is the main satellite telemetry system used by the wildlife research community, since its creation in 1978, for animal tracking and scientific data collection all around the world, to analyze and understand animal migrations and behavior. The sea-turtle biology is one of the major disciplines which had benefited from Argos telemetry, and conversely, sea-turtles biologists' community has contributed a lot to the growth and development of Argos use cases.

The Argos constellation with 6 satellites in orbit in 2017 is being extended in the following years with Argos 3 payload on METOP C (launch in October 2018), and Argos 4 payloads on Oceansat 3 (launch in 2019). The next generation of Argos satellite instrument, called Argos 4, will allow more frequency bands (600 kHz for Argos4NG, instead of 110 kHz for Argos 3), new modulation dedicated to animal (sea turtle) tracking allowing very low transmission power transmitters (50 to 100mW), with very low data rates (124 bps), enhancement of high data rates (1200-4800 bps), and downlink performance, at the whole contribution to enhance the system capacity (50,000 active beacons per month instead of 20,000 today).

In parallel, in the context of a miniaturization trend in spatial industry in order to reduce the costs and multiply the satellites to serve more and more societal needs, the French Space Agency CNES, which designs the Argos payloads, is innovating and launching the Argos ANGELS project (Argos NEO Generic Economic Light Satellites). ANGELS will lead to a nanosatellite prototype with an Argos NEO instrument (30 cm x 30 cm x 20cm) that will be launched in 2019.

In the meantime, the design of the renewal of the Argos constellation, called Argos For Next Generations (Argos4NG), is on track and will be operational in 2022.

The presentation will then be an overview of the Argos system, present and future and new capacities coming with it for wildlife tracking. On top of that, use cases of two Argos hardware modules will be presented: the goniometer path finder allowing recovering Argos beacons and collect data in direct reception at sea or on ground in a 100 km radius horizon-free circle around the beacon location and the new Argos-3/4 chipset called "Artic", already available and being integrated by several tag manufacturers.

Finally some aspects of ground segment processing and added value services such as data display, Kalman filter reprocessing, remote sensing oceanographic data extraction along track, will be presented.

A PRELIMINARY INVESTIGATION INTO THE EARLY EMBRYO DEATH SYNDROME (EEDS) AT THE WORLD'S LARGEST GREEN TURTLE ROOKERY

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The University of Queensland | Queensland Government Department of National Parks, Sports & Racing

Raine Island hosts the largest nesting aggregation of green turtles in the world, but in recent decades nest emergence success and hence recruitment of hatchlings off the beach are thought to be low compared to pre-1990 times. Nests destroyed by subsequent nesting turtles, and nest failure due to flooding account for most of the nest failure, but many nests still have poor hatch success even when undisturbed and flood-free. In undisturbed, flood-free nests that experience high mortality, embryos typically die at a very early stage of develop, a phenomenon we term early embryo death syndrome (EEDS). EEDS is correlated with the number of females nesting at Raine Island during a nesting season. Here, we monitor nest temperature and oxygen (PO_2) and carbon dioxide (PCO_2) partial pressures during the first week after nest construction to discover if they are associated with EEDS. Our preliminary results found that the proportion of early embryo death was correlated with nest temperature, PO_2 and PCO_2 suggesting that these variables either by themselves or in combination may cause EEDS.

IS IT WORTH IT? COSTS AND BENEFITS OF CAGING NESTS

Kristen Mazzarella | Melissa Bernhard
Mote Marine Laboratory | Mote Marine Laboratory

Sea turtle nest depredation has been identified as one of the primary threats to the recovery of loggerhead sea turtles (*Caretta caretta*) in the Northwest Atlantic Population with the recommendation that nest depredation be reduced to less than ten percent within a recovery unit (2008 Recovery Plan). Predators such as raccoons, armadillos, and coyotes are known culprits of nest depredations. Self-releasing cages and screens have been utilized to prevent damage to nests. Studies have shown that initial nest depredation increases the likelihood of future depredation on the same nest; therefore self-releasing cages may be used to protect the remainder of the clutch. Although effective at deterring predators, caging is costly both in time and resources, and may have unforeseen adverse effects on the ecosystem. We analyzed 731 nests at four field sites to determine whether the use of caging after initial depredation (as a predator deterrent) was beneficial to nest survival. We compared caged and not caged areas over two years and three islands in Sarasota County on the Gulf Coast of Florida, USA where raccoon, armadillo, and coyote are common. Preliminary results indicate that for most areas when cages were employed, the depredation rate was higher and overall hatch success was lower. Exceptions include one area that was predated by coyote and another area where no significant difference was observed. Based on initial findings, the use of cages after initial depredation, while protecting a single nest, may not benefit the overall hatchling output.

INFLUENCE OF SANDY COAST VEGETATION IN THE REPRODUCTIVE SUCCESS OF GREEN TURTLES IN CUBAN NESTING BEACHES

Julia Azanza Ricardo | Claudia Cabrera Guerra | Ryan Betancourt Ávila | Randy Calderón Peña | Fernando Bretos

Higher Institute of Technology and Applied Sciences, Havana University | Faculty of Biology, Havana University | Faculty of Biology, Havana University | Faculty of Biology, Havana University | Cuba Marine Research & Conservation, Patricia and Phillip Frost Museum of Science

Several are the factors affecting marine turtles' nest selection and hatchlings survival, but the degree of influence is not always well established. Vegetation is one of them, since many aspects of its interaction with turtles are unknown. Therefore, our objectives were: to evaluate the effect of vegetation shading in the incubation period and hatching success and to compare incubation period and hatching success among nests close to two different species of shrubs. Spatial and temporal variation of the vegetation cover by *S. maritima* and *T. gnaphalodes* was compare in 100 m^2 parcels in which it was verified that the covered increased among years and had a positive relation with nest number (r= 0,56; p= 0,01). Hatching success and incubation period was established according to: nest location at the beach (first or second fringe), shading degree provided by vegetation and associated shrub species. Both indicators were higher in the fringe farer from the sea. Differences between the hatching success (H (2;157) = 8,9; p = 0,01) and incubation period (H (2;139) = 22, 08; p< 0,01) considering shading degree were found. The first indicator varied also considering the associated shrub species (U (26) =109; p< 0,05) with higher values for S. maritima. Sand coast vegetation has a determinant role in marine turtles nesting since, its presences and the level of vegetation cover, has a positive impact in the reproductive success of Guanahacabibes nests. Vegetation shade increase hatching success at the same time, increase incubation duration, allowing the optimal completion of the embryo development. Shrub species associated with nests affects embryo developments parameters since close to *S. maritima* there is a better hatching success compared to *T. gnaphalodes*. On the other hand, shrub species seems to have no effect on incubation duration. It is evident the relevance to consider the shrub species associated to nest in any planned conservation action

ONTOGENY OF ORIENTATION RESPONSES IN DEVELOPING SEA TURTLE EMBRYOS

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By the time they emerge from their nests, hatchling sea turtles are prepared to use a suite of environmental cues to guide their movements across the beach to the sea and, from there, to the open ocean. Among the orientation cues used by hatchlings during sea-finding and the offshore migration are visual cues, the direction of ocean waves, and Earth's magnetic field. Little is known, however, about when orientation abilities first arise during embryonic development or whether such processes might play a role in natal beach imprinting or other events that shape subsequent behavior. As a first step toward investigating these possibilities, we studied the orientation of late-stage embryos in eggs collected from an east-coast Florida beach. The results revealed a striking bimodal alignment: the embryos overwhelmingly faced to the north or south but not to the east or west. To investigate further, we developed a methodology to non-invasively observe embryo orientation via trans-illumination, or "candling". This technique was subsequently used in Costa Rica to confirm bimodal north-south alignment of olive ridley turtle embryos near the end of incubation. Although the environmental cue used by turtles to align non-randomly is not yet known with certainty, an interesting possibility is that embryos might align their bodies relative to Earth's magnetic field, one of the few sources of directional information present in an underground nest chamber. In a preliminary experiment, a clutch of loggerhead eggs was incubated inside a magnetic coil system that was used to rotate Earth's field by 90 degrees. During pipping, the orientation of hatchlings was aligned with the new north-south magnetic axis within the coil, providing initial evidence consistent with the hypothesis that the alignment of sea turtle embryos is mediated by detection of Earth's magnetic field. Although additional experiments are needed, the initial findings suggest that the ability to detect magnetic fields may develop before embryos emerge from their eggs. The observed alignment of embryos might aid in the development of a well-tuned magnetic sense and/or facilitate accurate measurement of the local magnetic field at the natal beach, which is thought to be intimately involved in natal homing. In either case magnetic alignment of sea turtle embryos might be critical to sea turtles' navigational abilities at later life stages.

INCREASING NEST NUMBER AND HATCHLING PRODUCTION OF GREEN SEA TURTLE (*CHELONIA MYDAS*) WITH LOW EMERGENCE SUCCESS CAUSED BY SEVERE DEPREDATION OF GHOST CRAB IN OGASAWARA, JAPAN, 2010-2017

Satomi Kondo | Chiyo Kitayama | Yukari Morimoto | Takayuki Sato | Hiroyuki Suganuma
Everlasting Nature of Asia | Everlasting Nature of Asia | Everlasting Nature of Asia | Everlasting Nature of Asia | Everlasting Natureof Asia

The Ogasawara Islands are the largest green sea turtle *Chelonia mydas* rookery in the north Pacific. There are 41 nesting beaches in the largest island group, Chichi-jima. The marine turtle population in these islands was severely depleted due to over exploitation in the 1800s; however, upward trend of nesting females has been observed in recent years. Number of nests, hatchling production, emergence success, and sources of egg mortality in green sea turtle *in-situ* nests of 2010 to 2017 nesting seasons in Chichi-jima were determined in this study, and some were compared to the past records in other literatures. A total of 396 202 hatchlings were produced with emergence success of 38.8±4.3%, which are relatively low compared to other major green rookeries. Depredation by ghost crabs *Ocypode cordimanus* is the most important cause of egg mortality during incubation. Although 76.9% of nests were disturbed by ghost crabs, overall nests disturbed by ghost crabs (n=8473) produced more hatchlings (261 149 hatchlings) than nests with no damages (n=3148, 125 749 hatchlings) during sample years. Depredation by the crab causes declined emergence success but those nests still produce significant amount of hatchlings.

Other studies revealed that hatchling production was much less in the past few decades with relatively low emergence success of 32.2±6.8%, mainly caused by ghost crabs from 1983 to 1990 in the same study beaches (Suganuma et al, 1994). Thus, it is assumed that Ogasawara turtles maintain its population with consistently low emergence success, and depredation of ghost crabs has been the major mortality cause but not threatening source for the turtle population.

Moreover, total nest numbers were annually correlated with emergence success for the sample years (r=0.75), but there is no correlation for 8 years from 1983-1990 in the same study location (r=0.20). This difference may be attributed to a remarkable increase of nest numbers in the past decade, as the mean annual number of nests is 262.5±103.2 from 1983 to 1990, whereas 1666.0±574.3 nests from 2010 to 2017. Degree of damages caused by ghost crabs and the others might be limited under the recent increased nest numbers. This implies that future hatchling production is expected to stably grow with the upward trend of the nest numbers seen in this study in Chichi-jima.

DISCOVERY OF MAJOR EAST PACIFIC GREEN TURTLE (*CHELONIA MYDAS*) NESTING POPULATION IN NORTHWEST COSTA RICA

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Here we report on a newly discovered nesting population of East Pacific green turtles (*Chelonia mydas*) in northwest Costa Rica at San José Island, Murciélago Archipelago that rivals those of Mexico and the Galapagos Islands, Ecuador. A total of 1,232 individual green turtles were tagged over four nesting seasons (2012–2013 to 2015–2016). Mean (± SD) annual number of nests (1077 ± 414; range: 490-1698 nests) and females (306 ± 133; range: 164-466 females) was higher than those previously reported for Pacific Costa Rica. The number of deposited nests was similar to that registered on the Galapagos main beaches but density of nests (number of nests/km) was the second highest for any green turtle beach in the eastern Pacific. Reproductive output was similar (mean clutch frequency: 4.4 ± 2.2 clutches and mean clutch size: 75.8 ± 14.6 eggs/clutch), and mean hatching success was higher (0.89 ± 0.14) than those reported at other sites in the eastern Pacific. As the study site was located on an island within a protected area, several of the common threats that sea turtles face at more accessible mainland sites (i.e. egg poaching, tourist development and predation by large mammals) were absent. Our data indicate that San José Island is the most important nesting site for east Pacific green turtles in Central America. The large size of this population, along with its isolated and protected status, suggest that this rookery is making a significant contribution to the conservation of east Pacific green turtles. Additional information at the country level will help determine the relative importance of Costa Rica for green turtle nesting in the broad eastern Pacific region.

COMPARISON OF HATCHING SUCCESS OF LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) AT TORTUGUERO BEACH IN COSTA RICA AND SOROPTA BEACH IN PANAMA.

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Since 1959 the Sea Turtle Conservancy (STC) has been working for the conservation of marine turtles, monitoring nesting beaches, collecting data and collaborating with local communities and management authorities in order to minimize the effect of human activities on nesting sites and implement sustainable use of sea turtles as a natural resource. Due to their peculiar characteristics, Caribbean beaches provide essential nesting habitat for leatherback sea turtle (*Dermochelys coriacea*) populations. Analyzing the survival and productivity rates of *D. coriacea* nests for recent years (2013 – 2017) at Tortuguero Beach, Costa Rica and at Soropta, Panama; two beaches with very similar physical characteristics and prevalence of local communities, sets an important base, to better understand the conditions that favor this specie's reproduction. The objective of this study is to determine recruitment for the leatherback population from each one of these nesting beaches, and to identify the primary threats to each site in order to inform management strategies for enhanced survival rates at these sites. We analyzed the data for 744 leatherback nests (Tortuguero = 107, Soropta = 637). The hatching and emergence success were determined as 34.03% (S.E. ± 1.35) and 30.40% (S.E. ± 1.29) respectively for Panama, whereas Tortuguero presented lower rates: 22.35% (S.E. ± 2.86) hatching success and 21.57% (S.E ±.2.95) emergence success. Poaching rates in Tortuguero are 3.03% of nests laid, not comparable with a 24.5% rate presented in Soropta in recent years. Removing poached nests from the sample resulted in higher hatching success at both beaches with 42.1% (S.E. ± 1.45) for Soropta, and 22.9% (S.E. ± 2.94) for Tortuguero; revealing the impact of poaching on sea turtle populations in Panama. Notably, a record 61% of the nests were poached in Soropta beach in 2013. Another factor affecting hatching production on these beaches is erosion; Tortuguero Beach has lost 32.62% of nests due to the effect of high tides on the beach; while, Soropta Beach has only had a 9.55% loss. Nevertheless, because of the shallow phreatic levels, this beach has lost 3.89% of nests to inundation and water effects. Finally, depredation of Leatherback nests by dogs and other animals occurs in Panama only, at a 2.35% rate. Although low, this rate still differs from Tortuguero where predation is negligible. In conclusion, thanks to the support and founding of the Sea Turtle Conservancy and their field staff both in Costa Rica and Panama, we were able to investigate the different variables affecting hatching and emerging success of Leatherback nests at both beaches, and suggested management strategies such as relocation of nests and an increase in monitor presence on the beach in order to address the known primary threats and improve the survival rates for *D. coriacea* at these sites.

PIVOTAL TEMPERATURE AND HATCHING SUCCESS FOR GREEN TURTLES NESTING ON ASCENSION ISLAND

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Adaptation to increasing temperatures may be an essential characteristic for species to mitigate the long terms impacts of climate change. Sea turtles exhibit philopatry and temperature-dependent sex determination (TSD): characteristics that can be used to compare the thermal tolerances of populations that naturally experience different conditions and which may therefore shed light on their adaptive potential. The ability to alter the pivotal temperature, at which a 1:1 offspring sex ratio is produced, has been suggested as a potential adaptive mechanism to rising temperatures. In this study, we use the Ascension Island green turtle, *Chelonia mydas*, nesting population to compare pivotal temperatures and hatching success in both laboratory and *in-situ* conditions, using eggs laid on beaches that represent the extremes of the range of incubation temperatures experienced by this population. We find no effect of beach of origin on the temperature response curves for sex ratio or hatching success, suggesting that turtles nesting at these sites are not locally adapted to their differing thermal environments. This will ultimately lead to long term reductions in hatchling survivorship and increasingly female biased sex ratios.
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DO LARGER SEA TURTLE HATCHLINGS HAVE BETTER SURVIVAL PERFORMANCE?

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The nesting environment can influence the morphological characters and behavior of sea turtle hatchlings. In Taiwan, there are three major nesting sites: Wan-an Island, Lanyu Island and Liuchiu Island. Geographical location and environment vary from one island to another. During our study, the weather differed among the three islands in the nesting season. We have determined the influence of these environmental variations on the behavior and morphological characters of the hatchlings. The straight carapace length, front flipper length, body weight, swimming and crawling speeds and ability of the hatchlings to turnover were determined. Size and weight were largest for hatchlings from Wan-an, followed by Lanyu and least from Liuchiu. However, the differences in size did not accordingly affect their locomotory abilities. Hatchlings from Lanyu crawled and swam fastest, followed by Wan-an and Liuchiu. Hatchlings from Lanyu had stronger locomotory ability than those from the other two islands, even though they were intermediate in size. Hatchlings from Liuchiu spent the briefest times before standing up, followed by Wan-an, with longest times from Lanyu. Body size and movement ability must affect the survivorship of hatchlings, but that was not reflected in our study. The differences in morphological characters and behavior might relate to the potential predation pressure they encountered after emerging from the nests and entering the sea.

INCUBATION TEMPERATURES INFLUENCE THE SEX DIFFERENCES IN THE SURVIVAL OF LOGGERHEAD SEA TURTLE DURING EARLY LIFE STAGES

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In the sea turtle species, the early life stages are considered to be the most critical period for their survival. Recent accumulating knowledges indicated that incubation temperatures affect some aspects of their survival, such as embryonic mortality rate, size, terrestrial and swimming locomotor performances, and growth rate. Because sea turtles possess temperature-dependent sex determination systems, with warmer incubation temperatures producing females, there may be the sex differences in the survival during early life stages. Investigating the effect of the male/female-producing temperatures on the survival aspects is crucial to establish effective conservation strategies under the situation of climate change.

In 2015, we comprehensively investigated the above-mentioned survival aspects during the incubation and terrestrial periods of the loggerhead sea turtle (*Caretta caretta*) in the male and female producing-nests in Kochi Beach, Kochi Prefecture, Japan. Mortality rates during the early embryonic stage in the male-producing nests (mean: 1.4 %) were significantly lower than those in the female-producing nests (mean: 14.9 %). The hatchlings from the male-producing nests showed significantly faster crawls (mean: 7.5 cm/s) and greater self-righting abilities than those from the female-producing nests (mean: 5.2 cm/s). These results suggested that male hatchlings and/or male-fate embryos are likely to have superior survival rates than females during the incubation and terrestrial periods.

We then focused on the survival aspects during the oceanic dispersal period. Clutches were divided and incubated in the incubators set at mean incubation temperatures of the male-producing (cool: 27.5°C) or female-producing (warm: 30.5°C) nests, at the previous field study area in 2015. Hatchlings swam at 27°C or 30°C, corresponding to minimum or maximum sea surface temperatures (SSTs), which the hatchlings most likely experienced during the dispersal phase in the study area. Hatchlings from the female-producing temperatures showed superior swimming performances during the frenzy period and higher glucose concentrations. On the other hand, hatchlings from the male-producing temperatures showed superior swimming performances on the third day and had higher growth rates. Interestingly, the initial dates of food consumption were correlated with the growth rates, and were earlier in the hatchlings from the male-producing temperature (mean: 1.6 day) than hatchlings from the female-producing temperature (mean: 3.5 day). In addition, warmer swimming temperatures enhanced their swimming performances. These findings suggested that there would be the sex differences in the survival during the oceanic dispersal period as well as in the incubation and terrestrial periods; however, part of these differences could depend on the oceanic environment such as food availability and SST.

Under the situation of climate change, artificial manipulation of the incubation temperature is one of the conservation strategies. However, our results suggested that the responses from the incubation temperatures would imply preexisting strategies against climate change, and so the artificial manipulation of the incubation temperature should be carefully considered.

TURNING AROUND GREEN TURTLE REPRODUCTIVE FAILURE THROUGH ADAPTIVE MANAGEMENT AT RAINE ISLAND

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Raine Island, a cay in the northern Great Barrier Reef, supports the largest aggregation of nesting green turtles in the world and is the nesting site for 90% of the northern Great Barrier Reef green turtle population. In large nesting season more than 60,000 green turtles aggregate in the waters around the Island, with thousands of turtles on the beach attempting to nest each night. Monitoring since the late 1990’s, has raised concerns about the low reproductive success of green turtles at Raine Island.
Turtle nesting failure is a major concern, with failure attributed to dry sand causing nest collapse and high-density nesting resulting in frequent inter-turtle nesting disturbance. Nesting success varies from 20% to 61%, much lower when compared with other Great Barrier Reef coral cay green turtle rookeries. Hatching success has been between 25% - 67% over the last six breeding seasons, with embryonic death mostly occurring in the early development. Tidal inundation at nest level is widespread across the Island and research suggests it is one of drivers for hatching failure. Mapping of clutches around the Island demonstrates variability in hatching success, however clutches laid in the inundated areas of the beach have an average hatching success of below 40%. Research has shown that a negative correlation between lower hatching success and peak nesting seasons occurs.
A major decline in this green turtle stock was predicted within the next 20-30 years unless immediate actions to mitigate these problems are undertaken. Installation of fencing around the perimeter of the inner phosphate cliff to reduce the number of nesting turtle toppling over the cliffs and dying, commenced in 2011. In September 2014, a trial section of beach was re-profiled to raise sand levels so that nests laid in that area would be above tidal inundation levels and to increase the viable nesting area.
Three nesting season data has been collected since this section was re-profiled sector, comparing turtle nesting and hatching success between the re-profiled area and the unmodified areas. The re-profiled section has continued to remain above inundation levels and retain its profile over three years. Marked improvement in hatching success and higher hatchlings counts in the re-profiled sectors as been seen over the past three seasons.
The results of the adaptive management actions already undertaken at Raine Island has increased reproductive output, demonstrating their effectiveness. In 2015, the Raine Island Recovery Project was initiated, which is a five-year, $7.95 million collaboration between BHP, the Queensland Government, the Great Barrier Reef Marine Park Authority, the Wuthathi Nation and the Kemer Kemer Meriam Nation (Ugar, Mer, Erub) Traditional Owners and the Great Barrier Reef Foundation. This project aims to improve the reproductive success and reduce female green turtle mortality on the Island by continuing to support the on-going intervention works and monitoring at Raine Island.

TESTING CLIMATE CHANGE HYPOTHESES: CHANGES IN FLATBACK TURTLE, *NATATOR DEPRESSUS*, BREEDING IN EASTERN AUSTRALIA IN THE LAST 50 YEARS

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The flatback turtle, which is endemic to the Australian-New Guinea continental shelf, represents an ancient lineage of marine turtles that originated tens of millions of years ago. The species has survived millennia of climate change. Like all marine turtles, the flatback turtle is characterised by temperature dependent sex determination. As a consequence, the species potentially will be susceptible to significant changes in regional temperatures which have the potential for negatively impacting on successful incubation of eggs and severely biasing the hatchling sex ratio. Current concerns regarding global warming hypothesise that marine turtle populations are at risk of being feminised and experiencing reductions in hatching success. To have survived the major climate changes of the past, it is often hypothesised that the population may survive by either shifting their nesting to higher latitudes (with cooler beaches) or changing the timing of their breeding season to cooler months of the year. In the present study we test these climate change hypotheses against functioning of the eastern Australian flatback turtle nesting population: Has the population shifted nesting distribution to higher latitudes? Has the population changed nesting seasonality? The study explores changes in the breeding biology of flatback turtles nesting on the Woongarra Coast, south Queensland, one of the longest monitored marine turtle populations with 50 years of full-season tagging census.

TEMPORAL CHANGES IN, AND INFLUENCE OF STORAGE CONDITIONS ON, THE FRENZY SWIMMING ACTIVITY OF LOGGERHEAD TURTLE HATCHLINGS

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Loggerhead turtle hatchlings that have just emerged from their nests enter a state called “frenzy,” which is known to be an important property for enhancing survival in the early life stage. Therefore, the chances of survival will decrease if the hatchlings do not enter the sea quickly. Although the duration of the frenzy is considered to be temporary, the exact details of the activity are not clear.
This study assayed the strength and persistence of frenzy swimming in loggerhead hatchlings and compared the differences when they were kept under various conditions. Four nests found at the beach of the Niyodo River mouth in Kochi Prefecture in 2016–2017 were incubated in 28°C incubators. As the artificially incubated hatchlings lacked the hatch-to-emergence process of their naturally nested counterparts, emergence in this study was defined as day 4 after hatching. After the emergence, every 12 hatchlings of mean size were kept under one of the following conditions: 1) in water under bright condition (as BW = C (control)); 2) in water under dark condition (DW); 3) in air under bright condition (BA); and 4) in air under dark condition (DA). Swimming thrust was measured after 24, 48, and 72 h of storage. Each experiment measured the maximum and mean thrusts (mN) from the beginning (0 h) through day 3 (72 h).
Just after emergence, the group C hatchlings showed the highest maximum and mean thrust values of 199.0 and 29.1 mN, respectively. The mean thrust of C decreased over time to 20% of the 0 h value at 12 h, and thereafter recovered to some extent, but was still only 30% of the 0 h value afterwards. The mean thrusts of DW stored at 24, 48, and 72 h measured from 15 to 6 mN at 0 h, which were lower than the 0 h value of C. Meanwhile, after 24, 48, and 72 h of storage, BA and DA showed similar 0 h mean thrust values to that of C, and at 24 h later with the end of frenzy, the values had decreased to 70% of the 0 h values. The maximum thrusts did not differ remarkably among the hatchlings under each storage condition.
The present study indicates that hatchlings can be kept in air for at least 3 days after emergence without the need for frenzy activity. Light does not stimulate the frenzy swimming. The period from hatching to emergence is variable depending on various factors, such as the nest substrates or the weather conditions. It was considered that hatchlings may have a possible habit of expressing frenzy swimming at any time as soon as they enter seawater. However, when we placed hatchlings into seawater, the frenzy swimming that occurred immediately, ended within 12 h, and was not observed again. Therefore, to maintain hatchlings, it is better to place them in air with moderate humidity.

GEOMAGNETIC IMPRINTING AND NATAL HOMING IN SEA TURTLES: INSIGHTS FROM ADULTS AND EMBRYOS

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Sea turtles are renowned for their ability to migrate extremely long distances before returning to the same stretch of coastline where they themselves hatched to lay eggs as adults. While this behavior, called natal homing, exists in all species of sea turtle, relatively little is known about how it is accomplished. One recent idea, known as the geomagnetic imprinting hypothesis, notes that sea turtles detect Earth's magnetic field and use it to navigate. Moreover, Earth's field varies across the globe and different geographic areas are characterized by unique magnetic signatures. Thus, hatchling turtles might learn the magnetic coordinates of their natal beach and use this information to return as adults. We explored the two central tenets of this hypothesis: first, that adult sea turtles use magnetic navigation to find the nesting beach, and second, that sea turtle embryos detect magnetic fields as is required for geomagnetic imprinting.

To determine if adult turtles use Earth's magnetic field to return to the nesting beach we captured females as they crawled onto the beach to nest in Ostional, Costa Rica. We tethered each turtle in a water-filled arena inside a magnetic coil system designed to precisely control the magnetic field within the arena. We then exposed turtles to the magnetic signature that exists 500 km northwest of the nesting beach (a location within the turtles' migratory range) and monitored their swimming direction. If turtles use Earth's field to identify their natal beach, then they should presumably swim southeast in response to this magnetic displacement. Initial analyses confirmed this prediction: as a group, turtles oriented significantly southeast in response to the magnetic field that exists 500 km northwest of the nesting beach. This result suggests that turtles use magnetic navigation to locate the nesting beach.

To begin investigating if sea turtle embryos detect Earth's magnetic field as is required for geomagnetic imprinting, we looked for magnetic orientation behavior prior to hatching. We non-invasively measured embryo orientation using transillumination ("candling"), and found bimodal alignment of embryos; late-stage-embryos preferentially aligned their bodies to the north or south, but not east or west. Preliminary findings suggest that this embryo alignment might be mediated by magnetic orientation behavior, although additional experiments are needed for confirmation.

Overall, both projects have provided evidence consistent with the geomagnetic imprinting hypothesis. The findings imply that adult sea turtles use magnetic navigation to return to the nesting beach and they suggest that embryos might detect Earth's magnetic field as is required for geomagnetic imprinting. In addition, the results bolster the conclusions of our previous work, which reported that shifts in sea turtle nesting distributions are strongly correlated with natural changes in Earth's field, and that spatial variation in Earth's field predicts genetic differentiation across nesting beaches while geographic and environmental distances do not. These four lines of research integrate across multiple scales of biological organization to elucidate the mystery of natal homing in sea turtles.

THE EFFECTS OF SEA LEVEL RISE AND NEST LOCATION ON REPRODUCTIVE SUCCESS IN LEATHERBACK (*DERMOCHELYS CORIACEA*) AND GREEN (*CHELONIA MYDAS*) SEA TURTLES ON BIOKO ISLAND, EQUATORIAL GUINEA

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Sea level is expected to rise about 40 to 63 cm by the year 2100, which may have critical, previously un-investigated implications for the nesting habitat on Bioko Island, Equatorial Guinea. Small islands are at great risk from climate change, and effects include increased salinity within the water table, beach erosion, and sand inundation with increased tide elevation. This study investigates how several environmental factors and beach characteristics on Bioko Island influence leatherback (*Dermochelys coriacea*) and green (*Chelonia mydas*) sea turtle reproductive success and models how these characteristics are subject to change based upon sea level rise predictions. Beach profiling datasets from Bioko's 5 southern nesting beaches (A-E) were used in GIS to create Digital Elevation and Triangulated Irregular Network models to predict increases in sea level by years 2046-2065 and 2081-2100. Moisture content, pH, conductivity, nest location, and temperature data were taken for 12 green and 24 leatherback in situ experimental nests on Beaches C and D, and a multi linear regression analysis was performed to assess the environmental characteristics that affected hatching success. The models indicate that an average of 62% of Bioko's current nesting habitat could be lost by 2046-2065 and 87% by the years 2081-2100. Beach D is predicted by the model to be the least vulnerable to increases in sea level. Clutch elevation (clutch center) relative to the high tide line (HTL) was found to be the most influential factor in determining hatching success for leatherback sea turtles, further compounding the importance of these sea level rise predictions. An optimum clutch elevation range for leatherback turtles was identified, where a distinct increase in hatching success was observed between -0.286 m to -0.0528 m clutch elevation. For leatherback turtles, 33% percent of nests were affected by inundation and 17% by predation, occurring at gradients from the vegetation to HTL. Multiple linear regression analysis demonstrates that nest distance to vegetation and sand conductivity also played significant, formative roles in hatching success. Extensive erosion and tall vegetation berms have been documented on Beaches A and B, causing green turtles to nest uncharacteristically in front of the vegetation line. Green turtle control nests on these two beaches had significantly higher nest sand conductivity than those on beaches C, D and E. Conclusions about the roles of environmental characteristics in green turtle hatching success were difficult for the model to make at this time, as 64% of experimental nests were depredated. Development plans are currently underway for Beach D. With Beach D being the least susceptible to future increases in sea level, development and anthropogenic encroachment would be detrimental to nesting turtle populations. Identified sensitivities of each species and beach to sea level rise will be used to encourage the government of Equatorial Guinea to consider the vulnerability of their resident turtle populations when planning for future development.

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HIGHER TEMPERATURES PRODUCE MORE FEMALES THOUGH AT SMALL SIZE, LOW QUANTITY AND BAD FITNESS

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For species that lay their nest in the sand beach like marine turtles, the beach features plays a critical role in the embryonic development and offspring survival and may therefore have consequences for the reproductive fitness of the adult. Among other factors, sand colour significantly influences sand temperature. For instance, dark sand absorbs more solar radiation than white sand leading to significant heterogeneity in incubation temperatures among nesting sites and consequently differences in embryonic development. To test whether the surface colour of a beach has a direct effect on embryonic survival, growth and gender, we conducted a field experiment on Boa Vista Island, Republic of Cape Verde, with the endangered loggerhead rookery during three consecutive nesting seasons 2015, 2016 and 2017. 192 doomed loggerhead nests were relocated to a beach hatchery and 16 of them, replicate identically in 3-fold replicates, were exposed to a different experimental treatment where sand colour was varied: light, dark gray and black. The first treatment was the control, whereas for the other two treatments 3-5 cm of sand from the surface was replaced with different colored sands (dark gray and black). This was the only factor that was modified of all the other conditions in the nests. A TidbiT® Temp Logger was buried in each treatment at the medium incubation depth (40 cm) to record sand temperature and another logger was placed in the middle of a nest belonging to each treatment to estimate the metabolic heat. Mean sand temperature varied significantly among treatments (light: 29.68 ± 1.07, brown: 30.48 ± 1.61: black: 31.45 ± 1.58 ºC), with the resulted suggest that the colour of sand layer had a significant influence on incubation duration, hatching success, size and hatchling behaviour. Nests incubated under darker sand hatched later (ANOVA: $F_{2, 189} = 32.11$, $p < 0.0001$), had higher mortality (ANOVA: $F_{2, 189} = 19.76$, $p < 0.0001$), hatchlings were small (ANOVA: $F_{2, 45} = 29.29$, $p < 0.0001$), slower (ANOVA: $F_{2, 3388} = 220.48$, $p < 0.0001$) and in minor number on the larger emergence (ANOVA: $F_{2, 185} = 10.32$, $p < 0.0001$). Observing the differences in the incubation temperature and duration allowed us to estimate a significant impact on hatchling sex ratio. Here we discuss the influence of these results on sea turtle ecology and conservation under global warming scenarios and how we can define conservation units in the Cape Verde Archipelago were the nestings beaches present different characteristic.

IMPACTS OF TEMPERATURE AND MOISTURE ON LOGGERHEAD HATCHLINGS IN FLORIDA

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The influence of environmental factors during sea turtle egg development makes the ongoing threat of climate change particularly worrisome. The nest environment greatly influences various aspects of sea turtle hatchling biology, including developmental rate and sexual differentiation. Sea turtles are considered particularly vulnerable to increasing temperatures because they have a cooler male/warmer female TSD system. Alarmingly, loggerhead nests from peninsular Florida beaches appear to already be strongly female biased. Another climate change effect that receives less attention is changes in precipitation patterns. While overall precipitation is expected to decrease, the severity of storms and precipitation events are expected to increase, particularly in Florida. Changes in precipitation pattern, in conjunction with incubation temperature increases, will alter nest conditions. Thus, it is imperative that we understand the effects of nest moisture changes on the incubation environment. This study examined the impact of increased moisture on hatchling sex ratios and nest temperatures across 3 nesting seasons (2015-2017), with each year varying in ambient temperature and precipitation. Environmental factors are seldom examined in the field (natural nests) in a controlled way. This study did not attempt to isolate any one individual factor, but rather examined the relationship between nest temperature and sand moisture and compared these factors between control nests (not watered) and experimental nests (watered). This study also investigated how the combination of these factors may influence hatchling sex ratios. Loggerhead (*Caretta caretta*) nests were relocated and divided into two smaller nests: a control group and an experimental group. We placed the experimental group in close proximity to sprinklers from a local condominium. Each nest contained a soil moisture probe and temperature datalogger to measure sand moisture content and nest temperature throughout incubation. A sample of hatchlings from each nest was collected and raised in the lab and their sex was verified. We identified correlations between nest moisture events (rainfall as well as nest watering) and nest conditions and compared sex ratios between control and experimental groups. Watered nests from experimental groups had overall lower nest temperatures and higher moisture content. Generally, nests from both groups in all years had strongly female-biased sex ratios but there was higher male production in 2017 likely due to a large rainfall event in the beginning of the season. In 2016, control and experimental groups differed in temperature, but temperatures in both groups remained too high to produce males. The water treatments in this study served two functions: to mimic the impact of increased nest moisture through rainfall and to evaluate nest watering as a management strategy. The impact of watering is largely dependent on ambient conditions with nest watering having very little impact on sex ratios when ambient temperatures are too high. A greater understanding of rainfall and nest watering will allow for a better understanding of hatchling sex ratios. It is particularly interesting to study the effects of increased moisture by rainfall in years with exceedingly high temperatures. This information will increase our understanding of the variation in, and drivers of, natural sex ratios and provide better predictions of climate change effects on loggerhead hatchlings in Florida.

NEST SITE SELECTION IN LOGGERHEAD SEA TURTLES THAT USE DIFFERENT FORAGING AREAS: DO LESS FECUND OCEANIC FORAGERS NEST AT SAFER SITES?

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Among species without parental care, nest sites selected by mothers determine their fitness via the survival of offspring. We examined nest site selection in oceanic (>200 m water depths) and neritic (<200 m water depths) foraging loggerhead sea turtles *Caretta caretta* with a large difference in reproductive output, in light of a trade-off between quantity and quality of offspring. Nest sites selected by oceanic and neritic foragers (which were classified by stable isotope ratios) on two adjacent beaches at Yakushima Island, Japan, were compared. Both oceanic and neritic foragers preferred a wider beach where they could nest further from the sea, with no significant differences being found in beach sections used for nesting between the two foragers. On the wider beach, both foragers clumped nests on open sand close to vegetation. Oceanic foragers nested significantly nearer to the sea than did neritic foragers, although the significant differences disappeared based on adjusted beach width. These results, together with the similar quality (morphology, emergence success, and activity levels) of hatchlings for the two foragers, suggest that the survival rate of offspring on land is similar. Thus, low fecundity of oceanic foragers would not be offset by the difference in offspring survival via nest site selection. These support unbalanced fitness between the two foragers and the environmental maintenance of the alternative life histories.

EFFECT OF HUMIDITY ON THE NEST ESCAPING OF SEA TURTLE HATCHLINGS

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After hatching, turtles spend some time in the nest before they emerge onto the surface. This is a critical stage in the natural history of turtles because hatchlings typically emerge from eggs in a premature condition, with residual yolk not fully incorporated into the abdominal cavity and the carapace still curved as a result of being enclosed in the egg. Subsequent to hatching, the residual yolk sac is retracted into the abdominal cavity through the umbilical opening on the plastron, probably by the contraction of the ruptured amniotic membrane as occurs in lizards. Most sea turtle hatchlings found on the nest surface have completely straightened carapaces and completely absorbed residual yolk, so carapace straightening and yolk internalization take place between hatching and nest emergence.
Our previous experimental manipulations of clutch size with green turtle hatchlings during simulated nest escape clearly demonstrated that hatchlings escaping in small groups not only experience longer nest escape times but they also incurred a greater individual energetic cost. This is the first time such a relationship has been demonstrated and supports the social facilitation hypothesis that states synchronous hatching and nest escape increases the fitness of hatchlings.
However, there are many variables that might influence the energy expenditure of an individual hatchling during nest escape. The key variables in determining nest escaping energetics of turtle hatchlings can be divided into three categories; (i) maternal factors (nest depth, yolk component, clutch size and egg size), (ii) incubation environment (gas partial pressure, humidity, and temperature), and (iii) individual variation (hatching success, position in nest and during nest escape).
Because dry conditions can occur at nesting beaches, we decided to investigate the effect of sand water content on hatchling nest escape. Dry sand has a tendency to collapse and flow downwards with gravity making air spaces difficult to create, while moist sand has the opposite effect, tending to stick together and allowing large airspaces to be created. How these different conditions influence digging activity, digging efficiency and energy expenditure are completely unknown.

HYDRIC ENVIRONMENTAL EFFECTS ON TURTLE DEVELOPMENT: HOW DOES MOISTURE INFLUENCE SEX RATIOS AND SEX DETERMINATION?

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Turtles are sensitive to environmental conditions during embryonic development. Experimental and field studies of different sea turtle and fresh water turtle species suggest that the interaction between the hydric and thermal environment influences hatchlings phenotype and sex ratio. Wetter substrates often produce more males; drier substrates often produce more females. But how is moisture affecting embryonic development and to what extent is it directing the molecular mechanism underlying sex determination?
Because sea turtles are imperiled, we used the red-eared slider (*Trachemys scripta*) as a surrogate for loggerheads to test the effect of moisture on (i) embryonic growth, (ii) sex ratio, and (iii) sex determination through expression patterns of genes that likely play important roles in both sex determination (*CIRBP*, *Wt1*, *Dmrt1*) and in sex differentiation (*Sox9*, *Aromatase*). We divided this study in two parts in order to address the different research questions.
First, we tested the effect of different moisture and temperature incubation conditions on development and sex ratio. We monitored embryonic development until stage 22 (after sex determination) and we assessed sex ratios. Among treatments, we found differences in developmental rates and sex ratio. Developmental differences were due to the interaction of moisture with temperature. Nests with higher water content were 2-3ºC lower than air temperatures. The coolest and wettest substrates produced 100% males and embryos of this treatment were the slowest in development; while, embryos from the warmest and driest treatment developed faster and the sex ratio resulted in a 42% males.
Next, eggs were incubated at male-promoting temperatures and moderate moisture until the beginning of the TSP. Then the eggs were randomly assigned to four different temperature and moisture treatments. Undifferentiated gonads were collected from half the eggs 48h after the movement into the treatments for RNA extractions to identify differences in gene expression early during sex determination. A second batch of differentiated gonad samples was obtained after completion of the TSP. This second experiment separated the effect of moisture and temperature allowing the effects of moisture on gene expression patterns to be addressed. *Sox9*, Aromatase, *CIRBP*, *Wt1* and *Dmrt1* sequences were obtained and submitted to GenBank databases. Specific *T. scripta* primers for quantitative PCR amplifying all those genes were designed and gene expression analysis is in process at the submission of this abstract.
This study is important because identifying key factors that influence development, sex determination, and sex ratio will contribute to more accurate demographic models and conservation strategies. By using environmental factors to estimate the current and future reproductive potential of sea turtle populations, we can improve the outlook for sea turtle survival.

NESTING ECOLOGY OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN ABU DHABI, UNITED ARAB EMIRATES

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Information on hawksbill turtles (*Eretmochelys imbricata*) from the Gulf region is scarce and this project is the first attempt to understand the nesting ecology and behavior of hawksbill turtles in Abu Dhabi, United Arab Emirates. The study concentrates on five nesting islands which have the highest number of nesting occurrences; Arzanah, Bu Tina, Diyenah, Qarnen and Zarkuh. The total number of nests recorded throughout the study period was 2,569 nests and the highest number of nests recorded was in 2011 (223 nests). Moreover, Zarkuh had a significantly higher number of nests compared to the other islands (ANOVA, $F_{4,64} = 98.13$, $p < 0.005$, mean = 67 nests). The expectation that the clutch size of marine turtles would increase with body size. Curved carapace length could statistically significantly predict clutch size, $F_{1,55} = 43.91$, $p < 0.0005$ and adj. R^2 0.434. Clutch size, depth of nest, mean ambient temperature during incubation, Julian date of nesting and incubation period were tested to see if they effect the percentage of hatching success. The percentage of hatching success could statistically significantly be predicted from Julian date of nesting, mean ambient temperature during incubation and clutch size; $F_{3,63} = 13.36$, $p < .0005$ adj. $R^2 = 0.36$. Based on these findings, we strongly suggest additional scientific research to better understand hawksbill turtles in the area incorporate shaded area on nesting beaches and targeted awareness for fishermen communities. Such measures are vital to reduce the pressures found on nesting beaches as well to ensure a higher percentage of hatching success.

BIO-LOGGING STUDIES OF LOGGERHEAD AND GREEN TURTLES MIGRATING TO A HIGH-LATITUDE HABITAT OF THE WESTERN NORTH PACIFIC OCEAN

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Generally most of sea turtle studies are concentrated around nesting beaches. When I was a graduate student (1989-1994), I also tried to investigate foraging ecology of adult female loggerhead turtles landing on a nesting beach. I used Bio-logging, which can be defined as “the use of miniaturized animal-attached tags for logging and/or transmitting data about an animal’s movement, behavior, physiology, and environment”. Depth and temperature loggers were deployed on the carapace to measure diving behavior and experienced water temperature during internesting periods. Another temperature logger was inserted into the stomach to detect feeding events. But, they did not forage actively during their internesting periods. I had to change my main theme to thermal physiology and found out that core body temperature of adult females were 0.7–1.7°C higher than ambient water temperature and were kept relatively constant by their metabolic heat and large body mass.
Since 2005 we have conducted by-catch survey and Bio-logging studies at the Sanriku Coast (38° 55′ -39° 40′ N, 141° 40′ -142° 05′ E), Japan, which is more than 500 and 1500 km north of the nearest nesting sites for loggerhead and green turtles, respectively. The first quantitative survey in the northern Japan revealed that the Sanriku coastal area served an important habitat for large juvenile loggerhead turtles (mean SCL ± s.d. = 71.7 ± 7.0 cm, range = 49.5-92.0 cm, n = 337) and small juvenile green turtles (mean SCL ± s.d. = 47.7 ± 11.0 cm, range = 36.8-90.9 cm, n = 121) during the period from June to November (water temperature 12-24° C). Fortunately, by-catch mortality rates of the both species were not high (2 and 5%, respectively). As a result the Sanriku Coast is a favorable area to study behavioral ecology of turtles.
The feces and gut contents analyses indicated that loggerhead and green turtles at the study site were primarily benthic carnivore and herbivore, respectively, which coincided with previous studies. However, loggerhead turtles with animal-borne cameras did not forage on benthic animals during the recorded periods, but fed primarily on jellyfish in mid-water. Although green turtles mainly foraged on marine algae, they also fed on jellyfish. Foraging events in mid-water tended to occur during the daytime, suggesting that turtles primarily used visual cues to locate prey. In addition, incidents of both species encountering plastic bags while swimming in mid-water were recorded. The fact that the turtles’ movements while approaching the plastic bag were analogous to those of a true foraging event, having a turning point and deceleration phase, support the use of vision in mid-water foraging. The encounter-ingestion ratio of the artificial debris in green turtles (61.8%) was significantly higher than that in loggerhead turtles (16.7%). They seemed to confuse solo drifting debris with their diet, and omnivorous green turtles were more attracted by the plastic bags.
According to satellite tracking, both species utilized the Sanriku coastal area as a summer restricted foraging habitat. Loggerhead turtles spent most of their winter time traveling in oceanic waters (>200 m) several hundreds to thousands kilometers east of Japan whereas green turtles moved along with coastline more than 500 km to reach southern habitats. There was no strong seasonal pattern in diving behavior of loggerhead turtles and daily average dive duration was 20.9±11.6 min, although ambient water temperature changed more than 10°C between summer and winter. In addition, loggerhead turtles sporadically performed deep dives, including the deepest dive (>340 m) ever recorded for this species, during winter. These results suggest that juvenile loggerhead turtles remained active and possibly foraging in oceanic habitats throughout the winter, rather than adopting the quiescent overwintering strategy previously reported in adult females.

SATELLITE TAGGING REVEALS MIGRATORY ROUTES OF POST-NESTING HAWKSBILL AND GREEN SEA TURTLES TOWARDS THE FORAGING AREAS IN THE NORTHERN ARABIAN GULF

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Although the major nesting sites for hawksbill and green sea turtles have been identified in the Northern Arabian Gulf, there are limited studies describing the movement patterns of the sea turtles in the study area. The aim of this study was to characterize the migration patterns of post-nesting sea turtles from the nesting islands in the Saudi waters to the foraging grounds in the Arabian Gulf. 14 hawksbill (*Eretmochelys imbricata* L.) and 16 green sea (*Chelonia mydas* L.) turtles were tagged with KiwiSat 202 and Splash10-BF-344E satellite transmitters at two occasions (June and July-August, 2017) at Jana and Karan Islands, respectively. Initial results covering the first 122 days post-tag attachment showed that the foraging sites of post-nesting hawksbill sea turtles were generally distributed along the western half of the Northern Arabian Gulf extending from the northern boundary of Saudi territorial waters over the top of Qatar into the western part of the southern basin to UAE. In contrast, movement of green sea turtles during the first 71 days post-tag attachment showed that their foraging sites are located both along the western and northeastern coasts of the Arabian Gulf. Differences in the migratory patterns between the two species are discussed in terms of temporal displacement relative to the nesting islands, duration in different countries Exclusive Economic Zones, sea surface temperature and bathymetry.

FORAGING GREEN TURTLES SURVEY AND MAPPING BY UAV

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Aerial surveys are the most appropriate technique to obtain abundance estimates and distribution for air-breathing marine species thanks to their spatio-temporal coverage efficiency. UAV (Unmanned Aerial Vehicle) technology considerably facilitates the accessibility to the marine environment and is a step forward in spatial ecology. A program using autonomous UAV was initiated in 2012 to census foraging green turtles in shallow seagrass meadows in the Nature Marine Park of Mayotte, Southwestern Indian Ocean. Thanks to a multidisciplinary partnerships work, we have developed a solution to speed up the overall process, from data acquisition by a drone to their representation in a free and open source GIS software. The “SEMMADRONE” project (French acronym for Monitoring and study of the marine megafauna by drone) aims to combine UAV and image processing SIG plugin to map sea turtles in a studied area and export post-processing data, such as date and time information and targets (turtles) location and dimensions. Results provide a spatio-temporal vision of the habitat use by a population of both juvenile and adult green turtles in 2012, 2016 and 2017. Habitat use mapping is critical for appropriate management of human activities on sea turtle foraging areas and constitutes a strong base for sea turtle conservation.

DIVERGENT NESTING BEHAVIOUR LINKED TO DIFFERENCES IN FORAGING BEHAVIOUR OF FEMALE OLIVE RIDLEY SEA TURTLES NESTING ON THE PACIFIC COAST OF COSTA RICA ELUCIDATED WITH STABLE ISOTOPE ANALYSIS

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The olive ridley turtle is the most abundant sea turtle species and is best known for its divergent nesting strategy that exists in a few populations around the world, including in the eastern tropical Pacific (ETP). Some females nest solitarily, and some females nest synchronously in large mass aggregations (*arribada*) . We know little about differences between solitary and arribada nesting females. It is unclear if olive ridley females exhibit exclusively and consistently one of two behaviours, or if a mixed strategy exists, nor do we know if the basis of this behavioural polymorphism is genetic or the result of phenotypic plasticity. There are life-historical and physiological differences between solitary and *arribada* nesters, but a 2012 study did not find significant genetic differences between solitary and *arribada* nesters. Thus, phenotypic plasticity as an underlying mechanism is feasible, and we hypothesize that the divergent nesting behaviour of olive ridley females is linked to a distinct dichotomy in foraging behaviour and habitat-use.

Data on olive ridley foraging behaviour is limited. Previous studies analysed stomach contents of females captured adjacent to nesting beaches. The migrations of 21 olive ridley females were tracked by satellite from an *arribada* beach in Costa Rica and did not reveal distinct foraging areas, but rather a nomadic opportunistic behaviour. One recent study investigated the foraging ecology of solitary olive ridley turtles in Brazil using stable isotope analysis (SIA), and found high plasticity in habitat use.

SIA has become increasingly popular for studying foraging ecology of elusive marine species. Stable isotopes (SI) from the turtle's diet are assimilated and integrated into tissues where they are retained for different amounts of time, representing a snapshot of an individual's foraging history. The two most commonly used SI's are δ13C and δ15N. Carbon reflects the primary producers of a foraging habitat and type of habitat utilized (coastal vs oceanic, high latitudes vs low latitudes). Nitrogen signatures represent the trophic position of an individual within a food web.

To test our hypothesis of a link between the divergent nesting strategy of olive ridley females and their foraging behaviour and habitat-use, we used SIA of δ13C and δ15N to elucidate the foraging history of 369 [solitary (n=186) and *arribada* (n=183)] olive ridley females in the ETP. We collected epidermis samples from nesting females on 12 beaches, including two *arribada* beaches, along the Costa Rican Pacific coast between 2014 and 2016.

Results of SIA of δ15N values ranged from 9.54‰ to 16.21‰ ($\bar{x}$=13.76, SD=1.04), and δ13C values ranged from -17.91‰ to -13.2‰ ($\bar{x}$=-15.42, SD=0.59). There were no visible clusters of SI values. There was a significant difference (Prob>|t|=0.0084) between δ13C means for solitary ($\bar{x}$=-15.5, SD=0.64) and *arribada* nesters ($\bar{x}$=-15.34, SD=0.52). There was no significant difference between δ15N means for solitary ($\bar{x}$=13.75, SD=0.99) and *arribada* nesters ($\bar{x}$=13.78, SD=1.09).

We conclude that the general foraging pattern of olive ridley turtles is indeed very plastic and complex (wide range in both δ15N and δ13C values) indicating an opportunistic strategy. Yet, the significant δ13C values suggest a difference in foraging behaviour between solitary and arribada nesters.

LONG-TERM RESULTS OF IN-WATER LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE AEOLIAN ARCHIPELAGO, AN IMPORTANT FORAGING AREA LOCATED IN SOUTHERN THYRRENIAN SEA (SICILY, ITALY).

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This study reported long term results of in-water loggerhead sea turtles (*Caretta caretta*) in the Aeolian Archipelago, an important foraging area located in Southern Thyrrenian Sea (Sicily, Italy) (Blasi and Mattei 2016; Blasi et al, 2017). Since 2009 annual and seasonal distribution, diet preferences and main threats to juvenile, sub-adult and adult loggerhead turtles were studied by dedicated boat surveys resulted in 488 surface observations and 361 captures of healthy (n = 395), ailing (n = 72) and dead (n = 21) individuals. Loggerheads were encountered at the sea water surface while resting (87%) or feeding on pelagic prey (13%). The geomorphology of the volcanic islands significantly influenced the selection of foraging hotspots in neritic habitats. However, the loggerheads were more frequently sighted during the autumn/winter suggesting the presence of important overwintering habitats in this area. During autumn/winter the turtles also interacted with Fishing Aggregating Devices (FADs), moving from neritic to oceanic habitats. The mean (± SD) curved carapace length (CCL) was 48.8 ± 10.7 cm, with 65% of the individuals ranging from 40–70 cm in size; however, juveniles (CCL< 40 cm) were encountered more frequently during the spring months, probably as a result of the abundant pelagic prey within the coastal area. $\delta^{13}C$ and $\delta^{15}N$ values from scutes of 54 loggerheads were also compared with those of 8 potential prey species (Blasi et al. submitted). Pelagic prey comprised the majority of loggerheads diet with small variations (i.e., benthic prey or fishery discards) depending on size and health of individuals. FADs also affected the distribution of turtles across years by habituating them to temporary and unnaturally aggregated food sources. During the colder season, larger turtles were more common in the afternoon than in the morning, suggesting that the time needed for rewarming might increase with turtle size.

Individual mortality was mainly related to longline fishery (70.6%) while ingestion of anthropogenic debris was reported in 48.5% of the rescued turtles. We also found high levels of bycatch in FADs (19.4%), especially for turtles already entangled in longlines (33%). Turtle-FAD interaction occurred in all life stages, although bycatch was more frequent for smaller turtles. Different threats affected particular life stages in different season, for example longline bycatch and boat collisions were higher in summer, whereas debris ingestion was highest in spring. These results increase the current ecological knowledge of the factors driving loggerhead turtle life and are important for implementing management plans for its conservation in the Mediterranean Sea.

THE IMPACT OF ARTIFICIAL LIGHT AND STRUCTURES ON NEARSHORE DISPERSAL AND PREDATION RATES OF TURTLE HATCHLINGS

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After hatching, neonate turtles entering the water are thought to orientate away from shore into the open ocean using a combination of wave direction and visual (light) cues. Light pollution may interfere with this process by attracting hatchlings at sea, but the relative importance of natural and anthropogenic cues to the dispersal of hatchlings is unknown, as is the impact of attraction to artificial light on survival. Here, we used passive acoustic telemetry to track the in-water movement of flatback turtle (*Natator depressus*) hatchlings dispersing through nearshore waters off Thevenard Island, Western Australia. We tagged turtles using acoustic tags and followed their dispersal offshore from beaches through a receiver array in the presence and absence of artificial light at two sites; one over a nearshore reef platform and one at a site with a jetty. At the reef platform site, we used Generalised Additive Mixed Models to show that artifical light reduced the swim speed of the hatchlings, increased the amount of time they spent in nearshore waters and increased the variance in bearing (a measure of the ability to orientate directly), regardless of oceanographic conditions. Under ambient conditions, ocean currents affected the bearing of hatchlings as they left the shore, but when light was present, this effect was diminished, showing that turtles actively swam against currents in their attempts to move towards the light, thus likely exacting energetic consequences. Although light affected hatchling navigation at the reef platform site, we could not test the effect of light on dispersal at the jetty because 70% of the tagged hatchlings released at this site were immediately consumed by predators. Evidence for consumption was provided by tag detachment or the extensive movement of the tags in the receiver array suggesting that the tag (and turtle) was inside the stomach of a predator. We found that 70% of these mobile predators that consumed tags used the jetty as a daytime refuge and expanded their range after dark. Sampling of candidate species (lutjanid reef fishes) under the jetty revealed the presence of turtle hatchlings in their gut contents. We showed that nearshore structures increased the mortality of hatchlings independent of the presence of artificial light, with mortality likely increased on lighted structures due to hatchlings' attraction to the light and their slow dispersal speeds through the high risk areas.

DIFFERENTIATED SETTLEMENT OF JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) IN TWO CLOSE BUT DISTINCT FORAGING GROUNDS LOCATED ON THE COAST OF SÃO TOMÉ ISLAND, WEST CENTRAL AFRICA

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The island of São Tomé, in São Tomé and Príncipe archipelago in West Africa, is a known nesting ground for the green turtle (*Chelonia mydas*) in the region but is also used for foraging by this species.
This study presents results obtained from exploratory surveys of two foraging grounds that provide distinct food sources (seagrass vs. macroalgae) to explore how this could affect the distribution of juvenile sea turtles of different size groups, and their diet. Isotopic signatures of juveniles hand-captured at each foraging site as well as adult reproducing females was used to infer juvenile recruitment sizes and establishment times in the waters of São Tomé. Juveniles recruited at a minimum size of 34 cm CCL, while settlement time could not be inferred, although resident turtles (immatures) ranged from 53 to 87 cm CCL.
Immatures sampled at each site show clear differences in isotopic signatures, suggesting that they establish specific home ranges related to the available prey items, with different degrees of specialization, as macroalgae (especially the red algae *Polisyphonia* spp) appear to be an important food source, despite some evidence that this population is not strictly herbivore due to enriched d15N values in epidermal tissue.
Our study indicates that São Tomé, despite being an oceanic island with a limited coastal shelf, is an important recruitment/development habitat for juvenile green turtles in the region.
This project is ongoing and developed in São Tomé island under Programa Tatô, a partnership between two NGOs, ATM (Portugal) and MARAPA (São Tomé). This study was mainly funded by CE3C- Lisbon, and PhD scholarship awarded to Joana Hancock by Fundação para a Ciência e Tecnologia in Portugal (PD/BD/52599/2014).
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SATELLITE TRACKING AND STABLE ISOTOPE ANALYSIS HIGHLIGHT DIFFERENTIAL RECRUITMENT AMONG FORAGING AREAS IN GREEN TURTLES

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Identifying links between breeding and non-breeding sites in migratory animals is an important step in understanding their ecology. Recognising the relative importance of foraging areas and ascertaining site specific levels of recruitment can provide fundamental and applied insights. Here, satellite telemetry and the stable isotope ratios ($\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$) of 230 green turtles (*Chelonia mydas*) from a regionally important rookery in northern Cyprus were employed to evaluate the relative importance of four foraging areas. A preliminary analysis of stable isotope ratios suggested that a major foraging area had been missed through satellite telemetry as a large proportion of turtles had isotope ratios that did not correspond to sites previously identified. Stable isotope ratios were then employed to select five turtles to be fitted with platform terminal transmitters in 2015. All five turtles were subsequently tracked to the same location, Lake Bardawil in Egypt. Serially collected tissue samples from 45 females, ranging over two to four breeding seasons, suggested that foraging site fidelity was very common with 82% of females exhibiting extremely high temporal consistency in isotope ratios. Quantifying fidelity allowed an evaluation of foraging area specific contributions to each breeding cohort over the past two decades and demonstrated that recruitment was unequal among sites, and dynamic over-time, with Egypt now currently the major contributor to the nesting aggregation. This work demonstrates the utility of stable isotope analysis to elucidate the spatial ecology of cryptic taxa and illustrates how more robust baselines can be assembled against which to measure the success of future marine conservation initiatives.

LONG-TERM HABITAT USE STRATEGIES OF LOGGERHEADS AND GREEN TURTLES IN THE EASTERN NORTH PACIFIC: INTEGRATING MULTIPLE RESEARCH TOOLS HELPS PREDICT FISHERIES IMPACTS

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Sea turtle conservation relies on limited resources, and therefore efforts need to be prioritized, targeting the most important habitats first to obtain the greatest impact. Because threats and risks vary spatially, it is essential to know how long individual turtles use distinct habitats during their complex life history (residency duration), not just what habitats they use. Knowing the residency duration of turtles, especially in known high-risk areas, is key to prioritizing conservation efforts and predicting fisheries impacts. While great strides have been made to identify what distinct habitats turtles occupy and how they move between disparate foraging and breeding grounds, much remains unknown about habitat-specific residency duration. One way to address this challenge and elucidate long-term habitat use is by integrating multiple tools and applying them synergistically. Here we take this approach to better understand how two turtle populations are using a foraging hotspot in the eastern Pacific with known high bycatch rates.

Off the Pacific coast of the Baja California Peninsula (BCP) in Mexico, in the Gulf of Ulloa, turtle interactions with artisanal fisheries have resulted in high numbers of dead-stranded juvenile North Pacific loggerheads (*Caretta caretta*), as well as many East Pacific green turtles (*Chelonia mydas*). Ongoing conservation efforts would benefit greatly by knowing 1) how long are juvenile loggerheads spending in this foraging area? and 2) are the green turtles in this hotspot only transiting across the Gulf during movements between benthic foraging lagoons, or are they consistently foraging in the pelagic Gulf waters? We answered these questions by combining two powerful tools: skeletochronology and stable isotope (SI) analysis.

To investigate the timing of when loggerhead turtles recruit to the BCP from the central North Pacific (CNP), and then determine residency duration in the BCP, we sampled 258 annual growth layers from humerus bones of 45 dead-stranded BCP loggerheads for SI analysis. For the sympatric green turtles, we similarly estimated age and body size for 35 turtles and sampled 189 growth layers.

The stable nitrogen isotope (δ^{15}N) values for the loggerheads ranged from 8.8 to 20.6‰, and increased with both size and age. After validating isotopic differences between the CNP and the BCP, we identified the timing of this ontogenetic habitat shift for 33 of the 45 turtles. Turtle size and age at recruitment to the BCP ranged from 30 to 74 cm curved carapace length, (CCL) (53.6 ± 14.2 cm), and three to 18 years old (10.9 ± 4.6 years). Our findings showed a bimodal distribution in the timing of this habitat shift, suggesting variable residency duration for these loggerheads. The green turtles sampled ranged in size and age from 42 to 95 cm CCL, and three to 32 years old. We compared our SI results to those from previous regional green turtle studies, and interestingly, only three of the 35 turtles had any SI values that indicated neritic benthic foraging, characterized by high stable carbon (δ^{13}C) and low δ^{15}N values. The remaining 32 turtles only reflected SI values indicating long-term pelagic and omnivorous/carnivorous foraging in the Gulf. Finally, we present the first empirical evidence for age-at-maturation for EP green turtles at 17 and 30 years (77 and 95 cm CCL, respectively), and briefly review the population recovery implications of these findings.

By integrating multiple tools, conservation efforts for these populations now have a clearer picture of how, and for how long, both loggerheads and green turtles use the foraging hotspot in the Gulf of Ulloa. Our approach allowed us to recreate and elucidate long-term habitat use patterns of individual turtles, and can be applied to any turtle population to help guide and prioritize conservation efforts.

THE ANATOMY OF AN ARRIBADA: AERIAL OBSERVATIONS OF NEARSHORE AGGREGATIONS OF MASS-NESTING TURTLES

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During the mass-nesting of olive ridley turtles, thousands of adult females emerge from the ocean simultaneously to dig nests and lay their eggs along a small stretch of beach. Although several studies have previously investigated the phenomenon of mass-nesting events (or '*arribadas*') from the perspective of the nesting beach, little is known about events that occur in the ocean before, during, and after the time when turtles nest. Specifically, no attempt has been made to document the in-water behavior of sea turtles around the time of mass-nesting. In this study, a drone was used to conduct regular aerial surveys over the nearshore waters of a mass-nesting site (Ostional, Costa Rica). Videos recorded during flight were then used to make observations of nearshore aggregations of sea turtles in the days preceding, during, and following seven different mass-nesting events. Although each *arribada* differed slightly from others, a common pattern was that a sizeable aggregation of sea turtles first formed approximately 2 km from shore, gradually increasing in size and density. In the days leading up to mass-nesting events, the aggregation gradually moved shoreward until it reached a distance of approximately 700 m from shore, where most turtles waited until mass-nesting began. Few turtles were observed within 500 m of shore until nesting had started. Overall, the observed pattern suggests a coordinated movement of large aggregations of turtles from an initial staging area approximately 2 km from shore, to a final staging area approximately 700 m from shore. Nevertheless, considerable variation was observed in the movement and distribution of turtles during different mass-nesting events, with some differences possibly existing between larger and smaller *arribadas*. In addition, a relatively constant density of turtles was observed at distances of 2 to 3 km from shore throughout mass-nesting events, suggesting that not all turtles in the area participate in all mass-nesting events. Overall, we observed a mean density of 205 turtles per square km in the nearshore waters at this site, with the largest aggregation covering approximately 6 square km at a density of 1 turtle per square meter; to our knowledge, this is the highest in-water density of sea turtles ever reported. This study provides the first insights into the collective, in-water behavior of sea turtles prior to mass-nesting events, as well as the first glimpse into how such events are structured and coordinated from the perspective of movements at sea.

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WHICH WAY DO YOU GO: SATELLITE TELEMETRY REVEALS REGIONALLY DIFFERENT FORAGING BEHAVIOR OF LEATHERBACK TURTLES

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Sea Turtle Conservancy | Florida Cooperative Fish & Wildlife Research Unit / University of Florida | Sea Turtle Conservancy

Leatherbacks (*Dermochelys coriacea*) are wide ranging, long-distance migrating marine turtles that have been characterized as wandering foragers. In order to examine leatherback foraging areas, a Switching Space-State Model (SSSM) was used to estimate the behavioral state of 25 satellite-tracked leatherbacks from nesting beaches in Panama and Costa Rica. Tracking revealed that more than half of the leatherbacks utilize the Gulf of Mexico (GoM) for foraging, while the rest utilize the North Atlantic Ocean (NAO). Total track distance ranged from 2,702.73–29,631.58 km with a mean distance of 10,728.15 km (±7,033.42). Mean distance for GoM and NAO turtles were 8,187.05 km and 13,481.02 km, respectively. Eight environmental variables were extracted from remote sensing imagery for each turtle location to compare the characteristics of migration and foraging behavior, and foraging regions. We used Hot Spot Analysis to elucidate high use foraging areas, focusing on temporal environmental trends and leatherback occupancy in these areas. The SSSM revealed an intermediate behavior between foraging and migration. The intermediate behavior had different movement characteristics between GoM and NAO, suggesting a casting behavior as opposed to a low foraging behavior at the respective sites. There were significant environmental differences ($p < 0.01$) between behaviors, both within and between foraging regions. Sea surface height and sea surface temperature associated with GoM hot spots showed seasonal oscillations. Leatherback occupancy in these areas often peaked with increases in Chlorophyll-a (Chla) and/or particulate organic carbon (POC). Our findings suggest that leatherbacks nesting along the Caribbean coast of Central America display different intermediate foraging strategies based on the turtle's foraging region, and that movement within the GoM may be influenced by peaks in Chla and POC. These differences are important considerations when developing conservation and management strategies for Atlantic leatherbacks.

ARGOS SATELLITE TELEMETRY OF LOGGERHEAD TURTLES NESTING AT OHAMA BEACH, HIWASA

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HIwasa Chelonian Museum

Ohama beach, located in Hiwasa of Tokushima prefecture (Japan), is a loggerhead turtle rookery known as the place where sea turtle conservation originated in Japan. Since 1950, this beach has been monitored for nesting turtles and used as an attraction for ecotourism. In the past, as many as 308 tracks of nesting females have been recorded at Ohama beach. However the number has dramatically decreased since 1995, with less than 50 tracks per season in recent years.

To gain an insight into the cause of decline, we investigated the movements and potential bycatch incidences of the breeding loggerhead turtles using satellite telemetry in cooperation with the Sea Turtle Association of Japan. The study was conducted during the breeding seasons between 2011 and 2013, and eight nesting loggerhead turtles (SCL 755-895mm) were deployed with platform terminal transmitters. Three turtles had been observed at Ohama beach in the past and the remaining five turtles with no previous record were selected based on size.

The movements of the inter-nesting turtles exhibited two distinct patterns. Some turtles stayed in the waters within 30 km from Ohama beach, and others travelled up to 180 km to other rookeries. The former three turtles likely stayed near Ohama beach to nest at the beach in the successive nesting occasion: two of them nested again at Ohama beach. Contrarily, the latter five turtles moved towards other rookeries in Kochi, Wakayama, and Mie prefectures. The five turtles likely moved to the distant beaches for the purpose of nesting given the time frame of their inter-nesting breeding cycles, although no location fix was acquired from the rookeries to confirm nesting. Our results showed that while some turtles exhibit site fidelity, nesting turtles at Ohama beach have a high probability of moving between other beaches.

Unlike other coastal areas in Tokushima Prefecture, Ohama beach has been spared from coastal development due to its tourism use. Sand is abundant in Ohama and the hatching success is substantially high (an average of 69% over the past 29 years). However, there are some issues with balancing tourism with the conservation of the turtles, raising concerns that guided tours to watch nesting turtles and light pollution from artificial objects behind the beach pose negative impacts.

The turtles that successively nested at Ohama tended to remain in the vicinity of Ohama beach during the inter-nesting period. We speculate these turtles were habituated to the unique environments of Ohama beach, and therefore were not discouraged by the disturbances from using the optimal nesting beach. Other turtles with lower tolerance to disturbances or less experience in nesting activities may have been disturbed during the initial nesting events and therefore did not return to Ohama for the subsequent nesting activities.

Our results also indicated high probability of in-water accidents by inter-nesting turtles. Transmission from two turtles ceased abruptly, and a bycatch incidence was reported by a fisher. These incidences imply substantial effects of fisheries on the decline of the loggerhead nesting population at Ohama beach.

We will use our findings to improve the conservation of sea turtles at Ohama beach. As an initial step, we are aiming to reduce the disturbance factors at Ohama beach so that nesting turtles would feel comfortable and return to Ohama beach for the successive nesting events.

APO ISLAND: A TURTLE HOTSPOT IN THE CORAL TRIANGLE

Alessandro Ponzo | Mary Jane Lamoste | David Lewis | Raphael Ethan Manasan | Ivan Patrick Tualla | Kristina Pahang | Sally Snow | Jessica Labaja | Gonzalo Araujo
Large Marine Vertebrates Research Institute Philippines | Large Marine Vertebrates Research Institute Philippines | Large Marine Vertebrates Research Institute Philippines | Large Marine Vertebrates Research Institute Philippines | Large Marine Vertebrates Research Institute Philippines, Sea Turle Conservancy | Large Marine Vertebrates Research Institute Philippines | Large Marine Vertebrates Research Institute Philippines | Large Marine Vertebrates Research Institute Philippines

The Apo Island Protected Landscape and Seascape (AIPLS) is one of the best examples of a marine protected area in the Philippines. While fish and corals have been studied in the seascape for decades, no dedicated work has been done to assess the population of green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles found there despite becoming a major driver of tourism on the island in recent years. Diving tourism and dedicated snorkeling interactions with turtles have grown fast in recent years, with >17,000 tourists (51% Filipino) visiting the island in 2015. In light of the increasing anthropogenic pressure, intensification of extreme climate events and the endangered status of sea turtles, we started the first dedicated assessment of turtles at AIPLS. Photographic identification (photo-ID) snorkel-based surveys were conducted between April 22nd and May 29th 2016, and between April 28th and June 7th 2017 along the west side of the island. Turtles were identified from their unique facial scute pattern, a cost-effective and minimally invasive technique. Visual matches were validated using the pattern recognition software I^{3}S Pattern©. A total of 528 encounters were recorded with 72 individual green turtles and 4 hawksbill turtles in 2016, and 1,104 encounters with 112 green and 7 hawksbill turtles respectively in 2017. In-water surveys were only conducted in the morning in 2016, but afternoon surveys and greater area coverage were introduced in 2017. In 2016, an average of 13.9 turtles were identified per day (range 5 – 32), and in 2017 an average of 30.5 turtles were identified (range 6 – 60). To expand our understanding on the site fidelity and habitat use of the resident turtles, the photographic catalogue was integrated with systematic but opportunistic photo-identification data collected since 2013 by a resident dive operator. Several of the resident turtles showed long-term site fidelity with the longest photographic recapture interval spanning 1,200 days. Furthermore, citizen science data showed the longest photographic match back to 2011. A total of 142 green and 7 hawksbill turtles have since been identified within 2 areas on the South-West coast of AIPLS, with very low intermixing (12.6% seen more than once in a different location) and high site fidelity. AIPLS is an important hotspot for green turtles, and their year-round presence, long-range movement and tourism interactions require further investigation. The critically endangered *E. imbricata* is present, but not as reliably encountered. Further work will ensure we understand their presence, distribution and habitat use at AIPLS.

AMINO ACID COMPOUND SPECIFIC NITROGEN ISOTOPIC COMPOSITIONS OF TWO GREEN TURTLE (*CHELONIA MYDAS*) FORAGING POPULATIONS: IMPLICATIONS FOR TROPHIC STUDIES OF A WIDE RANGING MARINE REPTILE

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Bulk tissue stable isotope analysis (i.e. $\delta^{13}C$ and $\delta^{15}N$ values; BSIA hereafter) has been widely applied to study the movement, habitat use, and the trophic ecology of marine organisms. However, interpretation of $\delta^{15}N$ values from bulk tissues can be confounded by nutrient dynamics and their effect on nitrate $\delta^{15}N$ values. Amino acid compound specific nitrogen isotope analysis (AA-CSIA), in contrast, may provide more accurate information on the trophic ecology of marine organisms by accounting for differences in $\delta^{15}N$ values at the base of the food web, which is especially important when applying this approach to wide-ranging animals that occupy multiple ocean regions throughout different life stages. The East Pacific green turtle (*Chelonia mydas*; hereafter referred to as the green turtle) occupies foraging grounds throughout the eastern Pacific Ocean, ranging from the U.S. West coast to Chile. Recent studies using bulk tissue $\delta^{15}N$ values have revealed different isotopic compositions in green turtle foraging populations across their range, making it challenging to determine whether these differences result from consumption of divergent prey or variability in the nutrient dynamics among foraging areas. In this study, we used BSIA and AA-CSIA of green turtle plasma collected from individuals of two different foraging locations in the East Pacific; Laguna San Ignacio, a pristine bay in Baja California Sur, Mexico and San Diego Bay, a highly industrialized bay in southern California, USA. Bulk tissue analysis revealed significant differences in mean $\delta^{15}N$ values between the two populations, with San Diego Bay green turtles having $\delta^{15}N$ values significantly higher than those of Laguna San Ignacio. Amino acid stable isotope analysis, however, indicated that the two populations were foraging at similar trophic levels, but revealed differences in foraging-ground specific primary production dynamics. This study highlights the importance of using amino acid compound specific nitrogen isotope analysis to gain more accurate insights into the trophic ecology of organisms that occupy distinct habitats over large spatial scales.

HIGH-RESOLUTION UNDERWATER 3D MOVEMENTS UNEARTHED HIGH-FREQUENCY GYRATION BEHAVIOUR IN HOMING GREEN TURTLES

Tomoko Narazaki | Hiroyuki Suganuma | Paolo Luschi | Simon Benhamou | Stephan Ciccione | Katsufumi Sato
University of Tokyo | Everlasting Nature of Asia | University of Pisa | Centre d’ Ecologie Fonctionnelle et Evolutive | Kelonia l’ Observatoire des Tortues Marines | University of Tokyo

Sea turtles migrate for long distances throughout their lives and are known to exhibit nest site fidelity. To examine their navigation mechanisms, a number of translocation experiments in which nesting females are captured at nesting beach and transferred to oceanic releasing site, have been conducted. Homing turtles are usually tracked by GPS and/or Argos satellite telemetry that provide horizontal movements at sea surface, but not in the water. Because potential navigation cues exist differently at sea surface and underwater, it is essential to monitor underwater movements to discuss their navigation mechanism. Here, we used high-resolution 3D data logger to reconstruct fine-scale underwater 3D movements of green turtles during translocation experiments conducted at Moheli Island in Comoro (N = 1) and Chichijima Island, Ogasawara in Japan (N = 2). From oceanic releasing sites, all turtles swam continuously and maintained near straight-line course regardless of day and night until they reached around the island. While travelling at oceanic zone, turtles utilized shallower depth undertaking a number of subsurface dives (< 4m) during daytime whereas they performed deeper dives (24.4 ± 9.7 m, N = 76) during night. Although turtles maintained unidirectional heading throughout dives, travel direction tended to shift by the end of dives. Such deflections in heading seemed to be compensated during subsequent surfacing periods, suggesting that turtles adjust their travel direction at sea surface. After homing turtles approached the island, mysterious machine-like gyration behaviours were recorded: turtles quickly gyrated (mean cycle = 22 - 35 s) more than 2 times (max. 83 times) at sea surface. It is possible that such gyration behaviours are related to goal-finding navigation because turtles changed the travel direction toward their destination after the gyrations. Our results highlight the importance of high-resolution underwater movements to understand navigation of sea turtles that utilize two fundamentally different environments (sea surface and underwater) during migration.

ESTIMATING DENSITY OF POST-HATCHLINGS AND SURFACE PELAGIC JUVENILE TURTLES ASSOCIATING WITH SARGASSUM COMMUNITY IN THE GULF OF MEXICO

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Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute | Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute | Disney's Animals, Science & Environment

After emerging from nests, sea turtle hatchlings enter the ocean, swim offshore, and find surface-Sargassum community (here after community). The Gulf Stream Current is largely responsible for the distribution of the community within the Gulf of Mexico, Caribbean Sea and North Atlantic Ocean. On a more localized scale, the size, shape and location of this community is influenced by abiotic factors (wind, surface currents). Estimating the density of turtles in this dynamic community is a primary objective of our research. To achieve this, we conducted vessel transect surveys and collected sea turtle observational and habitat data within the community in the northern Gulf of Mexico from 2012 to 2016. During the study period, we observed and collected data from two groups of turtles, post hatchlings (young of the year, up to few months old, n = 14) and pelagic juveniles (>1 year old, n = 123). We collected data on distance from transect to turtle observations and associated transect length. After determining appropriate detection probability function, the densities of the turtles for each size group were estimated, using program R with Rdistance package. Among detectability functions, Akaike's information criterion favored a half normal function for post-hatchlings and a negative exponential function for surface-pelagic juveniles. The results of density estimation was 1.98 (95 % CI: 0.742 – 5.28) post-hatchlings per km^2 and surface-pelagic juvenile turtles 9.73 (95 % CI: 7.19 – 13.2) per km^2.

SATELLITE TRACKING OF POST NESTING GREEN SEA TURTLES FROM THE TURTLE ISLANDS HERITAGE PROTECTED AREA

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Twenty five green sea turtles were tracked using Wildlife Computers SPOT transmitters between 2015 and 2016 from the Turtle Islands Heritage Protected Area, a group of nine islands shared by Malaysia and the Philippines, to identify foraging grounds determined migration paths of marine turtles and linkages between foraging and nesting populations within the important Sulu-Sulawesi biogeographic region.
Several distinct movement patterns emerged from these migrations, with (a) some turtles staying close to the TIHPA islands for long periods, (b) others migrating up the Sabah coastline but remaining in Sabah, (c) others following a similar path but moving northeast up into Palawan and beyond in the Philippines, and others (d) travelling southward along the Sabah coast and moving as far south as Sulawesi in Indonesia. Of note, turtles mostly stayed in coastal waters.
Some of the migrations highlight the value of Marine Protected Areas in safeguarding sea turtle habitat, as turtles from the protected nesting beaches took up residence in or near other protected areas. Our data also demonstrate the value of satellite tracking over tag returns for determining actual movement patterns, rather than those inferred by ‘straight line’ recaptures.
The data derived from this programme will build on the conservation and information needs for effective management of green sea turtles in the Sulu-Sulawesi Seascape. These tracking efforts also assist in refining the boundaries of green sea turtle RMUs. The differentiation between coastal and oceanic migrations, and the selection of identifiable foraging habitats provide regional and National management agencies with information to build conservation agendas for these species.
Expanding the current research on linkages between nesting and foraging grounds will better enable management efforts and support regional and global efforts to understand sea turtle population structure.

INDIVIDUAL SPECIALIZATION AND BEHAVIOURAL PLASTICITY IN LOGGERHEAD TURTLES FROM CAPE VERDE ARCHIPELAGO

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Individual specialization in vertebrates is often related to morphological variability, but can also reflect a diversity of trajectories during the learning sensitive period in early life. In both cases the capacity of adults to adapt to new environments can be limited if further morphological or behavioral change is not possible. Adult loggerhead turtles *Caretta caretta* (Linnaeus, 1758) from Cape Verde (NW Africa) may forage in the open ocean or on the continental shelf. Oceanic foragers prevail in the population, but neritic foragers grow larger, have a higher reproductive output and produce best fitted offspring. Previous research suggests that the high prevalence of oceanic foragers is because the migratory routes followed by juvenile turtles during their early life results into a low probability of settlement on the African shelf. The stable isotope ratios of C and N in 60 μm carapace layers from 14 adult females have been analyzed to reconstruct retrospectively their individual habitat use patterns and test the hypothesis that adult loggerhead turtles remain faithful to their foraging grounds even if sub-optimal. Only two turtles exhibited clear oceanic—neritic shifts, approximately 22 and 15 years before sampling. The remaining turtles had foraged in neritic (3) or oceanic (9) habitat as long as recorded in the carapace scutes (approximately 8–37 years), despite the smaller body size and the lower reproductive output associated to oceanic foraging. These results suggest that habitat shifts during adulthood are unlikely in this species and support the hypothesis that only during the juvenile stage loggerhead turtles are flexible enough to adapt to contrasting environments.

FORAGING SEGREGATION BETWEEN TWO SYMPATRIC SPECIES OF GENERALIST SEA TURTLES REVEALED WITH STABLE ISOTOPE ANALYSIS

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In their juvenile stages, Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtles inhabit coastal areas along the U.S. Atlantic coast with overlapping distributions. Previous studies have suggested that they rely on similar hard-shelled benthic invertebrates (i.e., crabs, mollusks, etc.). Segregation in diet and/or habitat is vital for the coexistence of potential competitors, which can be evidenced by differences in morphology and/or feeding behavior. In this study, we analyzed blood of juvenile Kemp's ridley and loggerhead turtles and their potential prey items for carbon and nitrogen stable isotope analysis ($d^{13}C$ and $d^{15}N$) to investigate how resources are partitioned between these two sympatric species of generalist carnivore turtles and to determine if body size influences the stable isotope values. Blood samples (n = 68) from turtles captured in nets in 2012 and in 2013 and potential prey items (n = 202) were collected from two foraging areas off the South Carolina and Georgia coasts. Kemp's ridley turtles had significantly higher $d^{13}C$ and $d^{15}N$ values than loggerhead turtles. This suggests that Kemp's ridley turtles, while being smaller in size than loggerheads, are feeding on higher trophic level organisms. Indeed, stable isotope mixing model suggests that Kemp's ridley turtles rely on crabs but also fish, while loggerhead turtles are feeding mostly on crabs and other invertebrates. A significant increase in $d^{15}N$ values with body size was observed for both turtle species with the largest size class of loggerhead turtles (SCL ≥70cm) having similar isotopic values as Kemp's ridleys. However, even though these turtles may be relying on similar prey items, as evidenced by the similar isotopic values, the contribution of these prey items in the turtles' diet varied. As conservation efforts continue and sea turtle populations increase, understanding how resources are partitioned between closely related species is important, because it will help us assess how loggerheads and Kemp's ridleys will utilize resources as population numbers rise.

SATELLITE TELEMETRY REVEALS INTERNESTING MOVEMENTS FOR LOGGERHEADS IN RIO DE JANEIRO, BRAZIL.

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UFBA | Braço Social Consultoria | Prumo Logística Global | Prumo Logística Global | Prumo Logística Global | Braço Social Consultoria

The Southern most loggerhead sea turtles nesting population in Brazil is located at the Northern coast of Rio de Janeiro State. In recent years this particular region has drawn attention due to higher rates of male offspring compared to other *C. caretta* nesting aggregations in the Southwestern Atlantic. Every nesting season, between September and March, about 2,500 nests are recorded in 100 km of cost. Due to high level of fishing activity as well as coastal development lead by navigation intensification, port infrastructure and oil production, new information on in-water behavior and habitat use becomes extremely important to propose and adjust sea turtle protection measures. Between December 2016 and January 2017, eight female loggerhead sea turtles were tagged with satellite transmitters after nesting was concluded at Maria Rosa, Farolzinho and Farol beaches, at the southern portion of the nesting area. Animals were then monitored during internesting period until they left the reproduction region in February 2017. Data obtained revealed a preference in the use of areas up to 15 m deep, with a median of 10 m, and distances as far as 8,000 m from the coast., with a median of 3,312 m. Tagged turtles also showed a preference in spending their internesting period at the mouth of Paraiba do Sul River, moving parallel and close to shore to the referred area after nesting and remaining in place with little variation until it was time to nest again. The preliminary information is already being used to organize, monitor, and coordinate dredging activities at Port of Açu, a recently built offshore port with a 20 km navigation channel which will need periodical maintenance dredging with frequency not yet defined. In parallel this information is contributing to the establishment of priority conservation areas and to review regulations for oil and gas production near sea turtle nesting areas. Additional data gathered from the region's fishing fleet indicate a large level of overlapping between fishing areas and areas where females spend their internesting intervals. As more tags will be deployed between October and December 2017, it is expected more information to be gathered on in-water habitat use by loggerhead females at this reproduction aggregation.

INVESTIGATING FORAGING HABITAT FOR OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) USING STABLE ISOTOPE ANALYSIS AND SATELLITE TELEMETRY

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Old Dominion University | Wildlife Conservation Society-Gabon | Aventures Sans Frontieres | Wildlife Conservation Society-Gabon | Wildlife Conservation Society-Gabon | University of California Santa Cruz | Foundation Liambissi | Wildlife Conservation Society-Gabon | University of Exeter-Penryn Campus | University of Exeter-Penryn Campus | Wildlife Conservation Society-Gabon | Agence Nationale des Parcs Nationaux | Centre Nationale des Donnees et des Informations Oceanographiques | Ibonga-ACPE | University of Exeter-Penryn Campus | WWF-Gabon | Wildlife Conservation Society-Gabon | Wildlife Conservation Society-Gabon | Aventures Sans Forntieres, Agence Natinale des Parcs Nationaux | University of Exeter-Penryn Campus | University of Exeter-Penryn Campus | Old Dominion University

Understanding the post-nesting foraging habitat of olive ridley sea turtles (*Lepidochelys olivacea*), a threatened species, is critical for determining regions of protection that may effectively reduce bycatch, the largest threat to this species. Post-nesting foraging sites are not well defined in the East Atlantic for this species, which utilizes the West African coast and coastline for nesting. $\delta^{13}C$ and $\delta^{15}N$ stable isotope analysis of 149 epidermis samples from female nesting olive ridley turtles in Gabon, 38 of which also had satellite transmitters, were used to determine if distinct foraging locations exist for this population. Tracked turtles allow for visualization of foraging areas, which can then be correlated to their distinct isotopic signatures and further matched to untracked turtle signatures. Cluster analysis of the isotope ratios from all turtles produced two significant clusters with a 95% predictability rate. Track visualization of each cluster did not show any foraging patterns and a generalized linear model determined that CCL, nesting beach, Atlantic Niño events, and average straight-line distance from foraging location were not indicators for cluster assignment. Due to olive ridley turtles being opportunistic feeders and following a "looping" pattern to find new food sources, it is difficult to use stable isotope analysis to identify foraging habitat for non-tracked turtles in this population.

SHELL WALLS: A NEW HOPE FOR SEA TURTLE CONSERVATION

Ryan Pearson | Jason van de Merwe | Michael Gagan | Colin Limpus | Rod Connolly
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Understanding the geographic distribution of migrating sea turtles within their sub-populations could enhance conservation and management, especially for sub-populations that are the most threatened. Isotope techniques have been used for this purpose and have become popular in the past decade with an increasing year-to-year trend in published studies. However, there is also a mismatch when comparing research effort to conservation needs. For example, regional management units (RMUs) listed as of 'least concern' by the IUCN have been studied at a rate many times higher than those considered threatened. We aim to address this mismatch with conservation needs by using isotope analyses to investigate the foraging distributions of critically endangered south Pacific loggerhead turtles. To achieve this, we present a novel method which uses isotope ratios from commensal barnacle shells to assign turtles to foraging areas with high success (up to 94%). Our method provides comparable spatial resolution to soft-tissue isotope analyses but with lower reliance on concurrent satellite telemetry to develop baseline signals within an area. We also show that analysis of successive shell layers provides information about migration distance and integration with water temperature and salinity data allows for inferences about habitat use within an area. This technique may allow for rapid assessment of connectivity between foraging and nesting habitats, foraging distributions and identification of critical habitats within RMUs. We expect this method to be applicable to most sea turtle species, as well as other taxa that carry commensal barnacles.

TROPHIC ECOLOGY OF THE GREEN TURTLE *CHELONIA MYDAS* IN THE CARIBBEAN IN THE CONTEXT OF THE COLONIZATION OF THE COASTS BY THE INVASIVE PHANEROGAM HALOPHILA STIPULACEA

Flora Siegwalt | Denis Etienne | Jordan Martin | Marc Bonola | Julie Gresser | Fabien Vedie | Yvon Le Maho | Jean-Patrice Robin | Damien Chevallier

Université de Strasbourg, IPHC, CNRS | DEAL Martinique | Université de Strasbourg, IPHC, CNRS | Université de Strasbourg, IPHC, CNRS | Office de l¥'Eau Martinique | DEAL Martinique | Université de Strasbourg, IPHC, CNRS | Université de Strasbourg, IPHC, CNRS | Université de Strasbourg, IPHC, CNRS

The seagrass *Halophila stipulacea* has expanded since 2002 from the Red Sea to most Caribbean islands, where it competes with native phanerogams. In coastal habitats, invasive species generally have a severe impact on marine ecosystems. Thus, to identify possible factors able to control its expansion, we focused on the trophic ecology of the green turtle (*Chelonia mydas*), the only large herbivore present in the area. The large population of immature individuals of various sizes in Martinique, because staying there during an extended period of growth, allowed us to investigate their foraging habitat selection through direct observation, in combination with spatial information and characterisation of biocenosis. Food selection by individuals was described using video-records and isotopic data from sea turtle biopsies and plant samples. Energy, ash and nutrient contents were measured in plant tissues as tentative explanatory factors for food selection. Conspicuous patterns of habitat use show a preference for the native *Syringodium filiforme*-rich communities. But multispecific seagrass meadows with dominance of *H. stipulacea* were also selected. This means that green turtles preferentially rely on native species (*Thalassia testudinum*) but do not avoid *H. stipulacea*, suggesting they might limit their invasion. The isotopic signatures supported these findings, but also indicated an important consumption of algae by young immatures and that they rely on animal matter in neritic environments. Lower carbon contents in algae and H. stipulacea, which could reflect lower fiber content, may explain that they are targeted by young individuals. Algae are more digestible since they do not contain lignin. Conversely, large immatures likely have a more efficient digestion system, which allows them to rely on native lignin-rich phanerogams that have also a higher energy content. They could therefore apply a greater herbivory pressure on native seagrasses, which could in turn favours the expansion of *H. stipulacea*. If *H. stipulacea* outcompetes native species in the future and does not satisfy turtle's energy requirements, it may raise concerns on the future status of green turtle populations in the Caribbean marine ecosystems.

Keywords: habitat selection, food selection, isotopic ratios, energy and nutrient content, seagrasses, algae.

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DIVING AND FORAGING BEHAVIOR OF LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) NESTING ON ST. CROIX, U.S. VIRGIN ISLANDS

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Sandy Point National Wildlife Refuge, St. Croix, US Virgin Islands supports nesting by approximately 200 leatherback sea turtles. With its offshore waters designated as Critical Habitat in 1978, and established as a National Wildlife Refuge in 1984, the 2.4 km long nesting colony has been monitored since 1982. Many of the females have been tagged, so their interannual nesting behavior and success is known. Each female typically lays six clutches of eggs separated by about 10 days at sea which enables researchers to attach and recover instruments reliably. Previous research in 1989 using a time-depth recorder showed that leatherbacks dive almost continually with duration averaging 12-14 minutes throughout the internesting period and are the deepest diving of the seven sea turtle species with a maximum dive depth of ca. 1,300 m. However, the motivation for such dive behavior remains poorly studied. It has been proposed that such dives could represent foraging or predator avoidance. In this study, we attached video and data recorders (VDRs) to three females during May of 2016-17. The VDRs recorded three dimensional dive behavior and feeding events from an average of 600 total dives from each individual. The turtles' movements at sea were recorded in near real time by satellite telemetry. After laying, females remained within 160 km of St. Croix, often moving into the Virgin Islands Trough or around the southeast side of the island at an average swim speed of ca. 0.7 m s^{-1}. Mean maximum dive depth and duration were 478 m and 23 min, respectively (maximum dive depth 505 m, duration 24 min). We video recorded the turtles feeding on the Atlantic sea nettle (*Chrysaora quinquecirrha*), Moon jelly (*Aurelia aurita*), Pelagic tunicate (*Salpa aspera*), and Giant fire salp (*Pyrosoma* spp.) at an average depth of 78 m (maximum foraging depth 315 m). Also irregular periods of rolling behaviors (+/- 180 degree flipping), typically known as a defense swim, were found occasionally when the turtles were located within 15 km off of Sandy Point. However, rather than intensive foraging, feeding appears to be opportunistic leaving us to speculate that the dive and movement behavior of leatherback sea turtles during the internesting periods appear to be necessary for maturation of the next clutch of eggs while avoiding sharks that patrol the nearshore waters of the nesting beach.

HIGH RESTING METABOLIC RATES INDUCE ACTIVE OVERWINTERING OF JUVENILE LOGGERHEAD TURTLES *CARETTA CARETTA* IN THE WESTERN NORTH PACIFIC

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For ectothermic sea turtles, ambient temperature is one of the most important factors influencing physiological states. The metabolic rate and activity of sea turtles decrease with decreasing ambient temperature. In winter, juvenile loggerhead turtles in the Mediterranean showed prolonged inactive dives lasting several times compared with summer. However, no seasonal difference in dive duration was reported in juveniles in western North Pacific, although the ambient water temperature changed more than 10℃. In this study, we aimed to test a hypothesis that active overwintering of juveniles in the western North Pacific is driven by their high resting metabolic rate (RMR). We measured RMR at various water temperature (15−25℃) of juveniles which were incidentally captured by set net at the Sanriku coastal area (N = 4). The RMR of juveniles was 1.7 to 6.2 times (Q_{10} = 1.9) higher than those of juveniles in the Mediterranean (previous study). To validate the value of high RMR, ΔT_b (difference between body core temperature and ambient water temperature) was estimated by RMR, and compared with measured ΔT_b (N = 4). The measured ΔT_b matched estimated ΔT_b. In addition, juvenile turtles in this area were tracked for more than 200 days to measure dive durations using satellite relayed data logger (SRDL). The turtles conducted most dives (41,769 out of 46,666; 89.5%; N = 12) within calculated aerobic dive limit (cADL) that were predicted from RMR. Our results imply high RMR induce active overwintering of juveniles in the western North Pacific. Loggerhead turtles have widest geographical range of any of the Cheloniidae, which might have led the inter-population variations in physiological states to adapt to various environments.

SLIDING INTO DSMS: DENSITY SURFACE MODELLING TO DETERMINE DISTRIBUTION AND SPATIAL SEGREGATION OF LARGE GREEN TURTLES ON A FORAGING GROUND

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University of Central Florida / Inwater Research Group | Inwater Reseach Group | Inwater Research Group | Inwater Research Group | Inwater Research Group

Intraspecific competition among green turtles (*Chelonia mydas*) remains an understudied aspect of the species' ecology. Previous work on this topic has focused solely on single size classes of green turtles; no published accounts have focused on competition between size classes. The Eastern Quicksand foraging grounds located near the Florida Keys, USA, are one of the highest density adult and sub-adult green turtle foraging aggregations in the world, containing approximately 100 turtles per square kilometer, second only to the Agatti Lagoon off the coast of India (Lal *et al*., 2010). In this study, we have divided these foraging areas using six predetermined lines to form standardized transects. Each transect is six kilometers long and is positioned one kilometer from adjacent transect lines. Surveys along the transect grid are conducted by boat with two observers located atop a two-meter elevated central tower, while a helmsman marks sightings with a Garmin Global Positioning System. Green turtles observed during these surveys are identified to life stage, while distance from the transect line and the animals position in the water column are estimated. Environmental factors including depth and water temperature are also recorded. We have run these transects 15 times in the past 13 years. We determined how green turtle size classes are distributed on these foraging grounds using Density Surface Modelling (DSM). DSM is a generalized additive model-based (GAM) approach used to calculate spatially-explicit estimates of abundance while incorporating significant environmental co-variates. Unlike Distance Sampling, in which animals are assumed to be evenly distributed throughout the survey area, DSM divides each transect into smaller sections, estimating abundance of green turtles for each individual section. These results are then used to create a prediction grid over the entire foraging grounds, including areas that were not directly surveyed. We used this grid to create abundance heat maps for the entire study area providing distribution for both size classes. These prediction grids can also be used as matrices where null model analysis can look for evidence of co-occurrence among the adult and sub-adult green turtles. Understanding how intraspecific competition shapes the distribution of size classes is necessary for the management and conservation of species with complex life histories. As these previously depleted species recover they may encounter degraded or fragmented habitats, in which aspects such as intraspecific competition could affect further species recovery. This can be especially true for species, such as green turtles, that are long lived and late maturing, where the effects from conservation programs may not become evident for many years.

USE OF DIFFERENT STRATEGIES TO AVOID NESTING FEMALES POACHING IN BOA VISTA PROTECTED AREAS

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Cape Verde beaches host the third largest loggerhead (*Caretta caretta*) rookery in the world and the only one in the eastern Atlantic. Southeastern Boa Vista beaches, included on protected areas "*Reserva Natural das Tartarugas*" (RNT) and "*Parque Natural do Norte*" (PNN), presents the highest nest densities throughout the archipelago (70%). Therefore, conservation and protection of these beaches is crucial for this important rookery. Last years, all groups involved in loggerhead conservation (NGOs, Local Associations and Government) have targeted their efforts to reduce nesting females poaching on the beaches. For this purpose, there have been implemented different strategies for beach monitoring, conducting night patrols by (1) volunteers (NGO staff), (2) local guards, (3) local guards + soldiers (4) local guards + police.
Until 2008, only 10km of beaches were patrolled each night, so poachers could use other beaches for females hunting. From 2009 others groups (NGO and Local Associations) had started working in Boa Vista, achieving all together to control most part of Boa Vista beaches, making more difficult females poaching. CVNAT2000 had worked almost the same 15-20km of beaches from 2009, using the 4 different surveillance strategies. Until 2011 national and international students (volunteers) conducted night patrols, mainly to learn and support turtle conservation activities. In 2012, Boa Vista Protected Areas Office (Environmental Minister, Cape Verde Government) involved local guards on beach protection and in 2013 included also soldiers in night patrols. Nevertheless the important turtle poaching reduction, no more soldiers has been sent in the next years, except in the end of the 2015, after the Fred Hurricane devastative effects. So, from 2014 to 2016, only local guards were used, in exception with occasional inclusion of Soldiers in September-October 2015 and Police reinforcement in September-October 2016. Significant differences have been observed, identifying the 3rd and 4th ones as the most effectives, or which achieves a greater reduction. However, using soldiers to beach monitoring has generated certain discontent among the local community, when there was considered very important to strengthen relationships with local communities.
In other hand and important change has been observed in Boa Vista Island in the last years, where the traditional use of turtle meat for local consumption had been changed to local trade of turtle meat in the island. Important differences have been observed in the number of females hunted and the poacher attitudes in the beaches due to this important change of use.

TWENTY YEARS IN THE SOUTHERN NICOYA PENINSULA, COSTA RICA: A EFFORD BASED IN THE COMMUNITIES.

Daniela Rojas-Cañizales | Madeleine Beange | Wilson Reyes Vargas | Randall Arauz | Isabel Naranjo
CREMA | CREMA | CREMA | Fins attached | CREMA

Centro de Rescate de Especies Marinas Amenazadas (CREMA), a Costa Rican NGO previously named PRETOMA, initiated a solitary nesting beach conservation program on the southern Nicoya peninsula in 1998. The sea turtle egg protection effort had been started three years earlier in Playa San Miguel as a grassroots initiative, because according to anecdotal records, nearly all of the olive ridley sea turtle eggs had been poached from the beach for at least a generation. Over the last two decades CREMA has successfully expanded the conservation effort to three additional neighboring coastal communities, using a holistic approach that includes both direct hatchery protection methods, and long term strategies of community development and environmental education. This study evaluates the results of the Playa San Miguel and Costa de Oro projects to demonstrate that although this holistic strategy is effective, it must be applied to each coastal community to provide a widespread, long term result. These two projects provide the perfect case study because they are based in two different communities located on a seven kilometer stretch of nesting beach, but are separated physically in the center by an estuary.

All the data were collect since 1998 between July- December, through morning census and nightly patrols conduce for training locals and research assistants, recording each event and categorized all in successfully (nested, poached, depredated) or unsuccessfully (aborted nest, false crawl). The entire nest found (no poached) in the same night was relocated in the hatchery. Over the last two decades a total of 9228 events were recorded in Playa San Miguel (6846 events) and Playa Costa de Oro (2382 events). In addition the number of nest poached this season shows the number in Playa San Miguel (7%) and Playa Costa de Oro (17%) is still decreasing. In the 98' in Playa San Miguel the 50% of nests on the beach was poached, twenty years of environmental education and hard work is the reason why the poached nest is decreasing year by year. The same is happened in Playa Costa de Oro only with six years since was open the effort on the beaches has the best results ever for this year. The poaching eggs is illegal and still concerns to the communities but the changes still happens on the southern Nicoya peninsula, the creation of a sustainably programs, jobs opportunities, environmental conservation and the strategies in long line of time in both nesting beaches are the reason of the successfully conservation program for us.

THE BASKING BEHAVIOR OF GREEN SEA TURTLES EXPLORED WITH THE TOOLS OF DATA SCIENCE AND MACHINE LEARNING

Andras Zsom | Shiying Luo | Hannah Bernard
CIS, Brown University | Brown University | Hawaii WIldlife Fund

The Hawaii Wildlife Fund (HWF) conducts green sea turtle monitoring dating back several years with the help of volunteers on one of the beaches of Maui, HI. Volunteers count the number of turtles basking on the shore as well as the number of humans visiting the beach every day between 2pm and 7pm every 30 minutes. The Data Science Practice team at the Computing and Information Services, Brown University, Providence, RI teamed up with the HWF to explore the relationships between turtle population and human visitation rates and the observed environmental conditions. The main objectives were to better understand the basking behavior of turtles by means of data analysis and to develop a predictive model for the number of turtles and human visitations one day ahead based on the weather forecast and the expected sea conditions.

Initial data exploration was used to understand why turtles bask on the shore and it provides supporting evidence for and against theories that explain the basking behavior. Mainly, we find that the tidal height and the turtle count are inversely correlated. While causal relationships are difficult to infer with analysis of observational data alone, the findings suggest that the available beach area directly impacts how many turtles can bask ashore. Our results indicate that beach erosion can significantly alter the basking behavior of green sea turtles in the future. One theory proposes that the turtles bask to warm their bodies and based on this we would expect a positive correlation between the air temperature or the air-sea temperature difference and the turtle count. However, we observe weak negative correlations which does not support the theory.

The predictive model helps HWF staff members to identify “busy days”, days when the beach will be crowded by both humans and turtles. One way to minimize human impacts is for the HWF to have a stronger presence on the beach on such days to educate the visitors and to keep the humans away from the turtles. We find that our model can predict the turtle count with a mean absolute error (MAE) of 17 and with a coefficient of determination (R2 score) of 0.28; the human count is predicted with a MAE of 9 and an R2 score of 0.13. The exact same features are used to predict the turtle and human counts, thus the higher R2 score of the turtle count suggests that the turtle behavior can be better predicted by the weather and sea conditions than the human visitation counts.

DISNEY'S INVOLVEMENT IN SEA TURTLE CONSERVATION

Rachel Smith | Blair Witherington | Anne Savage
Disney's Animals Science and Environment | Disney's Animals Science and Environment | Disney's Animals Science and Environment

Conservation of sea turtles at the Walt Disney Company assumes many forms, largely through our philanthropic support of nonprofit organizations around the world through the Disney Conservation Fund (DCF), collaboration with nonprofit partners through the DCF Reverse the Decline initiative, creation of sea turtle educational content, intellectual property, and beloved sea turtle characters through Walt Disney Studios, and direct involvement with *in situ* conservation, education, rehabilitation, and husbandry of sea turtles in our theme parks.

How did we get here? To answer that question, we explore the how Disney integrates conservation goals into an existing business model, develops synergistic relationships to expand reach, and fulfills a call to action initiated by none other than Walt Disney himself. Using our sea turtle conservation program as a case study, we will discuss the origins of the program and the decision-making process that we, as a business, must employ in order to advance and expand conservation initiatives. Lastly, we will discuss the benefits of leveraging businesses to advance a conservation agenda. What is a company like Disney uniquely qualified to offer, and how can we all work together towards a much larger goal? Understanding the needs and creating opportunities for non-profits, universities, and businesses to work together can be the tipping point in developing effective conservation programs for sea turtles.

IS TOURISTIC TURTLE WATCHING A THREAT TO ENDANGERED POPULATIONS?

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The touristic observation of wildlife is an alternative to its consume by local communities, contributing to their sustainable development, as well as to the conservation of endangered species and their habitats. However, wildlife watching can also be a threat to observed species and is extremely important to assess potential impacts and to implement the best practices to minimize them. For example, the observation of sea turtles during the nesting process is very attractive and can be an effective alternative to their easy capture on the nesting beach by coastal communities. The importance of this eco-touristic activity as well as the benefits and threats that can provide to an endangered sea turtle population has been studied in the island of Boa Vista (Cabo Verde). This island hosts around 75 % of one of the most isolated and endangered loggerhead population. During the last years, this island is experiencing an important touristic development and turtle watching is one of the most appreciated activities by tourists. This activity has been evaluated on high density nesting beaches with a long-term mark-recapture program, where many nesting females observed by tourists are identified. No effect of turtle watching has been observed on clutch size, female philopatry and nest abundance. Turtle watching did not affect the oviposition process because clutch sizes of observed and non-observed females was similar. Females observed by tourists renested on the same beaches with the same frequency than non-observed turtles. Furthermore, the beach sectors that have been traditionally used for turtle watching maintain similar and high levels of female nesting and nest abundance throughout the years. The female nesting behavior has been slightly altered in the phase of nest camouflage, which lasted less time in the presence of tourist groups. Tour guides relax their vigilance on tourist behavior after the end of oviposition. This threat can be solved very easily if tour guides maintain the discipline of the tour groups after oviposition until de females come back to the sea. Poaching is still a severe threat to nesting females on the island. However, the beaches with turtle watching suffered the lowest rate of turtle poaching. Similar protected beaches with no turtle watching activities suffered the highest levels of female hunting. It is not clear the existence of a cause effect relationship between turtle watching and lack of poaching. Thus, before recommending conducting touristic observation of turtles on beaches with high levels of female poaching, that possible relationship should be evaluated. At any case, and in order to reduce female poaching, it seems very important to built capacities in the coastal communities to increase their active participation on this important economic activity. Moreover, a significant part of the profit generated by turtle watching should be devoted for the sustainable development of coastal communities. Finally, it is very important to improve the identification and implementation of the best practices for all initiatives of turtle watching.

FLATBACK TURTLE CONSERVATION PRIORITIES: THE INTERSECTION OF BIOLOGY, PRESSURES, ECONOMICS, STAKEHOLDERS AND POLITICS

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Over the past decade, the Australian endemic flatback turtle (*Natator depressus*) has had an increased national conservation profile despite its data deficient IUCN status. Driven by its overlapping nesting distribution with major industrial projects in Western Australia (WA) and Queensland, flatback turtles have received increased political focus. This has resulted in a rapidly growing research effort funded through Environmental Impact Assessments, industry compliance monitoring and environmental offsets or similar. The Northwest Shelf Flatback Turtle Conservation Program (NWSFTCP) is an additional undertaking (offset) from the Gorgon Gas Project in WA operated by the WA Government. The funding spans 30 + 30 years with the objective to increase the conservation of flatback turtles through research and monitoring, education and intervention. The program, still in the establishment phase, has put in place strategic plans outlining priority actions including: foundational systems (e.g. financial and data systems), research projects to fill key knowledge gaps, long term monitoring programs and educational strategies to effect behavioural change. With feral animal predation, artificial light and climate change listed as major pressures, we will touch on a range of projects that address these issues as well as projects that address fundamental knowledge gaps such as aging, migration, population genetics and foraging. We will present the opportunities and challenges of planning, implementing and maintaining a program with a projected 60+ year life and the complexities of balancing program objectives within changing political environments. This includes periodic planning phases within an adaptive management framework. Guaranteed long term funding allows for long-term planning, ensures program stability, encourages long-term stakeholder partnerships and results in overflow of conservation benefits to broader marine issues including other turtle species.

DEVELOPMENT OF A DYNAMIC MANAGEMENT TOOL TO AID IN THE BYCATCH REDUCTION AND RECOVERY OF THE CRITICALLY ENDANGERED EASTERN PACIFIC LEATHERBACK TURTLE

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The Lost Years – Pelagic Life History Fund, The Ocean Foundation | NOAA, Sea Grant Knauss Marine Policy Fellow 2017, University of Maryland Center for Environmental Science (UMCES) | University of Maryland Center for Environmental Science (UMCES) | University of Maryland Center for Environmental Science (UMCES) | University of Maryland Center for Environmental Science (UMCES) | NOAA Fisheries Service's Southwest Fisheries Science Center (SWFSC) | Comisión Nacional de Áreas Naturales Protegidas (CONANP) | Cornell University | Instituto de Fomento Pesquero (IFOP) | Instituto de Fomento Pesquero (IFOP) | Instituto de Fomento Pesquero (IFOP) | ProDelphinus | ProDelphinus | Areas Costeras y Recursos Marinos (ACOREMA) | Inter-American Tropical Tuna Commission (IATTC) | NOAA National Marine Fisheries Service, Southwest Regional Office, Protected Resources Division | The Lost Years – Pelagic Life History Fund, The Ocean Foundation

The critically endangered Eastern Pacific leatherback turtle has declined by over 97% since the 1980s and is at risk of regional extinction. Leatherback turtles historically nested along Mexican and Central American nesting beaches. Impacts from fisheries bycatch and egg poaching are among the major reasons for their decline. Management of leatherback turtles and other highly migratory marine organisms requires an understanding of their year-round distributions to reduce fisheries bycatch both nearshore and offshore. In this study, we combined satellite telemetry data and fisheries observations of leatherback turtles to develop a habitat-based model of their distribution. In order to account for the complexities of the data set, a novel modeling approach was applied in this analysis. We used a Poisson generalized linear model in a continuous-time Markov chain (CTMC) model framework for the telemetry data to predict individual, post-nesting leatherback movement throughout the South Pacific based on environmental drivers, such as sea surface temperature. Population-level estimates of leatherback movement were obtained with a Bayesian approach. Fisheries observations were incorporated using a dynamic point process model to estimate density under varying environmental conditions for these predominantly juvenile leatherbacks. Monthly, near-real time predictions of leatherback movement throughout the South Pacific are then estimated with these parameters and the most recent satellite-derived environmental information. This tool will help to inform managers, fishers and other stakeholders how to anticipate and prevent fisheries interactions, which is vital for ensuring the viability of this leatherback turtle population.

LED LIGHTING: FIGHTING THE BRIGHTENING OF TURTLE NESTING BEACHES

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Pendoley Environmental Pty Ltd | Pendoley Environmental Pty Ltd | Pendoley Environmental Pty Ltd | Sunshine Coast Council | Moreton Bay Council

The Australian coastline is currently undergoing rapid development, particularly along the Queensland coast. Artificial light at night (ALAN) is an emerging threat to a wide range of taxa and specifically to adult and hatchling marine turtles. The beaches of the Sunshine Coast support nesting by loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles.

The Sunshine Coast Council (SCC) has endorsed an Urban Public Lighting Master Plan (ULMP) (September 2016). The ULMP is consistent with United Nations Environment Program (UNEP) Action Plan targets for *C. caretta* and the International Dark Sky Association (IDA) conventions for the protection of the night sky.

Light Emitting Diodes (LEDs) provide cost-efficiencies from reduced energy consumption due to longer-lasting bulbs and brighter light. Using LEDS to meet sustainability targets, councils across Australia are rapidly replacing incandescent bulbs, with over 300,000 bulbs replaced to date.

There is a growing body of research, providing evidence of directly related impairment of human, wildlife and ecosystem health resulting from artificial light. The impacts are amplified in the case of LEDs and are becoming harder to ignore. White LEDs are enriched in blue light, the wavelength turtles are most sensitive to.

We designed a regional light pollution monitoring program using Sky42™ technology, to provide information for SCC to meet targets within the ULMP. Once approved, a second council (Moreton Bay Council; MBC) were invited and included.

Sky42™ gathered light images over three nights at each of 27 monitoring sites on 16 nesting beaches covering a 60 km stretch of the Queensland coastline between South Bribie Island in the south and Coolum Beach in the north. Images were analysed using custom written software to quantify brightness at zenith, on the horizon and for the whole-of-sky in astronomical units of magnitude/arcsec^2.

In its first year, the program quantified and described the existing night sky horizon, identified primary sources of sky-glow and problematic point sources of light, designed a targeted emissions management approach and quantified the contribution of LED carpark lighting measured at an adjacent nesting beach.

In the current and repeat annual surveys, the program will establish benchmark light emission levels in each survey area, describing the night sky horizon and measuring lighting from marine turtle nesting beaches, providing data to address concerns regarding LED lighting and the understand cumulative impacts of light on turtles.

This information will inform strategic planning decisions and support effective management of light emissions on nesting marine turtle populations on Queensland's ever brighter nesting beaches. There is potential for rapid uptake of the program among Australia's coastal councils and scope to measure monitor and manage impacts to a broader range of biological receptors, including turtles.

SYSTEM FOR MONITORING MARINE TURTLES USING USSD

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Nowadays, the conservation of marine biodiversity is a way to keep ecosystems in balance and ensure the sustainable use of resources. In this context, technological resources have been used for monitoring marine species to allow biologists to obtain data in real-time. There are different mobile applications developed for data collection for monitoring purposes, and these systems are designed to be utilized only on 3rd generation (3G) phones or smartphones with internet access. The main problem is that in developing countries internet services are scarce. For example, in Mozambique, only 6.4% of the population has access to the internet. So, it is necessary to develop mobile applications using technologies that are more accessible to the communities. For this reason, the use of the Global System for Mobile Communication (GSM) with 2nd generation (2G) services, namely Short Message Service (SMS) or Unstructured Supplementary Service Data (USSD), is suggested. These technologies, SMS, and USSD, allow reliable and secure communication in remote areas with limited internet access. However, studies have shown that USSD technology, unlike SMS, provides a real-time and interactive connection between the customer and the service provider. Thus, the objective of this work is to develop a system to monitor marine turtles using USSD. The system aims to improve the data collection mechanism and enhance the effectiveness of current systems in monitoring sea turtles using any mobile devices without internet access. The system will be able to report information related to the biological activities of marine turtles. Also, it will be used as a platform to assist marine conservation entities to receive reports of illegal sales of sea turtles. On the other hand, the system can be utilized as an educational tool for communities, providing knowledge and allowing the inclusion of communities in the process of monitoring marine turtles. Therefore, this work may contribute with information to decision making and implementation of contingency plans for marine conservation programs.

IMPORTANCE OF LARGE MARINE PROTECTED AREAS FOR SEA TURTLES AND MARINE BIODIVERSITY

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Large marine protected areas (LMPAs; <10,000 km2), which cover 4.4% of the world's oceans, are considered to be effective for protecting highly mobile species such as sea turtles. This claim, however, has not been adequately evaluated particularly in regards to (a) the size of LMPAs in comparison to the current distributions of marine species (n=14,172), and (b) how this may change as species' distributions change under future climate scenarios. We evaluated the effectiveness of large marine protected areas in two components, with an emphasis on sea turtles. First, we determined the percent of the species' ranges and overall diversity encompassed by existing large marine protected areas using the Aquamaps database, an online species distribution modeling tool that produces standardized digital range maps. We also explored a subset of species, including sea turtles, using satellite tracking data to determine the percent of critical habitat that could be encompassed by LMPAs. Second, we determined the percent of the species' ranges encompassed by LMPAs using Aquamaps projected species distributions by the year 2100 based on projected global climate conditions described under IPCC SRES A2 scenario. Across all species, 26.9% had at least 10% of their range represented in LMPAs (the global target), and this was projected to increase to 40.1% in 2100, due to range contraction resulting in smaller overall ranges and thus a larger percent of coverage. For sea turtles, we found that only 1 of 7 species had more than 10% of their range covered by LMPAs, but that number would increase to 2 species in 2100. The average percent of range coverage by LMPAs for sea turtles varied from 0 to 22.6%, with an average of 7.3% coverage under current conditions. In 2100, this will range from 0 to 38.5% of species ranges covered, with an average of 10.4%. We recommend that future LMPAs be cited based on systematic conservation planning practices, and that the sea turtle community move forward with the development of global Important Marine Turtle Areas to help guide future LMPA development.

THEY KEEP COMING: CONSERVATION STRATEGIES IN RESPONSE TO THE INCREASING NUMBER OF LOGGERHEAD SEA TURTLE NESTING EVENTS IN THE SPANISH MEDITERRANEAN

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Since 2001, several loggerhead sea turtle nests and nesting attempts have been recorded in the Spanish Mediterranean coasts, as well as in other coasts of the European western Mediterranean, in what seems to be an increasing trend in nesting of this species in this basin. In Spain this trend is notorious since 2014, with a total of 27 out of the 33 nesting events recorded in the period 2014-2017. A total of 10 clutches have been managed for successful incubation of eggs in different ways, including relocation to incubators or to protected beaches, since most of the nesting attempts were made in urban/tourist beaches featuring promenades, buildings and lighting near the beach, and cleaned every morning with machinery. In fact, at least nine nesting attempts failed due to human disturbance on the nesting turtle. In the present study we report all the information concerning these nesting events describing the conditions affecting their success, the management strategy applied and discussing their conservation implications. All relocated clutches were successful (range: 31.4-84.5 % of hatching success), allowing to undertake head-starting programs. Post-hatchling survival and behavior after 1-2 years raised in captivity was studied through satellite telemetry. A total of 19 post-hatchlings from three of the clutches were satellite tracked after their release during three consecutive years (2015-2017). Despite differences in survival between clutches were observed, probably related to parasitic infections suffered during the head-starting period of one of them, the minimum daily survival probability of head-started turtles during the first three months after release was high (0.98 - 0.99). The fact that these nesting events are sporadic and spatially disperse over more than 2000 km of coast (including the Balearic Islands) makes difficult their detection, particularly in regions where stranding networks are not well developed. Hence, we cannot discard that more nesting events are occurring in this coast. In fact, most of the events were detected during weekends, when beaches are more visited. Implications of the different management practices, including the study of beach conditions and the effect of incubation temperature in relocated clutches, are discussed in order to increase the success of these sporadic nests and to analyze their value for long-term sea turtle conservation in the region. Management and protection of each clutch varied among provinces, but in all cases included the participation of members of different institutions, stranding networks, NGOs and volunteers. These nesting events, although sporadic, have been proven to be a successful way to involve public and private institutions in the conservation and awareness of this species in the region. Public awareness and training campaigns have been carried out over the last years in order to increase detection of these events. These efforts highlight the importance of the participation of individuals and local institutions in providing reports and data on nesting events to increase knowledge and improve conservation management of marine turtles in the Spanish Mediterranean.

OUTREACH AND EDUCATION STRATEGIES TO REDUCE THE IMPACT OF MARINE TURTLE BYCATCH IN PERU

Evelyn Luna Victoria Vargas | Nicolás Rovegno Arrese
WWF Peru | WWF Peru

Under the project “Reducing Turtle Bycatch in the Eastern Pacific”, WWF Peru and ACOREMA carried out surveys during 2016 to understand the perceptions on marine turtle bycatch in five ports along the coastline of Peru. Results showed that despite marine turtles being key species in the ecosystem, fishermen were not aware or did not have enough interest for their conservation. Although several efforts for marine turtle conservation exist, it seems this is not enough to cover the large number of fishermen throughout the coast.

In that regard, it was identified that it was necessary to design and implement cost-effective strategies that could have a wider reach and impact throughout the coast, while articulating efforts from organizations, and considering the idiosyncrasy, interests and lifestyle of fishermen. Under that approach it was sought for fishermen to internalize messages and to commit with correct handling and releasing techniques for marine turtles. Likewise, to reinforce this approach the project pushed for the establishment of a regulatory framework under the Marine Turtles National Conservation Plan (MTNCP), which allowed to pose a series of key principles for the project; a) participatory approach through dialogue, b) establishment of strategic alliances, c) target-based communication, d) establishment of trust-based relationships, and e) acknowledgement and incentives for change.

WWF is working through social strategies considering these principles, and has created a National Network of Instructors for the Safe Handling and Release of Marine Turtles called “SOS Turtles”. The reasoning behind the Network was based on having an increased reach of messages through a multiplier effect, while considering cost-effectiveness. Training sessions from specialist-to-fishermen have an elevated cost, reduced reach and message retention, coupled with logistic to organize massive talks. In that sense, it was identified as a more efficient and effective approach to build local capacities in safe handling and release techniques for marine turtles in government officials and civil society that were committed and interacted regularly with fishermen, so that they could replicate training sessions with fishermen throughout the coast.

Challenges have been identified through this strategy as it requires voluntary efforts, thus motivation, acknowledgements and constant monitoring are required. To overcome these challenges WWF has prepared several communicational materials in creative formats such as: instructor’s guides, a “cumbia” song, playing cards with handling and release techniques, t-shirts with encouraging messages, turtle-shaped backpacks, marine conservation festivals in coastal communities, among others. Likewise, through the participatory elaboration of the MTNCP it is expected for strategic alliances to strengthen and for institutions to formalize SOS Turtles Network work.

Keywords: bycatch, marine turtles, social strategies, Peru

FROM POACHING TO EFFECTIVE PROTECTION: CONSERVATION ACTIONS IMPROVE LOGGERHEAD TURTLE (*CARETTA CARETTA*) REPRODUCTION IN MAIO ISLAND, REPUBLIC OF CABO VERDE

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Maio Biodiversity Foundation (FMB) | Maio Biodiversity Foundation (FMB) | Maio Biodiversity Foundation (FMB) | Maio Biodiversity Foundation (FMB) | Queen Mary University of London | Maio Biodiversity Foundation (FMB)

The Republic of Cabo Verde is considered one of the strongholds for the threatened loggerhead turtle (*Caretta caretta*). After Boavista, the island of Maio is one of the most important breeding sites and its nesting turtles have been protected since 2013. By then, poaching for meat was common and 43% of the nesting females were killed. However, in 2017, meat poaching was less than 7% and egg poaching was also reduced from 18% to 2.3 %. A key element of this success was the measures adopted by Maio Biodiversity Foundation (FMB), a Cape Verdean conservation NGO founded in 2010. We will focus this presentation on the main achievements of FMB's turtle conservation programme and the involvement of the local community as a key factor for its success.

First of all, FMB developed an extensive monitoring study of the loggerhead turtle (*Caretta caretta*) nesting in Maio. In a coastline of 118 km, we studied intensively (on average, 130 nights per year), 38 km of sandy beaches that hold nearly 100% of the nesting activity. The total number of nesting activities was 10,872 and 13,015 in 2016 and 2017, respectively. 37% and 42% of those activities resulted in clutch deposition. Hatching success varied between locations and years ranging from 1% to 93%. We tested the utility of hatchery and nest relocation methodologies, and depending on the hatchling production, different management strategies may be applied in the future. Also, by measuring nest temperature and using a model to relate incubation temperature with hatchling sex ratio, we estimated that loggerhead sea turtles currently produce female-biased sex ratio in Maio. Models considering several factors including incubation, sand and air temperature and future climate change scenarios, showed that complete feminization could occur within a few decades. More importantly, our findings highlight that despite Cabo Verde is the largest nesting aggregation for this species in the eastern Atlantic, there are still major knowledge gaps that need to be addressed to protect marine turtles efficiently.

Secondly, FMB's large-scale conservation project has been made possible by working with over 600 Cape-Verdeans that have been trained in monitoring skills over the past five years. In addition, over 60 fishermen were trained, 20 have been monitoring illegal fishing activities in the sea and 15 integrated former wildlife poachers currently monitor and protect sea turtles during the nesting season.

Finally, FMB carries out an extensive ecotourism and educational programme to provide alternative livelihoods and empower unemployed women. 74 women have experienced homestay and 30 often receive field-workers and volunteers in their houses. This programme also creates sustainable touristic activities and delivers educational activities that currently involve a third of Maio's population every year.

We wish to acknowledge the funding of our programmes to MAVA, N.O.A.A., U.S. Fish & Wildlife Service, Fauna & Flora International, Arcadia and Queen Mary University of London. Also, we would like to thank to the local authorities and national and international organizations for supporting FMB in these ambitious project. We hope to continue these programmes that will benefit wildlife, people in Maio and the international conservation communities.

TOWARDS THE RECOVERY OF SEA TURTLE POPULATIONS IN REUNION ISLAND: OUTCOMES OF 35 YEARS OF CONSERVATION IN A HIGHLY ANTHROPIZED ISLAND OF THE SOUTHWESTERN INDIAN OCEAN

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Kelonia | CEDTM | Kelonia | IFREMER | Kelonia

Located 700 km East off Madagascar, Reunion Island is a small French overseas territory of 2512 km^2 with more than 800 000 inhabitants that was described as an important nesting site for the green sea turtle when the first navigators discovered the island in the 17th century. Unfortunately, sea turtle populations declined drastically after human exploitation and coastal urbanization, resulting in a rarefaction of either nesting or foraging populations around the island. After the first protection regulations in the early 80s and several consecutive conservation measures, and education and awareness programs, including a sea turtle farm to sustain local turtle meat consumption while preserving wild populations, and later the creation of a marine reserve, trends progressively inverted regarding foraging populations. An aerial survey program initiated in 1998 to monitor sea turtle populations and their spatial distribution along the west coast revealed a significant increase of turtle sightings (Spearman's rank correlation, $r_s = 0.96$, $n = 18$, $P < 0.05$). While a mean of 4.86 (SD = 4.33) turtles were sighted at the surface over the 30 km transect in 1998, 70 (SD = 33.82) turtles were recorded in average along the same transect in 2016. Comparatively, nesting activity recovered much more slowly. As only 4 nesting attempts had been confirmed in twenty years (from 1980 to 2000) over the entire island, a beach revegetation program initiated in 1999 was followed by several nesting events of green turtles on the same beach from 2004 to 2007 (N=11), and also on other beaches from 2007 to 2016 (N= 14). From all these nests, 15 were located on a revegetated beach. These results appeared very encouraging as urbanization and demography increased very fast during the last 30 years. Interestingly, these results have been accompanied by a gradual change in mentalities and behaviours of the local population who has become much more receptive and involved in sea turtle conservation. Today, people contribute much more easily and spontaneously to beach monitoring, marine observations, and also help a lot in sea turtle rescue. This allows the care centre settled since 2005 to rehabilitate around 30 injured and sick turtles each year. To strengthen and improve sea turtle conservation actions and measures, a National Action Plan started in 2015 in all the French overseas territories located in the region, including Reunion Island. The current challenge is to maintain the positive trends observed by increasing education programs, mitigating threats and preserve nesting and foraging habitats, while the island should reach one million of inhabitants between 2025 and 2030.

UNDERSTANDING THREATS TO SEA TURTLES IN CAMBODIA FROM BY-CATCH IN SMALL-SCALE AND COMMERCIAL FISHERIES

Kate West | Phalla Leng | Marianne Teoh | Manjula Tiwari | Sann Satya
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Cambodia's waters support rich yet little studied marine life, including coral reefs, seagrass meadows, and extensive mangrove forests. Records indicate that five species of sea turtle were historically found in Cambodia: the hawksbill, the green turtle, the leatherback, , the loggerhead, and the olive ridley. Starting in 2010, Fauna & Flora International (FFI), working together with the Cambodian government and community partners has gathered baseline information about the current status and distribution of sea turtles in the country, and the threats they face.
Beach surveys and community interviews conducted by FFI have indicated that eggs and turtles were harvested heavily in the 1970’s and 1980’s, with the last frequent nesting being observed in the 1990’s. Additionally, incidental and accidental by-catch in local fisheries may have contributed to depleted populations. Despite these pressures, hawksbills and green turtles are still reported fairly frequently as by-catch. Consultation meetings were undertaken in 2015 with community fishers, Fisheries staff, local NGOs and dive groups in each of Cambodia’s four coastal provinces to gather information on sightings, in-water threats and distribution of sea turtles in Cambodia. This assessment highlighted the Koh Sdach Archipelago and Kampong Som Bay as areas with frequent by-catch of sea turtles. Therefore, to evaluate the impact of local fisheries on current sea turtle populations in Cambodia’s waters, FFI supported a by-catch project during 2015 and 2016.
This study collected data, using the UNEP/CMS by-catch questionnaire, in coastal Southwest Cambodia, and a total of 224 interviews were conducted in the two community fisheries: Koh Sdach Community Fishery (n=130) and Chrouy Svay Community Fishery (n=94) in Koh Kong Province. Among these fishers interviewed, the most prevalent gear types used between the two communities were fish nets (including gill nets and shrimp nets; n=98) and ray hooks (n=62). Ray hooks caught sea turtles most often, followed by nets and trawlers, although trawlers were underrepresented in these surveys and are suspected of having a big impact. Responses indicate a decrease in catch and sightings over time with 43% (n=97) of the respondents having caught 1-2 turtles in the last year compared to 40% (n=90) reporting catching 4-6 sea turtles 2-5 years ago.
This work will be expanded along the Cambodian coastline to understand the by-catch status more widely, particularly to gather more detail on by-catch within the trawl fishery which presents a significant portion of Cambodia’s fishery sector, and can range from small semi-commercial boats, which fish in the shallow coastal waters, to larger commercial trawling boats. It is anticipated that these results will help support the introduction of fisheries management measures that reduce by-catch and protect sea turtles in Cambodian waters.

DIET-RELATED SELECTIVITY OF MACROPLASTIC INGESTION IN MARINE TURTLES

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Understanding the drivers of key interactions between marine vertebrates and plastic pollution is a global research priority. Sea turtles are primarily visual predators, with the ability to discriminate according to colour and shape; allowing these factors to play a role in feeding choices. Ingested plastic classification methodologies currently lack records of these variables, however. Here, more refined protocols allow us to test the hypothesis that plastic is selectively ingested when it resembles food items of green turtles (*Chelonia mydas*)(n=19) of Northern Cyprus, Eastern Mediterranean. Turtles displayed strong and statistically significant diet-related selection towards certain types (sheet and thread), colours (black, clear and green) and shapes (linear items strongly preferred) of plastic when compared to the environmental baseline of plastic beach debris. There was a significant relationship between size of turtle (curved carapace length) and number/mass of plastic pieces ingested, which may be explained through naivety and ontogenetic shifts in diet. In addition there was a significant relationship between size (indicative of gape size of turtle) and mean length of ingested plastic.

DEVELOPMENT OF A TURTLE RELEASING SYSTEM (TRS) FOR SET NET FISHERIES

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This presentation presents a turtle releasing system (TRS) for a set net. The set net fishery is a major and important coastal fishery in Japan, and the set net occasionally catches sea turtles in some coastal regions. Sea turtles straying into the fully-submerged bag net of the set net are often drown because the upper panel of the bag net blocks the turtles from swimming up to the surface to take breaths. The set net is not a mobile gear like a trawl but a stationary fixed gear, and thus sea turtles spontaneously have to go out of the set net. Sea turtles in the closed net start pushing their heads up against the upper panel when they want to take breaths.
The TRS has been developed for allowing turtles to escape from the fully-submerged bag net. This system consists of a turtle releasing device (TRD) and about 20 degrees sloping (quadratic-prism shaped) upper panel of the bag net. This sloping upper panel induces the turtle moving to the shallower and then guides it to the TRD installed at the top of the upper panel. In the tank experiments the loggerhead and green turtles moved to the top of the upper panel with pushing up, and escaped out from the bag net through the TRD successfully. Sea trials were also performed in TRS-introduced submerged bag net (30m x 10m x 10m) of the set net with loggerhead turtles. Loggerhead turtles were managed to escape out of the net successfully, and there was almost no fish escaping.

SAVING ENDANGERED SEA TURTLES BY OPERATIONALIZING TURTLE EXCLUDER DEVICES (TEDS) IN MALAYSIA

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Accidental bycatch of endangered sea turtles is of grave concern in Malaysia, where some 2,000 to 4,000 turtles are killed each year as bycatch in trawl fisheries in the State of Sabah alone, and this is likely double or triple at the National level. Fortunately this bycatch and turtle mortality can be mitigated through the use of Turtle Excluder Devices (TEDs).

The Marine Research Foundation (MRF), a small NGO based in Sabah (Malaysian Borneo) has successfully introduced TEDs in Malaysia, starting in 2007 with a volunteer trial program in two districts in Sabah. MRF has received substantial support from the US National Marine Fisheries Service in Pascagoula, and through this developed the technical capacity to run a TED programme in Malaysia.

To raise awareness amongst fishers, MRF commissioned a professional video in three local languages, and conducted site visits to the U.S. with fishermen and officers from the Department of Fisheries Malaysia (DOFM) and Sabah (DOFS). The trips provided a major boost to the TED program, and a final visit with the Director General of DOFM in 2013 led to an expression of commitment by the Malaysian government to implement a TED program. This led to the development of a National Implementation Committee to which MRF is a Technical Advisor, and the drafting of a long-term TED adoption plan.

To bring fishers on board using evidence-based systems, MRF developed a real-time video system (TEDsCam) which uses GoPro cameras and drone technology to deliver live video feeds to boat captains who can watch the TED while they fish, proving it does not lead to catch loss. MRF also developed a portable, fast-link fuel flow meter to demonstrate how TEDs can result in fuel savings.

We recently concluded an extensive and far-reaching two-year project in 2014-2016 providing training to fishermen and fisheries officers across all of the east coast of Peninsular Malaysia, Sabah and Sarawak, to engender greater TED buy-in amongst fishing communities and provide capacity to fishers and government agencies. These efforts have brought TEDs online across a number of States in Malaysia.

We are pleased to report that TEDs become a legal requirement in 2017 in four States in Peninsular Malaysia, and that the National government has committed to full-scale adoption by 2022. Malaysia has formally applied for Section 609 Certification for some of its fisheries, and the first official inspection by the U.S. State Department and NOAA will take place in November 2017.

Given the sheer size of Sabah and the great number of trawlers (>700), greater effort investment is needed in Sabah in comparison to Peninsular Malaysia. The State is committed to requiring TEDs on shrimp trawlers by 2019, becoming the fifth State to do so, and to bridge the knowledge and capacity gaps, MRF currently works across 16 districts in Sabah to raise capacity among fishers to adapt TEDs to local vessels, and help DOFS officers provide outreach and develop their enforcement capacity.

Together with the government and fishing communities across Sabah, the adoption of TED will enhance the conservation of sea turtles, while ensuring preservation of fisher livelihoods.

POTENTIAL FISHING INTERACTIONS WITH SEA TURTLES ON THE FRENCH MEDITERRANEAN COAST: INSIGHTS FROM SATELLITE DATA

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Dramatic population declines among species of sea turtles as a result of overfishing have been reported in the Mediterranean Sea. In France, the level of sea turtle bycatch on the Mediterranean coast is thought to be under-reported. The purposes of this study were to combine and to analyse the available data on sea turtles bycatch observations in the French Mediterranean waters collected through various data collection programs and to assess the potential interactions with coastal and offshore fisheries (pelagic longlines, trawlers and set nets). We investigated the spatial and temporal distribution of fishing effort of the major fleets operating in the studied area using vessel monitoring system (VMS) data. Satellite-linked archival transmitters deployed on loggerhead turtle *Caretta caretta*, the most common marine turtle reported in the area, were used to identify key habitat and particular behaviors. Space-use patterns of satellite-linked loggerhead turtle indicated where they can spend time in the same type of areas where vessels target commercial fish allowing recommendations for further conservation.

FIGHTING AGAINST ILLEGAL FISHING IN CONGO

Eva Chauvet
Renatura Congo

In the Republic of Congo, IUU (illegal, unreported and unregulated) fishing is a major threat for sea turtles and more generally marine biodiversity . Marine turtles suffer from numerous by-catch due to fishing in restricted areas normally secured for artisanal fishermen. Species are then either left dead in nets onboard, or mutilated to be released and end up dying in the waters. Renatura's data show every year a neat stranding peak in September and early October, with tens of dead turtles along the coast. These data match the beginning of nesting season in Congo, with lots of turtles approaching the coast.

The impact of bad fishing practices on marine and coastal biodiversity is considerable. Seabed is destroyed, protected species captured, fishing effort not controled and breeding areas not respected, leading to higher pressure on juvenile species. The ecosystemic balance is consequently affected, with major deregulations in fish stocks.

Fighting against illegal practices is above all a governance matter. IUU is a complex issue for a sovereign country. It deals with fishery policies as well as national security, food and products sanity. It needs important financial and technical means, and transparency in monitoring surveillance patrols. At least, several partners may be concerned by this problem, which means multi-stakeholders management responses. As illegal fishing is a worldwide curse, it also implies regional cooperation and multilateral actions.

Since 2012, Renatura Congo has implemented a joint program together with the Fisheries Administration in Congo to address these issues. The "PA2PC", for *Programme d'Accompagnement des Pratiques de Pêche au Congo*, is a public-private partnership in which each participant has a defined role to play. Renatura support fuel and repair costs, as well as boat pilots' expenses. The NGO benefits from access to fundings thanks to its status. On the meantime, state agents are assigned to surveillance sea patrols. The administration also remains the legal authority in case of financial sanctions or administrative penalties.

Running such a program is not an easy mission. Since the beginning, the partnership has suffered from several interruptions, from administration reorganisation to lack of means, corruption issues and convention revisions. The analyse of the situation shows successes and failures of this governance model. That is why the future of *PA2PC* or any policies fighting IUU in Congo have to take up new challenges: broadening of the collaboration to new organizations; increased public participation; law revision; and implementation of an efficient vessel monitoring system.

BYCATCH OR ILLEGAL TAKE? UNDERSTANDING ARTISANAL FISHERIES AND THEIR IMPACTS ON SEA TURTLES IN MOZAMBIQUE.

Jess Williams | Mariana Fuentes | Simon Pierce | Mark Hamann

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The life history characteristics (e.g. long-lived, late maturity) of most marine megafauna species are conservative and render them unsuitable for intensive or sustained harvest. Targeted or opportunistic harvest of sea turtles occurs throughout much of their range and this has led to significant population declines. Illegal harvest of sea turtles along the Mozambican coastline has been routinely reported but remains largely undocumented. Defining direct, opportunistic or incidental take by fishers is often challenging in itself. For instance, small-scale fishers though not specifically targeting turtles often take turtles opportunistically or retain turtles caught as bycatch. In the literature, the bycatch of turtles caught using gillnets, long-lines, beach and purse seines and fish traps is generally not considered as illegal take. Rather it is classified as accidental take because it is assumed the target species of the fishery is not turtle. However, if turtles which are caught accidentally are subsequently kept to be sold or eaten, this can, depending on the legal situation of a country constitute an illegal activity. One of the key issues in Mozambique is that small-scale fisheries techniques (particularly gillnetting or long-lining, or other non-selective fishing gears) are adopted by fishers to target a multi-species marine fish and megafauna fishery (i.e. sharks, turtles, dugong, rays, cetaceans). Typically, sea turtles captured using gillnets or longline is classified as bycatch or accidental take, because the target catch is not turtles. However, within developing nations, small-scale fisheries are diverse and fishers behaviour is varied, often driven by large-scale socio–economic drivers, such as poverty and food security. Thus, the scenario of turtle ‘bycatch’ and illegal take is more complicated than the generally accepted ‘accidental take’ definition because fishers in Mozambique retain bycatch. The prevalence and consequences of this intentional, planned megafauna fishery have not been thoroughly investigated in Mozambique or the SWIO. Here we describe the nature of artisanal fisheries in Mozambique and their interactions with sea turtles. A detailed case study of spatial overlap between sea turtles and small-scale fisheries (SSF) by calculating interaction risk for the area around Praia do Tofo, Inhambane, southern Mozambique using 2012- 2015 data will also be discussed.

SEA TURTLE BY-CATCH IN KALPITIYA PENINSULA OF SRI LANKA

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Project location is Kalpitiya peninsula which one side is sea and other side is Puttlam lagoon (8°12' 22.70 N, 79°42'02.70 E). This area is rich in lots of biodiversity including marine turtles, dolphins, whales, coral reefs, seagrasses & sea birds. Bar reef home to 156 species of coral and 283 species of fish. Puttalam lagoon has largest mangrove coverage in Sri Lanka. Fishery industry is major industry in the area having sea and lagoon fishing. Of the seven species of sea turtles in the world, five come ashore to nest in Sri Lanka while their feeding habitats & migratory routes located around the island. Although Sea turtles are protected since 1972 still there are many threats occur including turtle egg poaching, kill for meat etc. One of the least understood and possibly most serious threats that face marine turtle populations in Sri Lanka is by-catch in fishing gears. There was a fishing restriction in certain coastal areas of the Sri Lanka during the civil war for about 25 years. Most part of the Kalpitiya peninsular included to this restricted area. The armed conflict was over in 2009 and the number of boats increased rapidly and illegal fishing gears also used by fishermen due to the competition. The fishing communities in the Kalpitiya Peninsula depend on seasonal, artisanal gill net fisheries targeting pelagic shoaling fish. Marine turtles often get entangled in the sea and lagoon causing damage for fishing nets. This can happen to individual fishermen several times a season. So costs as a result of a single turtle entanglements can be significant, while multiple turtle entanglements compromise fishers' ability to provide for their families during limited fishery seasons. In response, fishers either beat the turtles' heads until they are rendered unconscious, or hack off the turtles' body parts to make disentanglement easier. The turtles are then either discarded at sea, or brought back to shore for illegal processing for their meat for local consumption. Harming and killing the turtles, or possessing their body parts is prohibited by Fauna and Flora Protection Ordinance of Sri Lanka (FFPO, 1972; amendment 1993 and 2009). Through these unwanted turtle interactions, fishing families are therefore compromised through significant costs incurred in repairing damaged gear, and losses suffered through reduced time at sea during a specific fishery season, as well as risk of illegal activity under the national legislation. The objective of this study is to conduct rapid assessment on the current status of sea turtle by-catch in the Kalpitiya peninsula. The study was conducted from June to July 2017. A fishermen attitudinal survey was conducted interviewing 152 fishermen from the Kalpitiya peninsula and a beach survey was conducted walking about 60 kilometer stretch to visually assess the abundance and distribution of dead turtles / discarded shells on beaches. About 50% fishermen answered that they caught sea turtles on their fishing nets while many sea turtle carcasses and carapaces found on the beach during the beach survey. So both attitudinal survey and beach survey confirmed that marine turtle by-catch still occur in considerable level in the project area. Acknowledgement: We would like to acknowledge International Sea Turtle Society, Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, the US Fish & Wildlife Service and International Sea Turtle Symposium for their support to attend the symposium. Moreover, we would acknowledge Rufford Foundation, U.K. for the financial support for the study.

POLLUTION PROFILES AMONG HAWKSBILL TURTLE NESTING BEACHES REFLECT TURTLE MIGRATION PATTERNS AND PERSISTENCE OF PCB, OCP AND PAH COMPOUNDS IN THE YUCATAN PENINSULA, MEXICO

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Legacy pollutants released from anthropogenic activities have demonstrated impacts on sea turtle health. Nonetheless, knowledge and data of spatial variation in pollutant profiles among sea turtle nesting locations is limited. This poses challenges in identifying processes shaping this variability, and sets constraints to the conservation management of sea turtles and their use as biomonitoring tools for environmental pollutants. We aim to increase understanding of the spatial variation in polycyclic aromatic hydrocarbon (PAH), organochlorine pesticide (OCP) and polychlorinated biphenyl (PCB) compounds among nesting beaches. We link the spatial variation to turtle migration patterns and the persistence of these pollutants. Specifically, using gas chromatography, we confirm maternal transfer of a large number of compounds (n=69 out of 70) among 104 eggs collected from 21 nests across three nesting beaches within the Yucatán Peninsula, one of the world's most important rookeries for hawksbill turtles (*Eretmochelys imbricata*). The use of substitution for handling data containing concentrations below detection limit has been debated because an arbitrary value is inserted that could bias results. Consequently, we approach our analysis by estimating a cumulative frequency distribution for each individual pollutant on each nesting beach using Kaplan Meier estimation. Analysis of each individual component is then conducted using univariate Peto-Prentice tests, while the pollutant profile as a whole is analyzed using multivariate correspondence analysis. High variation in PAH profiles is observed among nesting beaches, reflecting local acquisition during recent migration movements. Diagnostic PAH ratios further support a local acquisition, showing clear petrogenic origins of PAHs in Celestún, the beach closest to petroleum industries in the Gulf of Mexico. By contrast, pollution profiles of OCPs and PCBs show high similarity among beaches, reflecting the long-term accumulation of these pollutants at regional scales. We take a broader perspective by directly comparing our measured concentrations with other studies in the region. This confirms a general similarity for OCP and PCB concentrations within the wider Gulf of Mexico with some patterns unique to Mexico for DDTs and lindane. Meanwhile, we provide a first baseline for PAHs in eggs of hawksbills for this region. In conclusion, spatial planning of protected areas and the use of turtle eggs in biomonitoring needs to account for the spatial variation in pollution profiles among nesting beaches. Moreover, conservation management of sea turtles in the context of pollution requires cooperation across geographic and political boundaries.

COASTAL LIGHT POLLUTION AND MARINE TURTLES IN BRAZIL

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Light pollution can impact species, ecosystems and their processes. Coastal areas provide critical nesting habitat for marine turtles and understanding how artificial light might be impacting these species is key to effectively guide management strategies. Here we assess the extent to which nesting populations of four marine turtle species (leatherback, olive ridley, hawksbill and two subpopulations for loggerhead turtles) are exposed to light pollution across 604 km of the Brazilian coast. We used yearly nighttime stable lights composite satellite images from two different 5-year periods (1992–1996 and 2008–2012, n = 10) from the US Air Force Defense Meteorological Satellite Programme (DMSP) Operational Linescan System (OLS) to determine the proportion of nesting areas experiencing detectable levels of artificial light and how this has changed over time. Significant increases in brightness were experienced in 63.7% of the 604 ~1 km nesting beach segments. We identified 54 reproductive hotspots based on the relative nest densities: 62.9% were located in areas considered exposed to light pollution and 64.8% had experienced increasing light levels. In 42.6% the presence of artificial light influences in local management strategies. A negative relationship between nest density and light levels was found for olive ridley and leatherback turtles. For hawksbills and both the northern and southern loggerhead stocks, the relationship showed significant variation, with high nest densities also seen in areas where light levels are high. The status of all species/subpopulations has improved across the time period despite increased anthropogenic light levels. These findings suggest that (1) nest site selection is likely determined primarily by other variables rather than presence/absence of light and (2) conservation strategies in Brazil appear to have been successful. These include creation of protected areas, specific legislation to mitigate direct light incidence on some nesting beaches, as well as relocation of clutches away from heavily lit areas. There is, however, the possibility that the ecological trap posed by light on some beaches could take a longer period to fully manifest in nesting numbers.

WHAT'S FOR DINNER?: POLYMER IDENTIFICATION OF PLASTIC DEBRIS INGESTED BY PELAGIC-PHASE SEA TURTLES IN THE CENRAL PACIFIC

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Marine plastic debris ingestion has been documented in sea turtles since the late 1950's. Pacific pelagic-phase olive ridley, green, and loggerhead sea turtles frequently ingest large amounts of plastic debris. The amount, color, type, size, gastrointestinal location, and frequency of plastic ingestion have been investigated in these protected species; however polymer types of ingested plastics have not been well described. This study identified the polymer structure of those ingested plastic pieces. By identifying the main polymer types, plastic production and waste management practices can be modified to aid in the protection of sea turtles and other endangered species. We analyzed 838 representative pieces of ingested plastics from 50 sea turtles caught as bycatch in the Hawaiian and American Samoan longline fisheries using attenuated total reflectance Fourier transform infrared spectroscopy (ATR FT-IR). Samples (n = 27) that could not be identified using ATR FT-IR were analyzed using high temperature size exclusion chromatography (HT-SEC) with multiple detectors. We examined differences in ingested polymer composition among species using multi-response permutation procedures (MRPP) and indicator species analysis (ISA) with the hypothesis that deeper diving species would ingest more high-density, sinking polymers. Polymer composition differences were examined in regards to hook depth. Within species, we examined polymer composition differences based on sex, straight carapace length, size class, and year caught. Polyethylene (PE) and polypropylene (PP) composed the majority of the plastic mass ingested by olive ridley (n = 37), green (n = 9), and loggerhead (n = 4) sea turtles. The overall composition was 51% low-density polyethylene (LDPE), 26% PP, 10% unknown PE, 5% high-density polyethylene (HDPE), 5% PE/PP mixture, 1.5% polyurethane (PU), 0.8% unknown, 0.3% polyvinyl chloride (PVC), 0.2% polystyrene (PS), and 0.2% nylon. Pieces of high-density plastics (1 PVC, 5 PS, 7 PU, and 1 nylon) were found in deeper diving olive ridleys. Two pieces of PS and 3 PU were also found in intermediate diving green turtles and four pieces of PU were present in surface foraging loggerheads. Olive ridley (68.4 ± 52.2 m) and green (65.5 ± 28.1 m) sea turtles were caught significantly deeper than loggerhead (29.3 ± 1.6 m) sea turtles. No correlation was observed between polymer compositions and hook depth. Olive ridleys captured farther south and west ate significantly greater proportions of PP than those captured further northeast near the North Pacific Garbage Patch. Green sea turtles south of the equator ate proportionally more LDPE while those captured north of the equator and east ate significantly more proportions of PE/PP mixtures. No significant differences were observed in regards to hook depth, sex, straight carapace length, size class, or year. Our results indicate that LDPE and PP, two commonly used and rarely recycled polymers, are driving the problem of marine debris ingestion by sea turtles in the Central Pacific Ocean. These novel data are important details to describe the threat of plastic ingestion in sea turtles and can help inform environmentally-friendly practices for plastic production, use and waste management.

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APPLYING THE SEA TURTLE CLIMATE VULNERABILITY ASSESSMENT WITH U.S. SEA TURTLE POPULATIONS

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ECS Federal in support of NOAA Fisheries Office of Science and Technology | NOAA Fisheries Pacific Islands Fisheries Science Center | NOAA Fisheries Greater Atlantic Regional Fisheries Office

Climate change and the related ecological changes have significant implications for the conservation of sea turtles. We know that climate change can affect some individual phases of sea turtle life history, but there is a need to assess impacts across the entire life cycle annually and inter-annually. NOAA Fisheries manages multiple sea turtle populations across broad geographic areas that experience different environmental and human-caused pressures. Climate vulnerability assessment is one approach that allows us to characterize the effects of climate change and compare impacts and potential responses across a variety of species and locations. Here we describe a framework developed by NOAA Fisheries to assess the vulnerability of sea turtles to climate change. This rapid and broad assessment framework involves assessing species profiles and scoring exposure and sensitivity/adaptive capacity. The framework then combines those separate scores into relative vulnerability. This Sea Turtle Climate Vulnerability Assessment methodology was tested in March 2017 with five sea turtle populations in the Pacific Islands. We identified specific methodological improvements to assess various population types, with different management needs and data availability related to population parameters and threat impacts. The test results were used to clarify criteria used to score exposure factors and sensitivity/adaptive capacity attributes, streamline the assessment process, and identify gaps in the life history attributes assessed. With the revisions complete, we are now in the planning stages to apply the method with all U.S. sea turtle populations in 2018 with the goal of providing managers and researchers with population-specific climate vulnerability information.

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LEATHERBACK STRANDINGS IN VIRGINIA U.S.A. AND THE IMPACT OF GEAR MODIFICATIONS IN THE POUND NET FISHERY

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From 2008-2017, the Virginia Aquarium Foundation's Stranding Response Program (VAQS) recorded 44 leatherback sea turtle (*Dermochelys coriacea*) strandings in Virginia, U.S.A. The VAQS defines strandings in this way: *sometimes marine turtles wash ashore sick, injured or dead; at other times they can become entrapped or disoriented and unable to return to their natural habitats without assistance; these events are known as strandings*. Thus, this definition of strandings also includes entanglements.

Leatherbacks strandings in Virginia typically occur in coastal waters and along shorelines of the Atlantic Ocean and lower Chesapeake Bay. Though leatherbacks represent less than 2% of all sea turtle strandings in Virginia, their circumstances of stranding and their endangered conservation status make the species of significant interest for examination and study. Historically, leatherback strandings occur from April-November, though May, June and September (>70%) are the most active months. For strandings during the recent ten-year period (2008-2017), the 44 cases were attributed to the following causes: interactions with crab pot lines (n=7; 16%), interactions with pound net gear (n=16; 36%), vessel interactions (n=14; 32%), interactions with pot gear lines of unknown origin (n=1; 2%), entanglements of unknown origin (n=2; 5%), ingestion of marine debris (n=1; 2%), and unknown causes (n=3; 7%). Twenty of the 44 strandings were reported as live animals, including 5 crab pot line cases (25%), 14 pound net leader entanglement cases (70%) and 1 case (5%) involving a pot gear line of unknown origin. It is clear from the stranding data that pound nets are the leading source of leatherback strandings related to fisheries interactions in Virginia. All pound net interaction stranding records during this ten-year reporting period occurred in the last five years (2013-2017).

In 2007, 2008 and 2011, the VAQS worked with fishers at Cape Henry, located at the Chesapeake Bay mouth, to measure the catch of pound nets utilizing a modified leader designed to reduce sea turtle bycatch. It was believed the leader would also be successful in reducing significant bottlenose dolphin bycatch associated with pound nets in this location. The modified pound net leader replaced traditional netting with vertical stringers in the upper 2/3 of the gear. Researchers believed this spacing would provide protection from entanglement for sea turtles and dolphins. During initial testing for effectiveness in reducing sea turtle bycatch, a leatherback was entangled and died in the original gear design, prompting further modifications including the use of hard-lay line (e.g. tightly twisted) and increased spacing to 60cm between vertical stringers. The Cape Henry studies demonstrated that the modified pound net leaders should be equally effective for catching fish compared to traditional leaders. Following these studies, the state of Virginia and the National Marine Fisheries Service mandated the use of modified leaders on pound nets in certain areas of Chesapeake Bay. The results have been very promising, with hard-shell sea turtle and dolphin interactions and mortalities associated with pounds nets being greatly reduced. The exception to this positive assessment of the gear modifications has been the dramatic increase in entanglement interactions with leatherback sea turtles. The current modified leader design is apparently not sufficient to prevent leatherback entanglements. The leatherbacks swim into the vertical lines and ultimately twist together 3 or more lines until they are tightly pinched around the neck and fore-flippers. Further modifications to reduce slack in the vertical lines and/or otherwise prevent them from twisting together are needed.

This presentation will examine the recent history of leatherback strandings in Virginia, U.S.A., the concurrent development of a pound net modified leader, and how the otherwise successful fishing gear modification has produced unintended consequences for leatherback sea turtles.

AFTER THE IMPLEMENTATION OF TURTLE EXCLUDER DEVICES (TED) BY GABONESE SHRIMP TRAWLERS, TEDS WHERE SUCCESSFULLY TESTED ON GABONESE FISH TRAWLERS IN 2010 AND 2015

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NOAA/Virgina Sea Grant | Agence National des Pêches et de l'Aquaculture du Gabon | Agence National des Pêches et de l'Aquaculture du Gabon | Wildlife Conservation Society | Agence Nationale des Peches et de l’Aquaculture | Direction Generale des Peches et de l’Aquaculture | Wildlife Conservation Society | Direction Generale des Peches et de l’Aquaculture | Direction Generale des Peches et de l’Aquaculture | Direction Generale des Peches et de l’Aquaculture | National Marine Fisheries Service | Wildlife Conservation Society | National Oceanic and Atmospheric Administration

Gabon, West Africa is home to one of the most important Leatherback nesting assemblages in the world with nesting occurring on almost every stretch of sandy beach. National and foreign flagged vessels conduct industrial trawling for shrimp and fish and sea turtle stranding levels have coincided with fishing effort. The use of TEDs in shrimp trawls as a management tool to reduce fishery related mortality is a critical component of sea turtle recovery efforts worldwide. During the implementation of TEDs on shrimp trawls in Gabon, interests had shifted towards evaluating TEDs on Gabonese fish trawlers. In 2010 Catch data was collected from TED versus non-TED equipped trawls during 44 consecutive comparative tows (all top-opening). The duration of the tows and fishing zones were at the captain’s discretion. Fish loss was estimated at 4.5% for the top-shooting TED after 30 valid consecutive tows. Differences in bycatch between the TED equipped net and its corresponding control net was 23.6%. Statistical analysis of the catch data between TED-equipped trawl and non-TED trawl showed no significant difference in the catch rates of fish and a significant difference in the catch rates of fish bycatch. Following this successful experiment another one was conducted in 2015, this time aboard a Chinese owned Gabonese flagged fish trawler. Catch data was collected from TED versus non-TED equipped trawls during two series of 30 consecutive comparative tows (all top-opening). Once again the duration of the tows and fishing zones were at the captain’s discretion. Fish loss was estimated at 10.4% for the first 30 tows but after two minor adjustments (extension of TED flap by 40cm and shortening the tail end of the trawl by 2.4m) the next 30 tows showed a gain of 0.9% for the TED equipped trawl. Bycatch reduction in the TED equipped trawl was 11.2% for the second 30 tows. Statistical analysis of the catch data between the TED-equipped trawl and non-TED trawl for the second 30 tows showed no difference in the catch rates of targeted fish while the reduction of bycatch was statistically significant. Large fish specimens of guitarfish were captured less often in the TED equipped trawl. It is hoped that these successful trials will lead to continued buy in by industry and the government and lead to the adoption of TEDs in fish trawlers operating in Gabon. Gabon could be the first country to implement TED on all trawlers operating in their EEZ.

INCREASING TRENDS IN GREEN TURTLE (*CHELONIA MYDAS*) STRANDINGS IN SOUTHERN CALIFORNIA, USA FROM 1980-2017: A CAUSE FOR CONCERN?

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NOAA-Southwest Fisheries Science Center | NOAA-Southwest Fisheries Science Center | NOAA-Southwest Fisheries Science Center | NOAA-West Coast Regional Office | Ocean Associates, Inc. | NOAA-Southwest Fisheries Science Center | NOAA-West Coast Regional Office | NOAA-West Coast Regional Office | NOAA-West Coast Regional Office (retired) | NOAA-Southwest Fisheries Science Center | NOAA-Southwest Fisheries Science Center

The presence of green turtles off the coast of Southern California has been documented since the early 1900s. There are two established foraging aggregations in the area that have been regularly monitored: San Diego Bay, CA (since 1990) and Long Beach, CA (since 2006). A variety of studies have shown that coastal waters in this region of the eastern Pacific provide important foraging habitats for green turtles. Eastern Pacific green turtles have undergone a promising recovery due to decades of successful conservation efforts at nesting beaches in Mexico, and while this is a promising sign for conservation, it has likely resulted in increased human-turtle interactions and strandings of green turtles along the U.S. west coast.

Both live and dead green turtle strandings occur throughout the year along the U.S. West Coast, with a majority occurring in the Southern California region (San Diego, Orange and Los Angeles Counties). Over 180 green turtle strandings were recorded in Southern California between 1980 and 2017, with stranding response efforts being relatively stable over the last 15 years. Stranding data collected from live and dead turtles includes a variety of morphometric information, as well as signs of human interaction (e.g., boat strikes, fishing gear, power plant entrainments), some of which could be indicative of cause of mortality. On occasion carcasses were collected for necropsy. As unfortunate as strandings are, they provide key information about geographic ranges, natural and anthropogenic threats, seasonal distributions, demography and life history.

We conducted this study to better understand the significant increases in green turtle strandings in Southern California, which have been two-fold the last two years. Prior to 2016, green turtle strandings in the area ranged from 0 to 10. However, 2016 and 2017 have shown dramatic increases in strandings with 26 recorded in 2016 and 22 recorded as of mid-October 2017, respectively. We examined spatial distribution of strandings to determine if there are stranding “hot spots,” or specific areas or causes of concern in which to focus our efforts. Temporal distributions indicate that there is a seasonal trend to green turtle stranding patterns, with a large portion (39%) occurring in the late summer months of August and September. The number of annual strandings in relation to large scale oceanographic events, such as El Niño, were also assessed. Over 57% of the strandings in the last five years were associated with some level of human interaction (e.g. boat strikes, power plant entrainment or discarded fishing line), with a majority of the human interactions coded as probable boat strikes (58%), whereas overall probable boat strikes account for only 22% of the total strandings from 1980 to present. Demographic patterns indicate that juveniles make up a majority of strandings, especially in recent years, which could be in direct relation to the successful recovery of green turtles at the primary nesting rookery in Mexico. With the population recovering rapidly and the human population and its activities in shared turtle habitats also increasing, we expect to see more human-turtle interactions in the near future.

ILLEGAL SEA TURTLE TRADE IN SABAH, MALAYSIA: NEW MODE OF OPERATION WITH NATIONAL AND REGIONAL LINKAGES

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Sabah, a state located at the eastern part of the country Malaysia has important nesting beaches, foraging grounds and migratory corridors for green and hawksbill turtles. Despite the legal protection status of both species, the population are threatened by direct take and eggs being traded. Here provide an overview on the current trade status of turtles and eggs in Sabah, Malaysia. Past documented cases since 2004 includes observation of at least 160 dead and live turtles being found on board of foreign fishing vessels off the west coast of Sabah. Recently since 2015, there were documented cases of at least 60 dead carcasses without meat found at isolated islands off the districts of Kudat (north) and Semporna (Southeast). Between 2004 and 2016, at least 11 direct take cases amounting more than 784 turtles were recorded. Current investigations revealed that community members were involved with foreign fishermen in catching turtles at foraging grounds around Sabah. Cases of turtle eggs seized in various amounts for the purpose of trade were also documented. Between 1999 and 2016, at least 111 cases amounting more than 200,000 eggs were recorded. Interestingly, both threats were found to have national and regional linkages. It was found that foreign fishermen involved in trading turtles with community members were predominantly from China and Vietnam, to fulfill the demand of turtle meat and shell for consumption and ornamental purposes respectively. Furthermore, eggs were smuggled from neighboring countries such as the Philippines and Indonesia to Malaysia via sea and air to fulfill the demand of egg consumption. Various challenges could led to such threat which are can be vast sea areas for easy access, weak enforcement, insufficient equipment and technology, lack of allocation of funding for enforcement authorities, etc. Nonetheless, efforts has and currently being done to eliminate these threats i.e. establishing a multi-stakeholder turtle anti-poaching taskforce, empowering communities on the ground to conduct surveillance, and intergovernmental cooperation, which proposed to be the priorities to move forward in eradicating this illegal trade.

FISHERS' PERCEPTION AND PRACTICES ON TURTLE BY-CATCH IN SRI LANKA

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A major ecological impact of fisheries on sea turtles occurs through by-catch which is known to be high along the western and north-western coasts of Sri Lanka. It is an offence to kill, wound, harm or take a turtle using a net, trap, explosive or any other device, to keep in possession, sell or expose for sale a turtle or any part of a turtle. A survey was conducted in three fishing villages: Negambo (Gampaha District), Kandakuliya (Puttalum District) and Palali (Jaffna District) in north-western and northern coasts of Sri Lanka to assess the fishers' perception and practices on turtle by-catch. A pre-tested questionnaire was launched and the fishers were interviewed after obtaining verbal consent. Questions were asked to gather background information of the fisher, fishing practices and their perception on sea turtles and turtle by-catch. Of the 67 fishers interviewed, all were males, mostly (82%) between 30-55 years, having only primary education or less (85%). Fishing was the main income source of 97% of those interviewed with a monthly income of less than 350 USD. Fathers and grandfathers had also been fishers in almost all of them (97%). The majority (79%) had 10 or more years of experience in fishing. Although 57% of the fishers claimed that they were involved in catching sea turtles in the past, only 22% brings the by-catch home now. Of those, 89% was incidental but some were caught purposely (11%). The level of education of the fishers had no influence on their responses to questions on consumption and/or selling of turtle meat, their awareness on the fact that turtles are protected animals and illegal to kill (Fisher's exact test, $p > 0.05$). In the past the turtles caught in the fishing gear were either eaten (27%), or sold in the open market to meet cash needs (10%) or both (63%) but the fishers claimed that now they do not sell meat anymore because of the increased punishment for offenders. During 1990's there were reports witnessing the butchery and selling of live turtles openly especially in Kandakuliya and other north-western parts of the island. Eight percent of the fishers had been arrested and punished for catching and/or selling turtles. Majority of the fishers (63%) was aware that there were police, navy and coastguard officers monitoring the boats for turtle by-catch. The percentage of fishers who release by-catch had increased from 63% in the past to 90%. However, 53% of the respondents said that there was still a high demand for turtle meat. Among the three districts, fishers from Jaffna had better education than those from other two districts (Fisher's exact test, $p = 0.015$) but more people from Jaffna consumed meat than other two districts (Fisher's exact test, $p = 0.011$). Earlier, rules could hardly be enforced in Jaffna district due to the civil war but now the armed conflict is over, strict enforcement of the legislative measures is possible to control the killing of turtles for meat.

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SEA TURTLE BYCATCH CHARACTERIZATION IN GILLNET FISHERY IN PALOH WATER, SAMBAS DISTRICT

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Small scale gillnet fisheries are the dominant fisheries in Paloh waters located in West Borneo, Indonesia and have been associated with high interaction rates of sea turtles. Through rapid assessments, it has been estimated that at least 500 seaturtle are caught/year as a bycatch (WWF-Indonesia, 2014). This interaction between fisherman that target pomfret species (*Pampus* spp) and sea turtles is a major challenge for the gillnet fisheries in this region. Using onboard observers, we characterized the catch and bycatch of this gillnet fisheries in Paloh water from April 2014-June 2017. Gllnet fishing gear used in this fishery ranged from 1,175 – 1,385 m with a mesh size of 8 inches used to target Pampus spp. There are 48 gillnet vessels based in Liku Port in the town of Paloh. Each vessel conducts at least 4 trips/month which consist of 3-5 night time sets for each trip. The data were collected consisted of 149 gillnet sets from 56 trips.

The average CPUE (fish per 1000m X 12hrs) showed that the catch rate was 5.6274 for target species (pomfret), 10.3518 for retained commercial (scombiridae, snapper, rays), 7.8883 for retained other, and 3.1441 for discard (crabs, croacker). For endangered, threatened and protected (ETP) species bycatch, the sea turtle bycatch was 0.2417, 0.0473 for sharks and 0.0261 Mobulids. Composition of sea turtle bycatch are 68.75% green turtle (n=33), 12.5% hawksbill (n=6) and 18.75% oliveridley (n=9). Based on this CPUE of sea turtles, the size of the gillnet fleet, and the length of the fishing season, approximately 464 sea turtles are caught per year . This indicates that small scale gillnet fisheries may be a large threat to sea turtles in West borneo. Strategies to minimize threat from fishing gear modification technology such as LED lightsticks, developing a sea turtle conservation area, and working with fisherman to develop best sea turtle handling practices. Such conservation initiatives are currently underway through partnerships between WWF-Indonesia, local and national government agencies.
Keywords :bycatch, sea turtle, Paloh, gillnet, characterization

THE STRANDING ANOMALY AS POPULATION INDICATOR: THE CASE OF LOGGERHEAD TURTLES IN THE NORTHERN MEXICAN PACIFIC

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"We have shown the world that artisanal fishing has nothing to do with high loggerhead turtle mortalities at the Gulf of Ulloa". Such assertions provided by federal officials to national media are worsening the debate over the impact of artisanal non-selective fishing gear on abundant loggerhead turtles (*Caretta caretta*) distributed at the Gulf of Ulloa (western Baja California Sur). For the past thirteen years, several specialists have attributed the high stranding rates of dead loggerhead turtles in the area, to their incidental by-catch in fishing gear, estimating that ~2200 loggerhead turtles died/year in the area. Such mortality rates are among the highest in the world, threatening the only population of the species that nests in Japan, which was recently listed as 'endangered' under the US Endangered Species Act. The delayed response of the Mexican Government to mitigate this problem fueled the threat of economic sanctions by the US Government, which ultimately resulted in the decree of a fisheries refuge in the area, by banning all fishing activities. Years have passed, being evident that the issue has turned into a highly politicized one, and the tension between ecologists and fishermen is growing due to the lack of fresh and sound scientific knowledge. Thus, my goal was to improve the value of stranding data as population indicator as part of monitoring strategies, by constructing the spatial and temporal null hypothesis for loggerhead turtle strandings in the area. The null hypothesis is defined as: loggerhead mortality rates are uniform in space and constant in time, with relation to fishing effort (estimated as volume of artisanal scale, shrimp and elasmobranch captures in the area). I used time series analyses and Principal Component analyses to predict stranding probabilities and seasonal stranding patterns of loggerhead carcasses, for the period 2003–2015. The difference between the stranding rate expected under H_0, and the observed stranding rate is defined as the stranding anomaly. Therefore Loggerhead stranding anomalies increased during the summer months, as fishing effort in the area increased, and quite interestingly, highest peaks in loggerhead mortality were related to abnormally high captures of shrimp in 2006, an dhigh captures of flounder in 2012. In conclusion, this research adds new evidence on the high impact that incidental bycatch has on Japan's threatened loggerhead sea turtle population, and points that restrictions to fishing must prevail in the area until further and more detailed studies, specially those aiming to prevent the interaction between loggerhead turtles and fishing gear, are conducted at the Gulf of Ulloa Baja California Sur.

POTENTIAL IMPACT OF LIONFISH (PTEROIS SPP.) ON DEVELOPMENT HABITATS OF SEA TURTLES AND POPULATION CONTROL STRATEGIES IN BOCAS DEL TORO, PANAMA.

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Bocas del Toro is an archipelago located in the northwest Caribbean coast of Panama. It is an area with high marine ecosystem biodiversity, including mangroves, coral reefs and sea grass beds, all key benthic development habitats for sea turtle. Of the four sea turtle species present in the region, *Dermochelys coriacea*, *Eretmochelys imbricata*, *Chelonia mydas* and *Caretta caretta*, all but *D. coriacea* have been documented in benthic developmental stage at many sites. Potentially competing for these ecosystems are the invasive lionfish species *Pterois volitans* and *P. miles*. Native to the Indo-Pacific, they are highly predatory to native species, and will quickly reproduce and colonise an area due to the absence of natural predators. Since their first report in Florida in the mid-80's, lionfish have been invading the Caribbean Sea and the Western Atlantic causing great ecological problems; they were first registered in Bocas del Toro in 2009. La Autoridad de los Recursos Acuáticos de Panamá (ARAP) is a public Panamanian institution that organises lionfish catching tournaments in Bocas del Toro to reduce its population and provide an alternative food source to mitigate overfishing of threatened species. Since 2015 there have been six tournaments, observing the presence of lionfish in very important fishing sites such as Bocas del Drago and Isla Escudo de Veraguas. Up to 60 native species (around 50 of them in the juvenile phase) have been identified from lionfish stomachs, among them parrotfish species, which graze on toxic algae that poison reefs, keeping the coral healthy. It is estimated that lionfish can consume up to 80 per cent of an area's small reef fish in the space of just five weeks. They also feed on crustaceans, species that are a basic element of sea turtle's diet in developmental stages. The impact of lionfish on marine ecosystems and food availability, in addition to human impact such as fisheries (including sea turtles hunting) and pollution is a major problem for the survival of sea turtles in Bocas del Toro. The Sea Turtle Conservancy (STC) conducts sea turtle research and conservation programs in many countries, including Florida, Nevis and Bermuda, in addition to Bocas del Toro. Lionfish have been documented in very high numbers at these locations, and due to their potential threat to sea turtles, STC collaborates with different public institutions and private organizations to create strategies to manage their impact. The current abundance of lionfish in Bocas del Toro is not at the levels observed in other Caribbean regions, so population control strategies, if implemented quickly, may be more effective. Data obtained during previous lionfish campaigns and one planned in Bocas del Toro for November 2017 by ARAP and other organizations will be used to study distribution and abundance of lionfish in the region, length, weight, and stomach content analysis. Distribution will be mapped and compared to areas known to support sea turtles in benthic developmental stage. The other parameters will be evaluated to understand how the lionfish population is evolving. At the same time, outreach and educational strategies are being designed to promote the local use of lionfish as a handicraft and food resource through workshops, presentations, fishing and cooking contests, among others. The implementation of these strategies is expected to reduce sea turtle hunting by giving an alternative resource to local fishermen and communities. Also, reduction of lionfish populations will help restore the natural biodiversity of mangroves, coral reefs and sea grass beds, which will provide a stable food resources and habitats for sea turtles.

LESSONS LEARNED FROM A LIVELIHOOD-BASED STUDY ON HUMAN-SEA TURTLE INTERACTIONS IN MARINE PARK ISLANDS OF TERENGGANU, MALAYSIA

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Sea turtles occur mostly in developing countries where the livelihoods of local communities are closely linked to the state of natural resources. Legal protection and management decisions with little consideration of the livelihood reality of human interactions with natural resources often result in high level of noncompliance due to low level of acceptance. It is, therefore, important to understand the human dimensions in relation to their use and interactions with sea turtles and how conservation fits into the local context to ensure the sustainability of community livelihoods and sea turtle populations particularly in places where these two often appear to be in conflict. Such a place is the Malaysian state of Terengganu, which is one of the important nesting sites in Southeast Asia where knowledge on the social aspects of sea turtle interactions is limited. This study aims to bridge this gap using the Sustainable Livelihoods Approach which allows for holistic understanding of a wide spectrum of human dimensions that shape local perceptions on sea turtle management in Perhentian and Redang Islands - the two most populated marine park islands with nesting turtles in the state. These two islands are also popular tourist attractions, which makes them interesting sites for this study. Between October 2016 and July 2017, we conducted informal and open-ended interviews with local communities of Perhentian and Redang Islands to understand how they perceive human-sea turtle interactions and management efforts, and how they affect, or are affected by the presence of sea turtle populations in the area. Through the Sustainable Livelihoods Framework, we were able to explore how, in different contexts, people draw on different types of livelihood assets (e.g. natural capital) which are influenced by structures and processes (e.g. changes in policy) to develop livelihood strategies in order to achieve desired livelihood outcomes. Our findings suggest that the access component is the central element to understanding human-sea turtle interactions, which is interconnected to their livelihood strategies and assets. For example, the institutionalization of a no-take zone under the marine park since 1990s has driven many people to shift their traditional livelihood strategies in fisheries to a new one, i.e. tourism where two types of turtle-based tourism exist: viewing of in-water and nesting turtles. The latter, however, requires a license, which means that it is a livelihood activity with not open but conditional access. Furthermore, changes towards a more conservation-oriented legislation such as the creation of turtle sanctuaries have also reduced local communities' access to turtle eggs: a resource which is both traded and consumed locally. While turtle eggs are no longer traded as a shared common resource through a cooperative, there exists ambiguity on the access to turtle eggs on non-protected beaches. The situation creates discontent among local populations who feel “ripped off” their traditional rights. In sum, the framework has not only enabled us to capture the historical context of how local livelihoods interact with the local sea turtle population, but also understand the meaning of their perceptions. Such understanding can and should be used to improve management plans to ensure the sustainability of sea turtle populations and community livelihoods. Acknowledgements: We thank Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, US Fish & Wildlife Service and International Sea Turtle Symposium for the travel grant.

WINS AND LOSSES IN WILDLIFE TRADE BAN: A CASE STUDY ON SEA TURTLE EGG TRADE IN TERENGGANU, MALAYSIA

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Conservationists have battled with the trade in wildlife and wildlife derivatives for decades and the total trade ban has always been the popular conservation measures to combat the problem despite increasing debates on its effectiveness. In many cases, the decision for the ban are made purely from conservation perspectives based on the biological aspect of the species - leaving aside the fact that the issue intertwines people's socioeconomic, cultural and livelihood dimensions. Applying the Sustainable Livelihood Framework approach, this papers presents findings of a research that however attempts to provide a more holistic perspective the sea turtle egg trade in Terengganu, Malaysia. Here the consumption and trade (via a concession system) of turtle eggs are still practiced along with conservation. Using various data collecting methods from archival research to field observations and in-depth interviews with people in the industry, the papers does not only discuss the legal aspects of the trade on paper, but also considers the management practices on the ground by assessing available resources, constraints and readiness for the trade ban as well as simulates its consequences. Its findings suggest that the direct shift from status quo, to a total ban may in fact backfire against the conservation agenda. Instead, the paper, while acknowledging the need for sea turtle trade ban in Malaysia as a long term goal, recommends moving first towards a "pro-conservation concession scheme" as an interim measure. These findings highlight the benefits of considering livelihoods perspectives that provides the much needed "reality-check" in the decision making process towards ensuring the effectiveness of sea turtle management efforts.

Key word: Turtle Egg Trade, Sustainable Livelihood Approach, Sea Turtle Conservation, Resources Management

TRAWLING THE TURTLES: CONSERVATION AND ECONOMIC CONSEQUENCES FOR INDIA

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Shrimp trawl fisheries impose a great threat to one of the largest mass nesting population of olive ridleys along the east coast of India from net entanglements, often, washed ashore either severely injured or dead. As a matter of fact, the turtle congregation season coincides with shrimp fishing season. Locally, government undertook several protective measures, like, closed areas (congregation sites), seasonal fishing closure (nesting season) and mandating the use of TEDs in the trawl nets. Despite all these efforts the threat persists and very few trawl operators are known to use TEDs. What are the factors that has impacted the failure of successful implementation of these TEDs in the Indian waters?

Shrimp export industry in India account for about 6 billion dollars and over the last 3 years from the second it has now become one of the largest exporter of shrimps in the world. This has both environmental and social impacts varying from alternative livelihood, food security to coastal habitat loss. The Indian shrimps find its largest export markets at US, EU, Vietnam and Japan. With the US 609-certification while EU potentially following them and Indian government yet expressing interest in complying with the prior. What would it mean if all Indian shrimps are banned into US and EU countries?

How WWF in India is engaged with all the stakeholders from decision makers and trawl fisher community to resolve all the aforementioned issues, discussing the successes and major hurdles? The paper will answer all the above questions. Also, please note, the paper presented is from an ongoing work.

AMBAS IN ACTION: HOW AN ALL-WOMEN'S GROUP IS LEADING SEA TURTLE CONSERVATION EFFORTS IN EL SALVADOR

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Engaging women in conservation projects in developing countries can be socially and culturally challenging. In rural, impoverished areas, women's interests are often underrepresented due to their limited access to land rights, lack of formal education, and absence from decision-making processes. This shortsightedness can be detrimental to the progress of conservation work, as women often have a wealth of ecological knowledge to share and a strong influence on educating younger generations.

A unique example of women's impact on conservation can be seen in two coastal communities in El Salvador, where women are leading the way in sea turtle conservation. The conservation of hawksbill sea turtles (*Eretmochelys imbricata*) has recently become a top priority in El Salvador, as approximately 45% of known nesting sites occur along the Salvadoran coast. Hawksbill sea turtles in this region are overexploited due to the high demand for their carapaces for use in jewelry and handicrafts, and the collection of their eggs for consumption and sale. To explore the innovative ways women are working to conserve hawksbills and other sea turtle species, we conducted interviews with individuals from an all-women's group called the Association of Community Development of Women in Barra de Santiago (AMBAS, in Spanish) and women working in fishing cooperatives in the Bay of Jiquilisco. We also interviewed fishermen and egg collectors in Barra de Santiago to investigate community perceptions associated with AMBAS organizing conservation efforts as an all-women's group, which is remarkable for Salvadoran culture where women are typically house caretakers only.

The primary objectives of this study were to: 1) characterize wildlife conservation strategies in Barra de Santiago; 2) investigate how the women of AMBAS came to serve conservation leadership roles in the community; 3) discover how AMBAS facilitates endangered wildlife conservation efforts with an emphasis on hawksbill sea turtles; and, 4) determine how AMBAS' conservation priorities and knowledge of sea turtles compares to that of the women involved in fishing cooperatives in the Bay of Jiquilisco.

Based on interview responses, we discovered that AMBAS is exceptional in the way they pay community members for their participation in conservation projects, which results in increased income opportunities and a greater awareness of conservation issues and needs. AMBAS's many programs include the operation of a multi-species sea turtle hatchery, mangrove restoration projects, and beach cleanups, as well as professional development workshops for local women. Because AMBAS provides avenues for community members to earn additional income, they have gained tremendous support, which leads to their high rate of success with conservation initiatives. Most notably, the interview responses from non-AMBAS members indicated that AMBAS's strongest supporters are men who view them as the local stewards of Barra de Santiago's natural resources. In contrast, while the women participating in the Bay of Jiquilisco fishing cooperatives are not involved in organized sea turtle conservation projects, they showed an intimate knowledge of hawksbill sea turtles present in their fishing areas and unanimously claimed that in addition to earning income, they joined their cooperatives to help the environment and promote sustainable fishing practices that would help conserve hawksbill sea turtles.

These two extraordinary groups provide concrete examples of women leading conservation efforts. By sharing their stories and modeling their actions, we can achieve greater success in conservation and pave the way for future female leaders.

PERCEPTION OF THE BOA VISTA ISLAND (CABO VERDE) POPULATION CONCERNING THE CONSERVATION OF MARINE TURTLES

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The loggerhead turtle (*Caretta caretta*) is an emblematic species of the Cabo Verde Islands nesting mainly on the Islands of Boa Vista, Maio, and Sal.

In Cabo Verde, the sea turtles are protected by a legal framework (Regulatory Decree 7/2002 of 30th December) that supports various conservation actions and projects. The nesting population of *Caretta caretta* that nests in Cape Verde is the third largest in the world and the second largest in the Atlantic, and is redlisted by the IUCN as “Endangered” and denoted by SWOT (State of the World’s Sea Turtles) among the world’s 11 most threatened marine turtle populations.

Due to heavy poaching of nesting females, on Boa Vista research and conservation works are being conducted since 1998. During the last decade poaching activities could be largely reduced by beach patrolling accompanied by environmental education and information campaigns. However, in recent years poaching activity has increased again, while the behavior of poachers towards conservation patrols on the beaches became more aggressive, and in certain communities negative attitudes towards conservation organizations and their local employees accumulated.

While direct beach protection reduces poaching in the short run, sustainable conservation needs support by the local people. To better involve people into conservation, reliable information on public opinions, attitudes, and behavior towards turtle protection is needed, but also about demographic, social, educational, and economic structures of the population. Therefore, with support of the United States Fish and Wildlife Service (USFWS) we carried out a community survey with questionnaires provided to randomly selected members of all communities on Boa Vista.

Besides personal questions (e.g., age, education) the questionnaire asked for knowledge and opinions about sea turtle protection, consumption of turtle meat, and prohibition of turtle meat consumption. Further questions asked for knowledge about activities of local conservation organizations and requested to judge the quality of their work.

951 people participated (6.1% of the population of Boa Vista). It turned out that communities in the Northeast of Boa Vista, close to the nesting beaches, were most negative to the protection of sea turtles and the conservation organizations. Surprisingly, this was not going along with low education; it rather became clear that responses were deeply linked to the historical-cultural significance of turtles. Further, while recognizing the need for conservation of turtles and the importance of awareness-raising work many people didn’t agree with the way this work is being done. Further, we detected significant misconceptions about the role and work of conservation organizations, thus often creating false expectations among people and revealing failures of the organizations to explain their mission correctly. The results indicate that attitudes largely arise from cultural issues and from years of only few results in development assistance (agriculture, livestock, fisheries), thus impeding to understand the roles and limits of the organizations.

To continue successful conservation work we need to clarify misconceptions by establishing a situation where both parties are willing to listen to each other and to share their views. Further, we must increase activities to engage the communities in conservation activities, help to develop alternative activities compatible with conservation, and promote partnerships helping in fulfilling those needs of communities that are not being addressed by the government. The results of this study provide a starting point for an intervention strategy that integrates the conservation of sea turtles and the sustainable development of Boa Vista’s communities.

EXPLORING LOCAL COMMUNITY PERCEPTIONS OF SEA TURTLE EGG CONSUMPTION IN TORTUGUERO, COSTA RICA.

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Tortuguero has the largest green turtle (*Chelonia mydas*) rookery in the Western Atlantic Ocean. In addition, threatened hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) sea turtles nest on the same beach. Since 1955, when Archie Carr started studying the population of sea turtles in Tortuguero, long-term conservation efforts to protect these species have been implemented, with the creation of the Caribbean Conservation Corporation in 1959, currently known as Sea Turtle Conservancy. Furthermore, Tortuguero National Park was created in 1975 to strengthen the protection of the nesting beach and the adjacent habitats. The local community has also played a major role in these conservation efforts, shifting from a consumptive use of sea turtles, harvesting the turtles and their eggs, to a non-consumptive use, benefiting from ecotourism. At present, Tortuguero is globally recognized as an example of how marine turtles can be used to generate great revenue in a non-consumptive way. However, despite all the efforts to conserve sea turtle populations, poaching of nests and egg trade still occurs in the area, as shown by recent records. Effectively protecting sea turtle nests, not only requires vigilance and comprehensive protection efforts, but also a qualitative approach to understanding the dynamics of sea turtle egg consumption. Therefore, the aim of this ongoing study is to identify the perceptions and attitudes of the local community and other stakeholders towards the consumption of sea turtle eggs and its impact on sea turtle conservation. From September 2017 to December 2017, questionnaires are being distributed to the local community and semi-structured interviews are being conducted with key informants. Preliminary data suggest that sea turtle egg consumption still persists within the community of Tortuguero. Nevertheless, consumers are perceived to be between 30-50% of the population and consumption has shifted from being subsistence to occasional consumption, happening at least once a month. Among consumers there is some understanding of the issues surrounding sea turtle conservation, with egg consumption being negatively regarded. Despite this, consumption persists, though not publicly. Adjacent communities not benefitting from ecotourism are perceived by locals of Tortuguero to be the main consumers of eggs. The community also perceives that the majority of eggs extracted from Tortuguero are traded with nearby Caribbean communities. With the final results, we expect to create baseline information regarding local perceptions on the extent of egg consumption within the community, the frequency of consumption, and the drivers of this behaviour. The results will also look into the dynamics of egg trade and the impacts of consumption on the socio-economic and conservation aspects. Overall, the results will provide a better understanding of the problem of egg consumption and insights into the challenges of tackling this issue and the improvement of current conservation strategies.

UNDERSTANDING THE IDIOSYNCRASY, CULTURE AND LIFESTYLES OF ARTISANAL FISHERMEN FOR THE EFFECTIVENESS OF CONSERVATION PROJECTS

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WWF Perú | WWF Perú

Marine turtles have a key role in marine ecosystem health, for which we must protect them and reduce impacts on their populations. Nevertheless, Peru has one of the highest marine turtle bycatch rates in the Eastern Pacific. Several conservation efforts on marine turtles have been developing for long periods in Peru, but much remains to be done to ensure the conservation of these species.
Reviewing work done by local non-governmental organizations, the success of their efforts relies on the close relationship they have developed with artisanal fishermen from certain coastal communities and in the constancy of their work. However, the impact they have had is reduced due to the number of fishermen throughout the coast. Likewise, the government has been characterized for developing small and sporadic training sessions, which have not had a considerable impact to address the main threats marine turtles face.
Local NGOs have been able to develop close relationships with artisanal fishermen and have got to know them well, establishing close bonds of friendships from the understanding of the idiosyncrasy, culture and lifestyle of fishermen. Artisanal fishermen have as their main livelihood fishing, even sailing beyond 200 miles of the coast to maintain their families. Their lives are hard and sacrificed, working in a high-risk activity whereby the majority are believers of some religion. In addition, most artisanal fishermen in Peru like to listen to “cumbia” music, playing cards, and having a beer with friends.
Not just people from the coast are dedicated to this activity, also people from other regions migrate to the coast and end up fishing. Coastal fishermen differentiate them not only for their physical features but also their cultural background, as they consider fishermen from non-coastal locations to not have the same respect to the sea as them. Some coastal fishermen have commented that they liberate turtles to avoid having “bad luck” while fishing, or they feel pity looking at them “cry”, but they also comment that migrant fishermen are less respectful and prefer to consume them.
In that regard, a playing card game or a “cumbia” song with a marine turtle conservation message can have a much powerful remembrance and impact than a two-hour training session. Likewise, understanding their priorities and needs allow to explore and design adequate formats to deliver messages and solutions. Other indirect approaches could be through the children of fishermen, as they are their greatest treasure and pride. Marine conservation festivals with educational games and presents such as a turtle-shaped backpack can teach kids to care and protect marine turtles and encourage their parents in the conservation of these species. From the knowledge of these characteristics strategies for conservation projects should be prepared.
Keywords: bycatch, marine turtles, Peru, social analysis, impact strategies

A PLASTIC BAG BANNING PROCESS: CONVINCING A LOCAL COMMUNITY AND GOVERNMENT TO STOP USING SINGLE-USE PLASTIC BAGS IN A NESTING AREA IN THE PANAMANIAN CARIBBEAN.

Georgina Zamora Quílez
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Bocas del Toro, a fragile archipelago located in the northwest of the Panamanian Caribbean where the Sea Turtle Conservancy (STC) has been working since 2003, has a high ecosystem biodiversity, including important nesting, feeding and migrating areas for four sea turtle species. Additionally, poorly-managed tourism, a quiet local government and a community with little environmental awareness have resulted in a region with serious planning issues. This situation is reflected in a solid waste overproduction with no public management nor post-treatment.
One of the main issues in Bocas del Toro is the disproportionate use of plastic bags. These are a major threat worldwide; they can take up to 1,000 years to break down, re-entering the environment, posing a continuing threat to wildlife (*WWF, 2016*). At least 267 different species, including sea turtles, are known to have suffered from entanglement or ingestion of plastic marine debris (*Worldwatch Institute*). Just in Bocas del Toro town, an island populated by around 8000 people, 500 bags per supermarket are approximately delivered daily in a regular basis; thus, in two different town cleaning ups, the first of them collected 80% plastic bags of total trash and in the second, 1205 plastic bags were found in 2 days.
On account of that, an Environmental Committee called “Zero Waste in Bocas”, conformed by NGOs, including the STC, businesses, local government and civil society was created. The main goal of this Committee was to reach a change of paradigm in the bocatoranian society towards their relationship with their environment. By observing clear requests from a part of the population as well as analyzing the contrast between a challenging community and such a rich and fragile ecosystem, the first approach to follow was plain to see: a single-use-plastic-bag banning regulation with an educational and outreach campaign as a strategy to reduce trash and create a more aware community (*Xanthos, 2017*). Luckily, after several months of working together with the local government, an agreement was signed in April 2017 in order to ban the delivery of single-use plastic bags in supermarkets when shopping in Bocas del Toro district, with a one year period to adjust to the measurement, being the regulation effective in April 2018.
In the present case, the strategy the group “Zero Waste in Bocas” used to achieve a single-use plastic bag banning regulation, first and only one in Panama, has focused on three main actions: the first is the creation of local legislation on single-use plastic bags to have a legal backup, the second is an outreach campaign through different paths such as media (local TV, internet groups, local newspapers) and meetings with supermarket owners and local businesses, and the third is education projects, such as empowering local students as environmental community leaders; all these highlighting the importance of environmental education as an essential tool to lead towards a healthy and respectful society.
Additionally, interviews to supermarket owners and costumers have been conducted to capture people's perception about plastic bags and the new regulation; same interviews will be done after the regulation is effective, in order to measure the efficiency of the outreach and educational actions, thus ensuring the information is reached and understood by the different stakeholders.

Thank you to Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, US Fish & Wildlife Service.

FINDING INNOVATIVE WAYS TO BRING QUALITY EDUCATION TO CLASSROOMS STATEWIDE

Rebecca Mott
Inwater Research Group

In the field of conservation education, there are many factors that go into developing new programs as well as inevitable obstacles. Many organizations face setbacks such as low budgets, minimal staff, and limited geographic reach. In 2016, Inwater Research Group (IRG) sought to develop a program that would overcome these obstacles while providing a high quality educational experience.

Because IRG has no brick and mortar facility and limited education staff, we needed a program that could visit schools and that was run by teachers, not IRG educators. Limited funding required us to develop something that had only a one time cost and little to no upkeep financially. Teachers needed to be able to incorporate lessons into their curriculum so each one had to align with state standards while still engaging students.

This resulted in our *Traveling Turtles* traveling trunk program that could be lent out to local teachers free for up to three weeks. The program is housed entirely in a large wheeled trunk that carries all lessons and supplies teachers need to run a four-lesson module with their class.

After its first year, the program booked to capacity and we subsequently created two additional trunks to keep up with demand. In its second year, four trunks reached over 9,000 students locally. We realized, however, that while we were educating students locally, we were neglecting to carry that education geographically further. Because of this, we developed a statewide program, *Traveling Turtles of Florida*.

Traveling Turtles of Florida is a grant-funded program that allowed us partner with other conservation organizations around the state. These organizations received all the trunk supplies at no cost as well as detailed instructions to assist with putting the program together. They would re-create the trunk exactly as we had developed it for ourselves, and once complete, offer it in their local school districts. After its first year, the program reached 12,436 students statewide.

With this model proving successful and easy to implement, IRG developed a second statewide traveling trunk program, *Darker Skies, Darker Beaches*, which addresses the issue of sea turtles and lighting. Again, we partnered with five Florida organizations who received a ready-made trunk underwritten by grants. We estimate that we will reach 20,000 students statewide by the end of the 2017-18 school year with the program running for years to come.

PORTABLE SEA TURTLE CONSERVATION: TACTICAL INFLUENCE WE ALL SHOULD CARRY

Blair Witherington
Disney's Animals Science and Environment

We realize that sea turtles need our help, and we know a great deal about what that help should be. In most cases, help means recruiting assistance, not from fellow conservationists, but from a broad constituency. The “assistance” required is behavioral change. Most often, behavioral changes that would benefit sea turtles involve discontinuing actions rather than initiating them. So, how do we divert a culturally varied audience away from actions they may have done all their lives? As we socialize, give presentations, and speak through media, how might our words and actions alleviate behaviors harmful to sea turtles? What happens inside a person’s head to determine how they take part in actions affecting sea turtle conservation?

These questions are explored within the study of conservation psychology. This science tests hypotheses on the reciprocal relationships between humans and the rest of nature, with a focus on how to encourage conservation of the natural world. Recent findings in this field reveal how effective conservation persuasion can take place. Although the practice of persuasion may be an art, there is ample scientific evidence to describe how it works. Six key elements of influence, modified for how they might apply to conserving sea turtles, are to convey urgency (imminent risk of losing sea turtles as populations, species, or biological phenomena), use reciprocity (help someone and they will return the favor), seek/offer commitment (promises and recognition), reveal peer pressure (especially from one’s own tribe), present authority (especially from within one’s own tribe), and be likable (positive, pleasant people enjoy extended audience time and are harder to refuse).

Many details describe how these elements can be used effectively. In this talk, I’ll focus on some simple tactics that any sea turtle conservationist might use to bring about pro-conservation behavioral changes in a person or group. These tactics are meant to be “portable,” but are designed to fit within wider strategies to influence policy and bring about pro-conservation cultural changes. Examples will include how to leverage the persuasive elements above, how almost any member of the public can deliberately benefit sea turtles, and how to address fundamental questions from skeptics on why sea turtles should take part in our world.

FROM TRASH TO MONEY: A SUCCESSFUL CASE COMBINING GREEN TURTLES PROTECTION AND BEACH CLEAN-UP IN TAIWAN

Ning Yen
Hiin Studio

In last decade, Xiao Liuqiu has become a well-known island to see turtles in Taiwan. Located off the southwestern side of Taiwan near Kaohsiung, Xiao Liuqiu used to be an important base for fishery and there are hundreds of fishing vessels. Since the social economic condition changed, younger generation turn to run tourism instead of following traditional fishery. After few years of adjusting and developing, local community has realized that eco-tourism is better and more sustainable to attract tourists and they have recognized green turtles as one of the uniqueness. Actions initiated by local community such as volunteer doing regular underwater clean-up from 2011 and local fishing association proposing a ban of gill net fishing since 2013 have created Xiao Liuqiu suitable habitat for green turtles. In past five years, researchers have identified 163 sea turtles in Xiao Liuqiu. As a result, tourism business booms quickly and more external people move to the island running business.

As an environmentally educational non-profit organization, Hiin Studio devotes to raise public awareness on the problem of marine debris pollution and promotes sustainable clean ocean. Inspired by the concept of beach money which is proposed by a conscious surfer in Japan, we like the idea of using sea glass (broken glass picked at seaside) as money to get some discount in certain shops. To make stronger link between tourists, the local government, communities and shop owners further develop the idea of inviting local artist painting the sea glass with green turtle or marine lives pattern. These beautifully painted glass are then used as money only circulated in local shops. The only way to get painted glass beach money is participating environment education and beach clean-up.

With the support from local government, we hold a series of environment education and beach clean-up which we introduces green turtle’s life and identify plastic as the biggest threat to green turtles. We not only address on the environment impact of single use plastic utensils, but we also offer solution like refusing straw or using reusable straws, bringing cup and container when traveling. With the incentive of beautiful beach money, we have found that number of participants gets triple to quadruple compared to same activity we hold last year and participants become more willing and engaged, and pick much more trash after the environment education. While the average of waste picked during beach clean-up is around 3 to 4 kilo per person in Taiwan, we have recorded 6 to 11 kilo per person in our activity.

In our first trial to combine beach money with environment education and practice this year, we have cooperated with 88 local shops and engaged 441 people including tourists and local community during 5 beach clean-up. We discovered the interaction from online social media to offline activity and back to online experience sharing which benefit to build the story and outreach the idea of reduction single plastic usage in daily life and tourism. We have found local communities inspired by the concept of beach money and willing to extend from using turtles as tourist attraction to further actions like actively participating beach clean-up and using reusable tableware to replace single use plastic items in order to leaving a healthy environment for green turtles. The beach money played more than a coupon but brought the impact of changing people’s behavior and building the sense of honor on their actions. Although local economic circulation through beach money just begins, we look forward to expand this initiative, deepen the linkage between private and public sectors and make Xiao Liuqui an island free of single use plastic in the future.

MEASURING THE EFFECTIVENESS OF AN INTERNATIONAL SEA TURTLE INTERNSHIP PROGRAM IN DEVELOPING FUTURE LEADERS

Shelli Hendricks | Katherine Comer Santos | Wallace J. Nichols | Elizabeth Whitman | Lizette Guzman Zaragoza | Elizabeth Kocek Marquez

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Sea turtles are often referred to as the “ambassadors of the ocean,” and many people claim that just by being near turtles and the ocean, they experience a greater desire to conserve ocean health. Many who research or work long-term with sea turtles gain valuable skills in science, technology, engineering and math (STEM) and international leadership. However, the literature lacks longitudinal studies that document these transformative processes in individuals. To this end, our team analyzed quantitative and qualitative data collected from undergraduate and graduate interns enrolled in the Science Exchange Sea Turtle Internship Program which places undergraduate and graduate students from around the world under the supervision of sea turtle researchers in Latin America and the Caribbean. Interns work in the field for two months while they complete a research project for academic credit. The database covers a 10-year period (2008 – 2017) and 62 students from the United States, Mexico, and Australia representing 34 universities (and one high school). To track STEM knowledge, conservation attitudes, and leadership traits we used self-assessment before and after knowledge surveys, self-reporting “where are you now?” surveys, field journals, tracking via social media sites, direct contact via email, phone interviews, and direct observation during the internship. To date 85% of the contacted interns are active in some conservation issue. Eight-four % are considered leaders in STEM. meaning they have presented at conferences, published, or taught STEM topics after the internship. All eligible interns graduated from their schools, and 41% of those went on to graduate, vet, or medical school. Sixty-five % of graduated interns actively worked in STEM professionally. Despite these impressive long-term results, the before and after knowledge surveys did not show a considerable increase in STEM knowledge at the end of the two months of field work. Passion for conservation deepened for most and many mentioned their new appreciation for the socio-economic reality in which conservation work occurs. We report lessons learned from collecting and analyzing these types of data and offer suggestions that can help other groups better measure and improve their effectiveness in creating the next generation of ocean leaders. Our work will ideally lead to more integration of neuroconservation concepts and a deeper appreciation for and communication of the vast emotional benefits sea turtles offer.

CHAPUZON SUBMARINO – ARE YOU READY FOR AN UNDERWATER DIP?

Yadira trejo Hernandez | Anibal Murillo Lopez | Diego Azcoytia Rocher | Isabel Miranda | Delia Karen Oceguera | Jesus Lucero | Ana Razo Zaragoza | Agnese Mancini
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Environmental education is an essential component of marine turtle conservation, especially in areas where turtle consumption and turtle harvest were allowed until recently. For this reason, the Mexican NGO Grupo Tortuguero de las Californias has launched in 2014 a new awareness program called Chapuzon Submarino (which means underwater dip). Chapuzon Submarino combines arts, science and gamification to share information on marine turtle life-history with children aged 8 to 12 years old. Marine turtles are also used as sea sentinels to introduce other local and global issues like climate change, plastic pollution, overfishing and the role we have as humans in protecting natural resources. This program uses some innovative methods to ensure a long-lasting impact on the participants:

・It mixes arts (music and plastic arts) and science to allow for an enhanced teaching experience that stimulates appreciation for the natural environment, reduces school apathy, and encourages critical thinking;

・It uses a holistic approach where nature and marine turtles are experienced through all senses. One of the activities for example consists in closing eyes and imagining the life of a turtle by listening to music and by touching objects that remind of the obstacles turtles have to face during their lives;

・It promotes team work, solidarity and empathy for the natural environment and for other people. Although the program is taught during school hours, the activities do not generate competitions or a hierarchy, which helps decreasing problems of divisions and violence among students;

・By addressing children aged 8 to 12 who have a well-developed ability to share their learning experiences with their families and friends, this program has a snowball impact on communities where it is taught.

Approved by the Mexican Ministry of Public Education (SEP in Spanish), Chapuzon Submarino was designed to strengthen the teaching of natural science, geography, history, ethics and civic education. It also responds to a need highlighted by the Mexican Ministry of the Environment (SEMARNAT in Spanish) for incorporating criteria of sustainability and environmental education in the curricula of the national education system. During the past three years, more than 650 people benefitted directly from this program (scholars and teachers) and more than 1,500 have benefitted indirectly. For the current scholar year and in order to have a long lasting impact on participants, activities have expanded to include students from secondary and high schools (some of whom participated to Chapuzon Submarino in previous years), as well as adult community members. As a next step, an assessment of the short- and medium- term effects of the project will be implemented.

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COMMUNITY BASED RESOURCE MANAGEMENT THROUGH EDUCATION AND INCENTIVES.

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Turtle Conservation Project | Turtle Conservation Project | Turtle Conservation Project | Turtle Conservation Project

Five species of sea turtles nest in Sri Lanka. They are the Green turtle (*Chelonia mydas*), Leatherback turtle (*Dermochelys coriacea*), Olive ridley turtle (*Lepidochelys olivacea*), Loggerhead turtle (*Caretta caretta*) and the Hawksbill turtle (*Eretmochelys imbricata*). Coastal communities of Sri Lanka depend on surrounding natural resources for their survival. In addition, development activities are taking place in many coastal areas of the island. As a result, very important coastal habitats and coastal fauna and flora such as the coral reefs, sea grass beds, mangroves, marine turtles and other coastal vegetation are under serious threat of extinction. Studies have shown that involvement of communities in conservation actions increases the effectiveness of the programmes. In addition, research studies conducted on conservation and education suggest that education and awareness could change the attitudes of people resulting improved results of the conservation actions. Furthermore, providing incentives would increase the active community involvement and trust Therefore, many conservation and rural development managers around the world use incentives and education and awareness programmes in order to improve community based conservation programmes and community livelihoods.

Turtle Conservation Project (TCP), a non-governmental organisation in Sri Lanka implemented a community incentives and education and awareness programme along the coastal belt of Sri Lanka in 2016. The main objectives of these programmes were to increase the community participation in marine and coastal resource conservation and eradicate the poverty in selected coastal areas. The introduced incentives included introducing livelihoods such as sewing, batik, ornamental fish breeding, crab culture and sea bass culture etc. In addition to the incentives, TCP implemented an extensive education and awareness programme in order to increase the community understanding on coastal resource conservation and management. The types of education and awareness programmes included illustrated lectures with PowerPoint presentations, workshops, exhibitions, art competitions, TV and Radio programmes, newspaper articles, website, Facebook group and page, film shows, field trips etc. Well trained and experienced TCP staff conducted these programmes and external resource persons were hired as necessary. Target groups of these programmes were school children (27 programmes were conducted), university students (2 programmes), fishermen (20 programmes), government officials (5 programmes), media community (1 programme), politicians (1 programme), religious leaders (5 programmes), other NGO members (5 programmes) and general public (20 programmes).More than 5000 citizens were educated during the educational programmes. As a result of conducted educational programmes TCP was able to create an effective volunteer group and membership who support its conservation efforts. Furthermore, both incentives and educational programmes helped to increase the community participation and their support for community based coastal resource management programmes implemented by TCP.

ASSESSING THE EFFECTS OF CONTAMINANTS IN SEA TURTLES USING SPECIES-SPECIFIC CELL-BASED BIOASSAYS

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Australian Rivers Institute, Griffith School of Environment, Griffith University | Australian Rivers Institute, Griffith School of Environment, Griffith University | Australian Rivers Institute, Griffith School of Environment, Griffith University

The long-lived nature of marine turtles and their extensive use of coastal foraging grounds can result in high exposure to organic and inorganic contaminants from anthropogenic urban, industrial and agricultural sources. Organic or inorganic contaminants have been quantified in all species of marine turtles worldwide. However, very little is known about how these contaminants impact turtle health, valuable information for identifying populations at risk. To date, the effects of relatively few contaminants have been investigated for a small number of toxicological endpoints, driven largely by the logistical and ethical constraints of conducting direct exposure experiments on these large, protected animals. In vitro exposure experiments using cell lines established from turtle tissue provide an ethical, reproducible, cost-effective method to identify threats of environmentally relevant contaminants to marine turtles. This study uses primary cell cultures established from green turtles to investigate the effects of five organics and five inorganic compounds using a variety of endpoints such as cytotoxicity and oxidative stress. The results will allow more robust and meaningful risk assessments to be conducted for marine turtles, assisting conservation and management strategies worldwide. Our results also support the use of marine turtle cell cultures as an ethical and reliable method for investigating toxicological effects of environmental contaminants.

ACQUISITION OF THE MICROBIOTA IN HATCHLING GREEN SEA TURTLES

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A diverse array of microorganisms, known as the microbiota, reside on and within all metazoans. Acquisition of the microbiome during birth is critical for priming the gastrointestinal tract and immune system of mammals. Given the reliance of animals on their symbiotic micro-organisms, it is highly likely that initial microbial colonisation of reptile gastrointestinal tracts also plays a significant role in development of their immune systems. However, it is not know how microbes are aquired by hatchlings in order to prime them for healthy gut function and immunity.

Using an experimental protocol, combining laboratory and field data, we examined how environment and maternal microbes influence the microbiota of hatchling green sea turtles (*Chelonia mydas*). Colonic swabs were collected from nesting female turtles from Heron Island, Australia and their entire clutch of eggs was collected from the turtle into a sterile plastic bag. A small proportion of these eggs were opened using sterile technique and the contents of the egg were sampled. We then separated the remainder of the clutch into two treatment groups. Some eggs were buried in artificial nests on the island while others were taken back to the laboratory to incubate in commercially available sand. Swabs were collected from hatchling turtles as they emerged from the eggs from both treatment groups. Analysis of microbial composition was achieved using 16s rRNA gene sequencing. We then compared the microbiota of mother and hatchlings to determine how the hatchling microbes had been acquired. We will discuss these results in the context of how they improve our knowledge of sea turtle biology and their implications for artificial incubation of eggs.

DETERMINATE OR INDETERMINATE GROWTH? REVISITING THE GROWTH STRATEGY OF SEA TURTLES

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Traditionally, species have been classified into determinate or indeterminate growers. Under indeterminate growth, individuals retain the ability to grow throughout life, whereas growth ceases during the natural lifespan of an individual under determinate growth. Although indeterminate growth is a widely-accepted growth strategy and believed to be ubiquitous among long-lived species such as ectothermic vertebrates, recent studies suggest that it may not be as common as previously thought. Sea turtles are among these ectothermic vertebrates believed to be indeterminate growers despite the paucity of long-term studies into post-maturity growth. In this study, we provide the first temporal analysis of post-maturity growth rates in wild sea turtles, using 26 years of data on individual measurements of nesting females. We calculated both annual growth and compound annual growth rates from capture histories. We used generalised additive/linear mixed models to incorporate multiple growth measurements for each female and model post-maturity growth over time. We found post-maturity growth to persist in both wild green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles, decreasing for approximately 14 years before growth ceased. Growth plateaued around zero for a further decade in green turtles and was independent of size at sexual maturity in both species. Although both annual growth and compound annual growth rates were higher in green turtles than in loggerhead turtles, the difference in growth curve between the two species was not significant. While sea turtles were long thought to be indeterminate growers, in this study, we provide evidence of determinate growth. Our results highlight the need for long-term studies to refine life-history models and further our understanding of ageing and longevity of wild sea turtles for both conservation and management.

THE USE OF KETONE BODIES AS A BIOMARKER OF FORAGING BEHAVIOR IN WILD SEA TURTLES

Sydney Stewart | Roldán Valverde | Martha Villalba-Guerra | Barbara Schroeder | Allen Foley | Blair Witherington

Southeastern Louisiana University | Southeastern Louisiana University | Southeastern Louisiana University | National Oceanic and Atmospheric Administration - National Marine Fisheries Service | Florida Fish and Wildlife Conservation Commission | The University of Florida Archie Carr Center for Sea Turtle Research and Walt Disney Parks and Resorts

Sea turtles are considered capital breeders in that they accumulate nutrients prior to their reproductive migration and fast during their breeding season. As such, their nesting numbers may be regulated by environmental fluctuations that can influence food abundance and availability, such as EL Niño-Southern Oscillation events or climate change. Foraging success thus constitute a parameter of high conservation value. However, since sea turtles spend most of their lives at hard-to-access foraging sites it is difficult to evaluate whether wild populations accumulate sufficient nutrient stores to support migration and reproductive processes. In this presentation, we report on our efforts to characterize a biomarker of foraging success in wild sea turtles. During fasting, lipid stores are preferred over carbohydrates and proteins. As lipids are used to support energy demands, fatty acids such as triglycerides are converted to ketone bodies. Ketone bodies are produced in the mitochondria of liver cells with the most abundant being β-hydroxybutyrate. Laboratory studies have shown that β-hydroxybutyrate production is an indicator of fasting in Green sea turtles (*Chelonia mydas*). In addition, it has been shown that low doses of estrogen inhibit feeding in Green turtles, which suggest that sea turtles exhibit hypophagic behavior during the breeding season. We hypothesize that ketone bodies are elevated in nesting sea turtles to compensate for the lack of nutrient intake during fasting. Samples from Loggerhead (*Caretta caretta*) sea turtles were measured in the Florida Bay foraging grounds and the Hutchinson Island nesting grounds. Foraging Loggerhead females had an average β-hydroxybutyrate concentration of 0.55 ± 0.05 mM. Nesting females had a significantly higher average β-hydroxybutyrate concentration of 1.58 ± 0.18 mM ($P < 0.001$). Of the foraging animals, vitellogenic females had a significantly higher concentration of β-hydroxybutyrate (0.97 ± 0.11 mM) than that of non-vitellogenic females (0.41 ± 0.02 mM) ($P < 0.001$). We observed a positive relationship between vitellogenin concentration and β-hydroxybutyrate concentration ($R^2 = 0.5068$). Our results are consistent with the thesis that sea turtles are capital breeders that become hypophagic prior to migration and to the first nesting event. Our results suggest that sea turtles depend on high abundance and high-quality foraging to prepare for both migration and the reproductive season. Therefore, it is crucial that foraging areas be identified and protected to ensure the successful migration and reproduction of these animals.

PRELIMINARY INSIGHTS INTO HEALTH STATUS AND PATHOLOGICAL FINDINGS OF THE INDIAN OCEAN SEA TURTLES OF WESTERN AUSTRALIA

Erina Young | Nahiid Stephens | Rebecca Vaughan-Higgins | Scott Whiting | David Blair | Mark O'dea | Jo Bannister | Nicky Buller | Terry Miller | Mark Flint | Lian Yeap | Kris Warren

Murdoch University | Murdoch University | Murdoch University | Department of Biodiversity, Conservation and Attractions | James Cook University | Murdoch University | Department of Fisheries | Department of Agriculture and Water Resources | Department of Fisheries | Ohio State University | Murdoch University | Murdoch University

The status of sea turtle health in Western Australia is largely unknown, particularly for the endemic flatback turtle (*Natator depressus*). Several hundred turtle strandings are reported annually in Western Australia (WA) with numbers fluctuating due to factors such as inter-annual variation in ocean currents and winds driving turtles ashore and, variation in reporting rates along the remote and sparsely populated coast. Anecdotal reports for the causes of sick, injured and dead turtles seem comparable to those in other parts of Australia and the world (e.g. spirorchiidiasis, fibropapillomatosis and marine debris ingestion) but no scientific studies to validate these reports have been conducted in this region. We investigated the causes of stranding through diagnostic techniques including necropsy, clinical pathology, diagnostic imaging, histopathology, parasitology, microbiology, toxicology and molecular analyses. The source animals include both live and dead stranded turtles found on the WA coastline and waters. In addition, we determined baseline levels of health and disease for specific populations, predominately nesting flatback turtles. The high incidence of spirorchiid fluke infestation and associated pathology in sea turtles examined, including flatbacks, will be discussed as well as other cases of interest including histologically diagnosed visceral fibropapillomatosis. We also discovered a novel bacterium, *Streptococcus iniae*, responsible for a mass mortality event in the Kimberley region, in the northwest of WA in February 2016. This bacterium caused the death of 14 juvenile flatback turtles, 18 sea snakes (including *Aipysurus laevis* and *Hydrelaps darwinensis*), 17000 fish of numerous species, as well as other marine species. This study has greatly improved knowledge of sea turtle health and disease status for WA and the eastern Indian Ocean. It will assist sea turtle conservation in Western Australia by improving ante- and post-mortem diagnoses, identifying newly emerging diseases, and will guide long-term population health monitoring programs. This study is the first statewide health and disease investigation in the eastern Indian Ocean and will provide broader insights to sea turtle health and disease status on a regional scale.

EMBRYONIC DEVELOPMENT OF LEATHERBACK TURTLES AND THE EFFECTS OF PRE-OVIPOSITIONAL EMBRYONIC ARREST ON REPRODUCTIVE SUCCESS

Sean Williamson | Roger Evans | Richard Reina
Monash University | Monash University | Monash University

Leatherback sea turtle egg clutches consistently experience lower hatching success (~50%) than those of other sea turtle species. The majority of embryonic death (>50%) occurs at early stages of development, possibly because embryos fail to break pre-ovipositional embryonic arrest after they are oviposited. Pre-ovipositional arrest is maintained by hypoxia in the oviduct and increased oxygen availability is the trigger that breaks the arrest after oviposition in all turtle species studied to date. Here, we examined the impact of pre-ovipositional embryonic arrest on reproductive success in leatherbacks. We conducted an 'ex-situ' incubator experiment and an 'in-situ' hatchery experiment. After oviposition eggs (N = 1005) were exposed to either normoxia (21% O_2), hyperoxia (32-42% O_2) for five days, or hypoxia (1% O_2) for three or five days. As has been found for other turtles, hypoxic incubation maintained embryos in arrest, equivalent to the time spent in hypoxia. However, extending arrest for five days resulted in greater early-stage death and a significant decrease in hatching success (68% lower than normoxic treatment). Eggs placed in incubators experienced greater hatching success than those placed into hatchery nests (67% vs 47%). We found no impact of hyperoxia on stage of embryonic death, hatching success, hatchling phenotype or fitness. Our findings indicate that delayed nesting and the subsequent extension of embryonic arrest may negatively impact embryonic development and therefore the reproductive success of leatherback turtles. They also indicate that incubation under hyperoxic conditions is unlikely to be a useful method to improve hatching success in this species.

MERCURY CONCENTRATIONS AS RELATED TO CONGENITAL MALFORMATIONS IN OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) FROM NORTHWESTERN MEXICO: PRELIMINARY RESULTS

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Research on the Mexican Northwestern Pacific Coast Olive ridleys revealed high levels of congenital malformations (CMs); however, there is no available information about its etiology. CMs have been considered to occur sporadically in sea turtles and prevalence levels are relatively low. We propose that mercury is a possible cause for the elevated CM levels found in this nesting colony. Mercury is a global concern contaminant due to its ubiquity, toxicity, and ability to bioaccumulate and biomagnify. Mercury is neurotoxic and an endocrine disruptor. Early life stages can be particularly sensitive to low level exposure. This exposure can lead to subtle sublethal effects leading to reduced reproductive success, high mortality, and CMs. We correlated the mercury concentrations to CMs to elucidate if mercury is the source of the high number of CMs in this nesting colony. Data was collected from 28 nesting female recaptures at El Verde nesting beach during the 2012 nesting season. Data for each nesting female capture and following recaptures included: CMs per nest, blood samples from nesting females, and tissue samples from normal and malformed dead hatchlings and embryos. Mercury concentrations were measured in maternal blood and embryos and dead hatchlings tissues. Values ranged from < 0.2 to 592.0 ng/g. We evaluated the relation of the mercury concentration to CMs and reproductive success at each sampling in the colony. The most common CM was the Schistosomus reflexus syndrome, grossly characterized by the presence of exposed abdominal viscera due to a severe fissures on the ventral or midventral abdominal wall (schistosomus), and marked spinal inversion of either dorsiflexion or retroflexion, producing a distinctive ventral convex curvature (reflexus). This is consistent with other vertebrate taxa in which mercury contamination results mostly in severe vertebral and abdominal wall malformations. Our preliminary results fail to show an unequivocal relationship between Mercury concentrations and reproductive success at the nesting colony of El Verde.

ASSESSING HYPERBARIC OXYGEN THERAPY EFFECT ON LUNG DISORDERS DUE TO GAS EMBOLISM. SPIROMETRY AS A DIAGNOSTIC TOOL.

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Lung function testing, or spirometry, is a minimally invasive method to assess lung health and is commonly used in humans to diagnose a variety of respiratory diseases. The goal of this study was to assess how gas embolism (GE) alters respiratory function in by-caught turtles before and after recompression therapy. Fisheries are a major global threat to sea turtle populations. A recent study showed that underwater entrapment in fishing gear followed by rapid decompression might cause gas bubble formation within the blood stream (gas embolism) and tissues leading to decompression sickness [DCS] (organ injury, impairment) and even mortality in some by-caught individuals.Based on clinical observations, turtles with a higher degree of GE often showed reduced lung fields on diagnostic imaging and experienced respiratory dyspnea/distress that would reverse following hyperbaric oxygen therapy (HBOT). In the present work the effect of GE on lung function was investigated and quantified in loggerhead sea turtles (*Caretta caretta*) by performing opportunistic lung function testing on by-caught individuals with different degree of GE. Lung function testing was performed before and at regular intervals after hyperbaric chamber treatment throughout the recovery period in order to assess the level of respiratory compromise following arrival and the efficacy of HBOT in recovery of normal breathing performance. An ultrasonic spirometer that measured respiratory flow was used for lung testing. The respiratory flow allowed us to determine breathing frequency (f_R), breath duration, tidal volume (V_T) and minute ventilation. Respiratory flow and V_T increased after HBOT. Repeated lung function testing indicated a temporal increase in both respiratory flow and V_T for all by-caught turtles, but the changes were smaller than those seen immediately following HBOT. The current study suggests that respiratory function is significantly compromised in by-caught turtles with GE and that HBOT effectively restores lung function. Our data clearly indicate the efficacy of lung function testing as a diagnostic tool to assess respiratory function in loggerhead sea turtles with GE. While limitations when working in field conditions and with wild animals should be considered, there is potential for lung function testing as a minimally invasive method to assess respiratory performance in veterinary medicine.

THE FUNCTIONS OF FLIPPERS

Jeanette Wyneken
Florida Atlantic University

Perhaps flippers are the most iconic trait of sea turtles. All other turtles have a shell. A few other turtle taxa use marine habitats for all or parts of their lives. It is the sea turtles alone that have flippers and rely on them for long distance migration as well as routine transit. The flapping of the forelimbs as marine turtles swim away is reminiscent of bird flight. In fact, may studies draw upon the analogies to flight. However, sea turtles do far more with their flippers than flapping locomotion. Flippers are the primary structures that sea turtles use in maneuvering along the sea floor, avoiding predators, and stabilizing themselves. In cheloniids species, the flippers' axial scales may serve in feeding. Flippers of males are critical in successful mounting to mate. In yet other situations, the flippers may be used to clean away epibionts from the shell. As turtles ventilate, the proximal muscles of the flippers function in respiration.

These various, non-flapping, functions of the flippers are important to the ways sea turtles make a living. These diverse flipper functions are relevant to understanding sea turtle natural history, entanglement risks, and rehabilitation alternatives for injured sea turtles.

ASSESSING ON BOARD A FISHING VESSEL THE OCCURRENCE AND SEVERITY OF DECOMPRESSION SICKNESS IN SEA TURTLES INCIDENTALLY CAPTURED BY TRAWL FISHERIES

Mariluz Parga | Danielle Monteiro | José Luís Crespo | Yonat Swimmer | Suzana Paz | Daniel García-Párraga
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Decompression Sickness (DCS) has been recently discovered in sea turtles incidentally captured by trawl and gillnets. Findings in the Mediterranean show a high prevalence (50-55%) of DCS in by-caught turtles coming from these fishing gears, and an estimated 30% of the trawl/gillnet by-caught turtles surfaced alive in Valencia present with a severity of embolism that would lead to death during the following hours/days if left untreated (Fahlman et al, 2017). It appears that DCS could be responsible for a much higher post-release mortality after trawl and gillnet by-catch than previously estimated. Determination of the incidence and effects of DCS in turtles after incidental capture by nets is vital. These animals are usually hauled on board alive and in apparently good health and are released by fishermen. However, studies at rescue centers strongly suggest that turtles affected by DCS only start showing signs of disease several hours after coming to surface. These signs have a strong neurological component, usually involving hyperactivity, followed by progressive lethargy, limb paresis and loss of sensitivity, rendering the turtle unable to control its movements and to dive. Therefore, it is of upmost importance to ascertain the fate of the released animals out at sea.
This is the first report of DCS in incidentally captured sea turtles studied on board a fishing vessel. The project assesses the frequency of turtles that develop gaseous embolia in a trawling fishery of a new region (South-West Atlantic) off of Brazil, its severity associated with trawl characteristics, and the fate of the animals after near-immediate release without treatment. It compares between species and other variables such as water temperature or animal size, and evaluates which clinical signs, if any, may be distinguished by trained fishermen during the first phase of decompression. So far researchers have worked on board a South Brazilian trawl vessel in summer examining all incidentally captured turtles. Each trawling lasted 3-4 hours, at depths between 20 and 40m and with surface water temperature of 24C. Examination included a general physical and neurological exam and ultrasound scan of kidneys, heart and liver, done as soon as possible after hauling the animal, and every 30-40 minutes up till 2 hours post-capture, when the animal was released with a post-mortality (1 month) pop-up tag attached. Blood was collected for full biochemistry and gas analysis at hauling and before release. A necropsy was completed in all turtles that died on board.
Eight turtles (seven *Caretta caretta* and one *Lepidochelys olivacea*) were captured, but only three survived the interaction (all *C. caretta*). Of them, two turtles were released with transmitters. All captured animals developed renal, hepatic and/or cardiac intravascular gas bubbles; renal bubbles were detectable on ultrasound within the first 20-40 minutes after hauling and worsened over the next hour. The five dead animals showed severe embolia and signs of drowning in necropsy. One of the released animals was tired during the first hour on board, but then recovered and showed somewhat hyper-responsive reactions when neck or fore-flippers were touched: sudden and strong withdrawal of both while widely opening the mouth. The two tagged and released animals survived the first month after release. This the first time that DCS has been diagnosed in a *L. olivacea*.

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CORTICOSTERONE CONCENTRATIONS IN MIGRATORY LOGGERHEAD SEA TURTLES

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The U.S. Mid-Atlantic Bight supports a large summertime foraging aggregation of loggerhead (*Caretta caretta*) sea turtles. Annual migration into this region begins in early spring when sea surface temperatures are colder (Patel et al. 2017) than typical loggerhead foraging preferences. Long distance migrations can be physiologically difficult for sea turtles because of the energy requirements, and because early arrival into a prime foraging location can lead to periods of time when turtles are on the edge of their physiological tolerance of environmental factors (e.g. temperature). To assess one aspect of stress, we examined baseline and post-capture corticosterone (C) concentrations of turtles as they migrated into the Mid-Atlantic Bight. Corticosterone is released in response to stress and thus is an ideal hormone to measure the sub-lethal impacts related to stress. Blood samples were collected from wild loggerhead turtles [n = 29; mean (range) size: 76.8 (61.9 – 103) cm CCL] captured in-water via dip-net in the Northwest Atlantic to assess baseline C values during this migratory period. ood samples were obtained within 20 minutes from the initial capture harassment to represent pre-capture baseline C concentrations. To assess the impact of capture and handling stress, we examined C concentrations in additional samples (n = 22) collected from individual turtles (n = 21) 12 – 41 min after initial harassment to determine how quickly a blood sample must be collected to prevent any effects of capture/handling stress on blood parameters. We validated C enzyme-linked immunosorbent assays (ELISAs) to determine immature loggerhead sea turtle stress response following capture. Baseline median (range) C concentrations were 264.4 (not detectable – 2,583.4) pg/mL. These values are well within the bounds observed in other wild loggerheads (Gregory et al. 1996), suggesting that migratory stress is not having a large impact on at least this one measure of stress. The additional samples collected more than 20 minutes after initial harassment had C concentrations of 343.6 (57.5 – 2,339.3) pg/mL. Corticosterone concentrations varied individually by turtle, with the subsequent samples sometimes being similar in C values to the first sample, sometimes lower, and sometimes higher, suggesting minimal stress due to capture. Examination of blood samples taken from turtles with warm (>20C) body temperature suggests that capture and handling stress and associated C production may be more pronounced when turtles are warm. Our determination of C concentrations in wild turtles following capture stress provides insight into the acute effects of capture on sea turtle stress response and validation of a C ELISA provides the ability to investigate anthropogenic impacts for multiple threatened and endangered sea turtle populations.

THE FUTURE IS FEMALE: ENVIRONMENTAL WARMING AND FEMINIZATION OF ONE OF THE LARGEST SEA TURTLE POPULATIONS IN THE WORLD.

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Climate change affects species and ecosystems around the globe. The impacts of rising temperature are particularly pertinent in species with temperature-dependent sex determination (TSD) where the sex of an individual is determined by incubation temperature during embryonic development. In sea turtles, the proportion of female hatchlings increases with the incubation temperature. With average global temperature predicted to increase 2.6°C by 2100, many sea turtle populations are in danger of high egg mortality and female-only offspring production. Unfortunately, determining the sex ratios of hatchlings at nesting beaches carries both logistical and ethical complications. However, sex ratio data obtained at foraging grounds provides information on the amalgamation of immature and adult turtles hatched from different nesting beaches over many years. Here, for the first time, we use genetic markers and a mixed-stock analysis (MSA), combined with sex determination through laparoscopy and endocrinology, to link male and female green turtles foraging in the Great Barrier Reef (GBR) to the nesting beach from which they hatched. Our results show a moderate female sex bias (65-69% female) in turtles originating from the cooler southern GBR nesting beaches while turtles originating from warmer northern GBR nesting beaches was extremely female-biased (99.1% of juvenile, 99.8% of subadult, and 86.8% of adult turtles) . Combining our results with temperature data show that the northern GBR green turtle rookeries have been primarily producing females for more than two decades, and the complete feminization of this population is possible in the near future.

A LONG-TERM DECLINE IN THE ABUNDANCE OF LEATHERBACK TURTLES, *DERMOCHELYS CORIACEA*, AT A FORAGING GROUND OFF CALIFORNIA, USA

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A multi-decadal decline of endangered Pacific leatherback turtle populations (*Dermochelys coriacea*) has been documented at primary nesting sites in the western Pacific. Foraging destinations for western Pacific leatherbacks vary by nesting season and include multiple large marine ecosystems in temperate and tropical waters in the Pacific Ocean and Indo-Pacific region. Boreal summer nesters forage in various regions of the northern hemisphere, with about 30% foraging in the eastern North Pacific off the U.S. West Coast during summer and fall. One foraging area in neritic waters off California has been regularly monitored via aerial surveys, and the abundance of foraging leatherbacks was previously estimated to range between 12 to 366 individuals during 1990-2003, with marked interannual variability. Abundance appeared to be linked to the strength of upwelling in each year, and no apparent long-term trend was identified. These aerial surveys have continued through 2016, providing a 26-year time series to examine long-term population trends at a key foraging ground for western Pacific leatherback turtles. This provides an opportunity to examine population trends for male and female turtles combined, relative to those documented for females at nesting beaches.

In this study, we examine trends in the abundance of foraging leatherbacks off California using a Bayesian hierarchical modeling framework, combining the long-term coast-wide aerial surveys with additional fine-scale surveys in local areas of leatherback occurrence. All surveys were conducted using standard line-transect methods, at 90-100 kts airspeed and 650 ft altitude, in Partenavia P-68 or DHC-6 Twin Otter aircraft outfitted with bubble and belly windows. Suction-cup attached time-depth-recorders were deployed on 21 foraging leatherbacks to estimate the proportion of time leatherbacks are visible to an aerial survey team. Based on these telemetry studies, we derived a correction factor, *g(0)*, to account for diving animals missed during aerial surveys. The Bayesian hierarchical framework specified 1) a process model of leatherback population density as a function of year and random process terms, and 2) an observation model of leatherback counts during aerial surveys using distance sampling methods. Broad, uninformative priors were specified for the growth rate, process error, and the initial population size, N_0. Informed priors derived from the line-transect and telemetry data, respectively, were specified for effective half-strip width (*ESW*= 247 m, SE=0.017) and *g(0)* = 0.607, SE=0.039. We ran Markov Chain Monte Carlo simulations until convergence was attained.

Bayesian posterior distributions for leatherback abundance were similar to previously published estimates for the period 1990-2003, with median estimates ranging from a low of 35 individuals (95% credible interval [CI]: 6-118) to a peak of 325 animals (CI: 155 - 720). Abundance estimates during 2004-2016 were lower, ranging from 22 (CI: 6 - 63) to 121 (CI 49 - 315). Overall, the population declined at an annual rate of -3.7% (CI: -8.0% - 0.7%), but there was interannual variability in abundance that could be related to ocean condition, prey availability, and remigration intervals. This annual rate of decline is less than the -5.9% documented for Indonesian nesting beaches. Possible explanations for this apparent difference include a) lower survival rates of leatherbacks that forage in other areas, b) lower survival rates of females than males (because nesting beach trends are based only on females and our surveys included both sexes). Females might experience lower survival because of greater physiological costs of nesting and egg-laying, or because they are exposed to additional risks on and adjacent to

nesting beaches (e.g. crocodiles, coastal gillnets, direct harvest). These results underscore the critical importance of coordinated international efforts and longterm population monitoring for successful conservation of wide-ranging species such as leatherback turtles.

FORAGING DYNAMICS OF GREEN TURTLES AROUND JAPANESE WATERS AND DISTRIBUTION BOUNDARY OBSERVED BETWEEN SUBTROPICAL AND TEMPERATE WATERS

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Understanding the habitat range of sea turtles throughout their life is important for their conservation, but is difficult because of their migratory nature and long lifespans.

While green turtles (*Chelonia mydas*) in the Atlantic Ocean are known to use multiple foraging grounds (FGs) after the initial epipelagic stage, long-term mark-recapture studies conducted in the foraging grounds around Hawaii and Australia, Pacific Ocean, have suggested that exchange of individuals among Pacific FGs is infrequent and that many turtles are long-term residents in their FGs. However, several foraging aggregations in the northwestern Pacific comprised or lacked turtles of the specific size class, suggesting that the Pacific green turtles continue developmental migrations after the initial epipelagic stage in some regions.

Japanese waters provide the northern limit of FGs for green turtles, and foraging turtles around the Japanese main islands originated from Japanese rookeries. It is known that the size compositions in the FGs along the coasts of Japanese main islands show the bi-modal distribution with peaks around 50 cm straight carapace lengths (SCL) and 70 cm SCL, and less abundant turtles of 50–70 cm SCL occur in these areas. These size compositions strongly suggest the juvenile turtles around Japanese waters undergo developmental migrations, and emigration of these juvenile turtles from the coasts of Japanese main islands should result in the foraging dynamics among other FGs.

In order to find candidate destinations of the turtles leaving from the coasts of main islands, we examined whether the origins of foraging turtles vary by the size classes in two FGs in the Ryukyu Archipelago (“the Ryukyus”), Japan, using mixed stock analysis (MSA) of 380-bp control regions of mitochondrial DNA. At both sites, we found that the contribution of Japanese turtles increased in the size class of 50–70 cm SCLs compared to the other size classes, although contribution from southern rookeries around Micronesia and Marshall Islands were present in all size classes. The enhanced contributions of Japanese stocks with SCLs of 50–70 cm were maintained in both the late 1990s and 2005–2011. Population trends in Japanese green turtle rookeries have shown steady increase and unsynchronized with this variation. These results suggested that some juvenile turtles attain SCLs of 50 cm around the coasts of main islands may move to the coastal areas of the Ryukyus, and some turtles from southern rookeries also migrate from the Ryukyus to the different FGs around 50 cm SCL. The present investigation about the foraging dynamics of turtles with SCLs of 50–70 cm implies that it might be a general migration pattern of the green turtles in northwestern Pacific region.

In addition, the genetic structure based on the present increased sample size defines the boundary between foraging turtles from the Ryukyus and those from the Japanese main islands, which are characterized by the presence/absence of such turtles in southern rookeries. We hypothesized that the boundary may have been created by a lack of adaptation by turtles from southern rookeries to northern seasonal water temperatures. Although all extant marine turtles have weathered past climatic changes, including the Pleistocene oscillation, we know little about how marine turtle species and populations survive in, and become adapted to, environmental changes. Hence, we cannot forecast how turtles will respond to ongoing anthropogenic climate change. Sea surface temperatures in northwestern Pacific around Japan are rising more rapidly along coasts than in the oceans overall. Monitoring the foraging turtles in both sides of this boundary will increase our understanding of biological responses to past climate changes and the effect of current global warming to this species.

ESTIMATION BIOLOGICAL PARAMETERS OF GREEN SEA TURTLES (*CHELONIA MYDAS*) USING BEAYSEAN HIERARCHICAL MODEL WITH LATENT VARIABLE IN OGASAWARA ISLANDS, JAPAN

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Ogasawara islands are known as one of major spawning areas of this species. Tagging survey has been conducted since 1975 for understanding course and range of migration. The population size in this ground has also been estimated based on surveys for the number of nests. (Today, all survey is implemented by Certified NPO Everlasting Nature of ASIA, Japan.) However, no formal statistical analyses for Mark-recapture data have been performed yet.
In this study, we aimed at estimating key biological parameters, such as annual survival probability and probability of remigration, for mature females. For this purpose, we extended a conventional Cormack-Jolly-Seber (CJS) model as hierarchical Bayesian models with latent variables to take in account for remigration as well as detection process. Several models were developed to examine if any inter-annual variation happens for survival and detection parameters. The estimation was performed with a Markov chain Monte Carlo (MCMC) method.
For example, in the simplest model, annual survival probability and detection probability are defined to be constant over survey periods and among individuals. A emigration parameter is defined as a probability which an individual migrates to nesting ground from feeding ground t years after the latest remigration. In addition, we assumed that the upper limit of remigration interval is five years. The results for the simplest model showed that annual survival probability and detection probability are estimated 0.85(95%CI=0.83-0.87) and 0.42 (95%CI=0.39-0.46), respectively. The estimated value of survival probability is close to a value shown in a previous study in Costa Rica (Sebastian et al, 2007). For a remigration parameter, the highest probability was attained at year interval of 4and its value was estimated at 0.43 (95%CI=0.38-0.48). Other detailed results will be shown on site.
It was noted that the Bayesian hierarchical models proposed here are generally useful for the Mark-recapture data of sea turtles. Moreover, the models can be extended for estimating the number of individuals and recruitments as well.

EVALUATING THE IMPACT OF THE CAYMAN ISLAND TURTLE FARM: CHARACTERISTICS AND CONSEQUENCES OF AN EX SITU CONSERVATION STRATEGY.

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Ex situ management strategies have become an important tool in species conservation programmes. These particular programmes aim to conserve components of biological diversity outside their natural habitats while supporting species survival in the wild. Captive breeding followed by a reintroduction of individuals in their natural habitat may be a solution to improve endangered species conservation and to preserve the maximum genetic variability within a species. However, such conservation actions need thorough management and monitoring to minimize inbreeding depression and loss of genetic diversity, as well as to evaluate the impact of the program in wild populations. In 1968, a green turtle (*Chelonia mydas*) captive breeding program, called Cayman Turtle farm, was started in the Cayman Islands. To ensure higher genetic variability, the founder stock included adult turtles and eggs belonging to several different sites in the Caribbean and the South Atlantic. This ex situ reintroduction program has been releasing green turtles for almost 40 years and wild females are nesting in the Cayman Island again. The purpose of the present study was to determine the current population structure of the captive breeding stock of the Cayman Turtle Farm (female n=257) and to evaluate the potential impact of the reintroduction program on the actual wild green turtle population (female n=57). Using genetic markers (microsatellites, D-loop and STR mtDNA) we identified parental relationships and population structuring within the farm and between wild and captive individuals. We found 17 D-loop haplotypes in our sample set, 15 of them from the Caribbean region and 2 from the South Atlantic and African region, matching the origin of the farm founder stock. Parental and sibship assignation identified 6 farm individuals as mothers of 8 wild and 33 farm individuals. We found a substantial contribution of the farm in the wild population, which shows a clear impact of the farm on present wild individuals. Furthermore, we divided the sample set in three main generation groups: founders, generation 23 and wild. We identified a decreasing trend of haplotype and nucleotide diversity from the oldest generation to the youngest, indicating a progressive loss of variability in the wild population and an increase of the degree of relatedness in the youngest generation. However, the genetic diversity was high for all three generations when compared to other populations in the world, probably as a result of a high initial diversity consequential to the diverse origin of the founder stock. Genetic based analyses are advantageous not only to evaluate the outcome of the reintroduction, but also to improve future management to maintain genetic diversity in the long term and to prevent potential undesirable outcomes from inbreeding or outbreeding.

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Fish & Wildlife Service and the Sea Turtle Symposium.

INFERRING THE GEOGRAPHIC LOCATION OF FORAGING GROUNDS FROM NESTING LOGGERHEAD TURTLES IN CENTRAL QUEENSLAND, SW PACIFIC

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Integrated analytical approaches utilising satellite telemetry and stable isotope analysis have become popular methods for investigating foraging ground habitat use, diet and migratory behaviour in marine turtles. In this study, the aim was to infer the foraging location of nesting loggerhead turtles from the Mon Repos turtle rookery, Central Queensland using the skin stable isotope ratios of carbon and nitrogen as reported in similar studies. Over the course of two nesting seasons we sampled 324 nesting individuals encompassing turtles with migratory distances up to 2000 km. This sample included 16 individuals with known foraging locations ascertained through satellite telemetry. The isotopic values of the 324 sampled individuals were compared to 50 samples taken from individuals at their foraging grounds. Despite the large latitudinal range they were likely to travel from, as observed through telemetry, individuals sampled from the nesting beach did not differentiate into discernible clusters or foraging regions. In addition, individuals from known foraging regions could not be distinguished by their isotopic values. Surprisingly, individuals sampled from the Moreton Bay foraging grounds, which were within 10 km of each other, had isotopic values with a range that encompassed the entire range of all loggerhead turtles sampled over the 2000 km north-south distribution. Of the 50 foraging individuals, 12 individuals were sampled for faecal material to determine recent dietary composition. We observed large variation in the skin isotope values taken from these individuals, which were feeding on prey items within the same feeding ground. Implying that within the foraging population there were individuals that change their diet significantly through time and potentially some that exhibited specialisation in choice of prey. Our findings indicate that stable isotope values, which are determined by diet, cannot always be used to accurately identify the foraging regions of loggerhead turtles. These findings potentially highlight the need to re-think when and where the use of isotopic analysis is appropriate for inferring foraging location in marine turtle species.

PREVALANCE OF POLYGYNY IN A CRITICALLY ENDANGERED MARINE TURTLE POPULATION

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Genetic analyses of nuclear DNA (e.g., microsatellites) are a primary tool for investigating mating systems in reptiles, particularly marine turtles. Studies over the past two decades have demonstrated that polyandry (i.e., females mating with multiple males) is common in marine turtles. In this study we investigated the mating structure of hawksbill turtles (*Eretmochelys imbricata*), a critically endangered marine turtle that is particularly threatened in the eastern Pacific Ocean, at Bahía de Jiquilisco in El Salvador, one of the largest rookeries in this ocean region. We collected samples from 34 nesting females and hatchlings from 41 clutches during the 2015 nesting season, including one nest from each of 27 females and two nests from seven additional females. Using six microsatellite loci, we reconstructed the paternal genotypes for 22–30 male turtles and discovered that 26.6–31.8% of males sired nests from multiple females, which suggests that polygyny (i.e., males mating with multiple females) may be a common mating structure for this population. We also detected multiple paternity in four (11.8%) of the 34 females analyzed, confirming polyandrous mating strategies are also employed. Our findings represent the highest polygyny values reported to date for marine turtles and suggest there may be a limited number of sexually mature males at Bahía de Jiquilisco, likely the result of the small overall hawksbill population in this ocean region. Our results can support hawksbill management in the region and represent valuable baseline data for future studies at this and other hawksbill nesting grounds.

PHYLOGENY, BIOGEOGRAPHY AND METHODOLOGY: A META-ANALYTIC PERSPECTIVE ON HETEROGENEITY IN ADULT MARINE TURTLE SURVIVAL RATES

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Drawing robust conclusions from comparisons of key demographic parameters necessitates explicit consideration of sources of heterogeneity among studies. Meta-analysis has emerged as a powerful tool for combining the results of demographic studies while accounting for heterogeneity. To better understand adult survival in marine turtles and avoid drawing erroneous conclusions from current estimates, we conducted a comprehensive meta-analysis to test how heterogeneity among survival estimates was partitioned among phylogenetic, biogeographic and methodological factors. Fifty-nine studies from five marine turtle species met the minimum selection criteria for inclusion in our meta-analysis. Heterogeneity among survival estimates was first partitioned between differences in ocean basin (Indo-Pacific *versus* Atlantic), then by differences among family/tribe within the Indo-Pacific (Chelonini *versus* Carettini and Dermochelidae). However, apparent differences attributed to biogeography (ocean effect) and phylogeny (family/tribe effect) were highly correlated with methodological differences in tag type, model type, habitat type and study duration, thereby confounding biological interpretations and complicating efforts to use many current survival estimates to model population viability and interpret long-term population trends. Our results show the value of meta-analysis in generating robust species-specific demographic estimates, and highlight the importance of evaluating sources of heterogeneity when interpreting patterns among similar demographic studies.

PHILOPATRY IN LOGGERHEAD TURTLES: BEYOND THE GENDER PARADIGM

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Defining management units is of crucial importance in order to develop successful management plans for endangered species. The analysis of nuclear DNA (nDNA), representative of both female- and male-mediated gene flow, is of relevance when designing conservation and management plans as both sexes might not behave similarly. Marine turtles have been traditionally considered model organisms to study sex-biased behaviour and dispersal. Although female philopatry has been identified in the loggerhead turtle, with adult females returning to specific locations to nest, studies on the philopatry and breeding migrations of males remain limited. We examine the genetic structure of loggerhead turtles in the Mediterranean Sea by genotyping 152 hatchlings sampled from the eight main nesting grounds using 15 microsatellite markers. Our results revealed isolation by coastal distance suggesting restricted gene flow. Moreover we observed decreasing diversity when increasing distance to Libya, a sign of the colonisation process. Our results revealed the existence of five genetically differentiated units among the studied Mediterranean loggerhead nesting grounds: 1) Libya-Cyprus, 2) Israel, 3) Lebanon, 4) Turkey and 5) Greece. Our work suggests that widespread male-mediated gene flow between loggerhead nesting areas is likely to have been previously overstated, supporting satellite tracking studies that state that mating occurs close to nesting grounds in this region. Nonetheless, the genetic similarity between distant nesting areas (i.e. Libya and Cyprus) indicates the existence of other breeding behaviours that remain to be tested, and highlights the need for protection of this species across the whole basin.

DIFFERENTIAL SEXUAL MATURITY IN BLACK SEA TURTLE (*CHELONIA MYDAS AGASSIZII*) IN MICHOACÁN, MEXICO.

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The black turtle nesting population on the coast of Michoacan, Mexico due to its size, is one of the most important of the eastern Pacific and the largest of Chelonia in the entire Pacific basin which is characterized by the small size of females and males, dark coloration and characteristic shape of the dome-shaped carapace. In this work, an analysis was made of the age of sexual maturity of females and males of black turtle. To estimate the age of sexual maturity of females and males of the black turtle population, the minimum size and average length of Carapace Straight Length (LRC) of nesting females on Colola beach and of breeding males caught in the sea in front of Colola. We use the growth rate information of juvenile turtles (1.4 cm / year) and recruitment size of pelagic juveniles to developmental habitats and feeding grounds in Baja California of 40 cm (corresponding to approximately 10 years of age) obtained by Koch, (2002). According to the results obtained, the minimum age of sexual maturity in female black turtles is 22.4 years and reached a size of 60 cm of LRC, the average age of sexual maturity is 38.5 years at a size of 80.05 cm of LRC in nesting females. On the other hand, the average size (LRC) found in breeding males was 67.52 cm (+ -3.56 cm). To which corresponds a sexual maturity age of 29.6 years (+ -2.54 years). the minimum size of sexual maturity was 61.1 cm (LRC), estimating a sexual maturity of 25.07 years. Differences in the age of sexual maturity among females and black turtle males are likely to be due to different reproductive strategies between these two reproductive segments and to the polyandric mating system presented by females. Although the females mature to a smaller size than the males, the average size of the females is 80.05 cm and the males 67.5 cm LRC. This difference in average size of 12.5 cm of males in relation to the size of females can explain important aspects of the sexual dimorphism so marked between males and females even the characteristic form of the depression of the part of the carapace in females and males of black turtle in Michoacán.

MITOCHONDRIAL DNA - THE PERFECT TOOL FOR SEA TURTLE FINGERPRINTING, POPULATION DETERMINATION AND EVOLUTIONARY RESEARCH

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The most frequent marker used in sea turtles' genetic analysis is the first 800bp of the D-loop region of the mitochondrial DNA (mtDNA). While single nucleotide polymorphisms in this region proved to be scarce when compared to other species, the mitochondrial short tandem repeats (mtSTRs) revealed a high degree of polymorphism. Though nuclear DNA is inherited biparently, mitochondrial DNA inheritance in most organisms is exclusively maternal. An organism gets only one set of chromosomes from each parent, but starts its life with a few thousand molecules of mtDNA inherited from its mother. This mitochondrial population within a cell is not necessarily identical, a phenomenon termed heteroplasmy. Using Illumina high throughput sequencing, we were able to look at thousands mtDNA molecules in ~200 green sea turtles. Unlike the scarce point mutations, we have found heteroplasmy levels in the mtSTR ranging from 5% and up to 45% in all of the samples. Heteroplasmy gives another dimension of haplotyping and actually allows for individual fingerprinting. We report that even after 10 years of life, a sea turtle maintains the same pattern of heteroplasmy. Furthermore, the rare haplotypes in every individual are present as the main haplotypes in other members of the same population. We have shown that by analyzing the heteroplasmy within an individual, a sea turtle can be assigned to its population of origin. We have shown that heteroplasmy can explain the changes of haplotype frequency in a population, and propose an explanation to the common understanding that the rate of mitochondrial DNA mutation in sea turtles is much lower than the average in other species.

WHERE ARE WE AND WHERE DO WE COME FROM? - CONNECTIVITY AND HABITAT USE OF GREEN TURTLES (*CHELONIA MYDAS*) IN THE SOUTH CHINA REGION

Connie Ka Yan Ng | Peter H. Dutton | He Xiang Gu | Tsung Hsien Li | Ming Bin Ye | Zhong Rong Xia | Fei Yan Zhang | Jin Xia Duan | Chung Kang Hsu | George H. Balazs | Margaret B. Murphy

City University of Hong Kong/ Agriculture Fisheries and Conservation Department | NOAA National Marine Fisheries Service | Guangdong Huidong Sea Turtle National Nature Reserve Bureau | National Museum of Marine Biology and Aquarium | Guangdong Huidong Sea Turtle National Nature Reserve Bureau | Guangdong Huidong Sea Turtle National Nature Reserve Bureau | Guangdong Huidong Sea Turtle National Nature Reserve Bureau | Guangdong Huidong Sea Turtle National Nature Reserve Bureau | Penghu Marine Biology Research Center | NOAA Pacific Islands Fisheries Science Center | City University of Hong Kong

The globally endangered sea turtles face daily anthropogenic threats, such as direct harvest for trade, bycatch and habitat degradation. Current research efforts on sea turtles in the South China Region mainly focus on captivity and husbandry, hematology and blood chemistry, and nesting ecology. There is limited published information on the habitat use of wild populations. Information on genetic stock composition of green turtles (*Chelonia mydas*), which helps identify connectivity between nesting and foraging grounds, is also scarce. In this study, foraging grounds and migratory corridors of green turtles, in particular nesting turtles, in the South China Region were identified by satellite telemetry and sighting records to stress the need of higher priority for habitat and species protection. This study is also the first to investigate and report the source nesting populations of a relatively large number of foraging green turtles in the South China Region (including Hong Kong, Guangdong Province and Taiwan). Mixed stock analysis based on the 760 bp mitochondrial DNA (mtDNA) control region of green turtles (n=110) revealed that the primary source rookeries in the Pacific contributing to foraging green turtle aggregations in the South China Region were Peninsular Malaysia, Yap in the Federated States of Micronesia, Aru of Indonesia, Sulu Sea, northeastern Borneo, Republic of Marshall Islands, Wan-an of Taiwan, the central Ryukyu and Yaeyama of Japan. The genetic results also indicated possible use of coastal Guangdong, the Taiwan Strait and the East China Sea as habitat by pelagic-phase green turtles hatched from nesting beaches in Taiwan and mainland China. Anthropogenic threats to migratory pathways, nesting and foraging habitats of sea turtles, such as direct take for trade and fishery impacts, should be thoroughly assessed and effectively mitigated by regional collaboration to sustain the populations.

DETERMINING ABUNDANCE, APPARENT SURVIVAL, AND TEMPORARY EMIGRATION FOR HAWKSBILL TURTLES USING OPPORTUNISTIC PHOTO-ID DATA IN THE REPUBLIC OF MALDIVES

Jillian Hudgins | Emma Hudgins
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A photo-ID program requires little training – simply the ability to snorkel or SCUBA dive and take a good photo. The challenge remains how to use this opportunistic data effectively. The use of tourists and locals as citizen scientists increases the workforce and data coverage immensely. Out of this can evolve a regular, consistent "capture-mark-recapture" monitoring program, which can create a real-time snapshot of sea turtle population sizes at a particular reef or atoll, and can be used to assess survival and emigration rates. Every day across the Maldives, thousands of tourists and locals are snorkeling or diving with underwater cameras and encountering wildlife. Our photo-ID program chose to harness this large workforce for a non-invasive research data collection project to study green turtle and hawksbill turtle population dynamics and growth around the Maldives. Here we present the results from sightings of hawksbill turtles collected from six reefs in three atolls between 2013 and 2016.

Using four years of consistent photo-ID data collection, we used a robust design capture-recapture model to determine turtle abundance, apparent survival, and temporary emigration rates. A set of 30 models composed of parameters for population size, survival, temporary migration rates, and capture probability were fitted to the data using the program R, package RMark. We separated the sightings data into month-long secondary sampling intervals, which were then grouped within 6-month primary capture intervals between January 2013 and December 2016. The robust design meant that the population at each reef was modelled as open within primary sampling intervals but closed across each secondary interval. In most cases, the best model was robust design with no emigration and heterogeneous capture probabilities. These results indicate a strong association between turtles and their home reefs, and differences in detectability across individuals. A random emigration model was a better fit at Dhonfanu reef, potentially indicating a more transient association of turtles with this site. Markovian emigration – where emigrants have a different probability of remaining emigrants than residents have of emigrating – was detected at Muthaafushi reef, similarly indicating transient associations, while adding potential hysteresis in association and de-association with the reef.

Mean growth rates were positive over four years at all sites except at Dhuni Kolhu, where populations declined on average. Variance was highest at this site, indicating greater instability in population levels at this site. Mean growth rates were highest at Bodu Hithi Turtle Point (growing by a factor of 2.25/year) and this site had the lowest coefficient of variability indicating that it had the most stable population. Combined with a lack of evidence for emigration at many sites, our results may also suggest that turtles are immigrating and remaining at these sites with high fidelity.

Survival ranged from 0.90±0.04 to 0.77±0.05. Survival was higher at the sites in North Male and Ari Atolls and lower at the sites in Baa Atoll, which is notably a UNESCO Biosphere Reserve. This information can be used by the Maldivian government to inform conservation action and evaluate the conservation status of hawksbills in the country. The lack of robust abundance baseline data from the archipelago makes the detection of a decline resulting from anthropogenic impacts challenging; however, this work underlines the importance of simple, long-term monitoring programs that can contribute reliable information to help assess the conservation status and efficiency of management strategies.

THE LEATHERBACK (*DERMOCHELYS CORIACEA*) NESTING POPULATION IN THE NGÄBE-BUGLE COMARCA AND BOCAS DEL TORO PROVINCE, PANAMA.

CRISTINA ORDOÑEZ | XAVIER OW YOUNG | ANNE MEYLAN | PETER MEYLAN | ROLDAN VALVERDE
Sea Turtle Conservancy | Sea Turtle Conservancy | Eckerd College | Sea Turtle Conservancy

Since the 17th century, Bocas del Toro (which incorporates the Province of Bocas del Toro and the indigenous Ngäbe-Bugle Comarca) has been recognized as an important area for four species of sea turtle: hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), green turtle (*Chelonia mydas*) and loggerhead (*Caretta caretta*). Several leatherback nesting beaches have been monitored since the 1990's under the auspices of a variety of government and non-government organizations.

Leatherback nesting has been documented at numerous beaches along the Caribbean coast of Panama. A monitoring program conducted by STC since 2003 has identified Chiriquí Beach as the most important leatherback nesting beach in the region, where between 1,000 – 7,000 nests are recorded each season on the 24 km beach. Three additional beaches also have a significant number of leatherback nests: Soropta Beach (500 – 1000 nests / year), and Bluff Beach and Long Beach (100 - 300 nests / year each). Leatherback nesting on this coast extends from mid-February to mid-July, with peak nesting occurring in May.

Unlike hawksbill turtles, leatherbacks and their eggs are not consumed by Ngäbe residents and other inhabitants of the communities adjacent to the nesting beach within the Comarca. However, on beaches in the northern part of Bocas Province, leatherback eggs are actively collected and some females are killed and stripped of their eggs and follicles. In 1999, approximately 30 dead leatherbacks were counted during a ground survey of Soropta Beach. Since 2003, the mortality of nesting females has decreased by 90 %, because of the vigilance of the research and monitoring program.

The tagging efforts have shown that leatherback turtles have highly variable nesting beach selection patterns. During the same nesting season and in different years, females nesting in the Bocas region also nested on beaches in Costa Rica (Gandoca, Pacuare and Tortuguero), Colombia (Playona), and elsewhere in Panama (Sixaola, San San, Armila and Punta Rincon). In this paper, we present a summary of the distribution and abundance nesting of leatherback turtles in the Bocas del Toro Province and the Ngäbe-Bugle Comarca during the last five years (2013 - 2017) and describe the diverse threats that currently impact this globally important population.

Our results provide additional corroboration that the Bocas region leatherbacks are part of a southwest Caribbean metapopulation that includes populations from Costa Rica, Panama and Colombia. Playa Chiriqui continues to be the most important beach for the metapopulation.

WHAT DOES AN INDIVIDUAL BASED MODEL SIMULATION OF THE LONG-TERM ACTIVE DISPERSAL OF JUVENILE WESTERN PACIFIC LEATHERBACKS TELLS US ABOUT MORTALITY, AGE AT MATURITY AND THEIR VARIABILITY ?

Philippe Gaspar | Maxime Lalire
CLS Sustainable Management of Marine Resources | CLS Sustainable Management of Marine Resources

The mortality during the pelagic juvenile stage as well as the age of sexual maturity are known to be key parameters influencing the dynamics of sea turtle populations. Yet data are lacking to determine exactly where, and for how long, juveniles disperse before undertaking their first reproductive migration. The nature and severity of the principal threats to which they are exposed, are thus difficult to assess. Accordingly, juvenile mortality rates and age of sexual maturity are poorly estimated in most sea turtle populations. In this presentation we show how results from STAMM (Sea Turtle Active Movement Model, Gaspar and Lalire, 2017), a new Individual Based Model simulating the spatial dispersal of juvenile sea turtles, can provide valuable information on these demographic parameters and their environment-related variability.
STAMM simulates the dispersal of juvenile sea turtles under the combined effects of ocean currents and habitat-driven movements, i.e. movements triggered by the need to find food and stay in suitable water temperatures. Gaspar and Lalire (2017) calibrated STAMM for leatherback turtles (*Dermochelys coriacea*) and tested it in an 18-year long simulation of the active dispersal of 5000 juveniles originating from Jamursba-Medi (New Guinea), one of the last important nesting beaches of the Western Pacific population. We focus here on the nearly 3000 individuals which, in this simulation, disperse into the North Pacific Ocean.
After leaving their natal beach, they initially follow two main dispersal pathways. Some of them, which we call the Kuroshio individuals, rapidly circulate into the Philippines current and then the Kuroshio. This powerful current rapidly entrains them northwards, towards Japan. The others flow eastward into the North Equatorial Counter Current (NECC) before recirculating clockwise into the North Pacific subtropical gyre. After one to three years, both the Kuroshio and the NECC individuals reach the North Pacific Transition Zone (NPTZ - situated typically between 30 and 40°N) where they perform regular north-south seasonal migrations while progressively moving eastward under the influence of the North Pacific Current. After well over 10 years, they finally reach the US west coast where they disperse, mostly along the coast of California and Baja California.
Analysis of the water temperatures and Net Primary Production (NPP, used as a proxy for prey density) encountered by these individuals, reveals that:

・Cold-induced mortality affects about 20% of the simulated individuals.

・Cold-induced death events occur mostly in 1 to 3-year old individuals and happen between 30° and 40°N, between the coast of Japan and the date line.

・Cold-induced mortality strongly depends on the initial pathway. The mortality rate reaches 45 % in the Kuroshio individuals but remains well below 10% in the NECC individuals. The NECC position and intensity being directly related to El Niño activity, this mechanism likely induces marked inter-annual variability in juvenile survival.

・After having slowly crossed the central North Pacific, where food is relatively scarce and starvation-induced mortality more likely, simulated juveniles finally reach the food rich habitats of the California current system. This likely signals the beginning of a period of rapid energy accumulation after which the first reproductive migration might occur. If this is the case, sexual maturity should be reached after about 15 years, the mean time needed for active turtles to reach the California current region. Interestingly, this (reasonable) estimate of the age at maturity of leatherbacks is directly related to the width of the oceanic basin in which juvenile disperse!

LEATHERBACK BREEDING SEX RATIOS AT SANDY POINT NATIONAL WILDLIFE REFUGE OVER THREE CONSECUTIVE YEARS.

Kelly R. Stewart | Peter H. Dutton
The Ocean Foundation | NOAA-NMFS-SWFSC

The age to maturity for leatherback sea turtles (*Dermochelys coriacea*) is currently unknown but may be between five years of age to upwards of twenty-five years. In addition, there is little known about the male component of the species, for any population. Male leatherbacks are difficult to capture in the wild, and therefore it is hard to collect information on their life history parameters such as breeding periodicity, reproductive output and success, and mate choice, but this information is important for building a more complete picture of population dynamics for species recovery.

Since 2009, we have conducted a hatchling genetics program at Sandy Point National Wildlife Refuge (US Virgin Islands) to understand age to maturity, multiple paternity and adult breeding sex ratios for this population. We have collected over 50,000 samples to date and this has provided a wealth of information about the breeding strategies for leatherbacks at this island population.

We extracted 119 sets of samples from known females and their hatchlings using standard genetic techniques and microsatellite markers. We repeated this procedure for females and hatchlings over three consecutive years. Then using the genotypes generated for the females and their hatchlings, we established paternity (single or multiple) for each nest using the program GERUD 1.0. Paternal genotypes could be reconstructed for each nest, and from there we could identify individual males. Thus, when we examined paternity over the season for a majority of the nesting females, we could derive a count of the individual male turtles that had been successful in breeding that year.

We found that the breeding sex ratio for Sandy Point varied little from a 1:1 male to female sex ratio (range = 0.98:1 to 1.1:1) and that most nests had single paternity (multiple paternity ranged from 17% to 47%). The number of males was similar to the number of females breeding annually, with males returning to breed on a bi-annual basis, similar to females. We discuss implications of our findings with regard to concerns about climate change and sex ratios. Additionally, we recently began a similar program for the Eastern Pacific leatherback population in Mexico in collaboration with local partners and we should have results to share from that analysis (samples are now being processed). Comparisons to St. Croix will be made for breeding sex ratios and paternity assessments.

ESTIMATING ABUNDANCE OF NESTING FEMALES AT RAINE ISLAND, AUSTRALIA, USING MULTIPLE DATASETS AND BAYESIAN HIERARCHICAL MODELING

Tomoharu Eguchi | Andy Dunstan | Katharine Robertson | Tina Alderson
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Abundance of nesting marine turtles is sometimes used as an index of a population, although it only includes adult females. When a population is small and the number of nesting females is countable, a census is possible. When a population is large and a census is not possible, statistical sampling and estimation are needed to estimate the abundance of nesting females. At remote nesting beaches, sampling may be possible only during a fraction of a nesting season, which can result in imprecise estimates. During the sampling period, however, various data may be collected for evaluating nesting success and indices of abundance at the nesting beach. All these data may be linked to the total abundance of nesting females at the time. In this study, we use multiple data sources to improve the precision of abundance estimates of nesting females at the largest nesting beach of green turtles in the world. Datasets included counts of nesting females, mark-resight, and nesting success. In the past, counts of nesting females (called tally counts) and abundance estimates from mark-resight data through Lincoln-Petersen estimates were used independently as indices of abundance. We statistically modeled the nesting behavior of green turtles at Raine Island and estimated the total abundance during the sampling periods using all datasets at once. Advantages of the integrated approach include (1) flexibility in adding datasets, (2) ease of incorporating environmental variables as covariates that affect observed data, (3) possible to incorporate the observation model into an underlying population model, enabling to estimate population growth rates, and (4) inclusion of uncertainty from all parameter estimates in the final parameter distributions. Data in the recent years were collected by the Raine Island Recovery Project, which is a five-year partnership between BHP, the Queensland Government, the Great Barrier Reef Marine Park Authority, Wuthathi Nation and Kemer Kemer Meriam Nation (Ugar, Mer, Erub) Traditional Owners and the Great Barrier Reef Foundation. It aims to protect and restore the island’s critical habitat to ensure the future of key marine species, including green turtles and seabirds.

DOES HISTORICAL CONNECTIVITY REFLECT CONTEMPORARY CONNECTIVITY OF GREEN TURTLE (*CHELONIA MYDAS*)? – A CASE IN PACIFIC-SOUTHEAST ASIA

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Kyoto University Graduate School of Informatics | Universiti Malaysia Terengganu Institute of Oceanography and Environment | Universiti Malaysia Terengganu Institute of Oceanography and Environment | Terengganu Malaysia Fisheries Research Institute | Sabah Parks | Talang-Satang National Park | Universiti Malaysia Terengganu Institute of Oceanography and Environment | State Oceanic Administration First Institute of Oceanography Marine Ecology Research Center

Comparison of pattern in genetic difference, which reflects historical connection among rookeries, and contemporary movement of marine animals is important for understanding the effect of contemporary movement on genetic population structure. Migratory nature and long-distance movement of sea turtles has been reported, while natal philopatry has been indicated by the fact that genetic population differentiation is observed in relatively narrow geographic scale. Therefore, it is hypothesized that contemporary movement has a limited effect on genetic population structure. This study compared genetic relationship among rookeries and that between rookeries and foraging grounds of green turtles (Chelonia mydas) in Southeast Asia. Mitochondrial DNA (mtDNA) control region sequences of ~770-bp region of 511 turtles from 11 rookeries were analyzed in combination with previously reported Indo-Pacific rookeries. Genetic variance and network analysis based on linkages among 31 management units in total indicated genetic barrier at Torres Strait and Celebes Sea (i.e. Philippines-Sulawesi). On the other hand, same mtDNA region was determined in 149 turtles from 7 foraging sites. Three out of these sites, including two sites in Celebes Sea and one site in the Brunei Bay, were analyzed through mixed stock analyses. The results indicated contemporary movement across the historical genetic barrier at Philippines-Sulawesi, from Micronesian rookeries to foraging grounds at Celebes Sea (i.e. Sipadan Island and Tun Sakaran Marine Park). Isolation by distance was generally supported for relationship among rookeries, and the contemporary movement did not result in lower genetic distance between rookeries than predicted by geographic distance. The integrative approaches in this study supported difference in historical connectivity and contemporary connectivity of migratory sea turtle, at least green turtles in Southeast Asia, probably due to the effect of natal philopatry.

ABUNDANCE OF JUVENILE STAGE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE OPEN OCEAN

Frederic Vandeperre | Hugo Parra | Christopher Pham | Miguel Machete | Marco Santos | Helen R. Martins | Alan B. Bolten | Karen A. Bjorndal

IMAR - Institute of Marine Research | IMAR - Institute of Marine Research | IMAR - Institute of Marine Research | IMAR - Institute of Marine Research | Regional Directorate of Sea Affairs | IMAR - Institute of Marine Research | Archie Carr Center for Sea Turtle Research | Archie Carr Center for Sea Turtle Research

The life cycle of most sea turtles includes a prolonged oceanic phase during which juveniles roam the open oceans for several years. Assessing population abundance and demographic parameters during this cryptic oceanic stage is challenging. Two long-recognized deficiencies in population assessment are (i) the reliance on trends in numbers of nests or reproductive females at nesting beaches and (ii) ignorance of factors regulating recruitment to the early oceanic stage. To address these critical gaps, we examine 15 years of standardized loggerhead sighting data collected opportunistically by fisheries observers in the Azores archipelago in the central North Atlantic. We use generalized additive mixed models to evaluate the influence of environmental and operational factors on loggerhead sighting probability and to generate estimates of relative abundance. From 2001 to 2015, 306 loggerheads were sighted during 46,678 km of survey effort. We present the first estimates of relative abundance of oceanic-stage juvenile sea turtles and offer new insights to our understanding of early recruitment to the open ocean. We further discuss the value of opportunistic platforms to monitor low density aggregations such as oceanic juvenile stage loggerheads.

INTEGRATING CLIMATE PROJECTIONS INTO A POPULATION MODEL FOR THE HAWAIIAN GREEN TURTLE

Summer Martin | Jeffrey Maynard | Shawn Murakawa | George Balazs | T. Todd Jones
NOAA Fisheries, Pacific Islands Fisheries Science Center | Marine Applied Research Center | NOAA Fisheries, Pacific Islands Fisheries Science Center | NOAA Fisheries, Pacific Islands Fisheries Science Center | NOAA Fisheries, Pacific Islands Fisheries Science Center

The influence of climate change is a critical data gap limiting the ability of the NOAA Fisheries and the U.S. Fish and Wildlife Service to comprehensively review the status of marine turtles listed under the Endangered Species Act (ESA). To estimate the future risk of populations falling below important biological thresholds, ESA status review teams use the best available science to conduct population viability analyses (PVAs). To date, PVAs for Pacific turtle populations have relied almost exclusively on nesting female abundance and have not quantitatively included climate change impacts upon populations. Temperatures above critical thresholds produce female biases because sea turtle sex is determined by the incubation environment; additionally, high temperatures cause embryonic death and nest failures. Our objective is to incorporate climate projections for increased sand temperatures into a population model for the Hawaiian green turtle to explore possible impacts on the population. Our approach includes: 1) compiling nest temperature data obtained from data loggers deployed in nests on East Island, Hawaii – the primary nesting site for the population, 2) using remotely-sensed data to develop sea/air and nest temperature regression models, 3) generating climate model projections of nest temperatures, 4) developing an age-structured demographic model with stage-based mortality for the turtle population, and 5) conducting PVAs inclusive of the implications of nest temperature projections on sex ratios and nest success. Modeling projections show hatchling production increasing for 40 years into the future, but decreasing thereafter, and nesting female abundance increasing for 80 years before starting to decrease. These results suggest that the nesting population may initially benefit from a female-biased sex ratio as nest temperatures rise and produce more female hatchlings (and ultimately nesting females), but after a lag of 80 years nesting female abundance may decline as the population impacts of embryonic death become apparent. At that point, the current increasing trend in nesting female abundance for this population may reverse and start to decline. Results from this research will be instrumental for determining regional green turtle conservation status, and the climate integration approach can be applied to future assessments of turtle populations in the Pacific and other regions.

GRUPO TORTUGUERO DE LAS CALIFORNIAS – TWENTY YEARS MONITORING EAST PACIFIC GREEN TURTLES IN THEIR FEEDING GROUNDS IN NORTH WESTERN MEXICO

Delia Karen E. Oceguera Camacho | Jesus Lucero | Yaira Trejo Hernandez | Agnese Mancini | Jose Matilde Arce Smith | Fabian Castillo Romero | Noe Lopez Paz | Isidro Arce Arce | Ranulfo Mayoral Aguilar | Francisco Burgoin | Jose Hernandez Dominguez | Julio Cesar Solis Hernandez | Mario Castro Lucero | Francisco Camacho Romero | Felipe Cuevas Amador | Jose Manuel Rondero | Israel Popoca Arellano | Rigoberto Garcia A. | Mayra Estrella Astorga | Jose Luis Lopez Morales | Cosme Damian Becerra | Alan A. Zavala Norzagaray | Catherine Hart | Israel Llamas G. | Raquel Briseño Dueñas | Lourdes Martinez E. | Volker Koch | Alexander Gaos | Jeffrey A. Seminoff | Wallace J. Nichols | Beatriz Dos Santos Dias

Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias, Dodobase | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Instituto Politécnico Nacional, Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | Eco Mayto A.C, Grupo Tortuguero de las Californias | UNAM, Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias | GIZ, Grupo Tortuguero de las Californias | ICAPO, Grupo Tortuguero de las Californias | NOAA, Grupo Tortuguero de las Californias | Blue Mind, Grupo Tortuguero de las Californias | Grupo Tortuguero de las Californias

Officially founded in 1999, the Grupo Tortuguero de las Californias (GTC) is a network of fishermen, scientists, conservationists, and community members, which was created to collect information on the ecology and status of East Pacific (EP) green turtles (*Chelonia mydas*) in their feeding grounds in NW Mexico, for which data were scarce. The network currently counts with the support of more than 500 members from 50 communities and its activities span from monitoring of feeding and nesting grounds, to environmental education, ecotourism and community development. The GTC also works as a platform for national and international researchers to conduct studies on various aspects on marine turtle ecology. This work is a summary of the main findings obtained after 20 years of monitoring of EP green turtles in 25 different feeding grounds and is based on new data and a bibliographic review of previously conducted studies. At monitoring sites, turtles were captured using a 100-180 m long entanglement nets with 50-70 cm mesh size that was modified to allow for caught animals to surface and breathe. The nets were set for 12-24 hours and monitored at regular intervals. After capture, standard measurements (straight carapace length SCL and width SCW, body depth, total and partial tail length and head width) were taken. Turtles were also tagged using a variety of flipper tags, before being released. For EP green turtles, sexual maturity was defined at 77.3 cm SCL, the mean size of nesting females in Michoacán, Mexico (the closest nesting site). 7,219 turtles were captured, during 4,954 monitoring events, equivalent to more than 15,000 hours of monitoring. 75% of the turtles caught were East Pacific green turtles (n=5,414), 4% were hawksbill turtles (n=287), 2% were olive ridley turtles and 0.1% were loggerhead (n=6) and leatherback turtles (n=2), and 19% were not identified (n=1,370). A large majority of EP green turtles were juvenile (82%, n=4462). Average SCL was significantly larger in sites within the Gulf of California (67.5±10.4 cm, range: 21.0-103.8 cm, n=2162; ANOVA, F=158.9, df=1, $p<0.0001$), compared to sites on the Pacific Ocean side (63.5±11.8 cm, range: 24.3-109.5 cm, n=3252). The Body Condition Index (BCI) varied significantly among seasons (ANOVA, F=26.2, $p<0.0001$) and sites (ANOVA, F=13.1, $p<0.0001$), BCI being on average higher during summer months (1.5±0.7, range: 0.43-1.8, n=3012). Catch per unit effort showed great variability within and between sites and between seasons (range: 1.5 – 18.6 turtles per 100 m net per 24 hours) and therefore could not be used to determine population abundance over time. Nevertheless in sites like Bahia de Los Angeles and Laguna Ojo de Liebre, an increase in catch rate was detected. Recapture data were used to estimate survivorship rates and population abundance using a Cormack-Jolly-Seber model at two sites for which enough recaptures were available. It was estimated that on average 1,481±180 turtles inhabited Estero Coyote in Punta Abreojos and 205±58 in Bahia Magdalena. The marine turtle monitoring program conducted by the GTC is unique in the region, and has provided essential information on EP green turtles ecology. It also contributed to reduce consumption and illegal fishery in many communities where fishermen are now in charge of the monitoring and therefore can spread awareness about these endangered animals. The GTC model has been replicated in other countries and is often cited as an example of positive community-based conservation work.

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TRAPPED IN THE CROSSROADS OF HONU CONSERVATION

Irene Kelly | Jennifer Homcy | Adam Kurtz | Maiko Ikeda
NOAA Fisheries | Hawaii resident, Owner FoundWood | NOAA Fisheries | University of Hawaii

It is no secret that the Hawaiian green turtle population is recovering. Today, honu (green turtles) are abundant and thriving in Hawaiian waters, and people are learning to live, work, and recreate around them. The International Union for Conservation of Nature Red List classified the population as “least concern” in 2012, and the 2015 Endangered Species Act global status review concluded that Hawaii’s population of approximately 4,000 nesting females per year was increasing at a rate of 5.4 percent annually, a significant achievement compared with only 62 nesters in 1973! The success of the Hawaiian green turtle, however, means that local human communities now face some new and unexpected challenges. Tourism is sea turtles’ principal economic value in Hawaii now, and honu have become a globally recognized symbol of Hawaii’s stature as one of the world’s top vacation destinations. The turtles’ easy accessibility has not gone unnoticed by the nature tourism industry, which brings visitors to specific beaches by car, van, and tour busload. Record tourist visitation and the soaring popularity of social media mean that interactions between people and sea turtles are frequent. Some residents are happy about the honu’s resurgence, whereas others express annoyance. Sadly, the feelings of reverence for honu once felt by native Hawaiians and locals are now overshadowed by frustration and conflict. Residents in some areas report that it is common to sit in two hours of traffic for what would once have been a 15-minute drive. The frustration and anger are palpable, and many locals describe the delays and disorder caused by the hordes of tourists as “turtle traffic.” Furthermore, resentment can cut deep when locals are confronted with the disrespect to animals by tourists who approach too closely for a “selfie” with a resting turtle, or when off-island interlopers attempt to tell them how to behave around what they perceive to be “their” honu. The “us versus them” animosity of such interactions is intense and undeniable. Managers are now confronted with the challenge of finding ways to promote marine tourism experiences that are economically viable while balancing visitor expectations with the needs of the species, the environment, and the local culture. Managing the intense pressure placed on local communities that find themselves trapped in the crossroads of conservation and their daily lives, with insufficient infrastructure to support the current and growing visitor numbers, has become an enormous challenge. On the positive side, a number of community-based programs have emerged to try to manage and reduce negative human–turtle interactions. NOAA has also begun to proactively work with Hawaii Tourism Authority, other partners, and specialists to encourage lawful and responsible tourism marketing with messaging to manage visitor expectations and promote respectful honu viewing. Lessons and images will be shared to provide an overview of life in the crossroads of turtle conservation and recovery in Hawaii.

4000 YEARS OF CONNECTION: SOCIO-CULTURAL VALUES OF MARINE TURTLES TO WAYUÚ INDIGENOUS PEOPLE

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James Cook University

Marine turtles are considered by people of several cultures to be a gift from God. This belief often leads to the use of these reptiles in the traditional and belief systems of indigenous peoples. Certainly, this is the case for the South-American Wayuú people, direct descendent of the Arawak people, an indigenous group settled in the Guajira Peninsula between Venezuela and Colombia. Wayuu considered themselves as the protectors and custodians of an ancient culture system, which is based on the harmonic relationship and alliance with nature. They consider nature elements, such as mountains, trees and animals, as their relatives. To assess the socio-cultural values of marine turtles to Wayuú indigenous people, I used a comprehensive open-ended question-based questionnaire to survey 45 Wayuu members among traditional healers, caretakers, clan leaders, and artisanal fishers from 12 Wayuú communities in the Venezuelan portion of the Guajira Peninsula. In addition, I undertook an in-depth literature review on Wayuu anthropological findings. Recent research evidenced the presence of marine turtle remains in traditional burials in Wayuu territories, which had occurred at least 4000 years ago. Furthermore, I documented customary practices where marine turtle body parts are used as key elements: to cure or prevent diseases, to predict 'bonanza' time in fishing, or to arrive to the mythical place 'Jepira', where the 'Yolujas' (or spirits) wait before returning to Earth as 'Juyá' (or rain) bringing life to the Guajira Peninsula. Marine turtles' presence is also vital in reaching adulthood for Wayuu young people. Indeed, young male Apaalanchis (or Wayuu fishers) have to harvest a turtle in front of his family (sometimes in front of all the community) to commemorate his recent reached adulthood. A similar case occurs among young female Wayuu members, who have to take a shower with 'moon water' (water that received moonlight all night long) using as container a marine turtle carapace. Through these practices, both males and females may receive all the benefits and properties from marine turtles, such as longevity and fertility, to live their adulthood. Everything Apaalanchis have is provided by the sea. Four of the five species of marine turtles present in Venezuelan waters were identified as being used as traditional socio-cultural values of Wayuú people. Some aspects of Wayuú people's cosmovision, customs, traditions and beliefs systems can inform conservation practices by considering inclusion of the traditional practices of marine turtles in Venezuela in future evaluations of the current Venezuelan environmental legal framework. Similar traditions are found in West African aboriginal people, who also have strong cultural links with marine turtles. It remains unclear if these similarities are part of a coincidence, or if they are linked to the proven interaction between African ex-slaves and Wayuu people during the colonisation period. We are still in the process of understanding the traditional component of the consumptive use of marine turtles by Wayuu indigenous people. It is important to highlight that we are not promoting the illegal use of marine turtles in the Guajira Peninsula. Instead, we are encouraging that an in-depth discussion about the regulations that need to be placed in order to include Wayuu's traditions and beliefs in the legal framework is opened. Such a discussion must involve all stakeholders. Generating this knowledge is unquestionably vital in the short-term future in order to inform decision-making process and management plans.

STUDY THE HEAVY METALS IN THE LIVER, KIDNEY AND PECTORAL MUSCLE OF SEA TURTLES IN TAIWAN

YinTing Chan
National Taiwan Ocean University

Due to the industrialization and human development, large quantity of heavy metals discharges into the ocean. This will increase the metals in the marine organism continuously. Sea turtles stand on the higher trophic level of the ecosystem. Under the effect of bioaccumulation and biomagnification, the, essential and nonessential heavy metals tend to accumulate in sea turtle. When the concentration exceeds certain level, it causes lesion of the physiologies, influence the health status, and in the worst case, results in death of the organism. Previous studies found that, the main sources of heavy metals in sea turtle derived from the foods they consumed. In this study, we determine the concentration of common heavy metals, such as Cu, Cr, Zn, Mn, Ne, Se, As, Cd and Pb from liver, kidney and pectoral muscles of the stranded dead sea turtles, to estimate the content of heavy metals in the environment. This is the first study ever done in Taiwan to determine the concentration of heavy metals in sea turtles. It will provide great helps to the quality assessment of the ocean in Taiwan.

EPIBIONT ALGAE ON MEDITERRANEAN *CARETTA CARETTA* LINNAEUS FROM AEOLIAN ARCHIPELAGO (SICILY, ITALY)

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Algae are common epibionts on the carapace of the sea turtles. Despite this, most of the papers on marine species concern to the animal component . The flora of the loggerhead turtle, *Caretta caretta*, is one of the best studied. However, the data on Mediterranean individuals of this species are limited in number and are prevalently restricted to few areas. Here we report the results obtained studying 41 individuals of *Caretta caretta* from the Aeolian Archipelago (Sicily, Italy). Yearly boat-based surveys were conducted in an area of about 280 Kmq around Filicudi Island and specimens were obtained from October 2015 to January 2017. A total number of 16 species of algae were sampled and identified. They belong to 4 different classes: 9 species to the Cyanobacteria, 2 to the Chlorophyta, 4 to the Rhodophyta and only one to the Ochrophyta. Some of these species are reported for the first time as epibionts on *C. caretta* carapace. Their frequencies on the individuals are reported. Our data on the Cyanobacteria represent the only contribution on species of this phylum growing on the Mediterranean sea turtles. Seven of these species have been found for the first time on the carapace of *C. caretta* and one of these, *Chroococcidiopsis polansiana* Andersen in Komárek & Anagnostidis, is the first record for the Mediterranean Sea. Two species of the genus *Ulvella* Crouan P. and Crouan H. (Chlorophyta) have been reported for the first time on a sea turtle. On the morpho-anatomical bases, only an individual referable to Ochrophyta was collected on the carapace of the studied turtles. Our preliminary data suggest that this specimen could be assigned to the Fucales. No species of this order have been collected from the carapace of a turtle. Among the Rhodophyta, *Acrochaetium corymbiferum* (Thuret) Batters and *Acrosorium ciliolatum* (Harvey) Kylin were reported for the first time on a turtle. A *Polysiphonia* sp., representing the species more abundant on the carapace of our turtles, presented several morphological similarities with *P. carettia* Hollenberg and Melanothamnus cheloniae (Hollenberg & J.N. Norris) Díaz-Tapia & Maggs. About this individuals, molecular data suggest to ascribe them under the genus *Melanothamnus*.

ISOLATION, CHARACTERIZATION AND ANTIBIOTIC RESISTANCE IN THE AEROBIC HETEROTROPHIC MICROBIOTA FROM THE CLOACA OF THE MEDITERRANEAN *CARETTA CARETTA*

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The aerobic heterotrophic cloacal bacterial microbiota and their antimicrobial resistance were characterized for 33 Mediterranean loggerhead turtles (23 healthy and 10 weak individuals) captured at their foraging grounds (Aeolian Archipelago, Southern Thyrrenian Sea). The samples were collected from individuals of mean size of 51.5 ± 11.5 cm as curved carapace length (CCL) by dedicated boat surveys in the period May-October 2014. A total of 131 different isolates derived from 5 families of Gram-negative bacteria. The isolates found in the cloaca included dominant, codominant and rare not-dominant resistant bacteria. The most frequently isolated were Enterobacteriaceae (55%), Shewanellaceae (32%) and Pseudomonaceae (8.4%). Among Enterobacteriaceae, 28 different species belonging to 8 different genera were found. In particular, the most common dominant species were *Shewanella algae*, followed by *Klebsiella oxytoca*, *Enterobacter cloacale*, *Citrobacter freundii* and *Enterobacter cloacae*. Among codominants, the most representative was *Shewanella haliotis*. Dominant and codominant species did not differ between small and large size turtles; however, codominance was significantly more frequent in good health turtles than in weak ones.

Antibiotic resistance is quite rare: the rare not-dominant resistant component of the cloacal microbiota showed resistance to sulfaprim as the most frequent (50%) and to ampicillin (18%); while no resistance was found to gentamycin, amikacin and ciprofloxacin.

Our results suggest that, due to the limited number of potential human pathogens bacteria and the antibiotic resistance pattern found in the cloacal swabs, *Caretta caretta* is not a potential *reservoir* for human health threat in the Mediterranean area.

COMPARISON OF THE USE OF IMAGING DIAGNOSE BETWEEN SEA TURTLES AND CETACEANS.

Álvaro García de los ríos
CECAM

Sea turtles And cetaceans are The most common marine animals stranded in our coasts. In order to determine The cause of stranding (death or illness) The specialized vet may perform different thecniques such as Computer tomography (CT), Magnetic Resonance (MR) or disecction. The correct interpretation of The images obtained can reveal differents pathologies such as descompression syndrome, internal parasites, traumatisms, etc...that can be useful not only to the rescue and rehabilitation centers, but Also as a reference for the Oceanariums and Aquariums that hold these animals in their colecctions. In adition to This, normal non pathological images may underline aspects relatives to embriology, growth and anatomy. In This póster we compare The images of The sea turtle representing The marine reptiles and The dolphin representing marine mammals.

SKELETOCHRONOLOGY WITH FLATBACK TURTLES: CAN WINTER AND SUMMER HATCHLING COHORTS BE DISTINGUISHED??

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An understanding of marine turtle somatic growth is gained by size-at-age studies, growth increment analysis, or by skeletochronology studies with humerus cross-sections. Estimates of growth rates, age at maturity, and longevity are developed from the layers of arrested growth (LAG) found in vertebrate bone. However, a major knowledge gap remains for Australia's endemic flatback turtle (*Natator depressus*) because no growth curves have been produced nor skeletochronology studies conducted to date. To establish this study we reviewed all known museum specimens of flatback specimens in the Atlas of Living Australia. Preserved hatchling specimens represent 94% of the 276 specimens in Australian Museums. Carcasses of non-hatchling flatbacks are rarely found as intact beach washed carcasses to contribute new specimens. Clearly, non-hatchling animals need to be evaluated for flatback age-size relationships to be developed. We initiated a flatback skeletochronology study into 'lost years' and all size classes based on newly acquired humerus material from Western Australia, Northern Territory and Queensland. We used x-ray microcomputed tomography (micro-CT) to demonstrate intact laminar bone structure is structurally similar in appearance with LAG found in non-leatherback sea turtles. We used traditional skeletochronology to evaluate growth layers and seek patterns of age-size (curved carapace length). We report on size classes collected, and preliminary data from an ongoing skeletochronology study. Flatbacks pose a unique challenge to age estimation because tropical populations emerge to nest in the austral winter and subtropical populations emerge to nest in the summer. If LAG are deposited during slowed growth, can winter and summer hatchling cohorts be distinguished?

APPLYING AMBAR RESIN AND BEEWAX TO NORMAL MEDICAL TREATMENT PROCESS OF INJURED LOGGERHEAD SEA TURTLES

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Sea turtles are endangered species all around the world. Two species of sea turtles loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) are using Turkey's Mediterranean coastline for nesting and foraging. Dozens of sea turtles are being injured or died in consequence of fishery interactions, speed boat accidents, ghost nets etc. along the coastline of Turkey. The first sea turtle rescue center (DEKAMER) in Turkey was established in 2008 and a total of 250 injured turtles were admitted to the center, during 2008-2017. Most turtles are being admitted by serious head injuries and, amputated extremities, carapace damage. Treatment of these injuries requires long term rehabilitation process. There are many medications that was described for sea turtles but a need of a faster medication techniques are obvious. We used a new medication in order to fasten recovery process of traumatic injuries on sea turtles. Two loggerhead individuals with serious head injuries treated with topical antibiotics, beeswax and amber (*Liquidambar orientalis*) tree resins. Head injuries recovered very fast in 9 months period. Using new therapeutic medications with natural and herbal support resulted positively in a small group of patients admitted to DEKAMER. It's quite likely that using this method may increase treatment of injured turtles and shorten the duration of treatment at rehabilitation centers. We present the pictures of the recovery of one loggerhead turtle that released after 15 months of treatment.

ARRIBADAS ARE ASSOCIATED WITH AN ENHANCED CAPACITY FOR EXTENDED EMBRYONIC ARREST IN OLIVE RIDLEY SEA TURTLES.

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Monash University | Monash University | Cape Eleuthera Institute | Monash University

Aggregated and synchronised nesting is an unusual and interesting evolutionary life-history tactic exhibited by two sea turtle species from the *Lepidochelys* genus. Aggregated nesting events, termed ‘arribadas’, can involve hundreds of thousands of females congregating at a single nesting beach over a few days and nights to oviposit their eggs. However, individuals of both species of *Lepidochelys* show behavioural polymorphism and can also nest solitarily, in non-arribada events. The two tactics are associated with different inter-nesting intervals, 2-3 and 4-5 weeks for non-arribada and arribada nesters, respectively. Depending on the reproductive behaviour employed by the female, embryos are therefore maintained in pre-ovipositional embryonic arrest in the hypoxic oviduct for different lengths of time. Turtle embryos are limited in their capacity to remain in arrest. Here, we investigated whether embryos oviposited during arribadas differ in their capacity to be maintained in pre-ovipositional arrest when compared with those oviposited during non-arribada events. Olive ridley sea turtle (*Lepidochelys olivacea*) eggs from eight clutches (four from each nesting tactic) were divided among seven treatments after oviposition; normoxia (control; 21% O_2), or hypoxia (1% O_2) for 3, 3.5, 4, 8, 15 or 30 days, before being all returned to normoxia. Arribada eggs generally had lower hatching success (<25%) across all treatments, whereas non-arribada eggs exhibited much greater hatching success in the control and 3-day hypoxia treatment (>65%) than in the longer hypoxia treatments. However, arribada eggs were capable of extending pre-ovipositional arrest for longer, with some eggs from the 8- and 15-day hypoxia treatment still hatching while no non-arribada eggs hatched after more than four days in hypoxia. This difference in embryonic capacity to survive extended periods of arrest may be an important mechanism facilitating arribada behaviour by allowing longer inter-nesting intervals. Our finding provides an intriguing insight into the physiological mechanisms that are integral to this unique mass-nesting behaviour.

METAL CONCENTRATIONS IN BLOOD AND SCUTE TISSUES FROM WILD AND CAPTIVE HAWAIIAN GREEN SEA TURTLES (*CHELONIA MYDAS*)

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The Hawaiian subpopulation of green sea turtles is listed as threatened under the U.S. Endangered Species Act of 1973. Toxic heavy metals have been shown to decrease immune function, impair growth and decrease reproduction in wildlife. This study compares metal concentrations in green sea turtles living in captivity at Sea Life Park on Oahu, Hawaii, to wild green sea turtles around the Main Hawaiian Islands. The turtles at Sea Life Park are fed a nutritionally complete, commercially available diet of pelleted food (Melick 35% protein finisher). Blood and scute samples from six green turtles at Sea Life Park and nine similarly sized wild green turtles were selected from the NIST Biological and Environmental Monitoring and Archival of Sea Turtle Tissues (BEMAST) specimen bank. These samples, along with the pelleted food, were analyzed for Al, As, Cd, Cr, Cu, Ni, Pb, Ti, V, Se, Sn, and Sr by Inductively Coupled Plasma - Mass Spectrometry (ICP-MS). Blood provides a good representation of recent exposure to metal contaminants, while scutes sequester elements and indicate long term exposure.

The essential elements Cu, Se, V, and Cr were determined to be higher in the scutes of captive turtles whereas concentrations of a non-essential element, As, was significantly higher in wild turtles. Average blood As, at 36 ng/g and 66 ng/g in captive and wild turtles, respectively, is lower than that found in the scutes (101 ng/g captive and 388 ng/g wild). The high concentrations of Cu (9.2 mg/g), Se (0.91 mg/g), V (1.05 mg/g) and Cr (0.47 mg/g) in the pelleted turtle food correlate with the higher concentrations of these essential elements in the captive turtle scutes. Lead concentrations were below the detection limit in the scutes of both captive and wild green turtles but was significantly higher in the blood of wild green turtles than captive green turtles. The highest blood Pb concentration of 146 ng/g, which is three times higher than the concern level for children blood Pb, occurred in one wild turtle from Kailua Bay. This turtle was exposed to Pb as shown by the blood concentration, but was not chronically exposed to high Pb levels as seen from the low scute Pb concentration. Historically, a skeet shooting range was located on the beach near Kailua Bay. Though remediation has occurred, large piles of shotgun pellets containing lead and arsenic can still be found in the sand and tide pools of the beach. These pellets are exposed during storm events, and enter into the ocean likely exposing the fauna including this sea turtle.

The metal concentrations seen in these Hawaiian green sea turtles are similar or orders of magnitude lower than concentrations seen in wild green sea turtles inhabiting coastal areas of Texas and California. This is the first study to compare metal concentrations between captive and wild green sea turtles. The captive turtles may provide a baseline of contaminant levels of heavy metals including As and Pb. Establishing a baseline of blood and scute elemental concentrations will allow future studies to quantify changes in sea turtles.

DOES TEMPERATURE REGIME IN THE FIRST WEEK OF HOLDING DETERMINE OVERALL SUCCESS RATE FOR COLD STUN RECOVERY

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This study seeks to examine the correlation between the speed of temperature increase of cold stunned sea turtles found along New York's beaches, and success rate for their release. The term cold stun is well known in the sea turtle community. It is of great significance in the cold waters of the northeastern US, as hundreds of sea turtles wash onto beaches, and are rendered inactive due to extreme temperature shock. Much research has already been conducted by various sea turtle rehabilitation facilities to provide support to these cold stuns, in hope that they will be returned back to their natural environment. Various protocols involving the warming process have been developed at such facilities, however at this time, more research is needed to determine the regime that is not only manageable, but will lead to the lowest mortality rates for cold stuns that present in different classes (depending on their degree of thermal distress). The Riverhead Foundation for Marine Research and Preservation (RFMRP), located on Long Island, is the sole rehabilitation facility for all of New York State, and is the primary response team for sea turtle strandings in the area. This study will take place during the upcoming 2017-2018 cold stun season. Between the months of November and January, the RFRMP will receive all cold stuns that wash on to NY beaches. Typical species stranding during these months are Kemp's ridley (most common), greens, and loggerheads. Upon arrival to the facility, temperature is monitored using a cloacal temperature probe, and all turtles are assigned a class level denoting the severity of their condition (Class I - Class IV). Class I and II are more responsive animals. Class III and Class IV are patients that require greater care and attention by attending veterinarians. Physiological status of all turtles is further documented through blood analysis, evaluation of injuries, and cardio-respiratory assessment. Previous studies suggest that a slower increase (e.g. 5°C/day) in temperature will lead to higher success rates for release. Thus far, RFMRP has applied a more aggressive hourly rate of temperature increase (2-4°C/hour) with mixed success. This study will focus on the application of slower temperature increase by setting up temperature phases for incoming cold stuns. Four separate holding rooms will be maintained at distinct temperature ranges; Phase One 12-15°C, Phase Two 16-19°C, Phase Three 20-24°C and Phase Four 25-30 °C. Depending on the incoming temperature of the cold stun, they will be allocated to one of each of the four rooms, and the temperature regime (5°C/day) will continue until a maximum temperature of between 25°C and 30°C has been achieved. All other veterinary support for cold stuns will remain as previously handled throughout the holding period. RFMRP is striving for high release rates for all cold stunned sea turtles of Classes I through IV. It is hoped that a slower elevation in temperature for all cold stuns will lead to an overall greater success rate for release in the early spring of 2018.

DETECTION OF CHELONID HERPESVIRUS 5 (CHHV5) IN SEA TURTLES FROM FEEDING AREAS OF BAJA CALIFORNIA PENINSULA, MEXICO

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Fibropapillomatosis (FP) is a neoplastic disease characterized by cutaneous tumors and has been documented in all species of sea turtles. The primary etiological agent associated with this disease is Chelonid herpesvirus 5 (ChHV5). It is possible that a proportion of clinically healthy sea turtle populations carry ChHV5 as a persistent latent infection, suggesting that ChHV5 requires environment-related cofactors and turtle's immunosuppression to cause FP. Recently, researchers have been focused on the molecular detection of ChHV5, not only to determine frequency of the disease, but also to determine its distribution, affected species and possible vectors that could propagate it. In Mexico, the Peninsula of Baja California has feeding sites for the five species of sea turtles that inhabit it; however, no molecular studies have performed for ChHV5 detection; even though the disease has been previously reported utilizing histopathology and transmission electron microscopy techniques. The goal of this study was to detect by conventional PCR technique, ChHV5 on sea turtle samples and possible vectors from four feeding zones in the Baja California peninsula: Golfo de Ulloa (GU), Laguna Ojo de Liebre (LOL), Laguna San Ignacio (LSI) and Laguna Guerrero Negro (LGN). Among 2016 and 2017, 84 samples were collected from sea turtles of the species *Chelonia mydas*, *Caretta caretta* and *Lepidochelys olivacea* and 5 samples from leeches of the specie *Ozobranchus margoi*. For molecular detection, were used the primers GTHV2 and GTHV3 proposed by Quackenbush et al. (2001), which amplify a 483 bp fragment of the DNA polymerase gene (UL 30) from ChHV5. Of the total samples, 2.3% (2/84) of the sampled turtles and 20% (1/5) of the leeches were PCR positive for the target gene fragment, being *Lepidochelys olivacea* and *Chelonia mydas* the affected species. These results are the first PCR-confirmed report of Chelonid herpesvirus 5 in the peninsula of Baja California in both sea turtles and leeches. This finding confirms that there is a health risk to sea turtle populations due to the presence of the virus on the region, and it suggests that leeches could have a role in virus transmission.

FIRST REPORTED CASE OF FIBROPAPILLOMATOSIS IN GREEN TURTLES (*CHELONIA MYDAS*) IN SABAH, BORNEO

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Fibropapillomatosis (FP) is characterized by cutaneous tumours that have been documented to infect all sea turtle species globally. FP is associated with Chelonid fibropapilloma-associated herpesvirus (CFPHV), an alphaherpesvirus from the family Herpesviridae. However, reports of FP in Asia are limited. Here, we provide the first evidence of CFPHV associated FP in endangered green turtles (*Chelonia mydas*) from Sabah, Borneo. The aims of this study were firstly, to determine the present of CFPHV in both tumour exhibiting and tumour free turtles from Sabah and secondly, to determine the phylogeography of CFPHV from Sabah. We also aim to provide evidence of CFPHV infection through histopathological examinations. A total of 115 green turtles were collected from Mabul Island, Sabah. DNA was isolated from approximately 25 mg tissue using a modified cetyltrimethylammonium bromide (CTAB) and Polymerase Chain Reaction (PCR) was used to amplify three conserved regions of the CFPHV genes. The resulting amplicon were then sequenced to determine phylogenetic associations. CFPHV was successfully detected in nine of the 115 green turtle DNA. Although all of the green turtles that exhibit FP tumour were positive for CFPHV, surprisingly, so did four of the clinically healthy turtles. The use of three CFPHV regions to maximize detection efficiency proved extremely useful since in latent infections the virus copy number can be very low. In addition to the molecular evidence of CFPHV in FP, epidermal intranuclear inclusions were identified in tumour lesions upon histopathological examination. The phylogenetic tree revealed that CFPHV from the green turtles in Sabah were closest to the CFPHV from Hawaii and Florida. Thus, the emergence of CFPHV in green turtle in the waters of Sabah signifies a threat to sea turtle populations which elucidates the need for in-depth research on CFPHV manifestations and further monitoring along the Malaysian
Keywords: Borneo; CFPHV; *Chelonia mydas*; Fibropapillomatosis; Mabul Island; Sabah

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BIOELECTRICAL IMPEDANCE ANALYSIS IN SEA TURTLES – A NEW METHOD FOR HEALTH ASSESSMENT? A PILOT STUDY.

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Sea turtle medicine has been carefully studied over the last decades. However, health status assessment is often been hindered by the lack of a quick and practical diagnostic tools that can also be used in the field to support challenging triage decisions and reduce potential diagnostic errors. Bioelectrical impedance analysis (BIA) is considered a quick, non-invasive and effective method for estimating body composition. It is commonly used in humans and has been validated in several animal species.

Currently, both green turtle hatchlings and juveniles are being assessed using this technique at James Cook University in a pilot study. Computed tomography (CT) scanning is used as a calibration method. The aim of the project is to evaluate BIA as a tool in support of triage decisions and to create reference values for future sea turtle population studies. Preliminary results will be presented.

RESCUE AND REHABILITATION OF STRANDED SEA TURTLES IN OKINAWA CHURAUMI AQUARIUM

Mariko Omata | Kiyomi Murakumo | Haruka Kamisako | Risa Ikehara | Ken Maeda | Shingo Fukada | Keiichi Ueda | Isao Kawazu

Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium, Okinawa Churashima Reseach Center | Okinawa Churaumi Aquarium, Okinawa Churashima Reseach Center

Okinawa Churaumi Aquarium is a facility for rescuing and rehabilitating stranded sea turtle near Okinawa Island, Japan. The rescued turtles are evaluated using blood tests, X-ray imaging, computed tomography scanning, ultrasonography, and endoscopy and are provided treatments and rehabilitative care, including administration of antibiotics and other medications. Rehabilitated sea turtles are released back to the sea. Here, we report some recent cases of rehabilitation and release of rescued sea turtles.

On November 23, 2015, a green turtle (*Chelonia mydas*; straight carapace length: 38.0 cm; body mass: 7.6 kg) that had swallowed a fishhook was caught by fisherman and transported to our aquarium. We performed X-ray imaging to locate the fishhook and found that it had lodged in the esophagus; it was removed using pliers. The turtle's recovery was monitored using blood tests, wound examination, and food consumption assessment, and the turtle was subsequently released on November 29, 2015.

On February 15, 2016, a hawksbill turtle (*Eretmochelys imbricata*; straight carapace length: 37.4 cm; body mass: 4.75 kg) was found stranded on a sandy beach and was transported to our aquarium. Blood examination revealed an increased number of leukocytes, and computed tomography scanning showed the presence of a pulmonary cyst. Thus, the turtle was diagnosed with a bacterial infection, and we administered appropriate antibiotics. After confirming the decrease in leukocyte number and the improvement of the pulmonary cyst, we released the turtle on October 16, 2016.

On February 16, 2016, a green turtle (straight carapace length: 31.1 cm; body mass: 3.5 kg) was found stranded on a sandy beach and was transported to our aquarium. We observed swelling of the cheeks, and computed tomography scanning revealed that the tympanic cavity was filled with pus. After administration of appropriate antibiotics, the pus was eliminated, and swelling of the cheeks was reduced. We released the turtle on July 1, 2016.

We suggest that diagnosis using medical equipment may be effective for the rescue and rehabilitation of stranded sea turtles. This approach will also improve veterinary care procedures and help conservation efforts for wild sea turtles.

BARNACLES CLASSIFICATION IN BAJA CALIFORNIA SUR SEA TURTLES

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In Baja California Sur, five of the seven sea turtle species which are distributed throughout the state can be found. There, they carry out their different life cycle stages. In this research, barnacles are classificated and it can be use as an identification guide. Eastern pacific green turtles (*Chelonia mydas*), Loggerhead turtles (*Caretta caretta*) and Olive ridley turtles (*Lepidochelys olivacea*) were captured in Guerrero Negro, Ojo de Liebre lagoon and Gulf of Ulloa (BCS). The technique used was by nets and rodeo, during June, July, August and September of 2017. A total of 117 turtles were captured, including the three species. Each turtle was estudied, and the morphometric measurements were taken. After that, blood samples were collected and caparace, plastron and groin temperature was registred. Likewise, cirripedes samples were stored. Barnacles were collected scraping with spatulas and pliers in labeled plastic bottles preserved in ethanol 70% . The samples were transported to the UABCS oceanography laboratory, where were weighed, measured and photographed. Six different species were determined in different taxonomic groups. The most abundant species was *Chelonibia testudinaria* (Linnaeus, 1758) belonging to Family Coronulidae (Leach, 1817). This barnacle spends its adult life (about three years) attached to turtles. Another barnacle identified was *Platylepas hexastylos* (Fabricius, 1798). Chelonibia differs from Platylepas in their latter; it is smaller and has six calcareous plates instead of eight as *C. testudinaria*. Generally, they widely colonize the skin of its host and embed depeer than other barnacles, originating great lesions in turtles softest areas. *Stephanolepas muricata* (Fischer, 1886), gender Platylepas was also identified. This cirripid completely encapsulates into turtles skin. Its shell is fragile and presents different sutural structures that radiate outwards to be anchored inside the epidermis of the turtle. This barnacle penetrates the skin and sometimes bones of sea turtles causing damage. Therefore, it is important to identify these barnacles given the consequences that produce in the organisms.

REPRODUCTIVE AND STRESS PHYSIOLOGY OF LOGGERHEAD SEA TURTLES AT THE ST. LUCIE POWER PLANT IN FLORIDA

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The St. Lucie Nuclear Plant (SLNP), located on Hutchinson Island, FL, uses nearshore ocean water to cool its reactors. Often times, sea turtles enter the intake structures with the cooling water into a canal system, presenting researchers with a unique opportunity to collect samples from wild animals to learn more about their physiology. Blood samples were collected from 59 loggerhead sea turtles entrained in the SLNP and 30 samples were taken from nesting loggerheads as a reference during June-July 2016. Plasma samples were analyzed using enzyme-linked immunosorbent assays (ELISAs) to measure corticosterone (CORT), testosterone (T), estradiol (E_2) and vitellogenin (VTG) concentrations. The results showed that loggerheads entrained in the intake canal do not appear to be stressed initially but are capable of responding to handling stress, as demonstrated by low initial CORT concentration, followed by elevated CORT. We expect to see a gradual decrease of T, E_2, and VTG as the nesting season ends. This study will allow us to understand how sea turtles react to being entrained in the intake canal of a power plant and to apply the findings to management and conservation programs.
We would like to thank the staff of Inwater Research Group for making this project possible. We also thank Dr. Gary Childers and the Microbiology lab at SLU for access to their plate reader. This research was supported by the Harvey L. Foster Foundation for Science Education, the Joseph Ramspott Memorial Scholarship, Inwater Research Group, and the Southeastern Louisiana University Development Fund.

PARASITES OF HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA*, NESTING IN NORTH-EAST TOBAGO, WEST INDIES

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A diverse range of over one-hundred species of epibiont have been reported on marine turtles. Among these epibionts are organisms which form a 'parasitic association' meaning they exploit their host for nutrients. Some parasites may act as a mechanical vector of the fibropapilloma-associated turtle herpesvirus (FPTHV) which can lead to significant negative health consequences for hosts. Given the possible negative outcome for infected individuals and the generally unfavourable conservation status of marine turtle populations there is a clear need to document occurrences of parasitic associations where observed. Following an incidental report of an infected turtle, we recorded conspicuous parasites attached to the eyelids and cloaca of nesting hawksbill turtles encountered during an on-going beach monitoring programme in north-east Tobago, West Indies (11°19'13.53"N, -060°33'1.57"E). Collected parasite specimens were identified using gross external morphology. Eyelid inspections revealed isopod, *Excorallana* sp. (Phylum: Crustacea), infection during 27 of 145 encounters (n=68 *Excorallana* sp. individuals; range: 0-8 per turtle). Eighteen of sixty-eight (26.47%) tagged turtles were infected on at least one occasion; four turtles were seen infected twice. Cloaca inspections revealed leech, *Ozobranchus* sp. (Phylum: Annelida), infection during 26 of 124 encounters (n=120 *Ozobranchus* sp. individuals; range: 0-28 per turtle). Two collected specimens were identified to species level as *Ozobranchus margoi*. Nineteen of sixty-three (31.25%) tagged turtles were infected on at least one occasion. Our results provide a first insight into parasite infection rates at a rookery of the critically endangered hawksbill turtle in north-east Tobago. The finding of Ozobranchus margoi, a potential mechanical vector of fibropapilloma-associated turtle herpesvirus, is of clear importance while records of the isopod *Excorallana* sp. increase knowledge of a poorly understood parasitic association. Further research to establish a full inventory of turtle parasites in north-east Tobago would contribute to a baseline assessment of animal health within this population and allow for comparisons over greater temporal and geographical scales.

SEROPREVALENCE OF CHELONID ALPHAHERPESVIRUS-5 ANTIBODY TITRES IN CLINICAL AND NON-CLINICAL LESION EXPRESSING GREEN TURTLES (*CHELONIA MYDAS*) OF THE GREAT BARRIER REEF

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Fibropapillomatosis (FP) is a debilitating neoplastic disease which occurs in all extant species of sea turtle. This disease occurs globally in varying significance and is characterized by the formation of visual lesions on soft tissue areas and surrounding internal organs (in significant cases). While exact environmental stressors are not known for the expression of FP, a virus has previously been associated with a significant number of lesions tested and is widely considered the primary aetiological agent. Chelonid alphaherpesvirus-5 (ChHV5) is a latent, lifelong virus which infects turtles, both with and without (clinical healthy) visual FP lesions. However, little research is available on the seroprevalence of ChHV5 within local populations of green turtles (*Chelonia mydas*) along the Great Barrier Reef (GBR). Through the application of an indirect enzyme-linked immunosorbent assay (ELISA) technique, the prevalence of ChHV5 antibody titres was measured in serum samples from wild captured green turtle juveniles. Antibody titre presence provides insight into past and present exposure to ChHV5 in turtles sampled. Samples tested included both clinically healthy individuals and turtles with FP. It was hypothesized that a proportion of clinically healthy samples would test positive for ChHV5 antibody titres, while a vast proportion (>90%) of samples from individuals with FP lesions would also test positive for antibody titres. This study will provide additional insight into the probable association between FP and ChHV5. Additionally, increased knowledge of viral infection in clinically healthy individuals, will inform future research in potential environmental stressors suspected of increased prevalence of FP lesions in green turtle populations both locally and globally.

LOGGERHEAD SEA TURTLES: POTENTIAL DISPERSAL OF NON-INDIGENOUS SPECIES IN THE GULF OF GABÈS

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Among marine turtles, the loggerhead sea turtle *Caretta caretta* (Linnaeus, 1758) is known to be colonized by large and diverse communities of epibiont fauna and flora. Gathering knowledge on the composition, distribution patterns and abundance of epibiotic species represents the first stage in understanding the nature of epibiotic relationships. Information on the epibiont community can help in understanding the ecological traits and movements of the loggerheads.
Epibionts of thirty five loggerhead turtles from the gulf of Gabès, southeast Tunisia, were collected during the activities carried out by the Tunisian Sea Turtle Program (TunSTP) included in the activities of the National Institute of Sea Sciences and Technology (INSTM).
The analysis of the collected material revealed the presence of five invasive species: three lessepsian molluscs : *Cerithium scabridum*, *Pinctada radiata* and *Brachidontes variabilis*, one Indopacific cirripedia *Stephanolepas muricata*, and one red algae *Polysiphonia carettia* belonging to the Atlantic Ocean.
Key-word: epibiont, non-indigenous species, loggerhead turtle, Gulf of Gabes

TRANSIT TIME ON LOGGERHEAD TURTLES (*CARETTA CARETTA*)

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Investigate marine debris impacts on marine biota has become a major topic in the recent years. On sea turtles the interaction with marine debris could be caused by entanglement or by ingestion, where many images has been circulated around the world in the last years, but few scientific analysis has been conducted. Study the ingestion of marine debris on alive animals, mainly conducted through feces analysis, is difficult due to the inexistence of standardized protocols, and most difficult on endangered species as marine turtles, where manipulation and management of this animals is complicated.
One of the first steps to study debris ingestion on alive animals is to determine the specific digestive transit time to concrete the sampling period. On marine turtles, as reptiles, this digestive time is very influenced by several factors, such us temperature, kind of food and animal fitness.
This study aims to determinate the digestive transit time in loggerhead turtle (*Caretta caretta*) to standardize protocols for debris ingestion studies on alive loggerheads. Turtles used on this study belong to the project "Enlargement of breeding areas for loggerhead turtle (*Caretta caretta*) in the Macaronesia" conducted by Canary Islands regional Government (Spain), Cape Verde Government and two NGOs and has been reared in captivity under CITES permissions.
For the experiment natural foam disks (5mm of diameter) were placed inside the food supplied to turtles (squid, mackerel and sardine), and tanks were checked every day until foam disks presence was recorded. In order to avoid wasted foam disks, all tank drainages were covered by 1mm mesh. The influence of different parameters on digestive transit time, such us kind of food, water temperature, turtle size and body condition index has been analyzed.
Finally, I want to aknowledge to all the sponsors and donors of the Symposium (Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Orgabist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, the US Fish & Wildlife Service and Teikyo) , as well as to the The International Sea Turtle Symposium for their support through the travel grant to attend this Symposium.

CHELONID FIBROPAPILLOMA-ASSOCIATED HERPESVIRUS PRESENCE IN BLOOD OF JUVENILE GREEN TURTLES

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Fibropapillomatosis (FP) is a tumor-forming disease that mainly affects juvenile green turtles (*Chelonia mydas*) in coastal habitats. Chelonid fibropapilloma-associated herpesvirus (CFPHV) is believed to be the viral component necessary for FP to develop. CFPHV can be found in FP tumors using real-time polymerase chain reaction (qPCR) techniques, but is not necessarily located elsewhere within the turtle. Localization of the virus to certain areas of the body is a common trait in herpesviruses; therefore it is not surprising to find CFPHV in tumors, but not in other locations. However, CFPHV is occasionally detected in the blood of turtles both with and without FP tumors. The state where the virus is in the bloodstream is known as viremia, and is not well understood in the turtle-FP disease system. The goal of this study was to better understand why certain blood samples exhibit viremia, while others do not. We analyzed juvenile green turtle data from a long-term dataset (1995-2017) in the Indian River Lagoon, Florida, USA. All turtles assessed in this study had blood samples tested for CFPHV using qPCR.
This study was split into two analyses. The first was to consider how the status of FP tumors affects CFPHV viremia. CFPHV could potentially enter the bloodstream via tumors, and therefore viremia may be more likely in turtles more heavily afflicted with FP tumors, both in quantity and severity. Furthermore, CFPHV may be more likely to enter the bloodstream from tumors in specific locations, making turtles with tumors in these locations more likely to exhibit viremia. For over 300 turtles afflicted with FP, we used logistic regression models to assess the effects of the quantity, severity, and locations of tumors on CFPHV viremia. The second part of the study was to investigate viremia in recaptured individuals. Here we looked at individuals that tested positive for CFPHV in blood and were subsequently recaptured and tested again. From this we considered whether individuals maintained CFPHV viremia when recaptured, and whether the time between captures affected whether or not viremia remained. Additionally, we assessed how FP state affected CFPHV viremia in recaptures. This study gives us a better understanding of the role of viremia in FP development, including whether or not CFPHV remains in blood for an extended period of time, and whether viremia occurs during particular phases of FP. The results of this study will be informative for future research using blood samples for CFPHV detection, allowing better accuracy for measures such as CFPHV prevalence in populations.
Funding and support for this work was provided in part by the National Marine Fisheries Service, the Florida Fish and Wildlife Conservation Commission, the U.S. Fish and Wildlife Service, the Richard King Mellon Foundation, the Disney Wildlife Conservation Fund, the Bernice Barbour Foundation and the Brevard Zoo. In addition, this study was funded in part by a grant awarded from the Sea Turtle Grants Program. The Sea Turtle Grants Program is funded from proceeds from the sale of the Florida Sea Turtle License Plate. Learn more at www.helpingseaturtles.org.

ACCOUNTING FOR IMPERFECT HERPESVIRUS DETECTION TO ASSESS THE FIBROPAPILLOMATOSIS DISEASE SYSTEM IN JUVENILE GREEN TURTLES

Jake Kelley | Anna Savage | Kate Mansfield
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The sea turtle disease fibropapillomatosis (FP) is characterized by the development of tumors on the skin, eyes, and/or internal organs. These tumors can have lethal and sublethal effects. While all species of sea turtles can be afflicted by FP, juvenile green turtles (*Chelonia mydas*) in coastal habitats are most strongly affected by FP. The cause of FP is not fully understood, but is likely linked to chelonid fibropapilloma-associated herpesvirus (CFPHV), along with other environmental and immunological factors. While there is plenty of evidence to implicate CFPHV as the viral component of FP, little else is known about the CFPHV-FP disease system. There are several complicating factors when analyzing CFPHV data. CFPHV expresses many traits that are characteristic of herpesviruses, including latency and localization. Latency is when the virus exists in low quantities and without causing ill-effects to the host. Therefore, CFPHV can be present in individuals without FP. Furthermore, latent CFPHV can be difficult to detect due to the low quantities of the virus during latency. Localization is where the virus is concentrated in particular areas of the body, and absent in other areas. CFPHV shows strong localization in FP tumors, but can also be found in other locations. The combination of localization and latency makes it difficult to accurately test whether or not an individual turtle is infected with CFPHV. To address this issue, we used a large dataset and statistical methods that help account for imperfect detection of CFPHV to investigate the CFPHV-FP disease system in juvenile green turtles.
We analyzed a long-term dataset from the Indian River Lagoon (IRL), Florida, USA. The IRL study started in the late 1980s and is ongoing, with FP prevalence in green turtles averaging 50% throughout the study period. The longevity and high FP rates of the IRL study make it ideal for assessing the CFPHV-FP system. Using real-time polymerase chain reaction (qPCR) techniques, we tested for the presence of CFPHV in blood samples from over 700 juvenile green turtles captured between 1995 and 2017, making this the most expansive CFPHV dataset from one site, both in quantity and temporally. We used this dataset to assess CFPHV prevalence over time, FP prevalence relative to CFPHV prevalence, and potential factors affecting CFPHV and FP presence in individuals. We used Bayesian multilevel logistic regression models to help account for imperfect detection of CFPHV. By using these models, we can make more accurate assessments of CFPHV at the population level. With many juvenile foraging sites experiencing increasing FP rates, it is important to understand the drivers behind FP development, including viral, environmental, and immunological components of the disease system. In this study we assessed the viral component CFPHV, which will improve our broader understanding of FP development, thereby informing conservation efforts for the protection of juvenile sea turtles.
Funding and support for this work was provided in part by the National Marine Fisheries Service, the Florida Fish and Wildlife Conservation Commission, the U.S. Fish and Wildlife Service, the Richard King Mellon Foundation, the Disney Wildlife Conservation Fund, the Bernice Barbour Foundation and the Brevard Zoo. In addition, this study was funded in part by a grant awarded from the Sea Turtle Grants Program. The Sea Turtle Grants Program is funded from proceeds from the sale of the Florida Sea Turtle License Plate. Learn more at www.helpingseaturtles.org.

BLOOD BIOCHEMISTRY OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) SEA TURTLES FORAGING IN NORTHERN SINALOA, MEXICO

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Blood parameters provide an excellent tool to evaluate the health status of wildlife. However, there are few studies about health parameters of sea turtles in Mexico. For olive ridley turtles (*Lepidochelys olivacea*), no information was available to establish the health baseline for the species. The objective of this study was to establish reference blood biochemistry values for olive ridley turtles in foraging area in northern Sinaloa, Mexico. Between 2013-2015, 82 olive ridley turtles were captured. Body condition index (BCI) presented a mean of 1.46 ± 0.14 (1.17-2.02) that categorized the population with excellent body condition; in addition, 99% of the turtles captured had a good physical appearance. Blood was collected for biochemistry analysis for 60 turtles. Significantly higher values of total protein, albumin, A/G ratio (albumin/globulin) and PCV (packed cell volume or hematocrit) were observed in adult when compared to subadult turtles. On the other hand, no significant differences were found when females and males were compared. Based on the BCI, physical assessment, and blood parameters, and compared to other sea turtle species, olive ridley turtles in northern Sinaloa were considered in excellent health. To the best of our knowledge, this is the first study worldwide to establish normal blood biochemistry values of foraging olive ridley turtles of a healthy population in northern Sinaloa.

PRELIMINARY STUDIES ON FEMALE WELFARE DURING NESTING PROCCESS DATA COLLECTION ON CAPE VERDE LOGGERHEAD (*CARETTA CARETTA*) ROCKERY

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Loggerhead sea turtle (*Caretta caretta*) is catalogued as an endangered species due to important decrease of their populations all around the world. Anthropogenic threats at sea (bycatch, marine litter, pollution, etc.) and habitat destruction on nesting beaches and feeding areas have been added to important natural predation in their early life stages.

Sea turtles present complex life cycles where most of their life stages are at sea and it is very difficult to have access to the animals. For this reason, conservation programs have been focused on nesting beaches because is the most accessible moment to study breeding females and hatchling productivity. The breeding process in the most important moment for the survival of the species and is crucial in endangered species, so, in marine turtles where most part of the data collection is conducted during the nesting process, it is important to achieve a proper data collection reducing as much as possible disturbances to the animal.

This preliminary study aims to investigate if the management of the nesting female on the field for data collection (turtle size, tagging, anomalies review, etc.), or observation (turtle-watching), is affecting them and could disturb the nesting process. Stress response has been analyzed through corticosterone levels on blood samples, on nesting females exposed to different parameters: (i) number of people collecting data on a single animal, (ii) presence of tourists, (iii) distance to tide-line, (iv) nest success or (v) turtle size.

During 2011 nesting season 30 females were sampled in the three main nesting beaches of Boa Vista Island (Cape Verde). Two blood samples (3ml) were taken from each nesting female, first before any contact between researchers and the turtle, and the second after the manipulation process. Radioimmunoassay (RIA) technique was conducted to analyze corticosterone levels on blood samples.

This preliminary analysis has shown that animal manipulation conducted by standardized protocols after egg laying and tourist presence on the back of the turtle during nesting processes do not stress the turtles. The best way to collect data on each female is with a few people (2 or 3 people) and at more than 15 m from the tide line. Also, has been observed that nesting failure and biggest turtles present higher corticosterone levels .

THE CURRENT SITUATION OF INORGANIC ELEMENTS IN MARINE TURTLES: A GENERAL REVIEW AND META-ANALYSIS

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Inorganic elements (Pb, Cd, Hg, Al, As, Cr, Cu, Fe, Mn, Ni, Se and Zn) are present globally in aquatic systems and their potential transfer to marine turtles can be a serious threat to their health status. The environmental fate of these contaminants may be traced by the analysis of turtle tissues. Loggerhead turtles (*Caretta caretta*) are the most frequently investigated of all the sea turtle species with regards to inorganic elements, followed by Green turtles (*Chelonia mydas*); all the other species have considerably fewer studies. Literature shows that blood, liver, kidney and muscle are the tissues most frequently used for the quantification of inorganic elements, with Pb, Cd, Cu and Zn being the most studied elements. *Chelonia mydas* showed the highest concentrations of Cr in muscle (4.8±0.12), Cu in liver (37±7) and Mg in kidney (17 μg g^{-1} ww), Cr and Cu from the Gulf of Mexico and Mg from Japanese coasts; *Lepidochelys olivacea* presented the highest concentrations of Pb in blood (4.46 5) and Cd in kidney (150±110 μg g^{-1} ww), both from the Mexican Pacific; *Caretta caretta* from the Mediterranean Egyptian coast had the highest report of Hg in blood (0.66±0.13 μg g^{-1} ww); and *Eretmochelys imbricata* from Japan had the highest concentration of As in muscle (30±13 13 μg g^{-1} ww). The meta-analysis allows us to examine some features that were not visible when data was analyzed alone. For instance, Leatherbacks show a unique pattern of concentration compared to other species. Additionally, contamination of different tissues shows some tendencies independent of the species with liver and kidney on one side and bone on the other being different from other tissues. This review provides a general perspective on the accumulation and distribution of these inorganic elements alongside existing information for the 7 sea turtle species

DETECTION OF HERPESVIRUS IN TWO SPECIES OF SEA TURTLE (*CHELONIA MYDAS AGASSIZII* AND *LEPIDOCHELYS OLIVACEA*) IN NORTHERN SINALOA

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IPN-CIIDIR SINALOA ; GRUPO TORTUGUERO A.C ; ICSAS A.C. | IPN-CIIDIR SINALOA | IPN-CIIDIR SINALOA | IPN-CIIDIR SINALOA ; GRUPO TORTUGUERO A.C ; ICSAS A.C. | RED TORTUGUERA; GRUPO TORTUGUERO A.C ; ICSAS A.C. | Universidad de Occidente | Department of Environmental Science and Policy George Mason University | Laboratorio de Genética de la Conservación, Universidad de Costa Rica

Northern Sinaloa is recognized as an important foraging zone for sea turtles. Here, the most abundant species are the olive ridley turtle (*Lepidochelys olivacea*) and the black turtle (*Chelonia mydas agassizii*), both endangered species. In this area, there is a lack of information on the health status of turtle populations and the presence of fibropapillomatosis (FP). We capture 82 sea turtles (58 olive ridley and 24 black) to determine their apparent health status and to evaluate the presence of the FP-associated herpesvirus. Biometric data were collected to characterize the populations. To determine the apparent health status the following parameters were obtained: body condition index (BCI), based on the straight carapace length (SCL) and weight (SCL-body mass). Blood samples were taken to determine hematological parameters such as hematocrit (MH) and total protein (TP). For the diagnosis of herpesvirus, a skin biopsy was taken from each turtle. Total DNA was extracted to determine the presence of the virus by PCR. Prior to virus diagnosis, the amount and quality of DNA was evaluated by amplifying a fragment of turtle mitochondrial DNA using species-specific primers in PCR assays. The resulting PCR products were visualized in 1% agarose gels using a photodocumenter. In Black turtle, the SCL interval was 45 to 74.5 cm (64.2 ± 8.0 cm) and the weight interval was 11 to 49 kg (34.4 ± 11.4 kg). All the collected individuals were immature and for the same reason the sex could not be determined, with exception of one individual which was defined as male by sexual dimorphism. Mean ICC was 1.22 + 0.20. The MH interval varied from 17 to 43 % (29.33 ± 7.42 %) and TP varied from 2.8 to 6.8 g/100 ml (4.7± 0.9 g/100 ml). The mean ICC value was categorized as "Very Good". In olive ridley, LRC varied between 53 and 68.8 cm (60.4 ± 3.3 cm) and weight between 17 to 44 kg (31.7 ± 4.7 kg). By sexual dimorphism, 56 adults (26 male and 30 female) and two subadults were determined undefined. Mean ICC was 1.36 + 0.33. The MH interval varied from 13 to 42 % (28.47 ± 6.3 %), and the PT varied from 2.5 to 6.4 g/100 ml (3.73 ± 0.76 g/100 ml). The mean ICC value was considered as "Very Good". PCR analyses showed that three animals with abnormal protuberances were positive to herpesvirus, all from the olive ridley turtle, whereas all biopsies from normal tissues were negative. These results constitute the first record of FP in olive ridley turtle and the first diagnosis of herpesvirus associated to FP in northern Sinaloa.

EMBRYONIC STAGES CLASSIFICATION AND MALFORMATIONS IN BAJA CALIFORNIA SUR SEA TURTLES.

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In reptiles, order testudines and suborder Cryptodira, we can find terrestrial and marine species, a total of 75 genders and more than 220 species. Among all of them, only 6 genders and 7 species are marine. Sea turtles have a worldwide distribution, and belong to Cheloniidae and Dermochelydae families; Loggerhead turtle (*Caretta caretta*), Hawksbill turtle (*Eretmochelys imbricata*), Kemp's Ridley turtle (*Lepidochelys kempii*), Olive Ridley turtle (*Lepidochelys olivacea*), Eastern pacific green turtle (*Chelonia mydas*), and Leatherback turtle (*Dermochelyis coriacea*). To understand the ontogenic development of each species, it is necessary an embryological study, including the set of changes that the new organism undergoes from zygote to a newborn when it emerge. Analyzing , comparing and checking the embryonic stages of sea turtles, they were classified in different stages of development. A total of 56 samples fron not hatching eggs in nests that were in the corral were collected in 2015 and 2016 at the Turtle Camp ASUPMATOMA and Las Pacas fishing camp. Embryo samples were measured with a vernier and characteristics such as the development of the fins, shell and plastron, embryo shape, presence of vitelum and other distinctive development characters were recorded. The samples were classified according to their morphometry and structures development. Each stage was analyzed, described and photographed. The highest percentage of organisms was found in stage III, and only four organisms were represented in states I, II and IV. It was determined that the most important embryonic growth was in stage III, where sex determination and malformations develop. Moreover, is in this stage when external factors can help or disadvantage the embryo development. The embryonic study is a basic support for the sea turtles management and conservation, a highly threatened group, some of them classified as endangered according to IUCN

HEAVY METAL DETERMINATION IN BLOOD AND CARAPACE TISSUES OF GREEN TURTLES (*CHELONIA MYDAS*) IN PARACAS BAY, ICA – PERU (PRELIMINARY STUDY)

Carlos Calagua Yon | Gianmarco Rojas Moreno | Jose Luis Mena
World Wildlife Fund Inc | Universidad Científica del Sur | World Wildlife Fund Inc

Peruvian waters are highly biodiverse regions that are important foraging areas for juvenile and adult marine turtles. Five of the seven species in the world inhabit these waters, including the green (*Chelonia mydas*), leatherback (*Dermochelys coriaea*), loggerhead (*Caretta caretta*), hawskbill (*Eretmochelys imbricata*), and olive ridley (*Lepidochelys olivacea*) marine turtles. Despite the area's sea life abundance, the illegal hunt, bycatch, trade, retention, and consumption of marine turtle products are practiced in certain areas of the Peruvian coast. The city of Pisco is the center for these illegal activities, where turtle meat is consumed as an exotic dish and blood and oil are used according to popular belief as an alternative medicine for joint pain as well as respiratory and cardiovascular illnesses.

Studies around the world demonstrate that heavy metals can be traced in the blood and tissues of marine turtles, especially in loggerheads. This study will focus on the green turtle, one of the most consumed species in Peru that also has high bycatch rates. Our goal is to identify heavy metals present in blood and muscular tissues, which are most widely consumed in this region. Due to the negative effects that heavy metals have on public health, it is vital that this study takes place to argue against the popular belief that marine turtle products contain medicinal properties. Furthermore, we also aim to reduce the retention of these species when bycatch occurs.

Blood and carapace samples will be collected from adult green turtles during December of 2017 at the Paracas Bay. Samples will be processed at the Department of Physical Sciences of the Earth and the Environment of the University of Siena and the results obtained. The ultimate goal is to expand this investigation to other coastal areas of Peru where marine turtles continue to be harvested illegally for consumption.

REHABILITATION OF TWO SEA TURTLES, RESCUED AND RELEASED IN SAGAMI BAY, JAPAN

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Enoshima Aquarium | Enoshima Aquarium | Enoshima Aquarium | Enoshima Aquarium | Enoshima Aquarium

Shin-Enoshima Aquarium rescued one green turtle in 2016 and one loggerhead turtle in 2017 at Chigasaki city in Kanagawa. Here, we report details of the successful recovery and release of the turtles.

The juvenile green turtle was rescued at the Chigasaki port on the November 26, 2016. The turtle was measured for carapace length, weighed and bled. Since the turtle was debilitated and did not eat, it was taken to the aquarium and retained in the indoor tank filled with 26°C water. The turtle was given algae and white leg shrimps (heads removed), and was injected with antibiotics and fluid into the subcutis every 1 to 2 days, three times in total. On the 7th day, the turtle started feeding, gaining weight, and swimming actively. When this turtle was rescued, straight carapace length (SCL), straight carapace width (SCW) and weight were 423.0 mm, 362.0 mm and 10.35 kg, respectively. The turtle recovered well, and on the 305th day, SCL, SCW, and weight were 452.6 mm, 374.2 mm, and 12.20 kg respectively.
The juvenile loggerhead turtle was found stranded at the Chigasaki beach on the July 25, 2017. As this turtle was emaciated, covered with barnacles and debilitated, it was taken to the indoor tank which was continuously supplied with 26.4°C sea water. After the turtle was measured for the carapace length, weighed and bled, antibiotics and fluid were injected into the sucutis and an X-ray photography was taken. In addition, we removed the barnacles attached by the nose of the turtle because they may have been interfering with the turtle’s respiration. On the second day since the rescue, the turtle was given krill which were sprinkled with lactoferrin and nutritional supplements including calcium and vitamins. For the following days, the turtle was fed 3 times a day with krill, manila clam, silver-stripe round herring, and shelled shrimp. At the time of the rescue, the turtle had a barnacle attached on the right eye. We removed the barnacle but a white spot remained on the eye. Initially, we suspected poor eyesight or blindness of the turtle because it did not respond to an object placed by the right eye. However, its eyesight recovered as the white spot faded, and the turtle started swimming actively. Originally, SCL, SCW and body mass of this turtle were 145.9 mm, 134.2 mm and 0.55 kg, respectively. After 57 days of recovery, these parameters increased to 181.0 mm, 160.8 mm and 1.18 kg, respectively.
Since the turtles appeared to have recovered, they were tagged with plastic flipper tags and PIT tags and released at approximately 8 km off the Enoshima Island on the September 22, 2017.

BLOOD BIOCHEMICAL CHANGES IN CAPTIVE SEA TURTLES

Madoka Kitajima | Manami Sano | Toru Tokura | Fumio Terasawa | Chika Nishitani
Enoshima Aquarium | Enoshima Aquarium | Enoshima Aquarium | Enoshima Aquarium | Enoshima Aquarium

Hematological analysis of sea turtle was conducted to understand the health condition of captive individuals at Enoshima Aquarium. Blood was drawn at the interval of once a month, starting from March 2015. Samples were obtained from two male and one female loggerhead turtle, one male and female green turtle, and one female hawksbill turtle. Another female loggerhead turtle was added to the sampling group from June, 2015. 8 mL of blood was drawn from the cervical blood vessel using a syringe (needle; 18G×70R.B GA, NIPRO Corp., syringe; SS-10SZ, TERUMO Corp.) and stored at 4° C until analysis. Auto-analyzer (JCA-BM8030, JEOL Corp.) was used for detection of biochemical component. Concentrations of 16 components (TP, LDH, CPK, γ-GTP, ALP, BUN, Cre, Na, K, Cl, Ca, Mg, IP, Fe, T-CHO, TG) were measured. Sea turtles were fed three times a week, and health condition and behavior were observed. Follicular dynamics of female sea turtles were evaluated using an ultrasound system (Micro Maxx, SonoSite, Inc.), with abdominal scans conducted from the base of rear flipper towards the abdomen.

Values of Ca and TG increased in females with ovarian follicular growth, and changed in accordance with the maturation of follicle as confirmed through ultrasound monitoring. Values of γ-GTP rose from summer to autumn in one female loggerhead sea turtle. Mean values of LDH ALP, BUN, Mg, and Fe varied among the individuals. Cl and Na remained within the range of 91–122 mmol/L and 133–156 mmol/L, respectively. Compared to other analyzed components, the variations in Cl and Na values were low. Hawksbill sea turtle stopped eating for over one week and this behavior was observed for five times during the research. No relationship was observed between the fasting period and change in biochemical values.

The results from this research demonstrated that biochemical composition change in accordance with maturation of follicles in female sea turtles but seasonal variations and changes related to health condition were not observed. Reports on hematological data and its relationship with health condition of sea turtles are scarce. Ambiguity in the standard values prevents the health assessment based on blood biochemical composition. We plan to accumulate additional data in the future to understand the relationship between hematological parameters and health condition in sea turtles.. We also intend to partner with other institutions conducting similar research and contribute the results toward sea turtle health management and biological research.

RESCUE AND REHABILITATION OF A STRANDED ADULT OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) AT THE ANGLESEY SEA ZOO, THIS BEING THE FIRST EVER INSTANCE OF THE SPECIES BEING RECORDED IN GREAT BRITAIN AND IRELAND.

Frankie Hobro
Anglesey Sea Zoo and Marine Resource Centre

In November 2016 an adult female Olive Ridley sea turtle (*Lepidochelys olivacea*) was found stranded in critical condition on the shore of the Menai Strait on the island of Anglesey in North Wales, in the United Kingdom, just 300m from the gates of a local aquarium and visitor attraction, the Anglesey Sea Zoo. The local sea temperature in the Irish Sea at that time was just 8^{o}C.
Olive Ridley turtles are native to the tropical waters of the Pacific and Indian Oceans as well as the South Atlantic, and are classified as Vulnerable on the IUCN Red List. Detailed records from the British Isles and Republic of Ireland 'TURTLE' database which began in 1748 confirm that this is the first instance of the species being found anywhere in Great Britain and Ireland, the nearest breeding populations of the species being in the Southern Atlantic in French Guyana and Gabon over 7000 km away.
This presentation will document the initial critical care and the recovery of the turtle, nicknamed "Menai"; the techniques implemented in her recuperation and the lessons learned, giving a detailed account of the underlying health issues which were apparent when she was stranded and their means of diagnosis including blood samples, X-rays and a CT scan, and her ongoing treatment and recovery during the 8 months that she was in the care of the Anglesey Sea Zoo. We will discuss the logistical aspects of her care and temporary housing within an entirely native cold water aquarium and how these were overcome, and the temporary CITES permit which was granted for her recovery period, which enabled education, outreach and turtle conservation awareness raising to a large number of people during her temporary residence here.
The presentation will cover the results of genetic sampling and how we have now started to piece together the puzzle of her long and apparently traumatic journey north through the Atlantic Ocean from her breeding grounds before finally washing ashore in the Irish Sea and the theories behind this; then her continuing improvement and progress in captivity, and the collaboration between different organisations and experts in planning her future of further rehabilitation for eventual release back into the wild.
Finally, we will discuss her transportation for ongoing pre-release rehabilitation to a turtle rescue centre in Gran Canaria in June 2017, her current ongoing care there under the supervision of Veterinarian Pascual Calabuig at the Centro de Recuperation de Fauna Silvestre de Tafira, and the plans for her future release back into the wild.

FAST ACQUISITION OF A POLYSACCHARIDE FERMENTING GUT MICROBIOME BY JUVENILE GREEN TURTLES *CHELONIA MYDAS* AFTER SETTLEMENT IN COASTAL HABITATS

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Background
Tetrapods do not express hydrolases for cellulose and hemicellulose assimilation and, hence, the independent acquisition of herbivory required the establishment of new endosymbiotic relationships between tetrapods and microbes. Green turtles (*Chelonia mydas*) are one of the three groups of marine tetrapods with an herbivorous diet acquired after several years consuming pelagic animals. We characterized the microbiota present in the feces and rectum of 24 young wild and captive green turtle from Brazil, ranging in curved carapace length from 31.1 to 64.7 cm, to test the hypotheses that (1) the ontogenetic dietary shift after settlement is followed by a gradual change in the composition and diversity of the gut microbiome, and (2) that the consumption of omnivorous diets modifies the gut microbiota.

Results
A genomic library of 2,187,066 valid eubacterial 16S rRNA reads was obtained and these sequences were grouped into 6,321 different OTUs (at 97% sequence homology cutoff). The results indicated that most of the juvenile green turtles (less than 45 cm of curved carapace length) exhibited a fecal microbiota co-dominated by representative of the phyla *Bacteroidetes* and *Firmicutes* and high levels of *Clostridiaceae*, *Prophyromonas*, *Ruminococaceae* and *Lachnospiraceae* within the latter phylum. Furthermore, this was the only microbiota profile found in wild green turtles >45 cm CCL and in most of the captive green turtles of any size feeding on a macroalgae/fish mixed diet.

Conclusions
These results suggest a fast acquisition of a polysaccharide fermenting gut microbiota by juvenile green turtles after settlement into coastal habitats and no major changes take place as they grow.

PHOTO-ID PROVIDES NEW INSIGHTS INTO BARNACLE LONGEVITY, GROWTH RATES, AND DIRECTIONAL TRANSLOCATION ON SEA TURTLES

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The epibiotic barnacle Chelonibia testudinaria is found associating with a wide diversity of marine animals, including sea turtles. Individual turtles vary in their barnacle loads, possibly as a function of cleaning frequency or immune status (i.e. health) of the host. High barnacle loads may negatively influence hydrodynamics for turtles; yet, despite their ecological importance, knowledge concerning the biology and life-history of these hitchhiking commensals remains limited. We have begun to fill this knowledge gap through a long-term photo-identification project for loggerhead sea turtles, *Caretta caretta*, around Zakynthos Island in Greece. The turtles here include breeding males and females as well as adult and juvenile year-round residents. Inspection of repeat photographs of the same turtle over timeframes ranging from months to years has yielded new insights for C. testudinaria on its longevity, growth rate, and directional translocation on the host.

From a database of over 500 turtles, we selected the records of eight individuals for use in this study. These individuals were chosen because we had repeat photographs from each in which barnacles were clearly visible. After inspecting these photographs it was clear that it is possible to monitor individual barnacles over time. Indeed, we were confident that the barnacles observed in the same location on the same turtle were the same individuals over time (rather than being replaced by another individual after falling off/being removed), because: (1) the position and orientation were similar and (2) the increment in growth fitted the observed barnacle. Barnacles around Zakynthos require at least a month to grow 3-4 cm in shell length, making it highly unlikely that barnacles of a similar size found at the same location on the same turtle are due to replacement and growth of a new individual.

Repeat observations of three turtles within the same year, showed that the barnacles could remained attached to the host turtle for at least five months (max. consecutive observation period within the same year). Furthermore, across different years, we documented the same barnacle individuals on uniquely identified turtles over periods of up to four years (n = 2 barnacles on 1 turtle), with 15 lasting more than 1 years on five other individuals. Our data are the first to show that individual barnacles may live this long on sea turtles. We estimated a relative mean growth rate of 2 shell lengths/2 weeks, i.e., barnacles doubled their shell length every two weeks (n = 8 barnacles on 1 turtle). Interestingly, we were also able to confirm the results of Moriarty et al. (Marine Turtle Newsletter 119, 2008) who documented that attached C. testudinaria are able to translocate on their hosts (three juvenile green turtles) up to 1.4 mm per day . Similarly, we observed barnacles positioned on the head and carapace move a distance of up to 4 times their shell length within 14 days (n = 9 barnacles on 4 loggerhead sea turtles).

The first author is grateful to the ISTS for providing a travel grant.

ONTOGENY OF ENERGETICS AND SWIMMING PERFORMANCE IN GREEN SEA TURTLE (*CHELONIA MYDAS*) HATCHLINGS

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Sea turtle hatchlings undergo intense levels of predation during dispersal from their nesting beach. These predations levels decrease in intensity as the hatchlings enter pelagic waters and utilise currents to disperse further away from land. As such, hatchlings exhibit high levels of swimming activity during the first 24 hours post-emergence in order to minimise the time spent in predator-dense neritic zones. Modern techniques of measuring swimming performance have involved using transducers to measure the amount of force produced by hatchlings as they swim. These studies have shown that swimming force production and oxygen consumption decrease drastically and then stabilise within the first 24 hours of hatchlings entering the water. Yet, little is known about how hatchling swimming behaviours and energetics change as they enter pelagic waters after the initial 24 hours of dispersal.

Therefore, this study measured swimming behaviour and metabolic rates in green sea turtle (*Chelonia mydas*) hatchlings across 24 weeks in order to measure the change in these traits. We collected eggs from Heron Island, Australia and incubated them at Monash University, Melbourne. Hatchling resting and active metabolic rates were measured at hatching, 4 weeks, 12 weeks and 24 weeks of age. We also measured swimming performance by recording the amount of force that hatchlings produced as they swam. Data analysis is underway at the time of writing but this data will provide further insight into how hatchling behaviours and physiology change post-dispersal. It will also provide an insight into how these traits potentially impact hatchling survival and population dynamics.

DISPERSAL PATTERNS OF LOGGERHEAD SEA TURTLE POST-HATCHLINGS IN THE MEDITERRANEAN BASIN

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Despite that loggerhead sea turtle stocks are well studied in many aspects, ther is little information about dispersal of post-hatchlings. Several nests of this species have been recorded in the Mediterranean Spanish coast, out of its usual nesting range, providing an opportunity to assess this issue. Our aim is to describe, for the first time in the Mediterranean Sea, the dispersal movements of these post-hatchlings.

We satellite tracked 17 headstarted post-hatchlings (aged 9-24 months, size range (SCL): 13.6-29.1 cm) from three clutches laid during 2015-2017. Post-hatchlings were satellite monitered from 23 up to 123 days. We fit a hierachical correlated random walk switching model (hDCRWS) to obtained tracking data. Sea surface temperature and ocean current data were extracted from AVISO+. We obtained the combined maps of the dispersal routes and the environmental data.

Our results show the dispersal movements of loggerhead sea turtle post-hatchlings regarding ocean currents and sea surface temperature. Post-hatchlings in western Mediterranean could travel large and highly variable routes and could exhibit alternative behaviours (mostly resident or mostly migratory). These behaviours seem to be constrained by ocean currents, as the Algerian current and the turbulent current system present in the western Mediterranean, but also by the sea surface temperature, especially during the coldest months of monitoring (December and January). Our results may contribute to the head-starting management, especially regarding the place and season of post-hatchling release in the western Mediterranean.

TRAVELLERS OF THE SOUTH PACIFIC – ORIGIN OF GREEN SEA TURTLES IN FIJIAN FORAGING GROUNDS

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Fiji, an archipelago of over 300 islands and more than 500 islets in the central south Pacific, has extensive seagrass meadows hosting large foraging aggregations of green turtles despite the consistently low and diminishing level of green turtle nesting activity in recorded in Fiji in recent decades. As a result, the large number of green turtles legally harvested until 1996, and afterwards harvested illegally or officially authorized by permit are assumed to be from rookeries of other countries. Satellite telemetry and mark-recapture of nesting females have revealed links between central south Pacific rookeries and seagrass foraging meadows in Fiji, but the origin of juveniles and the contribution of each regional rookery to Fijian foraging aggregations was unknown. By using mixed-stocked analysis, we characterized the stock composition of the groups of juvenile green turtles tagged and sampled at two key Fijian foraging grounds in 2015-2016. The majority (mean= 70.6%; CI=9.7 – 89.1%) were estimated to be from American Samoa, and secondly from New Caledonia (mean=15.2%; CI=7.2-27.2%) and French Polynesia (mean= 7.7%; CI=7.3-25.3%). Assessing the importance of Fiji for the conservation of green turtle populations in the central South Pacific by identifying the genetic origin (mtDNA) and quantifying the contribution of different nesting populations to feeding aggregations in Fiji is particularly urgent as the current Sea Turtles Moratorium (no harvest) ends in 2018 and, if protection will no longer be granted, turtles in Fiji waters will be legally harvestable again.

SUMMERY OF THE SATELLITE TAGGING AND DEVICE PERFORMANCE REVIEW

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Marinelife Alliance | Marinelife Alliance

Marinelife Alliance conducting sea turtle monitoring and conservation in Bangladesh with government partnership. In water monitoring and migration study is underway and we so far attached 24 satellite tags on Olive ridley and Green turtle. we used brand SPOT5-293A and SPLASH10-309A, Platform Terminal Transmitter (PTT), from Wildlife Computer. The attachment glue was Sika Anchorfix-3, Anchorfix-2 and lastly we used Powers Fasteners PUREPRO 150 (585ml), Germany. The first tag has been attached with epoxy glue Sika Anchorfix-3.on March 29, 2010, the 2nd one on February 22, 2013 Sika Anchorfix-2, since Sika -3 was not available in nearest Bangladesh countries. Finding alternate of Sika -3 finally ended up with PowerPro-150 of Power Fasteners(Germany, 453 ml.). Sika Anchorfix-3 and the PowerPro-150 was good enough for gradual application and easy to shape the attachment. Comparatively the Sika Anchorfix-2 was not suitable and become hardened as soon as come out of the cylinder. The applied glue temperature has been monitored throughout the curing period very frequently with Craftsman Mini Infrared Thermometer. Curing temperature ranged from 35-72 ^{o}C.
All tags have been attached on 2nd -3rd vertebral scutes of Olive Ridley. The longest tracking turtle signal spanned for 357 days and traveled more than 12000 kms in the Bay of Bengal. The longest geographical length traveled by one turtle that went to Laksha Dweep of Indian west coast. Other turtle traveled and forage at the south of Sri Lanka. No turtle ever recorded to revisit the tagging spot or location close to nesting beach. Most of the tracking turtle migrated through the east coast of India, forage along the coastline, along the mangrove Sundarban, coast of Indian Orissa, Chennai, and most of them spent within the Bay of Bengal during their non nesting period. Stilt ere was no traveller found towards the Myanmar or southeast coast and marine territory. Although the tracking program needs more data we have so far explored some of the locations of probable foraging habitat and migrations routes. The details article is depicting the tracks of individual turtles and areas of interest predicting future MPA formation possibilities and recognizing areas of in water conservation measures to be taken by regional maritime and fisheries authorities.
Out of twelve olive ridley and two green turtle the longest transmission found from the first tracking turtle(Tag ID: 98209, Urmee), was an olive ridley lasted around one year, 359 days (Figure-2 & Table-1) transmitted during 29 March 2010 to 23 March 2011. Second longest was tag ID-133466, lasted for 245 days during 21 March 2014 to 21 November 2014 (Fig.7,). Other five turtles, Tag Id, 133463, 133465 (Paula), 133467a, 133468 and 75375 (Sagor Konna), transmitted for 4-6 months, spent respectively 175, 123, 137, 147, 180 days (Figure: 4, 6, 8, 9 and 14). Other 5 olive ridley transmission lasts for only for 15, 35, 44, 72, 81 days. The adult green turtle signal lasts for 81 days (Tag: 133477) and another juvenile ended at nearshore areas of south central area within 23 days(Tag:133476).
Although the tracking duration not solely depend on the TAG performance and attaching glues since there are lot of issues at offshore locations that harm sea turtle and we can get no tracking signal, but the attachment glue and technique is one of major issues for consideration in a successful satellite tracing program. More over the storage, of the device, time duration before deployment is also very important and take into account.

IS THERE AN ALTERNATIVE CHEAPER SYSTEM TO ARGOS FOR SEA TURTLE TRACKING? A CASE STUDY WITH GPS-GSM TAGS

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Despite technological advances in telemetry methods, Argos remains the most reliable system to track sea turtles, even with its many drawbacks (e.g. low temporal and spatial definition of localizations, significant costs). A possible alternative to Argos is to obtain GPS locations and relay them through the GSM international mobile phone networks: in this way frequent and highly precise localizations could be transmitted at very limited costs. Such a system, commonly used to track terrestrial animals, has never been systematically investigated in turtles.

The aim of this project was to test the feasibility of such a system to track sea turtles, by modifying existing GPS-GSM loggers commonly used in terrestrial animals, to make them suitable for deployments in the marine environment. Six GPS-GSM loggers have been deployed in 2016 and 2017 on rehabilitated and free-living adult loggerhead turtles (CCL >70 cm) in the Mediterranean Sea.

In 2016, two loggers were deployed along with an Argos PTT on rehabilitated turtles. The first logger sent 11 text messages to GSM in 75 days (total duration of Argos tracking), providing a total of 45 GPS localizations. In five occasions, GSM transmission occurred when the turtle was far from the coast (>55 km), but on the whole the logger's performances cannot be considered satisfactory if compared to the Argos system (nr. of locations: 45 vs. 105). The second logger did not send any message at all, probably because the turtle spent more than 90% of its time underwater, as recorded by the PTT's sensors. In 2017 we deployed four more loggers, but in these cases we could not equip the turtles also with PTTs. Three loggers were attached to two free-living turtles frequenting the Argostoli harbour and on a nesting female in Kefalonia (Greece) - but in all cases not a single message was received from any logger. From direct observations of the turtles frequenting the harbour waters, it was assessed that both individuals stayed virtually all the time submerged, surfacing for short time just with their heads to breathe, which prevented the logger to surface and get connected with GPS satellites and GSM networks. After a few days of deployment we could retrieve the instruments from these turtles: when out of the water both of them correctly transmitted text messages, showing they were still functioning. In one logger the GPS receiver made several attempts during the first day of deployment but failed in collecting any location, while the second did not work during the whole deployment period. The last logger was deployed on a rehabilitated turtle released in the Gulf of Naples (Italy). During a 3 weeks period the logger has been able to send only 4 messages, for a total of 9 GPS locations collected.

From these outcomes, we conclude that these tags, at least as are now configured, cannot work on sea turtles and that, in the few cases the GPS locations were received, the logger failed to meet our expectations. The main flaw detected is the GPS system used, mostly unable to properly collect locations, indicating that the standard GPS system, currently used to track terrestrial animals, does not have the same performances in sea turtles. On the other hand, these results also showed how GSM transmissions to the mobile phone networks may work just fine as an information channel, also when turtles are far from the coast, which could then be used to obtain non-positional information from the animal, like accelerometer data, or from the surrounding environment, such as sea temperatures.

The project was founded by the Save Our Seas Foundation (Small Grant nr. 354)

TEMPORAL SITE FIDELITY OF RESIDENT MARINE TURTLES IN MABUL ISLAND, SABAH, MALAYSIA

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Universiti Malaysia Sabah | Universiti Malaysia Sabah

Located within the Coral Triangle, Mabul Island, Malaysia is surrounded by coral reefs and seagrass beds. Mabul Island houses two species of marine turtles - Green turtle (*Chelonia mydas*) and Hawksbill turtle (*Eretmochelys imbricata*). This study focused on the temporal site fidelity of the population of foraging turtles at this island. A mark-recapture method was conducted at seven established dive sites around Mabul from August 2010 until May 2016 and there were 116 turtles (Green turtles = 97 and Hawksbills = 19) that we recaptured ranging from once to six times (Mean 1.5 years, range 0.12-4.6 years, s.d. 1.12). Most of the recaptured turtles were categorized as juveniles with 85.5% (p<0.001) indicating healthy recruitment into this population. The results show that the turtles significantly (p<0.05) favored Mabul as their home due to the dive sites with ample food and shelter. This study is vital to understand the temporal site fidelity of the resident turtles in Mabul Island.

Presenting author is a postgraduate student (MSc) of Universiti Malaysia Sabah and would like to be considered for the Archie Carr Student Awards.

Presenting author is also a recipient of International Sea Turtle Symposium Travel Grants thus would like to humbly acknowledge the sponsors and the ISTS committees for the travel grants.

LINKING GREEN TURTLE HABITATS IN THE ARABIAN REGION: MIGRATORY TRAJECTORIES AND CRITICAL HABITATS FOR LARGE-SCALE CONSERVATION MANAGEMENT

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Emirates Wildlife Society–World Wildlife Fund for Nature | Marine Research Foundation | Emirates Wildlife Society–World Wildlife Fund for Nature | Environment Protection and Development Authority Ras Al Khaimah | Five Oceans Consultancy | Environment Agency Abu-Dhabi | Environment Society of Oman | Ministry of Environment and Climate Affairs OMAN | Ministry of Climate Change and Environment UAE | Environment and Protected Areas Authority Sharjah

Green turtles are the most abundant turtle species in the Arabian Gulf region and the second most abundant in Oman. Main nesting sites are known to occur in Saudi Arabia, Oman and Yemen, and smaller sites occur in Iran. However, despite our understanding of nesting populations in the region, there remains a considerable information gap on foraging behavior, dispersal patterns and distribution of green turtle populations when they are at sea. Without a comprehensive understanding of the linkages between nesting and known foraging populations (e.g. in Abu Dhabi waters in the UAE), protection of only few sites might result in fragmented conservation. In 2016 EWS-WWF in partnership with MRF started the Gulf Green Turtle Conservation Project, in collaboration with numerous regional partners, aiming to identify areas of importance for green turtles in the region. To date, the project has remotely monitored 35 green turtles at foraging and nesting sites, with results indicating that (1) the vast majority of movements are in nearshore waters, with the turtles remaining in shallow coastal habitats; (2) turtles tagged at feeding grounds within the Arabian Gulf have not headed to Saudi Arabia or Iran, as seemed expedient, but two of them clearly migrated out of the Gulf towards Oman; and (3) turtles from Oman migrate into the Arabian Gulf, but also migrate eastwards towards India, and southwestwards into the Red Sea, with one inhabiting feeding grounds in Eritrea. These findings point to the regional significance of the Ras Al Hadd/Ras Al Jinz rookery in Oman and its importance to areas distant from the Arabian Gulf region. Results also confirm potential critical habitats located in the waters off Abu Dhabi and Ras Al Khaimah in the UAE as well as the Gulf of Kutch shared by Pakistan and India. The project will tag 20 more turtles by 2018, providing the first datasets on green turtle in-water habitat use in the Arabian region and the output of this research will provide critical information for policy making and spatial planning, that in turn will support action to reduce pressures to sea turtles at sea. In addition, habitat use information will help to assess the suitability of existent Marine Protected Areas (MPAs) with regards to protection of sea turtles and their habitats in the region.

THE CURIOUS CASE OF GREEN TURTLES AND SEAGRASS MEADOWS IN THE LAKSHADWEEP ISLANDS, INDIA

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Dakshin Foundation | Erasmus Mundus Masters Course in Tropical Biodiversity and Ecosystems | Indian Institute of Sciences

The green sea turtle is a well-known ecosystem modifier and known indirect effects on species assemblages, canopy structure and the detritus cycle of seagrass communities. The Lakshadweep Islands on the west coast of India are a well-known nesting and foraging ground for green turtles. There is also documented conflict between green turtles and fishers due to the perceived effect of turtles on baitfish and locally consumed seagrass-dwelling fish species through their impacts on seagrass meadows. Seagrass and green turtle densities in the Lakshadweep islands have been quantified by multiple agencies using standard sampling techniques and surveys. Green turtle numbers were found to be higher in lagoons with high seagrass abundance, and within lagoons, turtle spatial presence was found to overlap with areas of high seagrass density. Green turtles were also observed to impact seagrass shoot density, canopy height and species assemblages. These changes were perceived to have a cascading effect on several juvenile and adult seagrass- and lagoon-dwelling fishes, especially herbivorous species, leading to a conflict with artisanal fishing communities of the Lakshadweep islands. Over time, green turtle abundance was observed to fluctuate between islands; while there is no direct evidence, there is speculation that the turtles move from one island (patch) to another once the seagrass quality and quantity decline. These interactions pose complex challenges in the management of a charismatic and protected species of sea turtle, which has implications for the long-term health of the seagrass meadows of the Lakshadweep islands.

INTER-NESTING MOVEMENTS AND MIGRATORY PATHWAYS TO FORAGING AREAS BY SATELLITE TAGGED GREEN SEA TURTLES (*CHELONIA MYDAS*) IN SOUTHWEST FLORIDA

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Green sea turtle nesting in southwest Florida has increased markedly on both Keewaydin and Sanibel Islands in recent years. We suspect that this upturn in nesting is due at least in part to an outward radiation from the increasing number of green turtles that have been nesting on Florida's east coast.

There is a paucity of information available on the inter-nesting and post-nesting migratory patterns of the green turtles that nest in this region. This study delineates, for the first time, the migratory pathways and foraging grounds of seven satellite tagged green turtles from the lower west coast of Florida. Such information should be of considerable value to resource managers in this region and would be useful in the overall recovery effort for this species.

Of the satellite tagged green turtles, five were tagged on Sanibel Is. Four of these turtles were re-sighted during subsequent nesting or non-nesting emergences. The mean inter-nesting interval for the individuals seen during consecutive nesting events was 10.8 days (range 10-13 days). The other two were tagged on Keewaydin Is. One of these individuals was first seen during a non-nesting emergence but was later observed nesting on two occasions. The inter-nesting interval between those nesting events was 10 days.

Although there was substantial variation in the inter-nesting behavior among these turtles, all remained in shallow, nearshore waters during the nesting season. Preliminary Optimized Hot Spot Analysis using the Getis-Ord Gi* statistic identified statistically significant spatial clusters of high values in two discrete locations. Inter-seasonal/foraging habitat will be more clearly characterized in coming the months, but the current data suggest that three have taken up residence in the vicinity of the Marquesas, and three are in Florida Bay. To date, one individual has remained in the waters near Sanibel Is.

EVIDENCE FOR SIZE CLASS PARTITIONING ACROSS MULTIPLE SPECIES OF SEA TURTLES IN FLORIDA DEVELOPMENTAL HABITATS

Cody R Mott | Jonathan C Gorham | Jeffrey C Guertin | Ryan C Welsh | Ryan M Chabot | Michael J Bresette

Inwater Research Group | Inwater Research Group | Inwater Research Group | Inwater Research Group | Inwater Research Group | Inwater Research Group

The nearshore waters of Florida’s Big Bend region were identified as gaps in the understanding of the state’s sea turtles. Inwater Research Group has been conducting an in-water study of marine turtles in the Big Bend region for the past 5 years to fill in this knowledge gap. The initial goal of the project was to asses basic demographic characteristics (species, size-class, genetic origin, sex ratio, and disease rates) of the aggregation of turtles inhabiting these waters. The high density of turtles and excellent field conditions found at the study site offer an opportunity to expand the project’s goals. One goal is to better understand habitat utilization and partitioning by species and size class.

A previous study the Key West National Wildlife Refuge documented size class partitioning between juvenile and subadult/adult green turtles in adjacent areas. A similar pattern is observed at the Big Bend site. While dense seagrass beds are evenly distributed throughout the study area, turtle density is highly variable. Visual transect observations and target capture data were paired with water depth measurements to analyze habitat use by species [green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and Kemp’s ridley (*Lepidochelys kempii*)] and size class (juvenile, subadult, and adult). Initial results indicate that juvenile greens preferred shallower waters whereas subadults were found in deeper waters. Both juvenile and subadult Kemp’s ridleys tended to be found in shallower waters whereas subadult loggerheads and adult loggerheads were found more frequently in deeper waters.

The results are similar to the Key West National Wildlife Refuge study, with smaller sized turtles utilizing shallower waters compared to larger sized turtles. The trend is maintained across species, supporting the hypothesis that predation rather than food availability may be the most important factor in habitat selection. Moving forward we plan to adjust our study design to increase the robustness of our analysis and quantify predator species, size, and abundance across the entire study site.

NEONATE DISPERSAL OF ATLANTIC LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) FROM A NON-RECOVERING SUBPOPULATION

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The cryptic ‘lost years’ of sea turtles have posed a challenge to conservation efforts due to unknown movements and habitat utilization of young life stages. To prevent extirpation of declining populations and ensure the future of stable populations, modelling efforts of dispersal and habitat use have increased our understanding of population distributions. These models require testing and refinement with the inclusion of behavioural information. This study provides an understanding of survivorship, directionality, and speed of young turtles from a Costa Rican nesting beach and shows the utility of acoustic tracking of hatchling leatherbacks for fine-scale movement data. Leatherback hatchlings were tagged with Vemco V5 miniature acoustic tags and actively tracked for approximately 90 minutes (n = 42). Drifters were deployed throughout the tracking process to obtain data on surface currents. Over-ground and in-water swimming speed and heading of the hatchlings were determined. The mean over-ground distance travelled was 2.17 km (±0.77 km SD) with an over-ground average swim speed of 0.39 m/s (± 0.14 m/s SD). The mean bearing was 108.17° (± 18.95° SD), an approximately eastward dispersal, compared to the 147.16° (± 39.05° SD) and 152.91° (± 16.58° SD) bearings of the nearshore ocean currents during tracking. The mean in-water swimming speed of the hatchlings was 0.48 m/sec (± 0.20 m/s SD). The higher in-water than over-ground speed suggests hatchlings were swimming against the currents although overall their movement was strongly influenced by the current direction. Visual observations suggested headings were generally directly offshore in an eastward direction, with surface current influencing ultimate movement patterns. This information can be assimilated into broader spatial and temporal distribution models to interpret the influence of directional swimming on ecosystem utilization and allow for well-informed management decisions across all life stages of the population.

DISPERSAL AND PREDATION RATE OF TURTLE HATCHLINGS DURING EARLY SWIMMING EFFORT AT CHAGAR HUTANG BAY, PULAU REDANG.

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The greatest rate of mortality in sea turtles is thought to occur in early life phase; beginning from egg incubation, crawling down to the beach and early swimming effort. However, the natural mortality of incubating eggs and hatchlings on the nesting beach does not presumably high enough to explain the observed high fecundity. Therefore, it is crucial to provide empirical data on the survival rate of sea turtle hatchlings upon swimming leaving their natal beach. This experiment intended (i) to determine natural predation rate while swimming offshore, and (ii) to compare the predation rate between day and night time. Hatchlings were equipped with lighted float tethered with 5m fishing line and were followed individually by kayaker holding the GPS tracker when they leave the beach. We found out that most of our data shows night time predation rates were higher than day time. Variation in predation may associated with the phases of the moon is somewhat more difficult to account for in terms of known patterns of fish feeding behaviour. The natural night time emergence of turtle hatchling never meant to eliminate exposure to diurnal predators, but potentially avoiding lethal daytime heat while crawling down on the beach.

SEA TURTLE MONITORING AND TRACKING IN THE SEA OF JEJU ISLAND, REPUBLIC OF KOREA FROM 2015 TO 2016

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In the Sea of Jeju Island, the Republic of Korea, green sea turtles (*Chelonia mydas*) are observed year-round; however, there is limited information on their migration to and seasonal distribution in other countries. To investigate their distribution and spatiotemporal movement of green sea turtle around Jeju Island, (1) we collected stranding and bycatch data of sea turtles from 2015 to 2016 and (2) we tracked eight green sea turtles (ranges of straight carapace length: 49.7 – 85.9 cm, mean ± S.D.: 63.36 ± 10.99 cm) taken as by-catch in the pound net near Jeju Island using satellite transmitters from August 2015 to January 2017. A total of 28 sea turtles (20 green sea turtles, *Chelonia mydas*, 5 loggerhead turtles, *Caretta catetta*, and 3 unidentified species) were captured in 2015 and 2016. Stranding and bycatch data were recorded from April to October, and the number of reports reached a peak in September. The majority of sea turtles were found at Sinpoong-ri, located in the east of Jeju Island. Eight green sea turtles, which rescued from pound nets, were tracked for 17−314 days. Three turtles traveled more than 400 km from their release site in two different directions: one individual moved westward to China within 17 days of release and two individuals traveled eastward to Japan. One turtle that moved to Japan had been flipper-tagged from Kagoshima, Japan 1-month prior to capture from Jeju Island. The other five individuals remained near the Coast of Jeju Island. The individual tracked for the longest period (314 days) overwintered (temperature in winter: 12−14°C) in the eastern area of Jeju Island. These results indicate that green sea turtles in different regions, including Southeast Asia, south China, and Japan, and may use areas around Jeju Island as foraging hubs during their migration and/or overwintering. For the conservation of green sea turtles, international cooperation and additional ecological studies are needed.

SATELLITE TRACKING OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) IN NORTHERN PERU

SERGIO ARTURO PINGO PAIVA | ASTRID CAROLINA JIMÉNEZ HEREDIA | JEFFREY C. MANGEL | JOANNA ALFARO-SHIGUETO
Prodelphinus | Prodelphinus | Prodelphinus; University of Exeter | Prodelphinus; University of Exeter; Universidad Científica del Sur

The leatherback turtle (*Dermochelys coriacea*) is a globally distributed species which undertakes broad oceanic movements throughout its life history and while traveling between breeding and foraging areas. The nesting population in the eastern Pacific is considered critically endangered due to historic threats at nesting beaches and ongoing bycatch mortality from fisheries throughout the region. Toward better understanding their habitat use and overlap with fisheries, since 2014 we have fitted 14 leatherbacks with satellite transmitters after their incidental captures by small-scale gillnet fishing vessels originating from the ports of Parachique, San Jose and Salaverry in northern Peru. The mean curved carapace length of individuals was 121.9 ± 4.0 cm (CCL; range: 100 to 150 cm) and thus included both juveniles and adults. Tracking durations ranged from 3 to 297 days, with 1 PTT still active. The monitoring showed that upon release, all but one individuals travelled beyond the continental shelf to oceanic waters. The mean displacement travelled for all individuals was 2547 ± 704 km (min: 151 km; max: 10,555 km). One tracked individual was subsequently incidentally captured by fishermen in Ecuador. Another individual ceased transmissions east of Kiribati in the central south Pacific, highlighting potential linkages between leatherbacks in the eastern and western Pacific Ocean basins. Our results suggest that coastal Peru waters are an important developmental and foraging area for leatherbacks. Results from this study also provide valuable information about habitat use and fishery interactions. Given these insights, we recommend strengthening regional fishery monitoring programs, awareness-raising campaigns, and management and protection of critical at-sea areas to achieve improved leatherback turtle conservation in the eastern Pacific Ocean.

USE OF STABLE ISOTOPES TO IDENTIFY POSSIBLE FORAGING GROUNDS OF NESTING FEMALE GREEN TURTLES (*CHELONIA MYDAS*) FROM THE MEXICAN CARIBBEAN

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CICIMAR-IPN | CICIMAR-IPN | ECOSUR-Chetumal

Green turtles (*Chelonia mydas*) from the Caribbean are considered herbivorous species. Since green turtle in Mexico are protected under the status of "endangered species ", it highlights the importance of knowing the feeding habits of this species. The use of carbon and nitrogen stable isotopes (δ13C y δ15N) is a technique used to describe the trophic relationships, because it allows to investigate the resources that have been assimilated, described the diet and considered different integration times of the diet. The objective of this work is to identify potential feeding areas of nesting female green turtles from X'cacel beach using tissues with different metabolic rates. Thus, stable isotopes values of green turtle tissues (blood and skin) were compared to the stable isotope composition of diet items (seagrass and algae) from different sites at Quintana Roo. Plasma isotopic values suggest that nesting females feed in Puerto Morelos, Akumal or Mahahual. While the skin may reflect isotopic values of the diet from sites before the migration to the reproductive and/or nesting sites. This study may suggest that nesting female green turtles may feed during nesting season, although further studies are needed. Highlights the importance of identify and conserve feeding areas, and the protection of the resources used by the species.

EVALUATING ALGAL BLOOM IMPACTS ON JUVENILE GREEN TURTLES THROUGH THE COMPARISON OF FISH AND TURTLE STABLE ISOTOPE SIGNATURES

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Anthropogenic pressure has led to extensive impacts on the coastal environment. Marine conservation in the coastal realm requires understanding how organisms respond to these changes. Harmful algal blooms (HABs) are blooms of algal species that detrimentally affect an ecosystem, often indirectly through increased turbidity and associated die-offs of other flora and fauna. As harmful algal blooms are likely to become more common as anthropogenic pressure grows, it is necessary to evaluate how important these drastic events are in regulating the foraging ecology and habitat use of marine turtles. The Indian River Lagoon (IRL) along the east central coast of Florida has experienced an increased frequency of HABs in recent years, causing large-scale die-offs of fish and marine mammals in addition to severe reductions in seagrass cover and macroalgal biomass. While juvenile green turtles did not die-off at an increased rate during these blooms, University of Central Florida Marine Turtle Research Group data indicate capture rates and body condition of juvenile green turtles in the IRL decreased during and after the major blooms of 2011 and 2012. We hypothesize that these decreases were a result of decreased food resources in the IRL, resulting in diet shifts, changes in habitat use, or both.

To evaluate this hypothesis, we used stable isotope analysis on skin samples from 100 juvenile green turtles captured between 2010 and 2015. Briefly, stable isotope ratios in an animal's tissues reflect the ratios of what and where that animal has been eating. It is necessary to account for potential changes in baseline isotope ratios as a result of the anthropogenic nutrients that were a large contributor to the algal blooms in the IRL. Therefore, we will compare our turtle isotope signatures to those of 423 samples collected from fish resident in the IRL, thereby enabling us to disentangle changes in baseline ratios from the potential behavioral and foraging changes exhibited by the turtles. Specifically, we will compare the variability of fish signatures to those of turtles; if turtle signatures are more variable, than they experienced stronger changes in habitat use or diet than the resident fish. In so doing, we will elucidate how recent HABs have impacted juvenile green turtles in the Indian River Lagoon.

SUCCESSFUL USE OF THE IRIDIUM SATELLITE SYSTEM TO STUDY THE FINE-SCALE MOVEMENTS OF INTERNESTING MARINE TURTLES

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The ARGOS system has been useful in studying large-scale movement patterns in marine animals. However, air-breathing marine animals generally surface only briefly, limiting the number of transmissions received per satellite pass, and resulting in a high proportion of locations with large spatial errors (location classes (LC) 0, A and B). Marine turtles spend even less time at the sea surface during internesting, further limiting opportunities for uplinks to the satellite system [3]. Additionally, they nest globally on tropical and subtropical, often remote beaches. The ARGOS satellites are polar-orbiting and complete fewer satellite overpasses per day at low latitudes, which also limits the opportunity for uplinks to the satellite system. As a result, it is difficult to study fine-scale movements of marine turtles (e.g. internesting movements).
The ARGOS system estimates accuracy for each calculated location: LC 0,1,2,3 with estimated error rates >1,500m, 500m<1,500m, 250m<500m, and <250m respectively, and LC A, B with no accuracy estimation (www.argos-system.org). ARGOS can also store GPS positions and transmits them over an uplink to the ARGOS system, promising more accuracy. However, ARGOS satellite tags equipped with the GPS technology are expensive, as is the cost for their satellite time. An additional challenge is the high data volume that has to be transferred to the ARGOS system (limit of 31 bytes) during limited surface time in marine turtles and few overpasses in low latitudes. Thus, the study of fine-scale movements of marine turtles remains difficult and costly.
We had the opportunity to test a newly-developed satellite tag using the Iridium satellite constellation, which has been operating since 1998 and is used by the military and commercial GPS phone providers. The Iridium system is a low-orbit satellite system that provides continuous satellite coverage independent of latitude.
We installed an iridium unit (SeaTrkr-4370-4, Telonics) on each of two nesting olive ridley females in Costa Rica in August 2017. Their reproductive status was determined by ultrasound imaging, and the number of vitellogenic follicles present in the ovaries indicated they would nest again. The Iridium units stored hourly GPS positions with an accuracy of 9-12m, as well as additional information (e.g. dive duration, water temperature). After 340 bytes of data were saved, they were transmitted over an uplink to the satellite system (in our dataset 3-4 times/day). We compared the results obtained from the Iridium units to the internesting data of seven other olive ridley females that we tagged with ARGOS units in 2016 (SeaTag-TT, Desert Star LLC) and 2017 (TAM-4310-3, Telonics).
The ARGOS units had a mean transmission success rate (TSR) of 76% (range= 63.7-100%) [3]. Of the calculated locations, 25.5% were invalid (range= 7.7%-50%) (Z pings or pass durations of 0 s) and 63.8% had a high spatial error (range= 42.1-83.3%) (LC 0, A, and B). In contrast, the TSR for the Iridium units was 100% for both units with hourly GPS positions.
Our results show that only 3.8% of our ARGOS locations (LC 2 or 3) would be suitable to predict a turtle's location to <500m accurately, and this would still not indicate conclusively whether the turtles came ashore to nest again, or on which beach exactly. Yet the Iridium units provided a location estimation with 9-12 m accuracy hourly, and cost of data transfer was substantially lower compared to ARGOS (ARGOS max ~US$150/month vs Iridium max ~US$35/month). Both turtles returned to their initial nesting beach to nest again.
We conclude that the Iridium system is an extremely suitable and cost-effective method to investigate fine-scale movements of marine turtles, especially in low latitudes.

INTRODUCING SDLFILTER: AN R PACKAGE TO SCREEN GPS AND ARGOS LOCATION DATA

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Satellite telemetry is a powerful tool to investigate animal spatio-temporal ecology. In particular, satellite-linked Fastloc GPS tags provide researchers with almost unlimited temporal and spatial range to monitor animal movements, and provide more accurate and larger quantities of locations than earlier methods (e.g. platform transmitter terminals). However, it remains important to identify and remove locations with high error because some location fixes are much less accurate than others.
I introduce a new R package (SDLfilter) to aid the screening process of satellite-derived locations. Although some options currently exist to screen ARGOS location data, few are available for Fastloc GPS data. This new R package offers the following three main functions which are not available in existing software or services. The functions are especially designed for (but not limited to) Fastloc GPS data.
1. The "dupfilter" function and its variants identify rows of duplicated information and retain a location according to quality indices (e.g. number of GPS satellites involved in estimation, location classes), time, and/or distance from and to the previous and next locations.
2. The "ddfilter" function and its variants executes the published filtering method (https://dx.doi.org/10.3354/meps09747), which removes biologically unrealistic locations. The speed filter examines the speed from a previous location AND to a successive location, instead of using one way speed as used in some existing options. It then identifies potential outliers and compares the linear speed to the maximum speed an animal would travel while making a "loop trip". A loop trip is a series of locations which depart from a main cluster of locations and return to the area of departure. The threshold speed values can be estimated from the input data using the separate functions, "est.vmax" and "est.maxvlp".
3. The "depthfilter" function identifies locations which are above high tide lines. This function incorporates tidal information to bathymetry data, and therefore increases the accuracy of estimates, especially for areas with large tidal changes. To run this filter, users need a bathymetry model layer and tide records/predictions for the study areas. Tidal data from multiple stations can be used. This function will chose tidal data obtained from the station closest to each fix and estimates the tide at the specific time and location of each fix.
Many options are available in each function to make an adjustment to input parameters (e.g. threshold speed, angle, quality index value). Although the functions were developed using sea turtle data, they are applicable to any satellite-derived location datasets. This package is freely available from the GitHub repository (https://github.com/TakahiroShimada/SDLfilter).

SATELLITE TRACKING IN THE MALDIVES

Alejandra Carvallo | Gerardo Alvarez
Turtle Biologist | Manager

The Maldivian Sea Turtle Conservation Program launched in 2011 by marine biologists working for Reefscapers at the Four Seasons resorts Maldives, which aims to research and protect sea turtles in the Maldives.
One of the biggest problems in the Maldives is entanglement of sea turtles in ghost nets, who are brought to the Marine Discovery Center (MDC) in Kuda Huraa or Landaa Giravaavaru to receive treatment and rehabilitation.
Undertaking the satellite tracking project with some of the sea turtles belonging to our rehabilitation program in the Marine Discovery Centre in Kuda Huraa and Landaa Givaavaru. Using satellite-tracking devices, that will record position and immersion time from each individual that is being tracked. The benefits of this project are to assess the survival rate of the pool-reared turtles and therefore estimate the success of such Maldivian Sea Turtle Conservation Program, but also to obtain more scientific data regarding the migration patterns and habitat preferences of juvenile and adult Green, Hawksbill and Olive Ridley turtles.

ETHOLOGY AS A COMPLEMENTARY TOOL OF THE SATELLITE TELEMETRY

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Jorge Tadeo Lozano University | Sea Turtles and Marine Mammals Conservation Program | Sea Turtles and Marine Mammals Conservation Program | Sea Turtles and Marine Mammals Conservation Program

The behavioral study is a tool used in several fields including the satellite telemetry, due it allows to select which individuals are more suitable to carry a transmitter, taking into account that to obtain several and good quality locations, the turtle must emerge to activate the wet-dry sensor, allowing it to emit a signal. Based on this, the behavioral deployment of three specimens of the species *Caretta caretta* were evaluated, these individuals were part of the “head-started” rearing processes developed in 2015 by the STMMCPro in the Colombian Caribbean, working in the Mundo Marino Aquarium facilities. Applying the *Ad-libitum* method, an initial scheme was structured to elaborate a behavioral repertoire, which was enriched with the sampling phase. Through the Animal-Focal technique with continuous registry, the turtles daily cycle was elaborated with a 24 hours curve, in order to make a complete record of the behaviors. Using Chi-Square tests (X^2), significant differences were established between the behaviors and between the turtles. According to the ethogram obtained, seven states (spacing, locomotion, feeding, grooming, hierarchy, exploration and agonistic) were categorized, with their corresponding sub states and events, after 288 hours of active observation. Based on the frequencies and durations of the states and behaviors, the variables analyzed were the total duration of the dives, the level of activity, refers to the states that require some movement, the intra and interspecific interaction of the turtles, feeding forms, besides of including the health, well-being and shape of the shell. Analyzing the results, it was determined that the three individuals presented an optimum state of health being in conditions to be introduced. According to the variables studied, one specimen presented the set of ideal characteristics to carry the device; it had a shorter duration of apnea (7' 32'' compared with the individual with the greatest apnea = 10'), this makes the specimen to emerge more times to breath, increasing the probability of the transmitter to send signals to the satellite. The selected individual also showed a greater range of behaviors (38.08%> 36.04 and 25.87% corresponding to the others specimens) and it was the most active, offering a wider data set in terms of distance traveled. In addition, it had a higher frequency of bites (53.33%), being the most competitive specimen for food and space, allowing a greater survival capacity. Finally, it had a flattened shell, facilitating the adhesion of the rectangular transmitter. The selected turtle was introduced to the environment the 27of May of the present year (2017) in the Mendihuaca sector (Magdalena – Colombia) and until the present it has been transmitting 138 days, with an approximated traveled distance of 1400 km in straight line to Cuba, where actually its last position was registered. In conclusion, taking into account that the behavioral deployment is an honest and clear signal of the animal capability and ability, observed states were determinant in order to be able to select the most suitable individual to carry the satellite transmitter.

ASSESSING NEOPHILIC-NEOPHOBIC BEHAVIOR IN A GROUP OF POST-HATCHLINGS LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*).

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During 2017 twelve newborns were raised at rehabilitation center of the Oceanogràfic aquarium in Valencia (Spain) in a head-starting program. Taking advance of the unique opportunity of having this naïve group of sea turtles, initial response from turtles was assessed once expose to new potential food items. This response is considered relevant for animals living in an environment highly polluted with severe presence of marine debris.
Different novel elements, which can associate with food items (crab, jellyfish and plastic) with different characteristics (black or white, at the bottom or at the surface of the tank) were supplied to the animals. Initial approach was recorded as well any relevant behavior (biting, preferences...). Six of them were monitored as control group. Eight habituations days were done for six individuals, with the six different variables (white and black plastic on surface and on the bottom of the tank, crab and jellyfish) in a independent tank during 5 min. Eight different behavior observations were done from each of twelve turtles during 10 min in the experimental tank. Individual turtle behavior was observed from each turtle with these 6 objects together in the tank during 5 minutes and their preferences were registered. Despite small sample size, turtles showed an attraction for living elements according to statistical results. However, we can not state statistically that the position and the color of the item had an effect on the attempts of ingestion of items by post-neonates. Plastic ingestion attempts were six times higher (31%) in the control group without habituation period than the experimental group (5%). Additionally, we observed that the percentages of ingestion of live animals were high for turtles with previous contact with such items. Thanks to this experience, we obtained preliminary information on litter feeding behavior in nature, as well as the possible effect of captive maintenance during this phase on its innate behavior and the ability to feed in the natural environment.

GENETIC COMPOSITION AND TRACKED MOVEMENTS OF OCEANIC-STAGE GREEN TURTLES IN THE GULF OF MEXICO

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How hatchlings disperse to oceanic habitats and juveniles transition to coastal habitats remain significant gaps in our understanding of sea turtle ‘lost years’. To assess possible differences in oceanic juvenile distribution and movement from natal beaches, we sampled and satellite-tagged 56 oceanic-stage green turtles (*Chelonia mydas*) captured in *Sargassum* habitat in the Gulf of Mexico between 2011 and 2017. The turtles in this study ranged in size from 14.4 cm to 24.5 cm straight carapace length. We extracted DNA from blood and tissue samples and amplified a ~800-bp fragment of the mitochondrial DNA control region. The resulting sequences were aligned and compared to published green turtle haplotypes in the Atlantic basin. We used mixed stock analyses informed by the haplotype frequencies of potential source rookeries to infer natal origin. As a complement to the genetic analyses, we tracked each turtle using Microwave Telemetry 9.5-gram solar Argos tags to monitor movements in the oceanic environment and transitions to neritic habitats. The majority of tracked turtles remained within the Gulf of Mexico over the tracking period (3 to 81 days), and larger turtles were more likely to move over the continental shelf than smaller turtles. Our results provide valuable information on connectivity between rookeries and oceanic habitats and transitions to shallower areas. Support for this project was provided by the National Oceanic and Atmospheric Administration, Florida RESTORE Act Centers of Excellence Program, National Science Foundation, Friends of the Gumbo Limbo Nature Center, and Microwave Telemetry, Inc.

NITROGEN ISOTOPE FRACTIONATION OF AMINO ACIDS IN A HIGHLY MIGRATORY MARINE VERTEBRATE, THE GREEN TURTLE (*CHELONIA MYDAS*)

Garrett Lemons | Rebecca Lewison | Christina Coppenraith | Brian Popp
NOAA/NMFS | San Diego State University | Florida Atlantic University | University of Hawaii

Compound specific nitrogen isotope analysis of amino acids (CSIA-AA) has been used to study the trophic ecology of many marine organisms because of its ability to characterize the $\delta^{15}N$ value at the base of a food web while simultaneously providing trophic position information from a single sample of a consumer. Although the application of this methodology is becoming more widely used, critical assumptions, such as the incorporation rates of amino acids and specific ^{15}N isotope discrimination factors for amino acids are unknown for many taxa and tissue types. In this study, we used captive green turtles (*Chelonia mydas*) in a controlled feeding study to determine trophic discrimination factors and incorporation rates of amino acids for skin (stratum corneum) and plasma tissue. Turtles in this study were fed a diet of known nitrogen isotopic composition for > 720 days. Following isotopic steady state determination of our study subjects, we determined trophic discrimination factors (TDFs) in both skin and plasma tissue for seven trophic and two source amino acids. We determined TDFs for the commonly used Glu/Phe pairing of 3.5‰ ± 0.78 for skin and 6.59‰ ± 0.75 for plasma. A switch in diet from the original to a ^{15}N depleted (3-5‰) experimental diet for over 240 days was unable to detect turnover in either green turtle skin or plasma suggesting that a longer time period or a diet with a greater difference in $\delta^{15}N$ value might be necessary for turnover measurements in long-lived ectotherms. This study represents the first attempt to experimentally test assumptions of CSIA-AA for a long-lived marine turtle species. Results from this research will support robust applications of compound-specific isotope analysis of amino acids for future research on sea turtles, and the trophic ecology of other marine organisms.

HOME RANGE FOR NESTING HAWKSBILL TURTLES IN BRAZIL: NEW INSIGHTS THROUGH SATELLITE TELEMETRY

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The Rio Grande do Norte state, Brazil, hosts the highest nesting density of hawksbill turtles in the South Atlantic (05°53'19"S-06°22'13"S). During the nesting seasons 2014/2015, 2015/2016 and 2016/2017 respectively 12, 12 and 4 PTTs were attached to nesting hawksbill turtles in order to investigate its spatial ecology. The last cohort includes one female that was tracked in the first campaign. The average duration of PTTs was 172 d (range 16-531 d), however four are still transmitting. From 28 PTTs, one stopped tracking when still in the internesting area (16 d) and two during its migrations to the south (36 d) and the other to the north coast of Brazil (70 d); this three as well as the four that still active were excluded of further analysis. Home range size areas were defined based on the Kernel Density Estimation (KDE) with HRef as smoothing parameter for the maximum distribution (90%), as well as its core (50%). Considering all females together, the internesting area was close to the nesting beach within the continental shelf with maximum distribution of 1225 km2 (mainly up to 50 meters deep), with a core area of 201 km2, where they did spend in average 31 d, ranging 1 to 65 d. Migration to foraging grounds took from less than 24 hours to 28 days, with average distance of 453 km (range 17-2182 km). Six females with migration duration up to 1 d were considered residents, with average distance of 41 km (range 17 to 78 km) between tagging site and foraging destination. For those six turtles the forage use area shows a partially overlap with the internesting area. This group includes the female that was tracked twice (in 14/2015 and 16/2017); despite still transmitting we could check that this turtle in 16/2017 nesting season stayed in the same internesting/foraging site previously recorded. Nine females spent from 2 to 28 d migrating northward, an average distance of 839 km (range 82-2182 km), stationing off the states of Rio Grande do Norte (2), Ceará (5), Maranhão (1) and Pará (1). Six females spent from 2 to 17 d migrating southward, an average distance of 288 km (range 93-758 km), with forage areas located off the states of Paraiba (3), Pernambuco (2) and Sergipe (1). The average home range size area of foraging site showed maximum distribution of 100 km2 (range 54-187 km2) with a core of 16 km2 (range 6-53 km2). These findings demonstrate a behavioral variety regarding migration strategies, where some individuals, remain close to the nesting site. Individuals migrating northward showed the longest migrations, up to 2182 km and the southward group up to 758 km, however all individuals always remained within the continental shelf. From 21 individuals with forage grounds detected only three settled at marine protected areas (APA Costa dos Corais; APA Recifes de Corais; PARNA Parcel de Manuel Luís). The knowledge of home ranges as well as migratory corridor for the Critically Endangered hawksbill turtle is essential to address conservation strategies.

DOES LOGGERHEAD SEA TURTLE DIET COMPOSITION DIFFER WITH NUTRITIONAL STATUS?

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Nutritional status (NS) based on robustness of muscle and fat is one metric that is used to evaluate the general health of stranded sea turtles. The composition of organisms in a turtle's digestive tract also may indicate health and behavior around the time of stranding, and helps elucidate aspects of their life history. We hypothesized that the diets of nutritionally robust turtles differ from those in diminished condition because poorer NS may limit foraging ability or itself be the result of diet differences.
We analyzed digestive tracts from 65 loggerhead sea turtles (*Caretta caretta*) that stranded along the Atlantic and Gulf coasts of Florida, USA between 2011-2017, with straight carapace lengths (SCL) ranging from 34.0-103.1 cm (avg=77.4 cm, SD=13.6 cm). NS was subjectively scored on a scale of 1 (severe muscle and fat atrophy) to 5 (no atrophy, excessive fat). Archived wet and dry samples, as well as all relevant accompanying data, were provided by the National Marine Fisheries Service (NMFS), and new sample collection was conducted during 2016-2017 in cooperation with the Florida Fish and Wildlife Conservation Commission. Food items were identified to the lowest possible taxonomic level and counts of individual prey items were estimated. Of the 65 turtles sampled, NS of 8 was categorized as poor (NS1), 17 as thin (NS2), 14 as fair (NS3), and 26 as good (NS4). Preliminary results from 49 samples indicate that diet differences between NS 3-4 and NS 1-2 were minimal; additional samples and dry weights will be integrated to further explore this outcome. The NMFS provided in-kind support for this research, and a Florida Sea Turtle Grant supported 2016-2017 sample collection.

ADULT SEA TURTLE PREDATION BY ORCAS IN GALÁPAGOS

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The Galapagos has been well know as one of the most important sites in the Eastern Pacific in terms of nesting grounds for the green turtle, black morphotipe, (*Chelonia mydas agassizii*), with populations migrating from diferent feeding grounds to lay eggs in this oceanic archipelago. Many years of research have been able to measure predation and describe predators that include endemic and introduced animals like feral pigs, dogs, crabs, ants, birds and sharks, for the little hatchings that came out of the nest and move quickly to the beach.
More receantly and less studied we are seeing that Galapagos is a very important site in terms of aquatic enviroments for sea turtles principally for green turtles with many diferent populations agregating in shallow water feeding grounds, where you can find all range sizes male and female individuals adults and juveniles close to the shoreline. Hawcksbill turtles are also seen in the acuatic enviroments. However there are not studies on predators for adult or juveniles turtles founded in Galápagos.
Worldwide predation in adult sea turtles have largely been ignored, due to predation rates are low assuming that predators do not influence population size or turtle behaviour, even do, several studies calculate predators influencing sea turtle conduct, like the registers of turtles that avoid profitable feeding areas in order to be safe from tiger sharks in Australia .
Literature documents predation in all adult sea turtle species by sharks, crocodiles and orcas, been the interactions between sharks and sea turtles the mostly recorder and followed. Records of killer whale predation are less common and knowledge of their diet are valuable in understanding their ecological relationships. Killer whale predation on leatherback and other turtle species has been recorded) in the southern African subregion, in the northeastern Pacific and in the Caribbean (Best et al. 2010; Caldwell & Caldwell 1969; Oviedo et al. 2008,) and no registers exist in the Eastern Tropical Pacific with green turtles.
In Galápagos, orca interactions and predation to adult and juveniles sea turtles is getting a more common event, been the principal prey in feeding registers. Applying citizen science we are recording this orca-prey interaction and trying to understand the possibility that this will affect behaviour, population numbers, or community structure of green turtles in certain areas in the islands.
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CAMA, DAMA Y CHOCOLATE. WHY LEAVE IF I FOUND EVERYTHING HERE. DO YELLOW ADULT MALES GREEN SEA TURTLES STAY IN BLACK TURTLE HABITATS?

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Both Eastern and Western Pacific populations of Green Sea Turtles are sympatric in Galápagos Islands but their natal origins, developmental habitats, and migrations that are associated with reproduction are poorly understood. Individuals of the eastern Pacific Population tend to be heavily pigmented (black morphs) while those of the western Pacific tend to be lighter in color (yellow morphs). Currently, it has been suggested that some western Pacific Green Turtle turtles in Galapagos are derived from nesting grounds of the west Pacific that develop and mature during trans-Pacific travels to, and residence in eastern Pacific regions, only to return to the western Pacific natal beaches upon maturation. Alternatively, yellow morph, western Pacific Green Sea Turtles may represent a “genetic sink” in the eastern Pacific regions where adults fail to ever reproduce. Male Green Sea turtles show a high degree of philopatry to their natal beaches and likely breed more often than do females and therefore better lend themselves to the study of trans-Pacific movements than do females. Because adult “yellow” males are frequently observed foraging at the Galapagos Archipelago, we asked whether they return to their natal breeding grounds in the western Pacific. Here we present local and regional movements of “yellow” males at Galapagos Archipelago in order to reveal whether or not these turtles will embark on journeys to their natal beaches in the western Pacific. We monitored five adult male Green Sea Turtles mean CCL Range 88.5-95.8 cm. Between March 2016, and the present. We also assessed population derivations through genetic analysis using DNA-analysis of the control region (773 base pares) using primers LCM15382 and H950 (Abreu-Grobois et al. 2006). Genetic results show western pacific haplotypes CmP20.1n=2; CmP22.1n=1; CmP65.1n= 3. Turtles largely remained along the coastal regions where they were originally tagged (they do not travel from the satellite tag deployment location bay in literally in 284 days SD: 65.11 n=5). So, no satellite-tagged sea turtles were observed to leave the Galapagos islands. This study adds information in the still questioning long debated mystery on the sympatry of western and eastern Pacific green turtle populations at eastern Pacific foraging grounds and this lack of information strongly hinders the ability to connect habitats for adequate conservation strategies. A larger sample size and longer satellite tag deployments are needed.

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ISOTOPIC INSIGHT INTO THE PRE-NESTING FORAGING ECOLOGY OF FLORIDA'S NESTING LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*)

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The migratory behavior of North Atlantic leatherback turtles (*Dermochelys coriacea*) has been documented in the Wider Caribbean, but the migratory movements of leatherbacks nesting in South Florida are relatively understudied. Our knowledge of their migrations is currently limited to ten nesting females tracked from the east coast of Florida that either moved north to the Northern Atlantic or east to the coast of Western Africa. The results of this study bring to light the need for further investigation and larger sample sizes in order to identify and determine the relative importance of the different foraging areas for the leatherbacks nesting in South Florida. As Florida's nesting population has been experiencing increased nesting numbers (10-11% per year since 1979), it is important to know which geographic areas are providing the energy sources necessary for vitellogenesis, migration, and nesting. Here, we analyzed ??13C and ??15N signatures in whole blood and skin samples from leatherbacks nesting in South Florida between 2014 and 2017 to estimate where these nesters had been foraging prior to coming to South Florida to nest, most of which had likely been in the North Atlantic In 2017, we encountered remigrant turtles and were able to investigate how much their ??13C and ??15N signatures, and therefore their foraging patterns, had varied. The quality of forage has an impact of the quality of subsequent nesting seasons. It may be that North Atlantic leatherback turtles have a wide variety of foraging habitats available to them and are able to seek out food over a wide geographic region.

DIETARY PREFERENCES OF GREEN TURTLES IN YAEYAMA ARCHIPELAGO

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Habitat destruction and overhunting have caused substantial decline in the abundance of green turtles (*Chelonia mydas*) in Japan. Consequently green turtles are listed as endangered species by the Ministry of Environment. Importance of nesting beaches has been emphasized for the protection of this species. However, recent studies have also highlighted the importance of foraging areas. Availability of food sources, in particular algae, greatly affect the time to reach maturity and reproduction fitness of green turtles, as well as their preference to particular food items. In this study, we aimed to elucidate the relationship between the availability of food sources and feeding ecology of green turtles based on our annual survey, and then apply that to the conservation of this species.
We collected algae samples and gut contents of green turtles that were captured in the waters around Kuroshima Island in the Yaeyama Archipelago. The surveys were conducted every two months from December 2016 to October 2017. Availability of food sources were measured using a quadrat and transect sampling method across the foraging area. We placed a 0.5-m2 quadrat on the substrate at 10-m or 30-m intervals and collected algae in each quadrat. Samples were preserved in 10% formalin, weighed, and used to estimate the species and biomass of algae available to turtles at the foraging habitat. Gut contents were obtained by stomach flushing of green turtles captured by 200m-long gill nets. After gastric lavage and measurement of body length and weight, the turtles were tagged on their flippers and released at their capture location. By comparing availability of algae and the gut contents of the turtles, we discuss 1) seasonal variation in diet selection, 2) ontogenetic shifts in diet, and 3) individual diet preferences of Yaeyama green turtles.

ATTACHED DIATOMS ON THE CARAPACE OF GREEN SEA TURTLES (*CHELONIA MYDAS*) FROM OGASAWARA ISLANDS OF JAPAN

Miu Kobayashi | Hidekazu Suzuki | Hiroyuki Suganuma | Satomi Kondo | Tamotsu Nagumo | Jiro Tanaka

Tokyo University of Marine Science and Technology | Tokyo University of Marine Science and Technology | Everlasting Nature of Asia | Everlasting Nature of Asia | The Nippon Dental University School of Life Dentistry at Tokyo | Tokyo University of Marine Science and Technology

Diatom (Heterokontophyta, Bacillariophyceae) is a benthic or planktonic microalgae whose cell wall is composed of silica (SiO2), commonly growing on the marine environments. Some diatoms colonize on the surface of marine mammals and they are known as epizoic diatoms. Epibiosis has only recently started to receive research attention, with interest in its contribution to elucidating the life cycle of sea turtles including their diet, foraging locations, migration routes and times and stock provenance (Frick et al. 2013). In the recent research on epizoic diatoms associated with olive ridley sea turtles (*Lepidochelys olivacea*) from the Pacific coast of Costa Rica, four new species were described (Majewska et al. 2015a, b, 2017).

The present study is aimed to provide detailed information on the epibiotic associations of the green sea turtles (*Chelonia mydas*). Sampling was conducted on the Ogasawara Islands (24-27° N, 140-142° W), Japan, in April for turtles caught, and July for nesting females and captive turtles through two sample years 2016 and 2017. The collected diatoms including the associated diatom biofilm were studied using light and scanning electron microscopy. A special diatom community was present in every sample, and the 12 diatom taxa were found. *Achnanthes elongata* (monoraphid pennate diatom) was occurred from all samples, which forming a chain, connected at the apices via mucus. And *Poulinea lepidochelicola* (biraphid pennate diatom) was present approximately 70% of the samples, which attached by the footpole, and forming a dense tuft. These two species were recorded only from the sea turtles for now. Thus, it is suggested *A. elongata* and *P. lepidochelicola* commonly grow on the carapace of sea turtles.

This study provides the first information about epizoic diatoms of green sea turtles in Japan and on morphological and ecological features of *P. lepidochelicola* and *A. elongata* which are recorted from the Japanese waters for the first time.

DIGESTIVE TRACT CONTENTS OF GREEN SEA TURTLES DURING EARLY MATING SEASON IN THE OGASAWARA ISLANDS

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Sea Turtle Research Collegium of Tokyo University of Marine Science and Technology | Sea Turtle Research Collegium of Tokyo University of Marine Science and Technology | Sea Turtle Research Collegium of Tokyo University of Marine Science and Technology

Chichijima Island, one of the Ogasawara Islands, is located 1000 km south of Kanto region. This place is famous for the largest rookery for green sea turtles（*Chelonia mydas*）in Japan. Green sea turtles migrate to the vicinity of Chichijima Island for mating from late March to May, and females lay eggs from late April to early September. Harvesting green sea turtles is allowed legally in the Ogasawara Islands. Harvesting is strictly regulated by rules and slaughtering is prohibited during the nesting season, from June to July. There is a long history of harvesting green sea turtles in Ogasawara Islands since 1830.
Sea Turtle Research Collegium of Tokyo University of Marine Science and Technology has been researching to clarify the feeding ecology of adult green sea turtles during the mating season since 2013. To understand the feeding ecology of green sea turtles, esophageal, gastric, and intestinal contents of 17 green sea turtles (11 males and 6 females) were studied in 2017. Sampled contents were washed by sea water, identified their orders, and measured their wet weight.
Classified descriptions of digestive tract contents collected from the green sea turtles of the Ogasawara Islands in 2016 and 2017 were reported. Two species of brown algae, Dictyotales and Fucales were found in 2016. Brown algae were also observed in digestive tract contents collected in 2017, but appearance rate of Fucales was rare. In addition, brown algae and red algae were classified from few samples in 2017. These results suggested that species composition of sea algae in foraging area ware subjected to seasonal and environmental change. Difference in the reproductive migration season between 2016 and 2017 may also had contributed to this difference in digestive tract contents.

For further understanding the digestive tract contents of green sea turtles during early mating season, we studied a relationship between digestive tract contents and weight of follicles. Consistent with conventional studies, the weight of digestive tract contents was similar between the sexes. This confirmed that female green sea turtles forage during mating period. Positive correlation between the weight of follicles in abdominal cavity and digestive tract contents were observed. Female sea turtles might forage to accumulate the nutrition required for growing and laying eggs. Further research should focus on study of the correlation between the weight of eggs with shells and digestive tract contents.

TOKYO UNIVERSITY OF MARINE SCIENCE AND TECHNOLOGY SEA TURTLE RESEARCH COLLEGIUM, ACTIVITY REPORT

Yusuke Sugimoto | Takanori Kasahara | Kumiko Tsunoda

Sea Turtle Research Collegium of Tokyo University of Marine Science and Technology | Sea Turtle Research Collegium of Tokyo University of Marine Science and Technology | Sea Turtle Research Collegium of Tokyo University of Marine Science and Technology

Sea Turtle Research Collegium is established in 1997 as a student society in the Tokyo University of Marine Science and Technology. The number of members in this student society is about 40 people and our activities are mainly based in Tokyo. We have three main activities part; education, learning, and research.

In the education part, we have been sharing the knowledge of sea turtles to as many people as we can to make them interested in sea turtles. Through our activities, we also acquire more knowledge of sea turtles. In particular, we make presentations about ecology, bycatch, life history, and culture of sea turtles to elementary school students at some public libraries and a lot of people at our school festival.

In the learning part, we have two main activities to deepen our knowledge of sea turtles. First, we hold a meeting once a month to share the latest research about sea turtles. Second, we study and volunteer at Chichijima Island (Ogasawara archipelago, Tokyo), famous green turtle rookery in Japan, and at Kuroshima Island (Yaeyama archipelago, Okinawa) during our long vacations. Both of them have many beaches for sea turtles to lay eggs, so we can have field works there and study many things from living sea turtles.

In the research part, we have researched digestive tract contents from green sea turtles harvested in Chichijima Island and stranded in the coast of Kanto area since 2013. The main research theme of our group is to clarify the feeding ecology of adult green sea turtles. We collect esophageal, gastric, and intestinal contents. After that, we identify their orders and measure their wet weights.

COMPARISON OF HIDDEN BEHAVIORS INTO FLOATING ALGAE AMONG THREE SPECIES HATCHLINGS OF SEA TURTLE

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It is difficult to observe turtle hatchlings, regardless of sea turtle or fresh water turtle, in their general habitats. Therefore, it is predicted that the turtle hatchlings is hiding somewhere. Actually, loggerhead and green turtle hatchlings are known to hide in floating algae and drift in Atlantic Ocean. So that, their ecology or behavior is confuse because that we could not observe them. It seems that hatchlings have genetically hidden behaviors in floating algae. We clarify hidden behavior in floating algae using three species (*Carreta carreta*, *Chelonia mydas* and *Eretmochelys imbricata*) sea turtle hatchlings.

We used two loggerhead (CL: 48,53mm), three green (CL: 55-59mm) and three hawksbill turtles (CL: 47-48mm) for the experiment to confirm the approaching and hiding behavior. A water tank of 1m square was prepared and one of the four corners was randomly selected in each experiment. *Sargassum*-like artificial algae that made by plastic was placed on selected corner. Those turtles were released into the tank. Positions of turtle were recorded every ten minutes by camera. The position of the turtle was divided into 9 squares. We expressed the closeness to the artificial algae in proximity score (PS). On the bases of hatchling positions in 1106 photographs PS in each species was calculated and compared with the expected value, which is the PS, when hatchlings are randomly scattered. By the value of PS, it was statistical significantly shown that loggerhead and green turtle hatchlings approach artificial algae. However, the PS of hawksbill turtle hatchlings had no significant difference from the expected value. In the other side, we also examined the proportion of hidden hatchlings in each species and made it HR, HR of loggerhead, green and hawksbill hatchlings was 29.8%, 31.7% and 11.8% respectively. The proportion of hidden turtles also showed a tendency for hawksbill to not be dependent of artificial algae compared with other species.

By these experiments, the loggerhead and green turtle hatchlings visually recognized the floating algae and indicated they have a instinct to approach floating algae and hide them. It was revealed that the hawksbill hatchlings did not approach and hide to it. In the previous papers, it is the loggerhead and green hatchlings found from the floating algae in the Caribbean sea or western Pacific not the hawksbill hatchlings. The carapace color of hawksbill hatchlings is bright compared to the one of loggerhead and green turtle hatchlings. The dark brown or black colors of loggerhead and green turtle carapace adapt to hide in floating *Sargassum*. This bright color of hawksbill hatchlings reflects life that is not hidden by floating algae. Hawksbill hatchlings may grow in habitat different from other species, such as coral reef as suggested by previous papers.

DIVE BEHAVIOR DURING POST-NESTING MIGRATION OF LOGGERHEAD TURTLES NESTING IN JAPAN

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Size-related difference in feeding habitat of adult female loggerhead turtles (*Caretta caretta*) has been reported (Hatase et al. 2002). Tracking the post-nesting migration of Japanese population showed that smaller females migrate to the oceanic area in the North Pacific Ocean, whereas larger females migrate to the neritic area in the East China Sea. Isotope analysis revealed that the formers feed on planktonic organisms, while the latter feed on benthic animals. This dichotomy may result in different dive performances in each habitat. However, such difference has not been well understood, because the dive behaviors of the single female were previously investigated in each habitat (Hatase et al. 2007). This study aims to clarify the characteristics of dive behavior of loggerhead turtles during post-nesting migration, and in the neritic/oceanic feeding habitats, by satellite-linked depth data logger.

In June 2016 and 2017, the Satellite Relay Data Loggers (SRDLs, SMRU instrumentation) were attached to nine adult females nesting at Okinoerabu Island located at the southern part of Japan and Ichinomiya located at the eastern part of Japan. SRDL dive data provides a dive profile by determining the time and depth of the five most prominent points of inflection during the dive. To understand of the function of dive behavior, the dives were visually classified into six types following Houghton et al. (2002) and Seminoff et al. (2006). Type 1 called U-shaped dives were characterized by a steep descent, a flat bottom phase and a steep ascent. Type 2 were V-shaped dives with an extremely short bottom phase. Type 3 were characterized as the dives with a steep descent, a gradual ascent phase followed by a steep ascent, whereas type 4 displayed a steep ascent before the gradual ascent phase. Type 5 were shallow dives. Type 6 were W-shaped dives with a steep descent, a wiggle bottom phase, and a steep ascent.

Our SRDL tracking showed that the four females (Straight Carapace Length [SCL]: 784−870 mm) migrated into the oceanic North Pacific, whereas four individuals (SCL: 818–915 mm) headed for the neritic East China Sea. Another individual (SCL: 870 mm) migrated in short distance along the coastal area, and remained there. They were tracked for 12–448 days as of September 9, 2017 (tracking of five individuals is still ongoing).

The turtles moving to the East China Sea performed both deep dives (>80 m) and shallow dives (0–20 m), whereas most of the dives by the turtles migrating into the North Pacific were shallow (0–20 m). The deep dives in the East China Sea observed during a nighttime more than a daytime. Of females heading to the oceanic area, one stopped by around Kii Channel (coastal area) for approximately 90 days, where she performed U-shaped dives for more than 60% of the time spent in diving. These U-shaped dives were deeper than those in the other four oceanic females. The effects of geographical and environmental factors on dives were investigated.

REVIEW OF SEA TURTLE NESTING HABITAT AND STATUS ALONG ENTIRE BANGLADESH COAST.

Mohammad Zahirul Islam | M. Foysal Ehsan | Abdul Wahab Akonda | Rafat Adnan | Aoife Leonard
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The entire coast of Bangladesh is 710 kms and fringed with diverse habitat viz., mangrove, muddy, sandy and small rocky shore at southern St. Martin Island at south eastern end (20.584327 N, 92.331119 E) and at the south west at Sundarban mangrove near Mandarbaria (Lat21.717425 N, Lon 89.105782 E). The project area have trans-boundary portion at west with India and at the east with Myanmar. Monitoring and conservation along entire coast is ongoing by Bangladesh Sea Turtle Program of Marinelife Alliance since 2013.
The mentioned land end points were major nesting beach monitoring area and under the exploration of new nesting rookery. Program intervened along entire Bangladesh coast. According to our investigation approximately 400 kms are sandy and have records of nesting currently. The recorded nesting beaches are : a. Southeast coast (St. Martin Island (18kms), b. Teknaf Peninsula (100km beach), c. Sonadia Island (12kms), Kaladia-Laldia-Dhalghata-Matarbari beach (16kms), Kutubdia (20Kms), Bashkhali-Gohira-Parki(20 kms); Southcentral coast (Kuakata, Char Kukri Mukri, Sonar Char, Tuphania, Shib Char (114+kms) and Sundarban Mangrove coast (Dublar char, Katka, Mandarbaria, Egg Island, Hiron Point, 90kms). The southeast coast is currently under threat from the indiscriminate development, alteration of sand dunes and beach habitat. Government establishing Coal Based Power Generation Plant near Matarbari location, 21 kms north of Sonadia major nesting location. The project area have trans-boundary portion at west with India and at the east with Myanmar. The program also conducting marine foraging habitat survey within the Bangladesh marine territory and the records of satellite tracking revealed turtle both green (*Chelonia mydas*) and olive ridley (*Lepidochelys olivacea*) forage along the non nesting coast. The majority of nesting occurred along the south east coast particularly at Haserchar(Dhalghata), Sonadia and Cox Bazar-Teknaf peninsula. The best is Sonadia Island where within 12 kms the 40 % of all nests are being laid according to current nest monitoring by Marinelife Alliance.
The future of Haserchar to Sonadia Island is uncertain due to probable disturbances, pollution and light pollution of Matarbari coal power plant if proper mitigation is not taken. Hope we have overcome the deep sea port anxiety that prevailed last several years (Islam, 2009, 2010, 2011).
In the last 15 years the St. Martin Island Screw pine vegetation land area already severely degraded due to tourism development. Mass tourism, relative disturbances and lighting, marine habitat degradation resulted in declination of 70 % after 2000.
The 100 kms long Cox Bazar - Teknaf Peninsular beach stretched from Najirartek at north to Badar Mokam south at Shahporirdwip, whole coast is sandy with boulder habitat in intertidal zone at some points. During the last 10 years beach front lands already been sold to resort developers, thus new threats are coming in future along the entire coast. A large number of people living along this coast and more than 600 boats are landed here in 22 deferent spots. Currently the tourism increasing, but still there are large areas suitable for turtle nesting and wintering birds roosting. The average width of the peninsular beach is 100-150m, and up to 400-500 m wide in some places. The entire area of the coastal strip at the east is subtropical moist semi evergreen forested also much of this is degraded due to severe deforestation during the last 3 decades. About 850 olive ridley nests recorded seasonally during 2013 - 16 and some spots are very important with higher nesting frequencies. 23 spots have been reported for olive ridley nesting.

FIRST FIELD TRIAL OF DECOY TURTLE EGGS EMBEDDED WITH GPS TRACKING DEVICES

Helen pheasey | Kim Williams-Guillen | Sarah Otterstrom
Durrell Institute of Conservation and Ecology, University of Kent and Paso Pacifico | Paso Pacifico | Paso Pacifico

Replica turtle eggs containing a GPS-GSM tracking device (known as the InvestEGGator), developed by the conservation NGO Paso Pacifico, are a novel approach to understanding trafficking routes and are a possible future law enforcement tool. We present the results of the first field trial with the aim of answering three questions: 1. Does the technology function once deployed in green (*Chelonia mydas*) sea turtle nests? 2. Are the eggs detected by poachers on the beach? 3. Are there any negative effects on the nest if the decoy eggs remain for the duration of the incubation period?
In total 44 eggs were deployed on the Caribbean coast of Costa Rica between 21st July and 3rd September 2017. Eggs were placed in the middle of the nest whilst the turtle was in oviposition. All nests were excavated at the end of the incubation period and compared with excavation results from nests without decoy eggs.
Of the 44 nests, twelve were confirmed poached. Only two decoy eggs were detected and were later found on the beach. Of the nests confirmed poached, seven eggs did not emit a signal suggesting they were either detected off the beach or the contents of the nest was consumed locally. Two decoy eggs travelled inland; the first TT041 travelled 19km and the second TT047 travelled 88 km. There was no significant difference between any of the variables that compared nests with a decoy egg to the control nests (Hatchling success (%): W=617 P=0.1048, Stage 1 Mortality: W=455 P=0.4296, Micro-bacteria: W=445 P=0.4819, Deformities: W=506 P=0.821).
Sincere thanks to the International Sea Turtle Symposium for accepting this abstract and for the travel grant award and to Caño Palma Biological Station for hosting the project . This project is part of a PhD thesis and special thanks go to supervisors Dr David Roberts and Prof. Richard Griffiths.

GENETIC DETERMINATION OF TAG LOSS DYNAMICS IN NESTING LOGGERHEAD TURTLES

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Capture-mark-recapture (CMR) studies provide fundamental information for estimating demographic parameters in marine turtle populations, including abundance, survival, growth, migration and recruitment. A key assumption of CMR studies is that individual markings or markers are not lost, such that individuals are consistently identifiable upon subsequent recaptures. However, in the absence of truly permanent markers, studies that fail to account for the frequency and dynamics of marker loss risk generating biased demographic estimates, leading to erroneous management decisions. Despite recent advances in photo-recognition technology and genetic identification, physical tags remain the primary tool for marking individual marine turtles. While the problem of premature tag loss in marine turtles is widely acknowledged, our ability to accurately quantify the complex dynamics of tag loss remains a challenge. In this study, permanent multilocus genotypes (i.e., “genetic tags”) of individual loggerhead turtles (*Caretta caretta*) nesting on Wassaw Island, GA USA were used to quantify tag loss dynamics for both metal and Passive Integrated Transponder (PIT) tags. The goals of this study were to (1) generate robust estimates for the probability of metal and PIT tag loss over time and test for tag loss independence and symmetry, and (2) evaluate potential biases in tag loss estimates when PIT tags are assumed to be permanent. Results of this study provide the first truly accurate estimates of tag loss in marine turtles and highlight the importance of understanding tag loss dynamics when making assessments of marine turtle populations.

CURRENT STATUS OF THE NESTING GROUNDS FOR THE GREEN SEA TURTLE(*CHELONIA MYDAS*) AT SEVEN-CONNECTED ISLANDS, AMPHITRITE GROUP, THE SOUTH CHINA SEA

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To understand the current status of the nesting grounds of the green sea turtle (*Chelonia mydas*), we conducted field surveys and interviews in August and September 2017 in the Seven-Connected Islands of the Amphitrite Group, the Xisha Islands (i.e. the Paracel Islands), the South China Sea.

The preliminary results are:

1) The spawning season is from March to November with a peak in July-September;

2) In 2016 and 2017, about 150 nests were recorded each year;

3) Totally 95 nests were orientated which laid in March –September, 2017 (out of 130 nests reported), and the core beaches were identified;

4) Based on the flipper tag and external mark, a female green turtle was confirmed to lay eggs in an interval of 12 days with the two nest distance of about 20 m;

5) Based on the 15 nests examined after hatched, the hatching rates varied between 14.8% and 100%, the depth of the nests between 40 cm and 80 cm, and the number of eggs between 58 and 131;

6) The major predators for the newly-hatched turtles are the sea birds and the crab Ocypode stimpsoni;

7) Nests located near low tide zone gave low hatching rate.

The Seven-Connected Islands of the Amphitrite Group are revealed to be the largest nesting grounds for the green turtle in China in terms of the number of nests recorded. The present study provides valuable information for developing protection action plan.

INDIVIDUAL CONTRIBUTION OF GREEN TURTLE NESTING FEMALES IN CAYMAN ISLAND AS INFERRED USING MICROSATELLITES

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Conservation of endangered species rely on the knowledge of specific biological parameters of target species and populations in order to conduct effective management and conservation programs, and to build robust population demographic models. For marine turtle species, the collection of this information may be complicated due to the long-life cycle or the long migratory routes of their individuals. For instance, population sizes are based on the number of females nesting in a specific nesting site, but in certain sites, female monitoring may fail to detect all nesting females due to low nesting densities or low monitoring coverage. For this reason, the number of nests laid in a site are often used as a proxy of population abundance. In the present analysis we included extensive samplings of nesting females and individual clutches conducted in several nesting seasons, to assess nesting female individual contribution in the Cayman Island green turtle (*Chelonia mydas*) nesting population. The studied population may also be influenced by the presence of the Cayman Turtle Farm reintroduction program. For these reasons, we used a battery of 14 microsatellites developed for this species to reconstruct maternal and sibship relationships among nesting females and individual clutches. With this information we calculated the parental relationship between individuals, the impact of the farm on wild nesting, the reproductive contribution of each nesting female of the population, and we estimated the number of nests per female and year. The application of genetic markers to link individuals across generations could be thus applied to infer important biological parameters in marine endangered species.

I would like to thank the following organizations for their contribution to the presentation of this study at the 2018 Kobe Sea Turtle Symposium: Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, the US Fish & Wildlife Service and the Sea Turtle Symposium.

INCUBATION TEMPERATURE AND HATCHING SUCCESS OF GREEN TURTLE (*CHELONIA MYDAS*) NESTS IN TORTUGUERO, COSTA RICA

Kristina Pahang | Jaime Restrepo | Roldán Valverde
Sea Turtle Conservancy | Sea Turtle Conservancy | Sea Turtle Conservancy

Studies on incubation temperature of sea turtle nests focus on its role in sex determination of the embryo; however, extreme incubation temperatures can also be lethal to the developing embryo, a concept less studied in literature. Therefore, it is important to investigate this gap in knowledge, especially in the face of global warming and climate change. For almost two decades now, the Sea Turtle Conservancy (STC) has been collecting data on hatching success of sea turtle nests in Tortuguero, Costa Rica. From 2010 to 2016, STC has estimated an average of 80.54% hatching success for green turtle (*Chelonia mydas*) nests, ranging from 68.76% to 89.48%. Other data being collected includes nest zone (i.e. location of a nest on the beach relative to the amount of sunlight it gets throughout the day), nest depth, and clutch size. Although temperature plays a critical role in the success of sea turtle nests, no data has been collected yet for this parameter. This study investigates the effect of incubation temperature on the hatching success of *C. mydas* nests in Tortuguero. Between August 24, 2017 and September 27, 2017, 35 Hobo pendant temperature data loggers were deployed within a 5-mile stretch of beach monitored by STC in Tortuguero to record the incubation temperatures of *C. mydas* nests during the 2017 nesting season. Data loggers for measuring the mean sand temperature in the absence of nests were also deployed semi-randomly to examine the relationship between nest incubation temperature and sand temperature. A set of three data loggers were placed within each mile, with one data logger buried in the sand at each nest zone (i.e. vegetation, border, open). Retrieval of all data loggers were done during nest excavations. The data collected will be used to determine the mean incubation temperature of *C. mydas* nests and the mean sand temperature in the study area. The hatching success of studied nests will be assessed to examine its relationship with nest incubation temperature. If incubation temperature can explain hatching success, then extreme global temperatures could have a negative impact on nesting populations of *C. mydas* in the region, warranting conservation action. The presentation of this project at the 38th Annual Symposium on Sea Turtle Biology & Conservation has been made possible with the support of the International Sea Turtle Society, Suma Aqualife Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Orgabits, Nescafe, NYK Line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chubu Doboku, and the US Fish and Wildlife Service.

GREEN SEA TURTLE (*CHELONIA MYDAS*) NESTING OVER FOUR SEASONS (2014-2017) AT COCOS ISLAND, GUAM

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Guam Department of Agriculture's Division of Aquatic and Wildlife Resources

Guam Department of Agriculture’s Division of Aquatic and Wildlife Resources (DAWR) has been documenting sea turtle nesting since the 1970’s. However, documentation has been sporadic and opportunistic until recently. Beginning in 2014, Cocos Island was identified as an index beach for sea turtle nest monitoring and sea turtle nest surveys have been conducted consistently. The atoll-like island is located 2.5 km southwest of Guam and is 1.93 km long and 0.15 km wide. All sea turtle nesting occurs on the west side of the island, which is protected by the Cocos Lagoon. The two main nesting areas available for the sea turtles are separated by a privately owned day resort (nesting does sometimes occur at the resort). Cocos Island South (about 1.2 km in length) has limestone flats with more tree vegetation and beach forest with less and less open beach due to erosion, while Cocos Island North (about 0.6 km in length) has more open beach. Currently erosion is affecting the topography of both Cocos Island South and Cocos Island North, however the impacts are more prominent on the Cocos Island South. Climate change and rising sea levels may increase the changing topography of these beaches. Cocos Island North appears to be better nesting habitat than the South with larger, open beach arGuam ea. Data collected over the past four seasons indicates otherwise. In each of the years the majority of nesting has occurred on the South beach. DAWR will maintain Cocos Island as an index beach to record any changes to nesting behavior in the future.

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SCIENTIFIC MONITORING OF NESTING BEACHES FROM CAMBUTAL (PANAMÁ): PRELIMINARY RESULTS

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Pacific Ridley (*Lepidochelys olivacea*) is a threatened sea turtle, currently enlisted as Vulnerable and decreasing, according to the IUCN redlist. The main threatened for Pacific Ridley is the illegal harvest of eggs. For this reason, the distribution and local hatching success is an important issue for the conservation of local population of Pacific Ridley. The main aim of this study is show the preliminary scientific monitoring data from nesting beaches from Cambutal (Panamá) for the period 2014-2016. During the study period we performed surveys, nest and footprints counts, nesting females and translocation of recent hatchery nests were carried out. After hatching, the success rate of the nest was recorded for each nest and the newborns were released to the sea. The nesting period extended since July to December. The study shows that the mean of the straight length is inferior to the world average (approx. 66 cm) and that of neighboring countries. In the central months of the nesting season there is an increase in the number of viable nests and number of traces. Likewise, hatching success shows a pattern in which maximums are reached in the central months of the season.

POTENTIAL EFFECTS OF SEA-LEVEL RISE ON THE LARGEST LOGGERHEAD ROOKERY IN THE EAST ATLANTIC

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The climate change scenarios predict the rise of sea level and the increase of storm frequency and intensity principally in tropical sea. Is probably that these environmental changes increase beach erosion and flooding, thus affected the hybrid conditions of sand beaches. For animals that lay their eggs on the beach, like sea turtles, the hybrid condition along the beach may strong influence embryo development and offspring survival and possible affect the reproductive fitness of the adult. To test who hybrid condition of the beach is relate to embryo development and hatching success of sea turtle, a field study was conducted in the important loggerhead turtle rookery along 5 km of beach (Boa Vista Island, Cape Verde, West Africa region). 45 loggerhead nests were translocated and reburied in the same beach at a depth of 40 cm (depth average of the centre of nest on this population) in three different zone following the hybrid gradient in the sand from the intertidal to inland, i. e.: (a) the intertidal zone (close to the high water mark); (b) the mid-zone (in the center of the beach); and (c) vegetated zone (areas where vegetation begins to appear), and monitoring throughout their incubation.To measure sand water content, sand samples were taken one-metre close to the nests at 10 cm and 40 cm of depth at each 10 days until nest eclusion. Of the 45 nest studied, 2 were destroyed by high tide. The hatching success was significantly higher in the vegetation and center zone that in intertidal zone and revealed a negative correlation between water content and emergence success ($r = -0.55$, ANOVA: $F_{2, 42} = 9.12$, $p < 0.0001$), incubation time ($r = -0.59$, ANOVA: $F_{2, 42} = 9.12$, p <; 0.0001), and the offspring emerge in larger numbers in vegetation and centre of the beach than in the intertidal zone (ANOVA: $F_{2, 42} = 8.30$, $p = 0.001$). Nests in intertidal zone suffered higher mortality, principally in the earlier developmental stages. Hatchlings from the center of beach were significant larger and stronger than hatchlings from vegetation and intertidal zone (ANOVA: $F_{2, 357} = 6.16$, $p = 0.002$). In the context of climate change scenarios, the results suggesting that sea-level rise could negatively influence sea turtle productivity in the Cape Verde Archipelago were more than 60% of nest are concentrated in flat beaches (Sea Turtle Natural Reserve), with frequent inundation during the nesting season.

PROTECTION AND CONSERVATION OF NESTING BEACHES AND SEA TURTLES IN AYEYAWADY DELTA REGION, MYANMAR

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The present study was carried out in Kadongalay at (15° 40´ 50" N and 95° 16´ 16" E) and Gayetgyi at (15° 41´ 11" N and 95° 14 51"E) islands in Ayeyawady Delta Region, Myanmar. These two islands are main nesting habitats for Olive Ridley turtles. The study included field survey, questionnaire survey, and group discussion, consultation and presentation. There was official and academic research record of the Olive Ridley turtle's abundance that several thousands of nests occurred annually on the islands. The present showed that number of nests and nesting turtle population are extremely decreasing year by year which leading to going extinct if lack of better protection. Comparing the present number of nest to the past for one decade that showed about 75% declined as well as compares to past three decade about 90% declination. A total of 11 nests in 2015-2016 and 17 nests in 2016-2017 during the nesting season were recorded. The present study attempts to find the ways to protect this species from going extinct in locally. It included many activities such as sharing information on turtle nesting status, population, threats and conservation requirements to the public, the authority and the interested parties for turtle conservation and that support as a part of achievement for the study area Kadongalay and Gayetgyi islands to become an official sea protected area under the protection and management of new Ramsar site of Meinmahla Kyun Wildlife Sanctuary.

Key words: Olive Ridley turtle, Kadogalay and Gayetgyi Islands, nesting, protected area, conservation

CLIMATE CHANGE EFFECTS ON HATCHLING SEX RATIO: EXTINCTION FOR LOGGERHEAD TURTLES IN CAPE VERDE?

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With a global increase in temperature, which is predicted to rise exponentially (1.8 to 3.4^{o}C by 2090 to 2099), it is important to understand the effects that climate change could potentially have on endangered species' populations, such as the loggerhead turtle of the North-East Atlantic. Currently the only rookery of this endangered population is in Cabo Verde. Using predicted future scenarios for temperature increase in relation to climate change, sex ratios for loggerhead nests were estimated for the whole Cape Verde archipelago. There is a significant difference in the estimated sex ratio between current temperatures and all of the future scenarios, irrespective of beach, island or sand colour. Most of islands have dark sand beaches with very high sand temperatures that in some cases are lethal for loggerhead eggs. By the other hand, more than 95% of loggerhead nesting occurs in light sand beaches in the easternmost islands. Thus, loggerhead turtles are already nesting in the coldest beaches of the archipelago where average hatchling sex-ratios are already skewed toward female production. The Cape Verdean loggerhead rookery is predicted to produce minimal male hatchlings across all beaches, in all future scenarios. It is not known as to whether this could be detrimental to population abundance, or whether it has the potential to increase the nesting population through increased female recruitment. Loggerhead marine turtles could potentially mitigate these effects by altering the time of year at which they nest, though there is no evidence of any change on that direction. Furthermore, females could disperse their nesting to beaches at higher latitudes. However, there no evidence of this dispersal that could be complicated by the high level of geographic isolation of Cape Verde, the low surface temperatures in the Atlantic toward the north of Cape Verde and the high temperatures and the extremely low level of wildlife protection in the closest continental beaches (Senegal or Mauritania).

REPEATABILITY OF NEST SITE SELECTION BY GREEN SEA TURTLES IN REDANG ISLAND, MALAYSIA

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Green sea turtles, *Chelonia mydas*, nest multiple times over the course of a nesting season. Nest site selection is a long strenuous process: both energetically taxing for the mother and greatly impacting embryonic development. Despite the importance of nesting behavior in the continued growth of the green sea turtle population, little is known about the process of maternal nest site selection. Prior studies posit nest site selection is a random process while others suggest preferences may be individual or population based. Observations of individual mothers repeatedly selecting ecological characteristics with a higher degree of repeatability than those observed at a population level may suggest that individuals express unique nesting preferences. Consistent maternal nest site selection expressed at an individual level indicates a genetic component may underlie the observed trait and presents an opportunity for selection to act on the aforementioned behavior. Subsequently, underlying genetic components for maternal nest site selection may be inadvertently impacted by current conservation practices such as relocation of doomed nests. Understanding the mechanisms of maternal nest site selection will help elucidate this esoteric behavior and reassess the impact of current conservation practices on the genetic composition of the green sea turtle population.

Nest sites laid by 43 randomly selected green sea turtles were monitored at the Chagar Hutang turtle sanctuary on Redang Island, a small island of the east coast of Peninsular Malaysia, to study trends in nest site selection by green sea turtles. Samples were obtained from nest sites describing the distance of the nest to the highest spring tide line (HSTL), vegetative line, GPS location and percent vegetative cover. Measurements were taken at the top and bottom of the nest chamber to observe their impact on maternal nest site selection. Substrate samples were procured from depths salient to nest structure: surface, top and bottom of the nest chamber and analyzed to determine; compaction, percent water content and particle size. Data will be examined to observe the impact of ecological characteristics on maternal nest site selection. Analysis will be performed to observe potential trends in selection preferences and determine, if trends are present, whether they occur at an individual or population level.

Key Words: *Chelonia mydas*, green sea turtle, nest site selection, ecological analysis, genetic implications

TEMPORAL ANALYSES OF THE TRENDS OF EGG MORTALITY AND UNFERTILIZED EGGS ON TWO TURKISH BEACHES

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Conservation and monitoring of sea turtle (*Caretta caretta*) population studies have been carried out on Dalyan and Fethiye beaches for long period of time. Dalyan Beach has the largest nesting loggerhead turtle population in westernmost Mediterranean cost of Turkey. Also, Fethiye beach is one of the most important nesting sites of loggerhead sea turtles in Turkey. A significant increase for Dalyan has been observed in the annual number of nests although previous studies were showed a negative population trend of the loggerhead sea turtle population in Fethiye beach because of tourism and coastal development in recent years.

This research provides information on the egg mortality and unfertilized egg over the 8 nesting seasons (2010-2017). For Dalyan beach, a total of 248197 eggs were laid for last 8 years, of which 25.798 (10.4%) dead embryos were determined and 12900 (5.2%) were recorded as unfertilized eggs. On Fethiye beach, 62.610 eggs were laid totally, and 7892 (12.6%) of these determined as dead embryos and 6683 (10.6%) were recorded as unfertilized eggs. The minimum averages of the dead embryo were calculated as 3.3% (in 2010) and 7.3% (in 2015) for Dalyan and Fethiye respectively, and the maximum averages of the dead embryo were calculated as 17.2% (in 2012) and 18.5% (in 2017) for Dalyan and Fethiye respectively. Moreover, the unfertilized eggs were varied between 1-7% since on Dalyan beach and varied between 2-15% in Fethiye.

As a result of studies carried out by different researchers or volunteers every year, the annual percentage of dead embryos and unfertilized eggs were varied from year to year. These results were discussed if it is because of the data collectors or a trend in inundation of nests due to sea level rise or low level of male turtles in some populations. The fertilization rates are very important to monitor in order to save sea turtles, if the male population have enough sperms to fertilize all females in a population.

LIGHT WAVELENGTH PERCEPTION, PHOTOTAXIS THRESHOLDS AND SEAFINDING BY HATCHLING GREEN TURTLES (*CHELONIA MYDAS*)

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After emerging from their nest, hatchling marine turtles use visual cues to crawl on an oriented heading (known as a phototaxis) toward the sea. This orientation, which under most circumstances is amazingly accurate, usually occurs at night and is known as “seafinding”. Two cues used during seafinding have been identified. They are background elevation (higher view toward land; lower toward the surf zone) and light intensity (more light reflected from a seaward than a landward direction). Those cues are organized in a behavioral hierarchy so that even when the landward view is brightened by lunar illumination, horizon elevation dominates enabling the turtles to still orient toward the sea. Few studies, however, have been done to determine what light wavelengths are used during seafinding, or how sensitive the turtles are to those wavelengths. In a previous study, Kawamura and colleagues (2009) showed that at a sea turtle nesting beach in Japan, near-UV light wavelengths were present at night. They also showed that loggerhead hatchlings, known to be sensitive to UV light, were attracted to those wavelengths. However, at the time when they did their study they lacked equipment that could be used to directly measure irradiance levels at specific UV and visible light wavelengths.

In this study, we build upon those key findings. We used a UDT Optometer (Model S 471) to measure irradiance at 20 nm increments between 340 – 600 nm at a major rookery site (Juno Beach, Florida, USA). Measurements were made during full, new and the quarter lunar phases in a seaward and in a landward direction. In laboratory experiments, we presented each of those wavelengths to green turtle hatchlings to determine the lowest irradiance that attracted the turtles (the phototaxis “threshold”). To determine which wavelengths of light were most attractive to the turtles, we simultaneously presented a UV (340, 360 or 380 nm) and a visible (420, 500, or 600 nm) light stimulus to the hatchlings at perceptually equal intensities (1 log unit above their respective phototaxis threshold). Turtles then could choose to crawl toward one or the other light in a Y-maze.

Our results were as follows. (i) Specific wavelengths of UV irradiance at the beach were often comparable to, and sometimes exceeded, levels of visible light irradiance. Light levels were (as expected) highest under full moon illumination, with more light reflected from a seaward than a landward direction. (ii) Both UV and visible light wavelengths evoked a positive phototaxis. Thresholds between 380 and 480 nm were minimally 1 log lower than the lowest (new moon) irradiance measured at the beach. (iii) In choice experiments, hatchlings oriented preferentially toward a visible light over a UV light presented at a perceptually equal intensity. There was one exception. Given a choice between a 360 and 420 nm stimulus, the 360 nm light was preferred. Our beach measurements revealed that irradiance at 360 nm exceeded irradiance at 340 and 380 nm, and generally exceeded the visible light irradiance levels.

We conclude that both UV and visible light wavelengths are probably used by green turtles, and presumably by the hatchlings of other marine turtle species, to locate the sea from the nest. Our phototaxis thresholds for green turtles reveal a different sensitivity profile from their receptor sensitivities, suggesting that the seafinding response has been modified by natural selection to promote efficient hatchling orientation.

RISK ASSESSMMENT FOR LEATHERBACK NESTS (*DERMOCHELYS CORIACEA*) IN SOROPTA BEACH, BOCAS DEL TORO PROVINCE (PANAMA)

Silvia Agullo | Cristina Ordoñez | Raul Garcia
Sea Turtle Conservancy | Sea Turtle Conservancy | Sea Turtle Conservancy

The Sea Turtle Conservancy was established in 2003 in the "Comarca Ngäbe bugle" and Bocas del Toro province at the Caribbean coast of Panama. This is a really important worldwide known nesting area for two sea turtle species: leatherback (*Dermochelys coriácea*) and hawksbill (*Eretmochelys imbricata*), (*Carr 1956*, *Ordoñez 2007*). Soropta beach (9.477°N 82.453°W) is one of the most important beaches in the area with an average of 500 leatherback nests per season. During 2009 there was a 1,9km reduction in the beach length due to the Changuinola river rise. An alteration of the beach width during the nesting seasons from 2013 to 2017 has also been observed. This study wants to create a standardized and reliable method to understand which nests need to be relocated depending on their distance to the tide line and the beach zone where they are found; also define in which zone they should be moved to. The study area comprises 4,5km of the beach, divided into 100m long zones that are delimitated with markers from 20 to 75. During the nesting season (April-July 2017), we measured the variations of the beach width every 50m to determine what zones are more likely to have eroded or flooded nests during the season. To analyze the collected data, we assigned a risk value to each zone: high, medium, or low; that being based on the difference between the beach width during the low and high tides for each zone. In addition, the % of nests hatching success related with the zone where they were found has been analyzed. Knowing that the average % of leatherback nests hatching success in Soropta beach has been maintained at around 30% for the last years, we took that number as a reference to consider the nests high success (>30%) from a total of 86 nests. The results show the beach width varies from 106m to 0m; the presence of the three risk categories, being 3 low, 81 medium and 26 high risk zones of the total analyzed has also been recognized. From the total of high successfully nests, we only found 4% in a high risk zone. On the other hand, from the nests with 0% hatching success, 42% have been found in high risk zones, 58% in medium risk zones and 0% in low risk zones. With beach width measurements, we could determine that the high risk zones are between zone 56 and 75, so all the nests found between these areas should be relocated into a safer zone. The study safest zones are located between 20 and 34, where most of the hatching success % in the area is over 30%. Due to these results, we can consider that these zones are the most adequate to be relocated at. All the nests found in a higher distance from the minimum beach width in each zone should be relocated, given that during the high tides these nests would be under the tide line, and the probability of erosion or flooding rises.
With this study, we could establish criteria to determine which nests should be relocated depending on each zone's risk. However, the risk to have eroded or flooded nests mainly depends on their distance to the tide line. With this information, and studying the modifications of the beach during the nesting seasons, a more adequate relocate protocol could be established so the nest hatching success % would be probably risen for future seasons.

FACTORS IN HISTORICAL HATCHLING PRODUCTION AND IMPLICATIONS FOR NESTING HAWKSBILL SEA TURTLES (*ERETMOCHELYS IMBRICATA*) ON MAUI

Luke Sundquist | Hannah Bernard
Hawaiʻi Wildlife Fund | Hawaiʻi Wildlife Fund

Hawaiʻi Wildlife Fund partnered with the responsible state and federal agencies in 1996 to protect and research the nesting hawksbill sea turtle (*Eretmochelys imbricata*) population on Maui. Since its inception, this program has identified six nesting beaches on the south coast of Maui and tagged 10 nesting females. While hawksbills are listed as critically endangered throughout their pantropical distribution, this is one of the smallest consistent known nesting populations with means of only 1.3 females and 4.1 nests per year. Approximately 9,000 live hatchlings have been protected since 1996, but there has been no significant change in the number of nests or females observed each year over this period. Each nesting season staff and volunteers search for new tracks at dawn, conduct night patrols to encounter and tag females, and provide nest protection, monitoring, and excavation. These activities maximize the survival of these rare females and nests and enable researchers to better understand and mitigate the threats to their success. This long-term, intensive study of each nesting female and nest provides a unique opportunity to examine the factors contributing to hatchling production. Only one hawksbill nested in 2017, a previously untagged female who laid four nests. Comparing this season to previous available data from hawksbill nests on the south coast of Maui from 1996–2016, clutches were larger (221–232 eggs in 2017 compared to the historical mean of 178.9), incubation times were shorter (54–60 days compared to the mean of 60.4) and hatching success was higher (71.5%–94.4% compared to the mean of 61.4% for *in situ* nests). Inspired by these differences, we reviewed fluctuations and trends in incubation times and nest results between each nesting female, beach, and year. By examining 91 nests that have been monitored and excavated over the last 22 years, we can determine the possible effects of variables including female size, age since first nesting observation, time of year, temperature, incubation time, and beach conditions on clutch size and hatching success. Understanding these factors and their implications for population recovery within the context of hawksbill research in Hawaiʻi will help to focus continued conservation efforts on Maui and throughout their global range.
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CLIMATE CHANGE ASSOCIATED SEA LEVEL RISE IMPACTS ON CYPRUS SEA TURTLES NESTING BEACHES USING DRONES, PHOTOGRAMMETRY AND RTK

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Climate change is recognised as a major driver of ecosystem transformation worldwide, likely to cause shifts in species ranges and phenology, and potentially threatening the survival of entire species and habitats. Global sea level rise, due to ocean thermal expansion and melting of glaciers and ice caps, will affect mostly low lying coastal habitats and species which depend on these habitats. Remote sensing is an essential tool for coastal habitat mapping and management, increasingly used by the scientific community to describe and survey a variety of systems on a local, regional or global scale. Concerns regarding the impacts of future climate change is further demanding an increase of highly accurate and cost-effective monitoring techniques.

The latest Intergovernmental Panel on Climate Change (IPCC) projections on sea level rise (SLR) range from 0.47 m (95% CI: 0.26-0.55 m) to 0.63 m (95% CI: 0.45 – 0.82 m) by 2100 (Stocker et al., 2013), while semi-empirical models, including ice melt, project even worse scenarios. Although the sea level has varied a great deal during the glacial/interglacial cycles, current SLR is happening at an unprecedented rate, potentially too rapidly for species to adapt to the new conditions. Mean SLR is expected to have more impacts on coastal tropical areas, aggravated by increased storm activity.

All marine turtle species depend on temperate to tropical low-lying sandy beaches for their breeding stage. Nesting turtles generally display philopatry to their natal beaches, meaning that they return to the beach where they hatched to lay their eggs. This makes them vulnerable to SLR and storm activity, as clutches can be lost to coastal erosion, or to flooding. Several nesting beaches used by sea turtles have already been assessed regarding potential SLR impacts, with studies predicting significant losses of terrestrial habitat, under median scenarios, ranging from 45 to 65%.

To estimate habitat loss due to SLR on marine turtle nesting beaches a range of methods have been employed. Basic methods as using beach profiles measured with an Abney Level to create digital elevation models (DEMs) which proved highly portable and low-cost. The estimates from this type of surveys, however, are subject to systematic errors and low accuracy. At the other extreme, is the use of terrestrial LiDAR (Light Detection and Ranging) which enables the creation of highly accurate DEMs of sea turtle nesting beaches, but generally the costs are prohibitive for most sea turtle conservation projects. A robust DEM of the current nesting habitat, where possible impacts can be projected, is nevertheless an essential tool for conservation managers and other stakeholders to make informed decisions, and prioritize conservation efforts to mitigate the consequences of SLR to sea turtle populations.

Structure-from-motion (SfM) photogrammetry using aerial photos from drones, is emerging as a common process to generate robust DEMs in geographic and geological sciences. It consists of taking multiple overlapping aerial photos and merging them into a 3D model by aerial triangulation. However, to achieve an accurate model it is necessary to use a differential GPS (dGPS), or a real time kinematic (RTK) system, to survey ground control points (GCP) in the field, making this more expensive. we developed a novel way to produce accurate DEMs at a relatively low cost and with highly portable equipment, by combining the use of drones and photogrammetry with an alternative RTK solution. We used the important sea turtle rookery at Alagadi bay, northern Cyprus, as a case study to demonstrate the application of our method to estimate the future impacts of SLR on the nesting habitat.

CAPTIVE BREEDING OF SEA TURTLES IN OKINAWA CHURAUMI AQUARIUM

Shingo Fukada | Isao Kawazu | Ken Maeda | Konomi Maeda | Masakatsu Kino | Mariko Omata | Masae Makabe | Takahiro Kobuchi

Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium, Okinawa Churashima Research Center | Okinawa Churaumi Aquarium | Okinawa Churashima Research Center | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium

Captive breeding is important for many pioneering research approaches and insights that have developed. Okinawa Churaumi Aquarium, located in Ocean Expo Park, Okinawa Prefecture, Japan, has the facilities for sea turtles reproduction and rescue since 1994. In these facilities, the captive reproduction of loggerhead (*Caretta caretta*), green sea turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), and black turtles (*Chelonia agassizii*), has been successful using wild adults. The turtles were kept in an outdoor holding tank (16.8 m × 10.5 m × 2 m) with an open-water system and a sandy nesting area (115 m2). Water temperature of the tank, measured daily, ranged between 20°C and 30°C across a 12-month period, which was similar to that of the waters near Okinawa Island. The turtles were fed at approximately 0–1-day intervals, with a diet that included fish, squid, cabbage, and Chinese cabbage in quantities equivalent to 2% of their body weight. Loggerhead, green, hawksbill, and black turtles have hatched since 1995, 1999, 2009, and 2017, respectively. As for loggerhead turtle, total number of laid eggs, total number of hatchlings, and average emergence success rate were 9018 eggs, 1151 hatchlings, and 11.6%, respectively. The corresponding values in green turtles were 6498 eggs, 2587 hatchlings, and 33.0%, those in hawksbill turtles were 3796 eggs, 563 hatchlings, and 14.8%, and those in black turtles were 116 eggs, 14 hatchlings, and 23.6%, respectively. We suggest that similarity of the environment of the facility to that of the wild may underlie the breeding success of the four sea turtle species. Further studies are required for improving the hatching rate, which would extend our knowledge about the reproductive biology and of sea turtles.

POPULATION DYNAMIC BETWEEN COASTAL JAGUARS (PANTHERA ONCA), SEA TURTLES, AND NEST PREDATORS IN TORTUGUERO, COSTA RICA

Stephanie Butera | Jaime Restrepo
Global Vision International | Sea Turtle Conservancy

Newborn sea turtles face a number of land and sea predators between the times the eggs are laid to when the hatchlings grow into larger juveniles. Nest depredation severely impacts the reproductive success of nesting sea turtles by reducing recruitment rates. Tortuguero beach hosts the largest population of nesting green sea turtles in the Caribbean and common nest predators include dogs, coati, and raccoons. Nest depredation within Tortuguero National Park (TNP) has decreased dramatically since Fowler’s study in 1979 where 24.5% of nests were depredated within park limits. This decrease in nest depredation may be linked to the increased jaguar population within TNP as the nest predator species are considered as some of the jaguars’ natural prey. Although jaguars prey on nesting female turtles, they also control the populations of nest predators by patrolling the length of the beach, deterring nest predators from foraging in their territory. Global Vision International (GVI) and the Sea Turtle Conservancy (STC) created a partnership in 2005 to study sea turtle nesting in TNP. STC patrols the first 5 miles of the beach surrounding Tortuguero town, while GVI patrols the last 3 miles in Jalova at the southern limit of TNP. The locations and frequency of encounters of nest predators from incidental forest and beach surveys conducted by GVI in Jalova from 2010-2017 were examined to investigate whether changes in jaguar feeding behavior had an effect on their spatial distribution. Two patrols of the beach were conducted, a morning patrol to assess the nest depredation and destruction as well as a night patrol to mark nests in order to assess the hatchling success. The night patrols run through the green turtle nesting season from June 9th to October 31st and the morning patrols continue until December when the last marked nest is excavated. Night patrols during this period in 2017 marked a total of 201 nests between 0-5 miles and 72 nests between miles 15-18. The entire 18 miles of beach is surveyed once a week on Saturdays by a member of the STC to track the number of turtles predated by jaguars. The hatchling success, frequency of nest depredation and the number of adult turtles lost to jaguar depredation from 2010-2017 were examined to look for a relationship between nest predator and jaguar populations and how this relationship may affect sea turtle recruitment. For this study, the frequencies of nest depredation, and of adult turtles killed by jaguars were used as proxies to estimate the decline/growth of populations of nest predators and jaguars respectively. This study will produce a protocol to investigate the predator-prey relationship between jaguars, nest predators, and nesting female sea turtles, with the aim of assessing the impact that jaguars have on the turtle's populations. Lastly, this poses implications for the management of TNP as jaguars and sea turtles are species at risk, and the economy of Tortuguero town is largely dependent on ecotourism with these as keystone species.

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IMPACT OF SYMPATRIC GREEN SEA TURTLE AND LOGGERHEAD NESTING ON A HIGH DENSITY BEACH

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Marine turtles exhibit nest fidelity, providing compelling reasons to conserve nesting beaches. Conservation of these nesting beaches involves understanding how species interact with the environment and each other, and understanding how changes can affect the suitability of the nesting habitat. The Archie Carr National Wildlife Refuge (ACNWR) is unusual in its high density of sea turtle nesting from two species, green sea turtles (*Chelonia mydas*) and loggerheads (*Caretta caretta*). The ACNWR in Melbourne Beach, Florida was established in 1991 as a result of the University of Central Florida Marine Turtle Research Group's research efforts documenting the high density of loggerheads there, but in the time since it was established we have observed a significant increase in density of green turtle nesting, from fewer than 50 nests in 1982 and over 15,000 in 2017 within a 21 km stretch of beach. With such a high density of these two species in one relatively small area, the two species may compete for space. This is especially true for green turtles, which disturb large amounts of sand during their nesting process; in 2017, we observed 338 clutches disturbed by nesting females during nesting surveys, nearly all of which were disturbed by green turtles. Using observed spatial and temporal nesting patterns for both green turtles and loggerheads on the ACNWR, we examined the effects these species may have on each other now and in the future. Green turtles and loggerheads nest in different densities along the length of the ACNWR, with green turtles more concentrated in the southern portions of the Refuge. Finally, green turtle nesting begins and peaks approximately one month later on the ACNWR than loggerhead nesting. For each of these metrics, there is both considerable overlap and distinct separation between the two species. By using these metrics in a modeling approach, we estimate the probability of nest destruction by a subsequently nesting female, and how these probabilities change over time with a growing green turtle population. Evaluating the carrying capacity of this beach is important in the context of habitat disturbance, including climate change and an increase in storm frequency, and to inform adaptive management strategies for effective conservation.

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EVALUATION OF REPRODUCTIVE OUTPUTS AMONG CLUTCHES OF THE SAME INDIVIDUALS IN A SEASON: A FIVE YEARS STUDY ON DALYAN BEACH, TURKEY

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Reproductive output of breeding activities provides fundamental data for conservation and management of sea turtles. Turkish Mediterranean Coasts include important loggerhead sea turtle nesting beaches and marine habitats for loggerhead turtles and such monitoring studies were performed annually in some important nesting beaches. Dalyan beach is one of these important nesting beach of loggerhead turtles, and monitoring studies has been conducted since the end of 80's. In this context, reproductive outputs are well known while there is no data about internesting interval and nests information of a single females in a nesting season for Dalyan beach. With this respect, we combined the data about tagged individuals and their nests information during 2013-2017 nesting seasons. In this study, we used the data of individuals which have at least two nests in a nesting season. According to our data, a female made up to four nests we have recorded. The mean clutch size was 69±2.29 eggs (range: 24-120) per nest for each individual nests. The nesting interval is calculated as 12.91±0.205 days (range=9-17days). Moreover, the average egg numbers of the first nests (74.65 eggs), the second nests (65.83 eggs) and third nests (63.96 eggs) are shown variation of CSIS and we found a statistically significant decrease in the egg number (Pearson's correlation: r=-0.164; p=0.022). The distance to sea and hatching success are not shown statistically significant differences among clutches of the same individuals in a season, although we found statistically significant differences between incubation durations among nests. Our results suggest that the first clutches of loggerhead turtles produce more hatchling then the later season clutches. Loggerhead turtle nesting activities start during May but conservation and monitoring studies are usually start in June in Turkey which may cause a loss of important amount of loggerhead turtle nests during early season. Thus, starting date of conservation studies should be scheduled to the beginning of May in Turkey.
Keywords: Loggerhead turtle, clutch size, interesting period, Dalyan beach, Turkey.

GREEN TURTLE NESTING ACTIVITIES AT THE WESTERNMOST MEDITERRANEAN COAST OF TURKEY: A NEW GREEN TURTLE NEST RECORD FROM GOCEK, TURKEY

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Two sea turtle species; the loggerhead turtle (*Caretta caretta*) and green turtle (*Chelonia mydas*) regularly nest Mediterranean coastline of Turkey. Loggerhead turtle nesting is observed along the Mediterranean coast of Turkey but main loggerhead nesting beaches are located on the western Mediterranean beaches. Green turtle nesting is mainly localized on the easternmost beaches in Turkey and Turkey has the majority of green turtle nests in the entire Mediterranean with over 60% of the total nests. Nesting activity of green turtle is also regularly observed with very low density in some beaches in Antalya and but our knowledge about western beaches of Turkey on green turtle is limited. We only have foraging green turtle observations and stranding data from the western Mediterranean coasts of Turkey. Only two green turtle nests were reported from Dalyan (2001) and Fethiye (2010). In addition, a green turtle nest was reported from Rhodes Island, Greece, which is located 90 km southwest of Fethiye, in recent years. All previous reports were given from a nesting beach. During 2017, we located a green turtle nest in Göcek on a small beach (36°44'41.93" N, 28°55'29.50" E). Göcek is located in Fethiye-Göcek Specially Protected Area (SPA) with numerous small bays with small beaches and any sea turtle nesting activity was not observed in the previous years in the area. A total of 109 eggs were counted in the nest. A total of 46 hatchlings were produced, while dead embryos in different stages were found 63 eggs. The nest depth was less than average green turtle nests (55 cm). Stranded green turtles from different age classes reported from Fethiye-Göcek SPA in previous years but nesting activity is an unusual observation for this species. Göcek beaches are narrow in width and shorth in length and these small beaches can be evaluated as unsuitable for green turtle nests in compression with eastern Mediterranean beaches. In contrast, having green turtle nests in the area and its close vicinities might be a sign for potential nesting area for green turtles, especially considering the possible temperature changes related to climate change in the future.
Keywords: Green turtle, Sporadic Nesting, Specially Protected Area, Göcek

EARLY NESTING OF LOGGERHEAD TURTLES IN TURKEY: AN EVIDENCE OF INCREASING MALE PRODUCTION

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Sea turtle nesting activity starts in mid or late May according to the past 30 years data in Turkey's nesting beaches. However, an obvious shift of starting date of nesting activities was observed in the last ten years in Turkey. The very first nests of the season were observed on Dalyan Beach in the Mediterranean in recent years. Dalyan Beach is an important loggerhead turtle nesting beach with a length of 4.5 km. Despite it's relatively short length, it represents different characteristics along the beach which may allow us to examine the effects of natural and anthropogenic factors on sea turtle nest temperatures.

In this study, we recorded nest and sand temperatures in different sections along the beach and we estimated sex ratio of loggerhead turtle hatchlings during 2017 breeding season. We used the mean temperature during the middle third of the incubation as it is a good indicator of the sex ratio of the clutch. Temperature devices placed in 53 nests from May to August. In addition, eight devices placed in four different section (four devices placed at 20 meters from the sea and four devices placed five meters from the sea) and sand temperatures recorded from the beginning of May to end of September. The mean nest temperature during the incubation were 30.28±1.098°C (ranged from 27.40 to 32.22°C), while the mean temperature during the middle third was 30.70±1.279°C (ranged from 27.23 to 33.19°C). The mean sand temperature showed statistically significant difference in different sections. The sections at the both sides of the beach had higher mean sand temperatures and then the middle of the beach at 5 meters, while the mean temperature in the middle sections of the beach is lower than the both end of the beach at 20 meters. The mean distance of the nests from the sea was 19.6±4.98 meters (ranged from 10.0 meters to 34.3 meters). The mean incubation period as 54.1±6,60 days and the mean clutch size was 67.7±23,20 in the studied nests. Incubation period showed negative correlation with the mean temperature over the season. We analyzed the results for calculating sex ratios spatially and temporally. Although sand temperatures showed significant differences in different sections of the beach, no statistically significant differences were found in the mean nest temperatures among the studied nests. However, the mean temperatures in the nests were significantly different over the nesting date. 64% of the hatchlings produced on the Dalyan beach during the 2017 breeding season were female and female ratio varied between 21.63% and 96.06%. These results show that Dalyan is producing relatively high proportion of male hatchlings. The nests laid in early season produce more male hatchlings than later season: Early May (64.27%), late July (28.16%). Our results show that nesting date has more influence on incubation temperature than any other factors on Dayan Beach. First nest of the season was observed in April in three nesting seasons and the number of nests laid in late April and early May has increased in the last ten years (r^2 0,43). This may suggest that loggerhead turtles are nesting earlier for having more male hatchlings in a breeding season and more attention should be given.

Keywords: Sex Ratio, Nest temperature, Temporal and Seasonal Variation, Nesting Date Shift, Turkey

SEA TURTLE NESTING ACTIVITY ALONG THE MAURITANIAN COAST

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Until the onset of the 21st century, sea turtle nesting activities along the Mauritanian coast (West Africa) had been rarely mentioned in the available scientific literature. In order to fill this knowledge gap we have conducted a 7-year long sea turtle nesting study along the Mauritanian coastal area in different seasons between the years 2010 and 2016. The data collected during our field study provides the first evidence of occasionally high *Chelonia mydas* nest concentrations in the southern area of the Mauritanian coast. In the period between 2010 and 2013, nesting events along the Mauritanian coast seemed to be sporadic and spatially scattered. In 2011, we recorded our first *C. mydas* nest, which was located on the beach near the Diawling National Park. It was translocated to an enclosure at the Mouily locality and is the first attempt to establish an optimal translocation procedure in the entire Mauritanian coastal area. In 2014, a total of 127 *C. mydas* nests or nesting activities were recorded, of which 99 were inspected in detail. The majority of the nests were located on the beach between the 28th and 65th km south of Nouakchott city (Mauritania's capital). Embryos from most nests were estimated to be within 30 days of their emergence. However, only three were estimated to be at the start of their embryonic development. In 2015, one *Caretta caretta* and 25 *C. mydas* nesting activities were recorded whereas during the end of the nesting season in 2016, our team recorded 39 *C. mydas* nesting activities in the southern Mauritanian coastal area. In addition, numerous tracks of the African golden wolves, ghost crabs and humans were recorded around the located *C. mydas* nests. Some of the nests, with the remains of their content scattered around their nest chambers, were evidently dug out by wolves. Overall, the collected evidence indicates the presence of predation and poaching activity on *C. mydas* nests at the Mauritanian coast. This project was funded by the US Fish & Wildlife Service (Marine Turtle Conservation Fund) and the Federal Government Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit; GIZ). The travel grant for attending the ISTS 2018 symposium in Kobe (Japan) was supported by Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku and the US Fish & Wildlife Service.

SCOTT REEF GREEN TURTLES FACING AN UNCERTAIN FUTURE

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Scott Reef (14.059033S, 121.778081E) sits on the north-western edge of the Australian continental shelf. Green Turtles nesting at Scott Reef form a distinct regional management unit that includes the nearest island, Browse Island, 190 km to the East. The region is rich in hydrocarbon reserves. Scott Reef was visited eight times between 2006 and 2010 to assess the abundance and seasonality Green Turtle nesting. More than 550 Green Turtles were tagged while nesting on Sandy Islet, Scott Reef. This unvegetated sand cay is approximately 700 m long with 400 m remaining exposed during spring high tides and with a width of 60 m. Surveys in 2006 and 2007 established the population nested in the austral summer months. Colour-coded marking of nesting animals with subsequent in water identification of marked and unmarked individuals by manta board transects, hand-held bathyscope and deck-based observations enabled Peterson Estimates of the nesting populations in 2008-‘09 and 2009-’10 seasons. Turtles were painted with alphabetical and numeric symbols in day-specific colours as they returned to the water. An additional colour on the head indicated if the turtle successfully laid. At least one titanium tag was attached to the trailing edge of the front flipper. In addition, satellite transmitter tags were attached to 12 nesting turtles in the 2009-’10 season.

Estimates of the population in the 2008-‘09 and 2009-‘10 nesting seasons were 779 ± 383 and 79 ± 25.0 (mean ± se) respectively. The frequency of sightings of individuals in this latter season produced a Chao’s Moment Estimation of 76 with 95% limits of 36.4 to 224.2. Carapace dimensions of Green Turtles at Scott Reef were on average smaller than other Green Turtles reported from Australian populations. The curved carapace lengths of nesting females varied from 82.8 cm to 117.3 cm (mean ± sd. = 97.7 ± 5.36 cm; n = 538). Curved carapace widths varied from 73.0 cm to 106.0 cm (mean ± sd. = 88.5 cm ± 5.56; n = 549).

During the 2009-’10 survey, 87 kilometres of manta tows around Sandy Islet reef to identify internesting habitats resulted in 145 sightings of Green Turtles (42% immature, 6% males, 52% short-tail adults including 18.6% tagged females). Several females were sighted more than once with one individual sighted three times in two different locations on three separate surveys. Satellite location fixes were concentrated in the southern edge of Sandy Islet reef where the water depth ranged from 5 to 10m. Two individuals travelled up to 15 km across the lagoon but all internesting habitats were confined to the southern lagoon at Scott Reef.

Scott Reef sits above a large hydrocarbon reserve which when extracted will likely lead to Sandy Islet sinking due to the compaction and compression by the rock strata overlying the pockets of gas and oil. The survival of the island appears bleak when faced with the prospect of global warming, increased tropical cyclone activity, sea level rise, periodic thermal expansion of surface waters and in 2016, the second massive coral bleaching episode in two decades.

ENDANGERED GREEN TURTLES (*CHELONIA MYDAS*) OF THE NORTHERN MARIANA ISLANDS: NESTING ECOLOGY, POACHING, AND CLIMATE CONCERNS

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Marine turtles in the western Pacific remain threatened by anthropogenic impacts, but the region lacks long-term biological data for assessing conservation status and trends. The Central West Pacific (CWP) population of green turtles (*Chelonia mydas*) was listed as Endangered by the U.S. in 2016, highlighting a need to fill existing data gaps. Here, we summarize 11 years of nesting ecology research on green turtles in the Commonwealth of the Northern Mariana Islands (CNMI). Further, we model annual nester abundance trends, impacts from poaching, and the influence of nest temperature on reproductive success. In 2006-2016, diurnal nesting beach surveys, nocturnal identification tagging surveys, and nest excavations were conducted on index beaches on Saipan; rapid diurnal assessments were conducted on Tinian and Rota. Nesters were measured and tagged. Temperature data-loggers were deployed inside nests on Saipan. Evidence of poaching was recorded. These surveys document year-round nesting with a peak in March–July. Annual nester abundance across the three islands in 2012-2016 was 10-20 individuals, with at least 49-119 nests per year. Annual diurnal survey effort averaged 99 days per index beach on Saipan, and 1-2 on Tinian and Rota. For 39 individuals tagged, average straight carapace length (SCL) was 95.6 cm, remigration interval was 4.6 years, and growth was 0.26 cm yr^{-1}. Reproductive parameters included (on average) clutch frequency of 7 nests per female, inter-nesting interval of 11.4 days, clutch size of 93 eggs, incubation period of 55 days, hatching success of 77.9%, and emergence success of 69.6%. Mean nest temperature was 30.9°C, suggesting a possible female-bias already. Models suggested (i) hatching success decreases and embryonic death increases with maximum nest temperatures beyond 34°C, and (ii) embryonic death increases beyond mean nest temperatures of 31°C. On Saipan, 32% of nesters were poached, reducing the annual population growth rate from 11.4% to 7.4%. This study provides the first comprehensive characterization of a nesting green turtle population in the Mariana Archipelago, as well as the insular western Pacific, and provides baseline data for the endangered CWP population. Reproductive demographic data are critical for endangered species management, including assessments of population status and fisheries impacts.

THE SPORADIC NESTING SITES OF LOGGERHEAD AND GREEN TURTLES ON WESTERN ANATOLIAN COASTS

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In the Mediterranean, the main nesting sites of loggerhead and green turtles are located in Greece, Turkey and Cyprus, and both species use the Turkish Mediterranean Coast as a nesting beaches. In the 90's, 16 nesting beaches had been identified in Turkey while there are 21 beaches identified as sea turtle nesting beaches with a total length of 290 km. in recent years. The Loggerhead turtles nest mainly western beaches and the green turtle nest on the eastern beaches. Some of these beaches have been regularly monitored by different group of Volunteers and supervised by the University researchers while the rest of them are occasionally monitored for each nesting season. However, there is not any monitoring studies in many nesting sites in Turkey and other countries due to low or sporadic nesting effort, making it difficult to publish this information. We aimed to focus on sporadic nesting site importance, we searched western coasts of Mediterranean Sea and Aegean Coasts between 2015 - 2017 nesting season and we explored sporadic nesting sites for loggerhead and green turtles. The results of the nesting site surveys, we found 15 nests for loggerhead turtle and one nest for green turtle belong to eight different nesting site. Most of the nests (7 nests) is observed in Kabak beach where is located on Muğla province and 22 km away from Fethiye nesting beaches by bird's eye view. The other nests are observed Fethiye - Butterfly valley- (1 nest), Marmaris- İçmeler (1 nest), Muğla – Ören (1 nest), Aydın- Kuşadası (4 nest), İzmir-Urla (1 nest) and Çanakkale-Babakale (1 nest). In addition to these only one green turtle nest was observed in Göcek Bay (Muğla). Moreover a few non-nesting emergences were found in some beaches of Aegean Coast (ie. Gümüldür beach) and will be randomly monitored the following nesting seasons. With this study, the first green turtle nest is recorded in Göcek Bay, is located south western coasts of Turkey while the new sporadic nesting sites were found south western Mediterranean coasts of Turkey and Aegean coasts of Turkey. Furthermore, the northernmost nesting site was found in Çanakkale province (39° 30.675' N, 26° 05.024' E). Thus, this information supported the idea that is sea turtles to seek out alternative sites the reason of climate change and associated sea level rise.

Keywords: Sporadic nesting site, Loggerhead turtle, Green turtle, Anatolian Coasts, Turkey

ENVIRONMENTAL CORRELATES OF ARRESTED EMBRYONIC DEVELOPMENT IN LOGGERHEAD AND GREEN SEA TURTLES

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Understanding the variables that affect reproductive success in sea turtle populations provides insight into future conservation. Evaluations of sea turtle reproductive success include nest inventories that document the number of hatched and unhatched eggs in a clutch. Some unhatched eggs often contain partially developed embryos, but it is unclear why these eggs stopped developing. Arrested embryonic development is the term given to an embryo that stops development. To investigate arrested embryonic development in loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtles, we used nest inventory data from a long-term (1988-2017) monitoring program at Archie Carr National Wildlife Refuge (ACNWR) in Melbourne Beach, Florida, USA. Preliminary analyses for both species show that the likelihood of an egg experiencing arrested development varies significantly between nesting seasons, and is trending upward over time. Since environmental conditions likely vary between nesting seasons, there may be environmental explanations for the variation in the proportion of eggs experiencing arrested development. We assessed possible environmental conditions that could lead to arrested development at partial embryo stages by using mixed effect logistic regression models. We expected arrested development would be more likely in nests with stress from either extremely high incubation temperatures or lack of oxygen from tidal inundation. To test these hypotheses, we considered several potential environmental correlates, including rainfall, air temperature, drought, and tidal washover, all of which may alter the incubation environment. We used reproductive evaluations from over 3000 loggerhead nests and over 2000 green turtle nests laid from 1988 to 2017 in our analyses.
With a changing climate, it will be necessary to understand what effects environmental conditions may have on the incubation of sea turtle nests. The southeastern United States has already documented increasing temperature over the past 30 years. If temperatures continue to increase, nest incubation temperatures might also increase past the point of viability. The number of severe storms are expected to increase due to climate change, which could lead to higher seasonal tides and a narrower beach due to erosion. Sea level rise could also limit beach space. A narrower beach and higher tides would increase tidal washover and inundation of sea turtle nests. All of this could lead to higher likelihood of arrested embryonic development of sea turtle eggs, and therefore lower reproductive success. By understanding the effects these changes may cause, we can be better able to predict the future conservation needs for sea turtle populations.

EFFECT OF SAND TYPE AND NEST PLACEMENT ON LOGGERHEAD (*CARETTA CARETTA*) AND GREEN SEA TURTLE (*CHELONIA MYDAS*) HATCHING AND EMERGENCE SUCCESS

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Sea level rise and severe storms threaten coastline. Management efforts implemented to mitigate these threats include artificially restoring vulnerable dunes. Such restoration projects relocate sand in order to restore severely damaged dune locations, potentially altering the physical properties of the beach. The success of sea turtle hatching strongly depends on the abiotic properties of the environment. One important nesting site for sea turtles is the Archie Carr National Wildlife Refuge (ACNWR), on the Florida Atlantic coast, USA. Following hurricanes and other extreme weather events, dune restoration efforts are undertaken by local governments and communities in order to preserve properties close to the beach. To better understand the impact of sand placement projects on the viability of sea turtle nests, we assessed the effects of sand type and nest placement on emergence and hatching success of loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*) using mixed effects logistic regression models.

We analyzed data from 842 loggerhead and 889 green turtle nests laid between 2010 and 2017 on the ACNWR. Nest placement was classified using three categories for distance to the dune: ‘before’ (>1 m seaward of the base of the dune), ‘transition’ (within 1 m of the base of the dune in either direction) and ‘on the dune’ (>1 m inland of the base of the dune). Differences in sand type were also indicated; with native sand classified as ‘natural’ and imported sand classified as ‘nourished’. Green turtles nested more frequently in areas where nourishment occurred when compared to loggerheads. Specifically, 26% of green turtle nests were laid in nourished sand, while only 15% of the loggerhead nests occurred on nourished locations between 2010 and 2017. This could be attributed to the tendency of green turtles to nest closer to or on the dune. Storms remove large amounts of sand from the beach, causing nests laid in locations further from the dune to be more at risk of wash outs during storm seasons. However, because most local nourishment projects occur to restore the dunes, future nests laid ‘on the dune’ or in ‘transition’ would be expected to experience greater impacts from nourishment projects. This study provides further insight into the effects beach nourishment projects have on sea turtle reproductive output, including expanding our understanding of how such projects impact hatching and emergence success, in order to address and reduce impacts.

ARE THE THREATS TO EMBRYONIC DEVELOPMENT OF WARMER INCUBATION TEMPERATURES COMPENSATED BY LOWER NEST PREDATION RISK?

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Incubation temperature influences the embryonic development of sea turtles, affecting survival, defining the sex ratio and predicting the offspring fitness. Extreme temperatures may lead to total feminization of the clutch or compromise the embryos viability. However, sea turtles selects warm beaches for nesting in many occasions. For example, in Cape Verde there is a great heterogeneity of sand coloration on the beaches, and thus a great variability on incubation temperatures. In some islands, there are contiguous beaches with very different sand colors However, females are not avoiding dark sand beaches and nest in both dark and light sand beaches. We hypothesize that black sand beaches can have benefits to embryonic development that compensate the negative effects of warmer incubation. Predation or beach flooding are very important threats to sea turtle nests, and these threats could be lower on dark sand beaches, thus compensating the negative impacts of warmer incubation temperatures.

In Cape Verde ghost crabs (*Ocypode cursor*) has been observed intensively predating on loggerhead nests in white sand beaches. Moreover, many important nesting beaches are very flat and vulnerable to inundation. In the island of Maio, that host around 10% of loggerhead nesting, there are nesting beaches with many different sand colors within few kilometers of coastline. We have studied in Maio island the nest abundance, the predation risk and other causes of mortality on loggerhead nests, comparing beaches with strong differences on sand color and thus, incubation temperatures.

Darker beaches proved to be the least suitable beaches to incubate loggerhead sea turtle nests, with almost 80% of mortality rate. The light beaches revealed to be the most suitable for nesting, by showing the lowest mean mortality rate. Inundation and predation of nests were severe impacts on loggerhead nests. As expected, incubation temperature was significantly higher in dark sand beaches compared to light sand beaches. Sand color of beaches had no influence on inundation risk, but predation risk was clearly related to the color of the sand. However, and contrary to what was hypothesized, the density of ghost crabs and the predation risk on nests was significantly higher on dark sand beaches. The mixed beaches stood out for its opposite results, by recording the lowest crabs' density and the lowest predation impact of all beach types. Thus, the predation or inundation risks are not lower in dark sand beaches, not compensating for the negative effects of higher temperatures.

Though loggerhead turtles regularly come out to nest on dark sand beaches, nesting success and nest density is significantly affected by the sand beach color. Some seem to be actively avoiding dark sand beaches, thus, increasing their hatching success. Because nesting in dark sand beaches is still common, even when light sand beaches are available, these results reinforce the convenience of relocating nests from dark to light sand nesting beaches on endangered populations.

SEA TURTLES IN A LARGE SCALE TOURIST RESORT: SUCCESSES AND CHALLENGES OF CONSERVATION IN PUERTO VALLARTA, MEXICO

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Coastal development represents one of the multiple threats currently facing sea turtle species Worldwide. Extensive tourism-based development and the infrastructure that accompanies these developments has been shown to reduce the quality of sea turtle nesting beaches. This is especially true for species that nest high up on the beach dune. However, some species may be more adept at coping with coastal modification. Here we present data from olive ridley nesting beaches in Puerto Vallarta, Mexico. Puerto Vallarta was promoted in the 1970s as an important international tourism destination with a focus on the North American market and currently offers some 11,700 rooms 78% being targeted at beach & sun tourism. The majority of beaches were developed well before sea turtle protection laws were implemented and this resulted in the destruction of dune systems and construction of beach modifying breakwaters. Despite this Puerto Vallarta's beaches are an important nesting area for olive ridley sea turtles. We present nesting trends from four nesting beaches (Boca de Tomates, El Salado, Playa de Oro and Playa Gemelas) from 2012-2017. We also compare our data with that found in grey literature sources from 1998-2011. The number of protected turtle nests shows a general increase over the last five years and increased interest from hotels has helped protect a greater number of nests. That said, as nesting increases challenges include protecting nests from illegal poaching, erosion and finding adequate sites for the construction of hatcheries on high use beaches. With the current population (2015: 275,640) of Vallarta expected to grow to 304,141 people by 2020 it is imperative that management plans are created and reviewed with all participants (NGOs, Private Business, and government) work together to ensure the successful coexistence of sea turtles and humans.

Keywords: *Lepidochelys olivacea*; Jalisco; Mexico; Tourism; Conservation; Coastal development.

USING CURRENT TECHNOLOGY FOR MARINE AND NESTING SURVEY IN BANGLADESH SEA TURTLE PROGRAM

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Marinelife Alliance | Marinelife Alliance

Researcher of Marinelife Alliance in Bangladesh using current latest devices to explore and measure the nesting habitat. The diverse nesting beaches along Bangladesh coast at various locations apart geographically are very difficut to hike and travel by boat and time onsuming and not practical in reality due to lack of facilities and logistics and funding. But the scientific innovations exoanded the opportunity and drones of moderate capabitilities are being used where people can not travel.

UNUSUAL GREEN AND OLIVE RIDLEY NEST EVENTS IN CAPE VERDE IN THE LAST 15 YEARS

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The Cape Verde archipelago is constituted by ten volcanic islands and several islets located in the Atlantic Ocean, 600km west of Senegal, between 14°45'–17°10' N and 22°40'–25°20' W. The archipelago is spread over 58,000 km^2 of ocean with about 1050km of coastline.

Cape Verde is included in the African Sahelian arid and semi-arid climatic region, which presents a wet season of one to three months. The archipelago experiences climates ranging from tropical dry to semi-desertic and presents large white sandy beaches that host the nests of the third most important rookery of loggerhead turtle (*Caretta caretta*) in the world. Each year from middle June to middle October, approximately 3.000 loggerhead females, use the Cape Verde pristine beaches to lay an average of 15.000 nests, ranging from 6.000 to 30.000 nests, mainly in the eastern islands (Boa Vista, Sal and Maio Islands).

In Cape Verde, marine turtle conservation started in 1998, monitoring the most important nesting beaches for loggerhead turtle located in the *Reserva Natura das Tartarugas* (RNT), Boa Vista Island. Since 2008, several NGO and local associations arrived or were developed in the arquipelago achieving conservation activities in all the islands. Actually, daily census were conducted in main beaches of each one of the island observing important fluctuations in the number of nests deposited by loggerhead turtle each year.

In the archipelago it is also common observe juveniles of green (*Chelonia mydas*) and hawksbill turtle (*Eretmochelys imbricata*) feeding in shallow and protected bays. Genetic analysis has shown that over 30% of green juveniles located in Cape Verde are hatched on the American continent and undertake transatlantic migrations, and the rest come from rookeries located on West Africa coast, Brazil and Ascension Island in the South Atlantic. Hawksbill juveniles also originated from several rookeries, such us the endangered population of the Gulf of Guinea archipelagos, the Caribbean and western Atlantic populations. In the last years several individuals of Olive Ridley (*Lepidochelys olivacea*), adults and sub-adults, has been stranded in Cape Verde shores, usually emaciated and very debilitated.

The island of Poilão in the Bijagós Archipelago (Guinea-Bissau), is one of the most important nesting sites for green turtles in the Atlantic, and the largest known nesting colony on the west coast of Africa. Also in this area a significant nesting rookery of olive ridley turtles has been detected although with a much lower number of nests. The sporadic nesting of olive ridleys, as well as hawksbill, green and loggerhead turtles, has been documented along the continental coast from Mauritania to Guinea-Bissau.

In the last 15 years, several sporadic nest evens of green and olive ridley turtles have been observed in Cape Verde, mainly in Boa Vista, Sal and Maio Islands. This work aim to compile all this “rare” events to analyse if a better detectability is occurring due to large number and more experimented groups working in turtle conservation in the archipelago, or because both species, generally tropical nesters, are looking for colder beaches or changing their distribution in relation with global warming.

EFFECT OF STREETLIGHTS IN THE ORIENTATION AND SURVIVALS OF HATCHINGS OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) INCUBATED AT BEACHES OF MAZATLAN, SINALOA, MEXICO.

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In the Mazatlan Sinaloa beaches, throughout the year, nests are recorded of olive ridley turtle (*Lepidochelys olivacea*); although their highest nesting occurs in August, September and October, coinciding with the rainy summer and autumn months as the humidity and heat in the sand are indispensable for both the nesting and the optimum hatching of their eggs. These animals are in danger of extinction and are in the Mexican standard SEMARNAT 059, due to the consumption of their eggs and meat, as well as, the loss of their nesting areas for tourism use, pollution and strong meteorological phenomena combined with global warming. Although there is a conservation program, whose objective is to protect the eggs, some are not able to relocated, staying on the beach at the expense of innumerable problems, such as those mentioned above, causing serious effects on their hatching, birth rate and survival. Many of these nests are located after hatching by tracking the imprints on the sand, either in direction to the sea or towards the nearest light source, which attracts them by the effect of positive phototropism. Nests are analyzed and the data obtained are hatching rate and causes of mortality. This action also leads to save hatchings and embryos live that were trapped inside the nest; on the other hand, the tracking and drawings of the footprints that the breeds leave in their trajectories on the sand, allows us to structure a behavior map of the hatchings and to know the survival or number of organisms that reached the sea.

MONITORING OF BIOTIC AND ABIOTIC FACTORS ON TWO NESTING BEACHES OF LEATHERBACK TURTLE IN THE LAGUNAS DE CHACAHUA NATIONAL PARK, OAXACA, MEXICO.

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The efforts made by the community turtle camps on the coast of Oaxaca in favor of the conservation and protection of sea turtles represent one of the most important national strategies in terms of priority actions for recovery and conservation of the leatherback turtle (*Dermochelys coriacea*) population in the eastern Pacific. The Bahía de Chacahua and La Grúa beaches are priority nesting beaches of secondary importance that are found within the Lagunas de Chacahua National Park. Therefore, they acquire importance to generate knowledge of their physical and biological characteristics associated mainly with this specie.

The effects of climate change on sea turtles and the behavior of nesting beaches in terms of shape, size, location and their modifications over time are of paramount importance in identifying areas of vulnerability, as well as the gradual changes that harms or favors the nesting.

For this reason, it is useful to have information on the biotic and abiotic factors of nesting beaches inasmuch these characteristics can strongly influence the temperature of the beach and could help to explain the thermal patterns observed along those beaches, in the same way allows us to assess the vulnerability of those beaches to erosion, or to create detailed maps of nesting beaches.

The Fundacion Comunitaria Oaxaca A.C., Universidad del Mar Camus Puerto Escondido and community turtle camps, worked collaboratively during the nesting seasons 2014-2015 and 2015-2016, in order to monitor the biotic and abiotic factors of these nesting beaches. The results obtained allowed to make a comparative analysis of two consecutive years and a long term vision to continue monitoring, as well as the generation of knowledge about the dynamics of beaches and their relation with the nesting of leatherback turtles.

The abiotic factors that were monitored were: width and profile of the beach, temperature at the nesting beach, corrals and nests, dunes and vegetation type of the beach; the biotic factors analyzed were nesting density, hatching success, predators and man activities (sources of pollution, tourism, trade of eggs and meat).

Through the analysis of the monitoring profile of the beach, width and nesting density by zones, it was possible to verify the hypothesis that the shorter and more sloping beach areas are the preferred by the leatherback turtle for nesting on the coast of Oaxaca. Another factor to consider was the effect of the groundswell occurred in May of 2015, whose registries allow to observe up to 70% of the loss of beach because of the erosion, which coincide with the highest nesting density zones.

Temperature monitoring inside the corrals indicates that the use of 90% shade mesh is of utmost importance in the production of the largest number of live and healthy hatchlings. This strategy was adopted because previously by the high temperatures there was null production of hatchlings. The temperature varies depending on the angle of incidence and the location of the corral, but with the use of the shade mesh it was observed that on average the temperature decreases around 3°C.

It was also observed that the orientation of the seed line inside the corrals plays a fundamental role for the development of the embryos and for the thermosensitive period of the embryos. Based on this observation, it is recommended that it arise from the center of the corral and increase towards the sides in the form of a spiral, since according to observations the best incubation temperatures occurred in the center of the protection corrals.

NESTING BEHAVIOR OF BLACK SEA TURTLES FEMALES IN MICHOACAN, MEXICO

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The black turtle population in Michoacan is one of the most important in the Mexican Pacific and the beaches of Colola and Maruata historically have been the most important nesting beaches in the pacific coast of Mexico. The nesting activity in these sites begins in the month of August and extends until March with a peak of nesting activity in the months of November and December. The black turtles shares with other sea turtle species some reproductive characteristics (1) spawning of a relatively large number of eggs, (2) similar nesting behavior and (3) a marked fidelity to the nesting site. Several authors have described the nesting behavior in sea turtles (Green, 1983, Dobbs et al. 1999) in which at least six phases of nested behavior have been described (1) beach arrival, (2) nesting site search, (3) construction of the nest 4) oviposition 5) masking of the nest and 6) return to the sea. In this work, a qualitative and quantitative description of the nested behavior exhibited by black turtle nesting females was performed in Michoacán. On the other hand, an ethogram was constructed for the different phases of the nested behavior and the time invested in each of them. We observed the nested behavior of 60 black-turtle females during 29 nights from October 27 to December 3, 2014, preliminary observations were made to familiarize with the phases of nesting behavior and we use focal sampling and ad libitum sampling (Martín and Bateson, 1986). We identifícate a eight categories of nesting behavior in black turtle 1) beach climb, 2) nest site search, 3) body chamber construction, 4) nest chamber construction, 5) oviposition, 6) cover of the chamber of the nest, 7) nest masking, 8) return to the sea. The average time obtained from the black-turtle nesting process was 3:30 hrs (range = 2: 30-5: 30 hrs), which coincides with that reported by Green, 1983 for the black turtle population of the Galapagos island. Nested behavior phases were identified that are susceptible to disturbance, in which the black turtles aborts the nesting process and returns to the sea: During the ascent to the beach, selection of nesting site and construction of nest chamber. the cover of the nest chamber was the phase of nesting behavior where turtles spent less time (11 minutes + -0.57) (range = 6-20 minutes) and the phase where more nesting behavior was spent corresponded to nest masking with 72 minutes (+ - 2.95 minutes) (range = 36-96 minutes).

THE RIDDLE OF THE OLIVE'S NESTING STRATEGY - TWO DECADES OF SEA TURTLE CONSERVATION ON COSTA RICA'S SOUTHERN NICOYA SHEDS LIGHT ON THE CONDITIONAL NATURE OF SOLITARY AND ARRIBADA NESTING BEHAVIOURS MADDIE BEANGE,

Maddie Beange | ISABEL Naranjo | Randall Arauz
CREMA | CREMA | Fins Attached

Olive ridleys (*Lepidochelys olivacea*) are unique in that they exhibit two reproductive behaviours: solitary and arribada (mass synchronous) nesting. Past research on Costa Rica's Pacific ridley population, focusing on the two established arribada beaches Nancite and Ostional, have suggested that the majority of turtles nesting in arribadas are loyal to this unique behaviour. However, an overall understanding of the population's nesting ecology isn't possible without researching Costa Rica's extensive solitary nesting beaches and recently identified young arribada beaches. To investigate how olive ridleys utilize two nesting behaviours, we conducted nesting activity survey and flipper tagging programs during the nesting season at the following beaches: San Miguel (1998-2017), Caletas (2003-2015), Corozalito (2008-2017), Costa de Oro (2012-2017), and Bejuco (2016-17). Corozalito is a young arribada beach, whearas the other four are strictly solitary nesting beaches. Over the last decade 7722 solitary nesting turtles were tagged with inconel metal flipper tags on both forflippers, and a sample of 600 ridleys were tagged during Corozalito's 2016 and 2017 arribadas. Olive ridley nesting activity at the solitary nesting beaches remained constant, with the exception of a peak in 2017 of at least two thirds increase at all three sites. Corozalito has seen an overall increase in both solitary and arribada activity, with 2017 as a record year of 4 mass-nesting events, with the largest at an estimated 18,000 nesting females. Of the solitarily tagged turtles, 623 (8%) were recaptured – 465 (74%) nesting again solitarily, and 158 (25%) nesting in Corozalito, Ostional, and Nancite arribadas. In contrast, most of the 56 (9%) recaptures that had been tagged in Corozalito arribadas, with only 4 switching to solitary activity. The results of this study demonstrate a connection between solitary and arribada nesting beaches, and suggest a conditional reproductive strategy is a factor enabling the changing olive ridley nesting dynamics at southern Nicoya Peninsula beaches.

EFFECT OF INCUBATION TEMPERATURE FLUCTUATION ON LOGGERHEAD TURTLE HATCHLINGS

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Kochi University | Kochi University | Kochi University | Kochi University | Tokyo University of Agriculture and Technology | Haruno no Shizen wo Mamoru Kai | Kochi University

Sea turtle rookeries in Japan have been decreasing in recent years owing to environmental degradation. As such, it is necessary to relocate turtle eggs for artificial incubation and then to return the hatchlings to sea. However, a moderate management method has still not been established. Recently, we found that hatchlings from natural nests were more active in locomotor activity than those from incubators set at constant temperature. We questioned whether this difference was caused by a fluctuating incubation temperature under the natural condition. The purpose of this study was to determine how a fluctuating incubation temperature affects the hatching success, body size, and locomotor performance of turtle hatchlings.
We collected 40 loggerhead turtle eggs from each of 3 nests laid on the beaches at the Niyodo River mouth in Kochi Prefecture. Twenty eggs were held at fluctuated 29 ± 1.0 ^{o}C (fluctuated = F), whereas the other 20 were kept at a constant 29 ^{o}C (constant = C) in incubators. A temperature logger was set in the center of the incubator to record the temperature. After hatching, 4 hatchlings of mean body size in each experimental group were tested for their locomotor performance.
The hatching success (mean ± SD, %) from groups F and C was 75.8 ± 23.6% and 76.7 ± 26.0%, respectively. The incubation period (mean ± SD, days) of group F (50.0 ± 1.0 days) was shorter than that of group C (52.3 ± 0.7 days). The standard carapace lengths (mean ± SD, mm) were not significantly different between the 2 groups (F: 42.2 ± 0.4 mm; C: 42.5 ± 0.1 mm). The frequency of scute pattern abnormalities (mean ± SD, %) in group F (15.0 ± 21.5%) was higher than that in group C (8.0 ± 10.3%). Hatchlings from group F showed higher self-righting propensity than did those from group C. The hatchlings from both groups exhibited decreased swimming thrusts over time, with no significant differences between them.
These results indicate that a fluctuating incubation temperature is possibly related to the scute pattern abnormality and self-righting propensity. These differences in hatchling morphology and locomotor activity may be variable depending on the temperature fluctuation ranges; therefore, further research is needed before a sea turtle egg management method can be presented.

EFFECTS OF EMERGENCE ON LOGGERHEAD TURTLE HATCHLINGS

Sho Kosaka | Ryohei Fujimoto | Yosuke Kobayashi | Kanari Miyake | Shohei Kobayashi | Yoshinori Kumazawa | Tomomi Saito
Kochi University | Kochi University | Kochi University | Kochi University | Tokyo University of Agriculture and Technology | Haruno no Shizen wo Mamoru Kai | Kochi University

Sea turtle hatchlings exhibit an energetic state called “frenzy” when they crawl seaward after emergence from their nests, and then, swim offshore. As it helps them escape from predators in the vicinity of the coastal area, frenzy is known to be an important property for enhancing survival during their early life history. Previously, we analyzed the locomotor performances of hatchlings raised in artificial incubators when they were allowed to crawl over a sandy course of 3 m. Surprisingly, most hatchlings did not complete the running tests, and some of them never moved. We hypothesized that this was because of the lack of emergence as they were incubated in artificial incubators. To test this hypothesis, we examined how the experience of emergence from sand affected the locomotor performance of loggerhead turtle (*Caretta caretta*) hatchlings.

In 2017, two nests were collected on the beach alongside of the Niyodo River mouth, Kochi Prefecture, and 30 eggs from each nest were incubated in an incubator at a mean temperature of 29.0^{o} C. The first half of each clutch was buried in a sand tank at a depth of 30 cm with setting temperature at 29.0^{o} C, shortly before hatching by estimation from cumulative temperatures. The second half was allowed to hatch inside the incubator. After the emergence of hatchlings from the sand tank, the morphology, 3 m crawling tests, and self-righting propensity of the emerged hatchlings and those raised in the incubators were analyzed. The maximum and mean thrusts of swimming were measured at 0, 12, 24, 48, and 72 h after emergence using a swimming power-data acquisition system. To observe the effect of emergence on physiological status, blood lactate levels of untested hatchlings were measured at the beginning of the swimming tests.

The emerged hatchlings completed the 3 m crawling test, whereas none of the incubated hatchlings did so. The self-righting test revealed similar mean scores of 5.8 and 5.0 points for the emerged and incubated hatchlings, respectively. Swimming thrusts tended to be higher in the emerged hatchlings than those raised in the incubators especially 24 h after emergence. The mean thrust at emergence (0 h) was quite similar, 7.7 mN in the emerged hatchlings and 36.5 mN in the incubated hatchlings, and decreased to 25.7 mN and 14.2 mN, respectively. Mean blood lactate levels of the emerged hatchlings (9.5 mmolL^{-1}) were 3.4 times higher than those of the incubated hatchlings (2.8 mmolL^{-1}). Additionally, the blood lactate levels at 2 h of swimming decreased to 1.3 mmolL^{-1} and 1.2 mmolL^{-1} in the emerged and incubated hatchlings, respectively.

These results demonstrated that the locomotor performances and swimming activities of the emerged hatchlings were maintained higher than those of the incubated hatchings, despite considerable lactate accumulation in the former. These results suggested that emergence, namely crawling up through the sand, may play an important role in triggering frenzy in hatchlings.

ENVIRONMENTAL FACTORS INFLUENCING LOGGERHEAD TURTLE NESTING ON SANDY BEACHES IN KOCHI PREFECTURE

Yosuke Kobayashi | Ryohei Fujimoto | Sho Kosaka | Kanari Miyake | Kouki Tanaka | Tomomi Saito
Kochi University | Kochi University | Kochi University | Kochi University | Kochi University | Kochi University

Kochi Prefecture, located on the southern part of Shikoku Island in southwestern Japan, faces toward the Pacific Ocean with long stretches of coastal areas from east to west that are strongly influenced by the Kuroshio Current. Owing to these features, the beaches at Kochi Prefecture are a popular nesting ground for threatened loggerhead turtles (*Caretta caretta*), which reproduce in temperate areas worldwide. Kochi prefectural regulations have specified two protected beach areas for sea turtles. However, the sandy beaches and coastal areas along Kochi Prefecture have changed drastically owing to a shortage of sand caused by artificial alterations of sea coasts, rivers, and so on. The environments of sandy beaches have great effects on nesting sea turtle females and the hatching of juveniles. This study aimed to comprehensively understand the environmental factors influencing nesting numbers on the beaches of Kochi Prefecture and their current conditions.

Twenty-five beaches were chosen for survey on the basis of either of two conditions: 1) a designated protected area of sea turtles by the prefectural regulations; and 2) emergence of at least one turtle in the past 6 years. We investigated these beaches from July to October 2017 and recorded the following: distance, depth, height, slope, sand particle size, hardness of sand surface, and presence of vegetation zone, artifacts, and artificial light at the beaches. These factors were analyzed statistically.

As a result, sand particle size was found to be an important nesting factor. Because females are more likely to nest after emergence, the nesting success rate was high on beaches with finer sand grains. The length of beach was also an essential factor, as females needed to nest on those of more than 20 m. There were many beaches of insufficient length due to artificial influences, such as dike construction and the setting of wave-dissipating blocks. It is anticipated that increases in such environmental changes will make it difficult for sea turtles to nest, or that wave erosion will decrease the beach length required for nesting, thus further reducing the loggerhead population. It is important to continue the survey of loggerhead turtle nesting sites in the future in order to clarify the factors affecting their hatching success and to propose measures for beach conservation at Kochi Prefecture.

THE INVESTIGATION OF LOGGERHEAD NESTING ECOLOGY ON FUKIAGEHAMA, KAGOSHIMA, JAPAN

Masahiro Fukuda | Nobuhiro Nozaki | Takeshi Mori | Yuki Kotajima | Ryoya Sekio | Taichi Nakano | Naoto Shimizu | Sakurako Miyajima

Kagoshima University Sea Turtle Association | Kagoshima University Sea Turtle Association | Kagoshima University Sea Turtle Association | Kagoshima University Sea Turtle Association | Kagoshima University Sea Turtle Association | Kagoshima University Sea Turtle Association | Kagoshima University Sea Turtle Association | Kagoshima University Sea Turtle Association

Kagoshima University Sea Turtle Association has been conducting ecological surveys of sea turtles around Kagoshima City. At this meeting, we present the results of the May – September 2017 survey on landing, nesting, and hatchling success of loggerhead sea turtles at Fukiagehama, Kagoshima prefecture (2.5 km south from the lower Izaku River). To record landing and nesting, we started surveying Fukiagehama around 21:00 every night and recorded turtle tracks and characteristics of individuals (carapace length/width, epibionts, et al.). When a turtle nested, we recorded its location by using a Global Positioning System. This location information was used to find a nest when we conducted the hatching success rate survey. We estimated the hatching success rate by counting hatched and depredated eggs in a nest to determining the proportion of eggs that hatched. We will also present results comparing the 2017 results with the data our association has been collecting during 2000's. We discuss the results of re-sighting of individuals that was tagged at Fukiagehama, including their site fidelity and frequency. Our research is still in the process of developing, and we hope to receive valuable feedback and input from symposium participants.

BREEDING OF LOGGERHEAD SEA TURTLES IN INDOOR FACILITY AT THE PORT OF NAGOYA PUBLIC AQUARIUM

Yusuke Ando | Tsuyoshi Matsuda | Hitoshi Okamoto | Ken Sakaoka | Kiyoshige Kobayashi | Takashi Kasugai | Masanori Kurita | Hiroshi Nitto

Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium

Since 1992, the year of founding, the Port of Nagoya Public Aquarium has aimed to breed sea turtles in captivity. The aquarium constructed an indoor artificial beach that fulfills the optimum nesting condition of beach size, slope angle, and sand grain size. The artificial beach is connected to a tank with total water volume of 550 m^3, diameter of 13 m, and depth of 2.5 m. The water temperature of the tank was maintained between 22.5 °C during the winter and 28.5 °C during the summer. Diet was mixture of mollusks, fish, crustaceans, and vegetables. Amount fed were 0.1 to 8% of body weight. Blood characteristic analysis was used to assess the condition of sea turtle and determine the best breeding protocol. Development of suitable breeding condition resulted in frequent observation of behaviors related to reproduction. Mating and nesting behavior of sea turtles bred in captivity were studied in detail during the breeding season. One infrared sensor was set at the shore of artificial beach to detect the emergence of sea turtle from water. Two highly sensitive cameras and recorders were set above the tank, and three were set above the artificial beach. Condition and mechanism for mating, egg fertilization, and egg deposition were understood from dynamics of sexual hormones in blood and paternity test results of hatchlings. Mating activities were facilitated by managing male-female pairings, which also contributed to conservation of lineage. An artificial hatchery and 20 tanks were prepared for stable egg incubation and rearing of hatchlings. Sand from Atsumi-Peninsula, Aichi prefecture, was used for the artificial hatchery. The size of the facility was width x length x height = 1.6 x 4.0 x 1.2 m. The tank was 1.2 m^3 in volume, 0.62 m in diameter, and 0.2m in depth.

As a result of these efforts, our team succeeded in the first reproduction of loggerhead sea turtle bred under captivity in 1995. Ever since, beside the year 2011, 22 years of loggerhead sea turtle reproduction have been achieved. Six male and five female sea turtles were involved, resulting in a total of 15,820 eggs laid and 9,444 hatchlings emerged.

THE INFLUENCES OF NEST SAND TEMPERATURE ON LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) CLUTCH IN MIE, JAPAN

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Kameppuri (Investigation and Conservation Club of Sea Turtle and Finless Porpoise in Mie University) | Kameppuri (Investigation and Conservation Club of Sea Turtle and Finless Porpoise in Mie University) | Kameppuri (Investigation and Conservation Club of Sea Turtle and Finless Porpoise in Mie University) | Kameppuri (Investigation and Conservation Club of Sea Turtle and Finless Porpoise in Mie University) | Kameppuri (Investigation and Conservation Club of Sea Turtle and Finless Porpoise in Mie University) | Kameppuri (Investigation and Conservation Club of Sea Turtle and Finless Porpoise in Mie University) | Kameppuri (Investigation and Conservation Club of Sea Turtle and Finless Porpoise in Mie University)

Sand and nest temperatures are important factors for species displaying temperature-dependent sex determination such as sea turtles. It may have a greater impact on loggerhead sea turtle (*Caretta caretta*) rookeries that are distributed at a higher latitudinal range like Japan because the seasonal fluctuation in temperature is greater than in other areas. In addition, loggerhead nests in Mie Prefecture may be impacted by heavy rainfall accompanied by typhoons that occur from July to October. Rainfall decreases sand temperature, which may affect the reproductive success and skew hatchling sex ratio. The aim of this study was to investigate the influences of sand temperature on loggerhead sea turtle hatching.

Temperature data loggers were placed at 30 cm depth close to the nests (n = 2) in Tsu-city, Mie, Japan. Two weeks after hatching, each nest was excavated and the eggs were categorized as hatched, pipped, or unhatched. Unhatched eggs were broadly categorized as undeveloped, early, mid, late and terminal embryonic death. Meteorological data were obtained from the Tsu Local Meteorological Office located about 10 km away from the study site. A typhoon occurred on August 7 and there was a heavy rainfall at this area. Sand temperature around August 7 decreased remarkably. Based on these results, we discuss the influence of sand temperature on the hatching success and potential sex ratio of loggerhead sea turtles.

INTRODUCTION AND REPORT ON THE INVESTIGATION OF SEA TURTLES ON OKINAWA ISLAND AND KERAMA ISLANDS

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The University of the Ryukyus Sea Turtle Research Club Churagame was established in 2010 and conducts sea turtle research mainly on Okinawa Island, counting the numbers of landing/nesting, monitoring bycatch, and reporting turtle stranding. Here we report the summary of the data accumulated more than 5 years. On the nesting beach, we surveyed northern/southern parts of Okinawa Island and Zamamijima Island, identified species by tracks and egg shapes, and counted the number of landings and eggs. After hatching, we excavated nests and investigated the hatching success. Landing and nesting surveys in the southern part of Okinawa Island have been conducted since 2012 at 16 sandy beaches; loggerhead turtles account for more than 90% of the nesting. The number of nesting in the southern part of Okinawa Island has been drastically decreased since 2014. In the three beaches at the northern Okinawa Island, the loggerhead was the dominant species until 2015, but green turtles became more common in 2016. We started surveying in Zamamijima Island in 2012, and, in contrast to Okinawa Island, green turtles account for more than 90% of nesting on this island. The number of green turtle nests showed a biennial pattern, having over 200 nests in a high year. The hatching successes were compared among sites.
Bycatch surveys are conducted with assistance from the Yomitanson Fisheries Cooperative Association at the Toya fishing port on the western coast of Okinawa Island. We identified species of sea turtles that were caught in pound nets, measured body sizes, and applied flipper tags. We have confirmed five species of sea turtles (loggerhead, green, hawksbill, black and leatherback turtles); about 80% of them were green turtles. We also had seven recaptured turtles.
For stranding surveys, we identify species, collect morphometric data, and conduct necropsies of sea turtles that strand primarily at the coasts of the southern part of Okinawa Island. We bury carcass after the investigation. Three species (loggerhead, green and hawksbill) of stranded turtles were identified. About 80% of them were green turtles. The number of stranding tend to increase from December to April.
Our continuous research activity to date has improved the understanding of the status of sea turtles around Okinawa Island. Long-term data collected at the same research area is valuable in the study of sea turtles, and we plan to continue these surveys to further clarify the ecology of sea turtles around Okinawa Island.

CHANGES IN THE NUMBER OF LOGGERHEAD TURTLE NESTING EMERGENCES AT THE NORTHERN LIMIT NESTING SITES IN THE NORTH PACIFIC OCEAN

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Ichinomiya Sea Turtle Association | Sea Turtle Discussion Group in Sotobo Chiba

The sandy beaches along the Japanese coast are the sole nesting ground for loggerhead turtles in the North Pacific population. Chiba prefecture is located near the center of Japan, adjacent to Tokyo. It has industrial areas facing the Tokyo bay and a coastline from Choshi city to Tateyama city facing the Pacific Ocean. This coastline consists of two main regions: a relatively large sandy beach named Kujukurihama; and regions south of cape Taito where rocky and sandy beaches are distributed in an alternating pattern. The sandy beaches in Sotobo area, southeast region of Chiba prefecture, are the northern limit nesting sites for loggerhead turtles. Although the numbers are small, females nest and hatchlings emerge every year.
In 1999, Akio Akiyama, a former professor of Toho University, conducted a nesting survey of the Boso Peninsula, which includes the Sotobo area, and 76 emergence events were confirmed. From this number, the annual number of emergences in this area was estimated to be around 50 to 100.
A private organization “Sea Turtle Discussion Group in Sotobo, Chiba” is constituted of individual members and groups participating in sea turtle observation in the Boso Peninsula. This organization has been collecting data from 2008 and those data were used to summarize the change in the number of nesting emergences in the Sotobo area. The nesting survey was conducted in 16 cities and towns along the Sotobo area. An annual average of 143 emergences was confirmed between 2008 and 2012. The maximum number of 216 emergences was recorded in 2012 and the minimum of 86 in 2011. We will report on ten years’ worth of records, with the addition of the subsequent 5 years after 2012.

SEA TURTLE CONSERVATION ACTIVITIES IN AMAMI OSHIMA

Katsuki Oki | Yuna Kimoto | Kojiro Mizuno
Amami Marine Life Research Group | Amami Marine Life Research Group | Amami Marine Life Research Group

Amami Oshima Island and the islets around it have numerous sandy beaches of various sizes, but they are scattered and many of them are inaccessible by land routes. As a result, the status of sea turtle landing and nesting had only been determined for approximately 30% of all beaches. We therefore established the Amami Marine Research Group in April 2012 with volunteers, and began nesting surveys throughout the region in cooperation with government agencies and local community members. Although the local government had been conducting monitoring on some beaches in Amami city and at about 30 beaches in Tatsugo-cho, about 100 beaches had not been surveyed. We assigned personnel to monitor those remaining beaches and initiated surveys to collect sea turtle landing and nesting data in all of Amami Oshima. We held sea turtle lecture and nesting observation events (called “Umigame Meeting”) four times with the purpose of having local residents become more familiar with sea turtles and encouraging the conservation and utilization of sea turtles through these events. We combined our survey results with that of the government surveys in September 2013. In total, 1682 landings (loggerhead, n = 899; green, n = 503; unknown species, n = 281) and 1081 nestings (loggerhead n = 605; green, n = 327; unknown species, n = 149) were reported as the first complete survey data for Amami Oshima including the associated islets.

Through field surveys, we also faced various issues. The number of loggerhead nesting has decreased since 2015, and the dominant nesting species has been replaced with green turtles since 2016. In addition, egg predation by the native Ryukyu wild boar (*Sus scrofa riukiuanus*) is increasing in Amami Oshima, and reduced nesting rate corresponding to beach erosion is also of concern. The juvenile green turtle population in the coastal waters is on an increasing trend, and although they are utilized as a tourism resource, they are bycaught by recreational fishing as well as gillnet fishing, and are known to cause damage on the local fisheries.

Nesting beach surveys allow participation from local residents, which we hope will contribute toward fostering awareness for ecosystem conservation and facilitating community revitalization. In Kuninao settlement located in the central part of Amami Oshima, an effort is underway to install red covers on street lights near beaches to prevent hatchling disorientation from artificial lights. We would like to advance the community-centered framework, whereby local residents of each area are able to lead the conservation and utilization of beaches in each settlement.

SURVEY OF LANDING AND HATCHING RATE OF SEA TURTLES AROUND THE NASHIRO BEACH IN SOUTHERN OKINAWA ISLAND IN 2017

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The number of landing and hatching success of sea turtles were investigated around the Nashiro beach and Kahama, Itoman City, Okinawa Prefecture, from May to October, 2017. Sand temperature distribution was recorded at four sites (at 50 cm depth) every hour using a small data logger (Thermochron G, KN Laboratories, Inc.) from 12 April to the end of October, 2017.
The first landing of loggerhead turtle (*Caretta caretta*) was observed in Itoman City on 8 May, 2017. The total number of landings around Nashiro beach was 30 times, and all landings were made by loggerhead turtles (nine times in May, 16 times in July and five times in August). The number of successful nests (oviposition) was 29 out of the 30 landings. Hatchling emergence was confirmed in 22 (nine in July and 13 in August) of 29 nests through direct observation at night and/or the presence of a small hole after emergence. By the end of September, we had examined hatching success rates for 11 of 29 nests. The highest hatching success rate was 96.92% (130 eggs, 4 unhatched eggs) for a nest located at a site with shade from nearby trees and with enough distance from the sea.
On the other hand, the lowest hatching success rate was 58.34% (132 eggs, 55 unhatched eggs) for which landing was observed on July 3 and emergence was found on August 20. Of the 55 unhatched eggs, we confirmed six eggs that died just before hatching. This nest with low hatching success was located at a site with no shade and with strong and direct sunlight throughout the day. Highest summer temperatures on record continued in Okinawa in 2017, and the average sand temperature in places with direct sunlight at Nashiro beach rapidly increased from 25.7 ° C in June to 30.4 ° C in July and 32.5 ° C in August. It is inferred that the hatching rate became low because the developing eggs were exposed to unusually high temperatures. With respect to the relationship between hatching success rate and cumulative sand temperature, the hatching success rate tended to decrease as the cumulative temperature increased.
Furthermore, a large new resort hotel is under construction at Nashiro beach, the main landing location of sea turtles from this past spring. There were two nests where the hatching and emergence success rate seemed to be reduced due to beach sand compaction caused by passing heavy machinery for hotel construction. The first nest had 118 eggs, of which 34 were unhatched eggs and the hatching success rate was 71.19%. The second nest had 122 eggs, of which 20 were unhatched eggs and the hatching rate was 83.61%. We will also report on the results of hatching success surveys for the remaining 18 nests for which surveys were not yet completed as of the end of September.

We especially thank H. Tokumura for helping with everyday nightly patrols around Nashiro Beach, Itoman City. We also thank the Nashiro Beach Office on understanding of sea turtle survey under construction.

PAIRED LASER-PHOTOGRAMMETRY DETERMINES GROWTH RATES OF GREEN SEA TURTLES *CHELONIA MYDAS* AT A TROPICAL AGGREGATION IN PHILIPPINES

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Determining the growth of individuals within a population is an essential life-history trait necessary for models that assess the vulnerability of a species. In sea turtles, measurements are typically taken following the capture of the animals, and growth rates can be estimated by recapturing the animals over time. In green turtles *Chelonia mydas* growth rates of 1.0 – 11.4 cm y^{-1} have been reported from across their range, with habitat, diet, size and water temperature being major influencers of growth rates. Here, we employed paired-laser photogrammetry to estimate growth rates of *C. mydas* at a tropical aggregation in the Visayas region of the Philippines. This minimally-invasive approach recently described to determine life-history parameters of sea turtles allows the collection of morphometric data without the need to capture the animals. Individuals were photographically identified (photo-ID) through their facial scute patterns, unique to each individual, and photogrammetry was employed to measure their straight carapace length (SCL). We collected 298 measurements for 10 green turtles using photogrammetry ranging from 44.0 to 77.5 cm SCL, mean 61.1 cm 9.9 cm S.D., highlighting a primarily juvenile aggregation. Turtles were first measured in July to September 2015, and subsequently re-measured using the same methodology in July and August 2017. Growth rates in this 2-year period ranged from 4.0 to 11.0 cm, assumingly a 2.0 to 5.5 cm y^{-1} growth, consistent with growth rates obtained through conventional methods across their range. Unlike other reports, the fastest growth was observed on larger turtles, with the largest estimated at 77.5 cm SCL growing 11.0 cm in 2 years. To date, we have identified 70 green turtles within the study site. The longest photo-ID match spans 1,967 days, with 9 turtles encountered on at least 200 different calendar days since systematic photo-ID commenced in 2014. This aggregation of green turtles is primarily observed foraging on sea grass beds in close proximity to shallow (<15 m) reef habitat. We used modified maximum likelihood methods to estimate residency within the study site at 58.3 d ± SE 79.6 d whilst spending 8.6 d ± SE 35.5 d outside. This suggest turtles here reside for most of the time, but might leave for small periods of time. The turtles are monitored year-round, and conditions are normally stable, with water temperature ranging from 27 to 29°C throughout the year. These tropical conditions allow for *C. mydas* to grow consistently, with comparable growth rates to those observed in the Caribbean, Florida and California. A minimally-invasive approach like laser photogrammetry allows the collection of growth rate data without the need of capturing the animals. Further work is underway to establish the growth rate across the entire aggregation, and at comparable sites in the region to ascertain the growth rate of *C. mydas* in Philippines.

MODELLING LOGGERHEAD DISTRIBUTION USING OPPORTUNISTIC SIGHTINGS

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Studies on distribution and habitat selection of loggerhead turtle (*Caretta caretta*) involves high research costs due to the environment where they live and their migrations. In this context opportunistic sightings have been proved to be a useful tool for obtaining relevant information. From 1993 to 2014, the Spanish Institute of Oceanography has registered a dataset with 985 records of opportunistic sightings of different marine species in the Western Mediterranean Sea area and adjacent waters. Opportunistic sightings are defined as a watching of a living organism, performed by scientific or non-scientific people that sail frequently. The aim of this study is to explore the biogeography of the loggerhead turtle on a large scale in the context of this dataset by modeling the presence according to seasonal, environmental, geographic and anthropogenic factors expected to influence its distribution. A binary logistic regression model has been performed for the species in a presence-only framework, with the use of presences of the other marine species as a contrast (absences) when modeling target species. When combining different variables a significant multivariate model was obtained with an AUC = 0.798 where the presence of loggerhead turtles was related with season, being higher the sighting probability in spring and lower in autumn. According to the model, the probability of sighting would be higher from 00:00 to 5:59 and lower from 18:00 to 23:59. This model also show higher probability when the distance to coast (CD) increases. The most interesting feature of this model is related with the anthropogenic factor; towns (TD) and shipping routes (DMSR) seems to disturb this species, given that the probability of sighting increases with the distance, showing the impact of human activities on this species.
This study shows that key influencing biogeographical variables can be detected using this kind of datasets.

EXPLORING OF THE EFFECT OF ATMOSPHERIC OSCILLATIONS ON THE INTERANNUAL DIFFERENTIAL DISTRIBUTION OF TROPICAL SEA TURTLES AROUND AFRICA

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The purse seiners targeting tropical tunas could by-catch six different sea turtles species from Atlantic and Indian Oceans. The observed mortality is not significant. Incidental catch of sea turtles from the purse seiners fisheries targeting tropical tunas occur, but the mortality is very low, and not significant. However, the incidental of sea turtles from purse seiners fisheries targeting tropical tunas could report relevant information about sea turtle distribution. North Atlantic Oscillation (NAO) is the principal atmospheric oscillation that module the trade wings from North Atlantic Ocean. In a similar way South Oscillation Index (SOI), is the principal atmospheric oscillation that module the wings from Pacific and Indian middle latitudes. On the other hand, monsoons (rainy season, accompanied by winds), which cross the Indian Ocean. The principal aim of present study is understand the effect of NAO, SOI and monsoons in the interannual pattern distribution of sea turtle incidental catch in purse seiners targeting tropical tuna from Atlantic Ocean and Indian Ocean.

POPULATION GENOMICS OF NON-MODEL SPECIES: THE KEY OF ADEQUATE PILOT STUDIES

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The assessment of marine biodiversity is one of the research priorities, as stated in national and international research plans. This research field can benefit significantly from the application of genetic tools, especially those resulting from genome wide next generation sequencing. Among those RAD (restriction site associated DNA) sequencing technologies allow genotyping individuals of non-model species at multiple loci. These techniques are highly dependent on the selection of the restriction enzyme and depth sequencing. In this study, we tested the efficiency of 2b-RAD sequencing using two different restriction enzymes, *AlfI* and *CspCI*, characterised by different abundances of restriction sites in a genome. We tested two marine species with very different genome sizes, the loggerhead turtle (*Caretta caretta*, ≈2.4 Gb of genome size) and the sharpsnout seabream (*Diplodus puntazzo*, ≈0.9 Gb of genome size). Samples for *C. caretta* were from the Mediterranean nesting population of Sirte (Libya) and from the foraging area of València (Spain), known to be populated by individuals of Atlantic and Mediterranean origin. Samples for *D. puntazzo* were from Blanes and from Xàbia (Spain), separated by the Ibiza channel, a known oceanographic discontinuity for demersal fishes. Samples with degraded DNA and low DNA concentration (ng/ul) were included in the sample set to identify the bottom threshold of functioning of 2b-RAD with the two species. The preliminary results of the library showed that the outcome of the amplification was not conditioned by the initial status of the samples. For *D. puntazzo* the two enzymes used produced a similar outcome, although *AlfI* produced better amplifications than *CspCI*. For *C. caretta*, *AlfI* resulted in a much better outcome, while *CspCI* failed to amplify most samples. To evaluate the impact of read depth on genotyping, we pooled 48 2bRAD libraries relative to 24 individual samples per species and sequenced the pools on an Illumina HiSeq 4000 lane per species with 50bp single read module. The bioinformatic analyses will provide a detailed diagnostic of the impact of read depth on the number of markers obtained per species and enzyme. Furthermore, it will also determine the impact of depth sequencing for each specific combination of enzyme and species, providing a basis to optimize the number of samples to be analysed per Illumina lane. The outcome of this pilot study will allow the selection of the appropriate enzyme and adequate number of samples to be analysed simultaneously on the ongoing genomic projects of *D. puntazzo* and *C. caretta*. This work provides a case study to optimize laboratory protocols when starting new genomic projects on non-model organisms with different genome sizes.

HOW TO ORGANIZE AND OBTAIN ANSWERS FROM HUGE MARINE TURTLE GEO DATASETS BY USING "PANDAS" FROM ONE MONTH TO ONE DAY?

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Many researchers study sea turtles are organized and analyzed data by manually adding columns, copying and pasting data, and calculating the results by clicking multiple columns in some software such as EXCEL. However, the whole process may cause lots of errors compare to asking the computer to run the entire process. In our presentation, we demonstrate how Python helped us spending much less time and efforts to organize and analyze large geo datasets. Our organization, IUCN Marine Turtle Specialist Group in Taiwan, are collecting various kinds of data since 1992, includes nest locations, satellite tracks, diving patterns etc. Some of them need lot of time and efforts to organize raw data in order to answer the specific question, such as facial ID. Pandas is one of the most popular Python packages for many Data Scientists. We begin to develop Python data applications, which allows the computer to organize datasets and do calculations at the same time. It is important to get the most accuracy results for marine turtle research, especially for developing relevant management policies. This software package will allow us to get the most accuracy results, with less time, money, and efforts.

DISTRIBUTION AND ABUNDANCE OF NESTING MARINE TURTLES IN NORTHWESTERN AUSTRALIA: PAIRING THE LANDSCAPE AND LOCAL PERSPECTIVES

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An increased demand for knowledge of northwestern Australian marine turtle resources accompanied the newly established Kimberley Marine Parks, the indigenous ranger groups responsible for on-country management, and the 2017 Australian Commonwealth Marine Turtle Recovery Plans. The Western Australia Marine Science Institute Turtle Project 1.2.2 addressed that knowledge gap with comprehensive aerial surveys. Over 44,000 aerial photos included all known rookeries and 91% the remote Kimberley islands and coasts taken in mid-summer and mid-winter seasons of 2014. On-ground surveys were conducted for 37 accessible locations to verify species. The surveys inventoried turtle nesting at scales of 1-10-100-1000s of tracks.

The higher aggregations of tracks (above median of 20 nests) identified significant beaches to management interests. The rookeries with highest track counts and density were winter flatbacks at Cape Domett, summer greens at the Lacepedes and summer flatbacks at Wallal Downs-Eighty Mile Beach. Aerial surveys had low power to detect olive ridley or hawksbill turtles because those species were sparse and isolated in the Kimberley, the tracks of lighter-bodied species did not persist as long and the survey period was not ideally to pick their seasonal phenology. No leatherback or loggerhead tracks were recorded although migrations through the region are known through indigenous knowledge, fisheries bycatch or satellite telemetry.

The surveys give a landscape perspective to Commonwealth and State interests and new detailed data for local management by Traditional Owners through Healthy Country Plans. Pairing landscape and local perspectives identifies the priority turtle beaches and allows strategic recommendations for future studies and monitoring.

CLIMATE CHANGE RESISTANCE OF A GLOBALLY IMPORTANT GREEN TURTLE NESTING POPULATION

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Few studies have attempted estimate the resistance to climate change of wild populations. We use a model higher vertebrate, the sea turtle, as its life history and demography are fundamentally affected by climatic conditions, and apply empirical data from a globally important nesting population in West Africa to assess climate change resistance in a qualitative framework. We project 200 years of primary sex ratios, and create a digital elevation model of the nesting beach to project sea level rise (SLR). As higher temperatures enhance female production, we assess future nesting female recruitment. Primary sex ratio is currently almost balanced, with 52% of hatchlings produced being female. Under IPCC models we predict an increase in the proportion of females by 2100 to 74–94%. Cooler temperatures, both at the end of the nesting season and in shaded areas, will guarantee male hatchling production. Under IPCC scenarios, SLR will lead to loss of 33.4–43.0% of the current nesting area, although, under semi-empirical models of SLR this estimate rises to 86.2%. Climate change will, however, contribute to population growth through population feminization, with 32-64% more nesting females expected by 2120. As incubation temperatures approach lethal levels, population growth will halt and start to decline, but the long-term survival of this population does not seem to be at risk. Overall, this population should resist climate change, and the availability of spatial and temporal microrefugia, indicate potential for mitigation of climatic change impacts, through evolution of nest site selection behaviour or changes in nesting phenology. This is the single most comprehensive assessment to date of climate change resistance of a marine reptile, using the most up-to-date IPCC models, including the impacts of temperature and SLR, integrated with population size and trajectory.

TESTING THE UTILITY OF MITOCHONDRIAL SHORT TANDEM REPEATS (MTSTRS) FOR IMPROVED STOCK STRUCTURE RESOLUTION IN NORTHWEST ATLANTIC GREEN AND LOGGERHEAD TURTLES

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Mitochondrial DNA studies have made valuable contributions to resolving marine turtle life history. Despite these advances, extensive sharing of common control region haplotypes among rookeries remains a significant impediment in assessments of stock structure and migratory connectivity. Green turtle haplotype CM-A3 is ubiquitous across the Greater Caribbean region, including all rookeries comprising the nesting aggregation in Florida, USA. Previous population structure analysis of ten Florida rookeries spanning Cape Canaveral in east central Florida through the Dry Tortugas in the Gulf of Mexico indicated the presence of at least two subpopulations with a possible transition zone at Jupiter Island. However, the high frequency of CM-A3 in the seven southern rookeries obscured any possible fine scale structure. Previous analyses of a mitochondrial short tandem repeat (mtSTR) marker of Mediterranean and South Atlantic green turtles indicated the presence of four 'AT' repeat loci punctuated by point mutations that subdivided common control region haplotypes (CM-A13 and CM-A8, respectively) into several mtSTR variants. We sequenced the mtSTR in 298 CM-A3 green turtles to test for cryptic structure within the Florida nesting aggregation. Ten mtSTR variants were detected, with strong frequency differentiation among the ten sampling locations (AMOVA $F_{ST} = 0.200$, $p < 0.0001$). The Dry Tortugas and Marquesas Keys rookeries, separated by only 60 km, were strongly differentiated from one another, as well as from the barrier island rookeries in southeastern peninsular Florida. Pooled central eastern and southeastern CM-A3 frequencies were also significantly differentiated, reinforcing the structure inferred from previous control region analysis. Pooled Jupiter Island samples (Hobe Sound and Tequesta) were significantly different from central eastern and southeastern clusters. However, the mtSTR frequencies were not intermediate as expected from a transition zone. The Jupiter Island sample contained a dominant haplotype (27%) that was considerably less common to the north and south (5.5% and 6.6%, respectively). These results suggest that Jupiter Island may be demographically isolated from adjacent rookeries, warranting further investigation. Following the success in refining green turtle structure, we attempted to characterize the mtSTR in loggerhead turtles nesting in Georgia. Despite several attempts to optimize amplification and sequencing of the loggerhead mtSTR, sequencing consistency was elusive. We ultimately developed a genotyping approach and detected 66 haplotypes with pentanucleotide repeats. As in green turtles, heteroplasmy (the presence of more than one repeat haplotype within an individual) was extensive. Unlike the green turtle case, a clear dominant haplotype was often difficult to score based on peak relative fluorescence units due to heteroplasmy and/or peak stuttering. To test consistency of haplotype calls, we amplified multiple technical replicates and biological replicates representing different tissue types (skin biopsy, egg shells, and dead hatchling tissue) for 55 individual females. Of 304 pairwise comparisons among technical replicates of the same extraction, 33 had different dominant mtSTR haplotypes scored. Of even greater concern was the fact that biological replicates from the same female yielded different dominant haplotypes across tissue types in a large proportion of cases. Thus, while this marker is unquestionably highly polymorphic, it does not appear suitable for loggerhead turtle studies without further optimization and standardization. The mitochondrial repeats present in other Carettini species and leatherbacks appear to be perfect repeats with similar structure, suggesting that sequencing and scoring issues may be encountered with them as well. The mtSTR marker is clearly highly informative for discerning fine scale structure in green turtles, but additional pilot studies are necessary to determine the utility of this marker in other species.

RESULTS FROM AN 8-YEAR SATURATION TAGGING OF LOGGERHEADS NESTING AT PRAIA DO FORTE, BRAZIL

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Monitor trends in populations is important for the managements of endangered species. In sea turtles, the number of clutches laid on a nesting beach in a particular season is commonly used as a relative index of population density. However, it is recognized that long-term mark-recapture studies on nesting beaches should be undertaken whenever possible to ensure that valuable abundance and demographic data are being generated to inform conservation management strategies. To do this more assertively is necessary to use own population's parameters to be inserted in population models.

Praia do Forte beach in Bahia stretches along 14 km and encompasses one of the major loggerhead rookeries in Brazil, monitored since 1982 by Projeto Tamar. The nesting season for loggerheads in Praia do Forte lasts from September to April; however the period between October and February concentrates 90% of nesting activity. The most significant loggerhead nesting (60 % of the total) occurs along a 5 km segment where 88% of the females exhibit intra-seasonal high-site fidelity.

In 2008 we started a saturation tagging program of loggerheads nesting at the Praia do Forte beach to obtain site-specific demographic parameters for this population. During the first nesting season we conducted a preliminary study from October 15 to December 15. Nightly patrols were performed from 8pm to 5am. As a result we determined that 75% of the female encounters occurred between 8pm and 2am. According to this we conducted a tagging saturation effort from 2009/10 to 2015/16 (7 nesting seasons). Each season from October 1 to February 28 we patrolled the 5 km stretch from 8pm to 2am. Early morning surveys also identified any missed nesting activity in order to assess the efficiency of the methodology. We calculated: (1) the observed clutch frequency (OCF), (2) the estimated clutch frequency (ECF) corrected by taking into account missed nests based on inter-nesting intervals and (3) the remigration interval (RI). To increase the chances that the first and last nests laid by a female were counted, females included in the estimates of clutch frequency were those that initiated nesting between October 1 and January 1 and completed their nesting by the end of February when beach monitoring ceased. Females that were observed nesting only once in the season were eliminated from the estimation of clutch frequency.

Mean inter-nesting interval of females loggerheads was 14.9± 1.4 days (n=666), all seasons (2008 to 2015) combined. The OCF minimum was 6, and maximum was 8, mean 2.1 ± 1.4 (n=775) and the ECF varied from 6 to 10 , mean was 4,1 ± 1.5 clutches (n = 344 females). Although remigration intervals of individual females vary (range: 1 to 7) the 2 yr remigration interval was the most common, followed by 3 yr remigrations. Only one turtle came to nest every year.

Because sea turtles are long-lived animals, the trends observed on the beach today depend on many factors that may have occurred over decades. In this way, systematic long-term mark-recapture studies to estimate population parameters are essential in order to establish metrics for species recovery.

ESCAPING FROM PHILOPATRY: EVIDENCES OF LONG DISTANCE COLONISATION EVENTS IN THE LOGGERHEAD SEA TURTLE

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The colonisation of new suitable habitats is crucial for species survival at evolutionary scale under changing environmental conditions. However, colonisation potential may be limited by philopatry that facilitates exploiting successful habitats along generations. We examine the mechanisms of long distance dispersal of the philopatric loggerhead sea turtle (*Caretta caretta*) by analysing 40 sporadic nesting events in the western Mediterranean. The analysis of a fragment of the mitochondrial DNA and 7 microsatellites of 121 samples from 18 of these nesting events revealed that these nests were colonising events associated to juveniles from distant populations feeding in nearby foraging grounds. Considering the temperature-dependent sex determination of the species, we simulated the effect of the incubation temperature and propagule pressure on a potential colonisation scenario. Our results indicated that colonisation will succeed if warm temperature conditions, already existing in some of the beaches in the area, extend to the whole western Mediterranean. We hypothesize that the sporadic nesting events in developmental foraging grounds may be a mechanism to overcome philopatry limitations thus increasing the dispersal capabilities of the species and the adaptability to changing environments. Sporadic nesting in the western Mediterranean can be viewed as potential new populations in a scenario of rising temperatures.

MITOCHONDRIAL DNA SHORT TANDEM REPEATS UNVEIL HIDDEN POPULATION STRUCTURING AND MIGRATION ROUTES OF AN ENDANGERED MARINE TURTLE

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The assessment of links between sources of mortality and the affected populations is crucial for the management and conservation of endangered species, but sometimes this assessment is hampered by the lack of resolution of the genetic markers used. We investigated the genetic structuring of the Mediterranean green turtle (*Chelonia mydas*) nesting populations and the origin of the stranded animals found along the Israeli coast by using new highly polymorphic STR markers. A clear population genetic structure not detected before was unveiled using pairwise genetic distances and a Principal Coordinates analysis (PCoA). The four nesting populations (Turkey, Cyprus-Alagadi, Cyprus-Akamas and Israel) were genetically well differentiated and thus should be considered as different management units in conservation plans. Although genetically different, the populations from Turkey and Israel showed higher resemblance despite residing at opposite edges of the Mediterranean distribution. A Mixed Stock Analysis was used to assess the contribution of the different nesting populations to the stranded sample of Israel. The Turkish nesting population was revealed as the main source of the stranded turtles sampled along the Israeli shore indicating that individuals from this population migrate from north to south along the eastern shore of the Mediterranean as previously shown by telemetry studies. The use of a highly polymorphic haplotyping method enabled the detection of a deep genetic structuring of the green turtle populations in the eastern Mediterranean Sea that was not revealed in previous studies, demonstrating the importance of marker selection in population genetics. The analysis of the stranded turtles' genetic composition allowed us to look into the migration patterns from nesting to foraging areas, supporting previous satellite tracking and stable isotopes results.

MOLECULAR CHARACTERIZATION OF GREEN SEA TURTLE (*CHELONIA MYDAS*) AND EAST PACIFIC GREEN TURTLE (*CHELONIA MYDAS AGAZZISSI*) BY COI AND 16S GENES

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Introduction.

Green sea turtles (*Chelonia mydas*) are listed as globally endangered on the IUCN red list (Seminoff 2004); they are distributed in tropical and sub-tropical waters and nests on beaches of five continents between latitudes 30°N and 30°S. In the East Pacific, the species have nesting sites from the Galapagos Islands (Ecuador) northward to Michoacan and Revillagigedos Islands, both in Mexico, where it is well known as the east Pacific green turtle (EPGT) or 'black turtle' (Chaissin-Noria *et al*., 2004), other individuals of *C. mydas*, also nests in the Gulf of Mexico and Caribbean region (Valverde & Holzwart, 2017). There is a controversy between the two populations, because of morphological differences and meristics features that distinguish one population from another, leading some authors to consider EPTG as a separate species *C. agassizii*, others have instead indicated EPGT to be simply a regional, melanistic population within the Pacific clade of *C. mydas* (Dutton *et al*., 1996; Karl and Bowen, 1999; Chassin-Noria, 2002). Although, few studies show these sea turtles have the same molecular sequence. (Naro-Maciel, 2009). To carry out molecular identification of species, mitochondrial nucleotide sequences are used as markers, for example, the Cytochrome c Oxidase Subunit I gene (COI) and the 16S gene, both are complementary, thus their analysis is recommended to generate a DNA barcoding.

Objective. To make a molecular characterization *in silico* by DNA barcoding using COI and 16S genes and to compare genetic variability between EPGT nesting in Mexico and green sea turtle from worldwide.

Methodology. Thirty-two sequences of sea green turtle from GenBank and five EPGT obtained *in vitro* were analyzed, which of 15 sequences for the 16S gene and 12 sequences for COI (GenBank) and five sequences obtained *in vitro*, were all assigned in similar groups and transformed into FASTA format, then BioEdit v7.2.5, Network 5 and conform the haplotype networks were used; finally a phylogenetic tree with MEGA7 v7.0 was constructed, using the method of trees with ML, a bootstrap of 1000 and under the nucleotide substitution model of K2P.

Results. For the mitochondrial 16S gene, the aligned common sequence was 638 bp, obtaining 6 different haplotypes, where 4 were intraspecifically related in that gene, one out of haplotypes formed by 7 taxa, 2 ones conformed by 2 taxa and last one haplotype formed by 3 taxa. For COI gene, the aligned common sequence was 583 bp, grouped into 11 different haplotypes, which of 1 were related intraspecifically, conformed by 2 taxa.

Discussion. From the resulting and separated haplotypes in different 16S gene networks, 4 were found intraspecifically, due to nucleotide variation, 12 mutations found, reiterating a paraphilia of EPGT with respect to other green turtles. In addition to a division is verified between the lineages present in Pacific and Atlantic. However, the phylogeography of the species suggests links between Atlantic green turtles; as well as COI, where 5 haplotypes were generated and two of them were shared or related intraspecifically, besides presenting 9 mutations, together with the variation between nucleotides, coincides with the previously mentioned with respect to the 16S gene. Both sequences combined (16S and COI), prove to be of utility and reference for future research in populations of green turtles and later comparisons with other species of sea turtles.

Conclusion. The 16S gene showed less variability than the COI by clustering haplotypes; however, both genes are useful for the phylogenetic study of green turtles, with differences attributable to the number of sequences reported for each gene respectively. Moreover, further research is needed in evolutionary biology, to clarify taxonomy and systematic issues of these highly threatened and ecologically important species.

POPULATION STATUS AND SOME NESTING HABITATS OF MARINE TURTLES IN NOTHERN RAKHINE COAST, MYANMAR

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The present study was carried out from June 2016 to October 2017 at Oyster Island at (20 ° 14 ′ 23.3” N and 92 ° 45 ′05.4” E) and Nantha Island at (20 ° 18 ′ 26.3” N and 92 ° 46 ′15.3” E) located in Sittwe Township, Rakhine State. These islands had long history with the presence of marine turtles such as Greens, Hawksbills and Olives. Unfortunately, the marine turtle species and abundance status of those islands are still yet unknown except this report due to the difficulties of travel permission to the Military base. This study endeavors to draw out these valuable natural resources from secrete places with the conservation purposes in national level, to fulfill the gap in missing both regional and global distribution map of marine turtles. Three species of marine turtles were recorded during the study period: Green turtle, *Chelonia mydas* and Hawksbill turtle, *Eretmochelys imbricata* and Olive Ridley turtle *Lepidochelys olivacea*. Green turtles and Hawksbill turtles nesting were recorded on Oyster island while the Olive Ridley turtle recorded on Nantha island. The study investigated the number of Green turtle nests was 30 and Hawksbill turtle was 5 on Oyster island while the Olive Ridley turtle was 30 on Nantha island. The environmental parameters such as temperature, humidity, rainfall, salinity, sand type and vegetation structures were recorded. Threats are also recorded. Two nests of green turtle were hatched and 120 hatchlings were released for first and foremost record of in-situ incubation on Oyster Island was also presented.
Key words: marine turtle species, nesting, threats, Oyster island, Nantha island

PATERNAL CONTRIBUTION OF HAWKSBILL TURTLES TO THE NESTING POPUALTION IN FIJI

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Fiji, in central South Pacific, is a known nesting site for the globally distributed and critically endangered hawksbill turtle, *Eretmochelys imbricata*. This species has been hunted in Fiji since the 1800s for both traditional and commercial purposes and only recently, since 2004, has benefitted from moratoriums aim at sea turtles' populations' recovery. The status of the species will be reviewed towards the end of the current moratorium, in 2018. An understanding of hawksbill's reproductive biology and the mating system can ensure enhanced management efforts, hence the current study focuses on the first assessment of parentage and relatedness within and among *E. imbricata* nests in Fiji using genome-wide molecular markers. A total of 2,568 genome-wide Single Nucleotide Polymorphisms (SNPs) were discovered through a genotyping-by-sequence approach (DArTseq) and used to identify family relationships among 360 individual hatchlings collected from 7 nests in Fiji. Broad-scale (DAPC) and fine-scale (Netview-R) analyses of genetic structure detected the presence of 7 and 8 family groupings respectively, which were confirmed following relatedness assessments using a subset of 500 high-quality SNPs in COLONY. Three nests were found to contain full-sib dyads corresponding to 3 different parent pairs, due to an admixture of hatchlings upon collection. No evidence for multiple paternity was detected. This to some extent supports a monogamous mating system for this species.

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NEW INSIGHTS FROM GENOMICS? TESTING NEW APPROACHES TO POPULATION GENETICS IN FLATBACK AND GREEN TURTLE POPULATIONS IN AUSTRALIA.

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Our ability to define marine turtle populations is critical for effective conservation management. Deciphering the genetic structure within and among populations has contributed greatly to our understanding of the extent of interchange among rookeries and provided insights into marine turtle behavior. In Australia we have identified populations and established management units (MUs) as a focus for conservation, largely based on mitochondrial (mt) DNA data, as well as considering nuclear microsatellite data for some species. Extensive new tissue sampling of turtles at rookeries in Western Australia provided an opportunity to apply new genomics tools to investigate genetic structure in green and flatback rookeries around Australia. After the identification of several thousand SNP loci in each species, we analyzed ~1000 loci in flatback turtles and ~2000 loci in green turtles. Where comparisons were possible, genetic diversity at SNP loci was about 50% of that observed at microsatellite loci. Levels of genetic differentiation were very similar between microsatellite and SNP data for flatback turtles, but in green turtles the SNP data often produced lower values. Tests for the significance of genetic differentiation were similar between the two SNP and microsatellite data sets for both species. In contrast, patterns mtDNA genetic differentiation were quite different between species. Estimates of male-mediated gene flow varied among populations and species. Previously defined MUs for both species were supported, and new MUs were defined for flatback turtles in Western Australia. Consistency in the results between the genomic and microsatellite data have provided confidence in both approaches and opened possibilities for future research.

A THREE-YEAR ASSESSMENT OF FORAGING AREAS USED BY THE FLORIDA LOGGERHEAD NESTING AGGREGATION

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Determining patterns of migratory connectivity for highly-mobile, wide-ranging species, such as sea turtles, is challenging. Satellite telemetry and isotopic values of tissues collected on nesting beaches have been utilized successfully to identify foraging areas used by loggerheads (*Caretta caretta*) of the Northwest Atlantic (NWA) subpopulation. Almost 90% of this subpopulation nests in Florida, yet few research groups encounter nesting females. In contrast, thousands of nests are marked to assess hatchling production through an extensive program managed by the Florida Fish and Wildlife Conservation Commission (FWC). Until now, isotopic studies have been limited geographically or temporally and have focused mostly on few well-studied beaches where long-term projects target nesting females. Hence, a comprehensive assessment of foraging areas used by NWA loggerheads on an annual basis and over time is lacking. This study aimed to identify foraging hotspots and determine inter-annual contribution of foraging areas to the overall Florida nesting aggregation over three reproductive seasons. We relied on the established Florida permit-holder system to collect non-viable eggs from a subsample of loggerhead nests (n=200+/year) that were part of the FWC hatchling productivity assessment program during the 2013-2015 nesting seasons. Sampling design was based on the relative importance of the genetically distinct management units used in the FWC sampling scheme and reflected temporal distribution across the loggerhead nesting season. Non-viable eggs were collected for stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analysis during nest productivity assessment. Discriminant function analysis (DFA) was used to examine how well $\delta^{13}C$ and $\delta^{15}N$ classify loggerhead foraging grounds. The DFA model was derived from isotopic signatures of over 100 nesting loggerheads that have been equipped with satellite tags in Florida from the last decade and was used to assign the foraging ground used by the untracked loggerheads. The results of the assignment model were congruent with previous satellite telemetry studies. The Bahamas, Florida Keys and the southwest Florida continental shelf are prime and consistently used foraging areas for the overall loggerhead aggregation nesting in Florida. The majority of loggerheads nesting in Florida establish residence areas that are within the U.S. Exclusive Economic Zone, potentially simplifying strategies for the conservation of this critically important nesting aggregation.

ARE SMALL SEA TURTLES ROOKERIES DOOMED TO EXTINCTION? DOWNWARD NESTING TRENDS AT THE PARIA GULF, VENEZUELA.

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A small rookery of two species of sea turtles nest on five main beaches of the northeast coast of the Paria Gulf in Venezuela shows negative nesting tendencies: The critically endangered, hawksbill turtle (*Eretmochelys imbricata*) appear to be decreasing over 8 seasons 2009- 2016 (142 till 111 nests per year, Generalized Linear Model Slope Value GLMSV= -1.63);more concern,isthe trend of nesting of the vulnerable leatherbacks (*Dermochelys coriacea*) which denote a critical downward trend across the same period (69 to 8 nests/year; GLMSV = -6.02). Besides human and natural predation on the nests, no significant environmental impacts affect the beaches except on 2014 when a gas duct installation in Obispo Ism interrupted the nesting activity there. Changes in nesting pattern tendencies of the beaches show several remarks of the populations of the marine reptile community with conservation implications.

LONG-TERM TRENDS IN ABUNDANCE OF GREEN SEA TURTLES (*CHELONIA MYDAS*) ASSESSED BY NON-LETHAL CAPTURE RATES IN A COASTAL FISHERY

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Sea turtle populations underwent severe decline in historical times, mainly through harvesting eggs and adults on nesting beaches. With the reduction of this threat in many areas, coupled with other conservation actions, some populations have demonstrated encouraging recovery, although remaining below their previous levels and undergone additional modern threats such as incidental capture in fisheries and pollution. Trends in sea turtle populations have usually been assessed through monitoring of females or nests on nesting beaches. Here we present data from a 22-year monitoring period (January 1995 to April 2016) for a juvenile green sea turtle *Chelonia mydas* mixed-stock in southeastern Brazil that were incidentally captured in passive non-lethal pound nets. This fishery was introduced in southeastern Brazil by Japanese fishermen in the early 1920s and since then the gear had remained similar. Pounds are typically installed in bays with water depth 8–15 m, and constructed from nets with mesh size 3–10 cm, extended from the surface to the seabed, which allows capture fish throughout the water column. Those traps have used the same sites over the last seventy years. Once inside the trap, fish and turtles remain swimming without entangled themselves. Fishers visit the pound net two or three times a day to get captured fish. Capture rates are reported as number of turtles captured per day per pound. A total of 3639 green turtles were captured in 5323 fishing days.pound^{-1} with mortality rate of 2%. Captures occurred in all months, but bycatch rates, excluding recapture events, were higher in September and October, probably due to the recruitment of turtles migrating from southern areas, as well as recruits from the oceanic zone. Capture rates increased by 9.2% per year in the period from 1995 to 2016, in line with increasing source population verified for two of the main source contributors, i.e. Ascension Island (the most important contributor) and Aves Island (Venezuela). Another important source contributor for that mixed stock is Trindade Island (Brazil), where the population remains stable. Mean Curved Carapace Length of green turtles was higher during austral summer/early autumn and decreased markedly in May, probably due to the small-sized individuals that recruited to the study site. We show that the incidental capture of sea turtles in non-lethal fisheries, such as the Brazilian pound nets, could also provide data on trends of populations nesting in distant places, and can contribute to the assessment of population status of sea turtles within Regional Management Units throughout the Atlantic Ocean.

A COMPARISON OF LONG-TERM TRENDS IN NESTING ACTIVITY OF *CHELONIA MYDAS, ERETMOCHELYS IMBRICATA* AND *DERMOCHELYS CORIACEA* IN TORTUGUERO, COSTA RICA

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Tortuguero Beach, Costa Rica, hosts the largest rookery for endangered Green sea turtles (*Chelonia mydas*) in the Atlantic basin. Critically endangered Hawksbill (*Eretmochelys imbricata*) and vulnerable Leatherback (*Dermochelys coriacea*) and Loggerhead (*Caretta caretta*) turtles also nest here, though in substantially lower numbers. The Sea Turtle Conservancy has been working for the conservation of these nesting populations at Tortuguero since 1959. Here, poaching of turtle eggs and meat, predation by dogs and local wildlife and light pollution are some of the key inhibitors of successful production and recruitment of hatchlings. According to the most recent published evaluations, a positive trend in Green turtle nesting activity was observed at Tortuguero from 1999-2003, possibly in response to long-term conservation efforts and policy changes. Nevertheless, nesting activity of Leatherbacks decreased from 1995-2006 and though no nesting trend has been described for Hawksbills in Tortuguero, decreases in encounters with this species were reported from 1972-1990. In order to update these trends, we examined data from weekly track surveys conducted across 18 miles of nesting beach at Tortuguero for 22 years (1995-2017). New tracks and nests deposited in the previous night were identified and counted for Green and Leatherback turtles. General Additive Models (GAMs) were used to fit a curve to track survey results for the two species separately in order to determine nest counts for each day, and a total summed estimate for the season. Nesting seasons were defined with artificial end dates for the two species, encompassing deposition of >90% of nests throughout the year. A nonparametric regression model was used to calculate 95% confidence intervals for total nest estimates, and long-term trends in nesting activity were evaluated using a robust GAM for each species. Preliminary analysis suggests that though a positive trend in Green turtle nesting activity was observed prior to 2004, activity has plateaued in the 13 subsequent years. Leatherback activity has continued to decline since 2006. Nesting activity of Hawksbills at Tortuguero has not previously been comprehensively evaluated due to infrequency of nesting. In earlier studies, trends have been assessed based on numbers of encounters with nesting females, however these accounts are not fully representative of nesting activity as they are limited by monitoring effort. Hawksbill nests are easily mistaken as Greens', Loggerhead nests may exaggerate hawksbill nest counts, and weekly track surveys may exclude an important proportion of nests given the temporal spread of nesting events. Tag recapture assessment of Hawksbill activity, conducted along five of the 18 miles of nesting beach, may therefore provide a more appropriate means for estimating the Hawksbill population and nesting trends at Tortuguero. This study aims to update long-term nesting activity trends for Tortuguero, Costa Rica. In standardizing the methods used to analyze these trends, changes in nesting activity may be compared across three of the species utilizing this site. Nesting trends will be crosschecked with annual abundances inferred from tag recaptures for the entire study period, allowing for an evaluation of these two nesting trend assessment methodologies. Evidence of changing and declining nesting trends calls for an examination of the success of conservation efforts on the Tortuguero nesting populations, and is pivotal to shaping perceptions of threats to marine turtles. Determining these trends may influence management approaches, particularly in terms of prioritizing and distributing protection efforts, such as beach monitoring and nest relocations, to particular species. This project has been generously supported by a Travel Grant awarded from The International Sea Turtle Society.

AN OVERVIEW STATUS OF THE MARINE TURTLES IN SEMPORNA, SABAH, MALAYSIA

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The Semporna Priority Conservation Area (PCA) is located in the East coast of Sabah and within the vicinity of the Coral Triangle. Three species of marine turtles can be found nesting the beaches of Semporna – Olive Ridley (*Lepidochelys olivacea*), Hawksbill turtle (*Eretmochelys imbricata*) and Green turtle (*Chelonia mydas*) with the latter two having the most nests. Monthly marine turtle nesting monitoring was conducted in the six northeast islands from 2006 to 2016. The number of nesting females was recorded for the six islands. The number of nesting female marine turtle fluctuated for ten years, with the highest recorded number of nesting female was in 2012. This shows that the six northeast islands are an important nesting grounds. Direct take of marine turtle and eggs poaching is a major threat in Semporna. The number of reported cases of direct take of marine turtle has increased in the late 2016 until the mid of 2017. Several key locations have been identified as hotspots for the direct take of turtle operation. This paper will highlight the conservation efforts by WWF-Malaysia and the threats facing the marine turtles in Semporna. The data collected will provide a baseline for future management plans and the gazettement of the six northeast islands as marine conservation area.

CHANGE IN THE SPECIES COMPOSITION OF SEA TURTLES NESTING AT ISHIGAKI ISLAND, JAPAN WHERE THE EDGES OF NESTING AREAS OF THREE SPECIES ARE OVERLAPPED

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When effects of climate change on species get to appear (e.g. shift in geographic range), it is assumed that earliest place where such effect is clearly recognized would be the edge of geographical distribution range. Therefore, continuous monitoring of population status at the edge of distribution range is an adequate approach to assess the potential effect of climate change on species. Ishigaki Island, located on the southwestern part of Japan, has the nesting places for three species of sea turtles; loggerhead (*Caretta caretta*), green (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*). It is known to be the geographic southern limit of nesting places for north Pacific loggerhead turtles, meanwhile close to the northern limit for northwest Pacific green and hawksbill turtles. The objectives of this study were to assess the trends of nesting populations of three sea turtle species in Ishigaki Island which was at the edges of nesting areas of these species, and investigate the potential effect of climate change on those trends.

Ishigaki Island Sea Turtle Research Group started the nesting survey in Ishigaki Island at 1993, and has been doing systematic survey since 1995. Beach patrol was conducted during nesting season (generally, April to October). In the surveys, we counted the numbers of landing and nesting of sea turtles and estimated the day when those events occurred, based on the conditions of nesting crawls. Species of the nest was identified by using the morphology of nesting females, hatchlings, or adequately developed embryo in dead eggs as well as the characteristics of nesting crawl. The straight carapace length (SCL) and width (SCW) of individuals were measured, if turtles were encountered. Then, they were tagged internally using passive integrated transponder tags and externally using metal (Inconel) and plastic tags on both hind flippers. These procedures were conducted after turtles completed nesting, or before returning to the sea when a female failed to nest.

The results of 23-years nesting survey during 1995 to 2017, revealed that the number of nesting of loggerhead turtles decreased after peaking at 2008, while green turtles increased at a high rate. The hawksbill turtles have not shown a significant change in the number of nesting. This particular trend of loggerhead and green turtles results in the significant change in the ratio of the numbers of nesting among three sea turtle species. Given the dominant nesting species of sea turtles was loggerhead in Ishigaki Island in 1980s (Kamezaki 1991), the shift of dominant species in nesting sea turtles occurred from loggerhead to green turtles. In this presentation, we will investigate whether this shift of dominant nesting species occurred due to the climate change, based on air/ seawater temperature data.

LEATHERBACK TURTLES IN GABON (1998-2016); 18 YEARS OF BEACH MONITORING

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Monitoring of leatherback (*Dermochelys coriacea*) sea turtle nesting populations requires long temporal scales. We present here for the first time nest census surveys carried out in Gabon (Central Africa) from 1998 to 2016, combining daily track counts at index sites with coastal over flights at peak nesting. Although standardised data-collection was implemented from the 2006-07 nesting season, longer-term data was available as early as 1998-99 for two key sites. We first generated seasonal nesting curves from monitoring patrol data collected at nine nesting sites, deriving a mean curve for all sites and all seasons using half-monthly bins. We then calculated estimates of total nesting activities by dividing the aerial counts by the expected proportion of nesting during each survey date based on the seasonal curves. Finally we used Generalised Linear Models to investigate temporal trends in the data, from 2002 for all data and from 1998 for two of the sites. No significant trends were observed by season or by beach, except when data for the 2002-2003 season were included in the analysis. We present the implications for this nesting population in the global context and the threats to which it is vulnerable.

HOW TO INCREASE THE POPULATION OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN EIGHT YEARS BY ESTIMATING THE AGE OF SEXUAL MATURITY IN THE JAVA SEA, INDONESIA

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Egg poaching is the primary threat today to endangered Indonesian hawksbill turtle (*Eretmochelys imbricata*). We, Everlastig Nature of Asia (ELNA) and Yayasan Penyu Laut Indonesia (YPLI) conducted a nesting beach survey at 503 beaches in 38 areas in Indonesia from 1995 to 2008. Over 20,000 nests were recorded however, almost all of the eggs were poached and only 4 nests were found untouched.

We implemented an egg protection project on five major nesting islands which included the largest nesting site for hawksbills in Indonesia. Our protection protocol was to simply guard the eggs from the poachers and the nests were left *in situ* to incubate and hatch under the *natural* conditions. We hired the local egg poachers as a permanent egg guardian instead of trying to capture them, and they were responsible for recording the annual nesting data. We visited the islands 3-4 times in a year and surveyed the hatching conditions of all the nests.

The number of nests began to increase after 8 years on 3 out of four islands since the egg protection project was implemented. The initial average number of nests on the Segama-besar Island was 196.6±43.0 in 1998-2005. It increased to 351 nests in 2006 and 1080 nests in 2015. The rate of increase changed from 11.5 (1998-2005) to 72.2 (2006-2016) nests per year. On the Pesemut Island, the initial average was 136.8±48.3 nests in 1999-2006, increased to 224 nests in 2007 and 927 nests were recorded in 2015. The increase rate changed form 4.2 (1999-2006) to 43.6 (2007-2016) nests per year. The initial average number on the Kimar Island was 251.5±54.7 nests in 2007-2014, 499 in 2015 and 577 in 2016.

We speculate that this significant trend of an increase in nesting is caused by the hatchlings that were successfully hatched since the protection was implemented. This led us to infer those hatchlings took 8 years to reach their sexual maturity and participated in nesting. No other factors contributed to the increase were supposed due to the fact there were almost no hatchlings produced near and in the sites before the egg protection. Therefore, the age of maturity for hawksbill turtles in the Java Sea is estimated to be 8 years based on our result, which matches the estimation of 7 years 8 months studied by Hawkes (2014).

GENETIC VARIABILITY EVALUATION OF *CARETTA CARETTA* AND *CHELONIA MYDAS* FROM MITOCHONDRIAL DNA, NORTHEASTERN SECTOR OF THE COLOMBIAN CARIBBEAN

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Sea Turtles and Marine Mammals Conservation Program | Sea Turtles and Marine Mammals Conservation Program | Sea Turtles and Marine Mammals Conservation Program | Sea Turtles and Marine Mammals Conservation Program | Sea Turtles and Marine Mammals Conservation Program | Sea Turtles and Marine Mammals Conservation Program | Sea Turtles and Marine Mammals Conservation Program

Since 2013 the STMMCPro has been carrying out studies to evaluate the genetic variability in juvenile stages of the species *Caretta caretta* and *Chelonia mydas*, from the nesting areas in the departments of Magdalena and La Guajira, taking samples from individuals that were subjected to rehabilitation processes due to incidental fishing, as they were traveling through the program study area. Using oral smear and dermal tissue techniques, DNA extractions and segments amplification of 800 bp were performed using primers LCM15382 and H950; and subsequently sequenced and identified in the GenBank database obtaining a total of 63 mitochondrial DNA sequences of *C. caretta* and 24 of *C. mydas*. Revealing for the first time, the presence of 4 haplotypes for *C. caretta*: two of basal origin that define the presence of the haplogroups CC-A1.4 and CC-A2.1 and two derivatives CC-A17.1 and CC-A43.1, globally registered in the regions of the western Atlantic, eastern Atlantic and Mediterranean, particularly in areas of foraging. For *C. mydas*, 5 haplotypes were found: CM-A1.1, CM-A3.1, CM-A8.1, CM-8.2, CM-A5, being the last one the most frequent and ancestral, and like the rest, recognized in the main feeding and breeding areas of Tortuguero (Costa Rica), Buck Island (United States), Aves Island (Venezuela), Surinam and Brazil.

The results suggest the presence of a high genetic diversity in the northeastern Colombian Caribbean, contributing significantly to the genetic variability, possibly due to the geological age and environmental stability of the region. This provides the adequate conditions for its ecological and biological processes: reproduction cycles, development and displacement in its migratory routes, being the last ones favored by the global macro currents and the local micro currents, as the Caribbean current and the Panama-Colombia countercurrent, which provides the main transportation mean to the Colombian waters. For this reason, haplotypic information related with aggregations worldwide is obtained. In conclusion, the contribution and high productivity of the area to provide foraging zones, nesting and probably residence while the turtles reach the maturity and migrate to their respective breeding beaches (in the case of *C. mydas*) catalog the northeastern region of Colombia as a habitat that contributes significantly to the maintenance of multiple populations in the basin; which corroborates the hypothesis of the population expansion and the recovery of Atlantic shelters after the last Glacial Maximum. This points to the urgent need of increase the research efforts to protect the marine ecosystems and the nesting beaches in order to control and decrease the anthropogenic agents and deterioration that may affect the continuity and permanence of these populations.

DURABILITY AND EFFICIENCY OF METALLIC TAGS APPLIED IN THE TAGGING OF SEA TURTLES IN CUBA

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Tagging in sea turtles is generally done to obtain information about reproductive biology, movements, distribution and growth rates. The metallic tag (titanium, monel and iconel) has historically been one of the most used, despite the difficulties and limitations that it presents to the new methodologies existing for the development of these studies. Taking into account that the successful application of this method is related to the retention time of the tag; and that this depends on the type of tag, species of turtle, size of the specimen and the characteristics of the habitat among other factors, this work aims to extend on the efficiency and durability of this traditional method. For this purpose, the durability of the tags applied to sea turtles was analyzed by the tagging program developed by the Center for Fisheries Research (Cuba) since 1989, based on the recaptures obtained up to the present. All recaptures obtained for the three species studied were quantified per year: green turtle (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) in both water and nesting beaches. The time in years of all recaptures was calculated and the retention by size, species, environment where the turtle was tagged and by type of metal tag used was analyzed.

Key words: tagging, durability, green turtle, loggerhead, hawksbill, Cuba.

POPULATION STRUCTURE AND BODY CONDITION INDEX OF BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) FROM THE NAVACHISTE LAGOON SYSTEM, SINALOA, MEXICO.

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Sea turtle foraging areas are considered as congregation areas of these reptiles at different stages of life. The Navachiste Lagoon System (NLS) is considered a foraging zone of great importance for the black turtle within the Gulf of California, because it has particular physical and biological characteristics. During the years 2015 and 2016, 44 organisms of the species *C. mydas agassizii* were captured, in order to know the population structure and body condition index (BCI). For this purpose, the biometric data (size and weight) of the captured organisms were collected. Blood samples were also collected to perform a total protein (TP) and Microhematocrit (MH) analysis. The Straight Carapace Length (SCL) presented a general average of 62.99 ± 9.8 cm (73.4-29.1), while the weight presented an average of 36 ± 13.32 kg (59-2.55), reason why the population is composed mainly by juveniles. The BCI on average was 1.32 ± 0.21 (2.12-0.90), so that the captured organisms could be considered to have a very good BCI (BCI > 1.2 = Very Good). The mean MH was 29.7% ± 6.64 (43-17) and TP was 4.75 ± 1.02 g / 100ml (6.8-1.02). In conclusion, the population structure of the marine turtle *C. mydas agassizii* of the Lagunar Navachiste System, Sinaloa, Mexico, is composed mainly of juvenile organisms. The BCI can be used to infer about the availability of food in the foraging area. The values obtained work show that the turtles in the study area, have the physical and biological conditions suitable for a good population development. The correlation between BCI and total proteins is not statistically related ($R^2 = 0.1662$).

COMPARISON OF 16S RRNA, NAD, AND COI GENES BY DNA BARCODES TO STUDY GENETIC VARIATION FROM SEA TURTLES

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Introduction. In recent years, the barcode of life and the DNA barcode have become one of the major international approaches for cataloging and inventorying life on Earth (Hebert *et al*., 2003). DNA extraction, sequencing technique is used to get information from a unique identifier, such as the mitochondrial gene of the Cytochrome c Oxidase subunit I (COI or cox1). Mexico has a great biodiversity of species, among them many threatened or in danger of extinction, among them are sea turtles. Sea turtles have been inhabiting the Earth for nearly 100 million years, are highly migratory and occupy diverse ecosystems throughout their life cycles, are threatened worldwide due to fisheries and other cultural factors. which led to effective measures and conservation methods, such as the DNA barcode (Naro-Maciel, 2009). In Mexico nest, 6 of the 7 species of sea turtles all around the world, which are composed of two families, Dermochelidae (*Dermochelys coriacea*) and Chelonidae (*Lepidochelys kempii*, *L. olivacea*, *Caretta caretta*, *Eretmochelys imbricata*, *Chelonia mydas*).
Objective: to analyze genetic variation of Mexican sea turtles versus download sequences from GenBank by DNA barcoding.
Methodology. For the study, two procedures are carried out: a) *In vitro* analysis and b) Bioinformatic analysis. *IN VITRO* ANALYSIS. Six samples were collected from nesting sites and feeding areas of sea turtles in Mexico. BIOINFORMATIC ANALYSIS. Once, all possible sequences were obtained from 7 sea turtles published from GenBank (for COI, 16S and NAD genes), 67 for COI, 44 sequences for the NADH and 25 for the 16S, the sequences were transformed into FASTA format and aligned using the BioEdit v7.2.5 software with ClustalW. Then, networks of haplotypes were conformed with Network 5 for each gene and finally, MEGA7 was used for the reconstruction of phylogeny in a phylogenetic tree, using the NJ method, under the nucleotide substitution model of K2P, with 10,000 replicates (Bootstrap).
Results. For the COI gene from 73 sequences obtained, the average size of the aligned sequences was 484 bp. We found 24 haplotypes of *E. imbricata*, of which 4 haplotypes were shared among individuals of this species; 6 for *C. mydas*, where 3 of these haplotypes were shared by the same taxon; 3 for *L. olivacea*; 3 haplotypes for *C. caretta*, of which 1 was shared with taxa of the same species; while in *L. kempii*, *D. coriacea* and *N. depressus*, were grouped into 1 haplotype for each species; however, for the latter 3 species the same haplotype was shared for 2 individuals. The 16S gen, the alignment of 470bp, clustering in 12 haplotypes, 2 for *L. olivacea*, 3 for *C. mydas*, 2 for *C. caretta*, 1 for *N. depressus* and 1 shared between *E. imbricata* and *D. coriacea*. About of NAD gene, the number of bases was 300bp, resulting 29 haplotypes, of which 26 for *C. mydas*, 3 for *C. caretta* and 1 for *L. olivacea*.
Conclusions. The 16S gene maybe not appropriate for DNA barcode, because interspecific haplotypes are shares; while in NAD, there are not sequences for all species analyzed. It was observed that the COI gene sequence analysis of samples obtained *in vitro* and the downloaded samples show a clear genetic variation between genus and species, is discriminatory and relevant for use as a DNA barcode. The use of the DNA barcode based on the COI gene will allow to establish the existence or not of intraspecies variations; it will allow for a comprehensive analysis of all species. Finally, once the populations and species have been characterized, the analysis will allow identification of sea turtles in Mexico, which may be analyzed in wildlife, incidentally, illegally or wildlife traffic.

35 YEARS OF BLACK SEA TURTLE CONSERVATION ACTIVITYES IN MICHOACÁN, MÉXICO (1982-2017)

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In 1982, in a remote beach on the coast of Michoacán, one of the most important sea turtle conservation success stories in the Eastern Pacific region began. In that year, Javier Alvarado Díaz, professor of the Faculty of Biology of the Michoacan University of San Nicolás de Hidalgo, headed a group of enthusiastic students and teachers, traveled to the coast of Michoacán specifically to the beaches of Colola and Maruata to start systematic activities conservation and research in black turtle, then one of the most endangered populations in the eastern Pacific region. Since the 1960s, the black turtle population declined dramatically due to the intense harvest of eggs and adult breeding, which exceeded 4,500 metric tons only in the period from 1966 to 1970 according to Marquez et al. (1976) researcher of the National Institute of Fisheries in Mexico. Based on the poaching of black turtle nests that occurred only on Colola beach (70,000 eggs per night during peak nesting activity in October and November), it is estimated that 25,000 black turtle females nest only in Colola in 1965. In 1978, Kim Cliffton, a researcher at the Sonora-Arizona Museum, began census of the black turtle population on the coast of Michoacan, reporting important nesting sites on at least 12 beaches along the Michoacan coastline, mainly in Colola and Maruata nesting beaches (with approximately 48% of black turtle nesting). Conservation efforts were concentrated on these two beaches; however, between 1982 and 1999 the population decline did not stop; in 1988, the largest decline in the black turtle population was observed with only 170 nesting females throughout the nesting season, the decline continued and in 1998 again there was a significant reduction in the number of females.As of 2000, there was a significant increase in the number of protected nests that coincided with the beginning of the activities of monitoring and conservation of sea turtles in Baja California by the “Groupo Tortuguero de las Californias” and the recruitment of adult reproductive products of the conservation activities. The increase in the number of nesting females since 2000 has been maintained until 2016 and we estimate that the number of females that now nest only on Colola beach is approximately 10,000 nesting females of black turtle. 35 years of conservation activities to recover the black turtle population have revealed important aspects of the biology of this population.

NATAL-HOMING AND POPULATION STRUCTURING OF HAWKSBILL TURTLES IN THE NORTHEASTERN CARIBBEAN

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Marine turtles migrate back to their natal region during reproduction, but the precision of this homing behavior and whether the precision varies within a species or across regions is unclear. We analyze new mitochondrial haplotype data from hawksbill turtles (*Eretmochelys imbricata*) at several nesting sites across Antigua and Barbuda to better characterize genetic diversity at this sister-island nation and to assess the scale of natal-homing across islands separated by 40 kilometers. We then combine these data with published haplotype data from Western Atlantic rookeries to examine patterns of population structure across the region. Antiguan and Barbudan nesting sites were remarkably differentiated for their proximity, suggesting that these hawksbills are homing with high precision and that the two islands should be considered separate management units. Nesting sites within the island of Antigua, separated by an average of 25km, also showed some structuring with respect to haplotype frequencies. Regionally, we found stronger population differentiation among the rookeries of the Lesser Antilles than among those of the Greater Antilles and continents despite their smaller geographical range. This supports the hypothesis that rookeries on small, isolated land masses have more genetic structuring (i.e. natal homing to a finer scale) than rookeries on large, continuous land masses. Further, we hypothesize that hawksbills nesting on small, isolated islands may be more threatened by dynamic coastlines than hawksbills nesting on larger land masses due to their strong natal-homing precision, high nest-site fidelity, and thus reduced ability to colonize new nesting sites.

LONGITUDINAL STUDY OF BREEDING SEX RATIOS OF TWO IMPERILED MARINE TURTLES NESTING IN SOUTHERN FLORIDA

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Species that display temperature dependent sex determination are at risk due to increasing global temperatures. Marine turtles in the southeast region of the United States are especially at risk due to the high feminization of offspring due to these increases that may skew adult sex ratios. Adult sex ratios are difficult to assess as marine turtles are widely distributed and males remain in the ocean, so a functional alternative is sought: breeding sex ratios (BSR). One method to examine BSR is to identify the number of males that successfully contribute to each nest by examining paternity of hatchlings. We sampled nesting mothers and their hatchlings from two beaches in southern Florida of two species: the leatherback (*Dermochelys coriacea*) and the green sea turtle (*Chelonia mydas*). Sampling occurred over multiple nesting seasons (2013-2017) and included over 200 nesting individuals and over 5000 hatchlings. Our findings suggest that there are many males contributing to nests. We compare our results between species and assess how different mating behavior may affect population growth in these imperiled turtles. It is imperative to establish how mating affects the population structure of these turtles before extreme environmental effects are evident.

NEW MITOGENOMIC VARIATION HELPS RESOLVE FINE-SCALE POPULATION STRUCTURE IN PACIFIC GREEN TURTLES.

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Analyses of mitochondrial control region polymorphism have enabled identification of demographically independent green turtle rookeries globally. However, extensive sharing of common control region haplotypes confounds assessment of the scale of population structure among some rookeries in the Pacific, particularly those of the central and western Pacific Islands. Furthermore, overlap of common haplotypes among rookeries also introduces uncertainty into estimates of rookery contributions to mixed foraging aggregations and fisheries bycatch. To determine whether informative variation occurred outside of the established (780 bp) control region fragment, we sequenced the entire mitochondrial genome of all green turtles in our collection that had a common ubiquitous Pacific haplotype (CmP20.1). These turtles represented the rookeries of Federated States of Micronesia (FSM), the Mariana Islands (Guam and the Commonwealth of the Northern Mariana Islands (CNMI)), the Republic of the Marshall Islands (RMI) and Palau. We identified new single nucleotide polymorphisms (SNPs) that subdivided CmP20.1 into eight mitogenomic haplotypes partitioned among rookeries. Stock structure analysis performed with previously published mtDNA control region data combined with new mitogenomic sub-haplotype frequencies indicated much higher levels of population differentiation among these Pacific Island rookeries than previously reported. Furthermore, we found haplotype frequency divergence of Cmp20.1 mitogenomic sub-haplotypes between Guam and CNMI, indicating that these rookeries are also demographically independent, whereas they were previously indistinguishable with the control region data. Sequence determination at these CmP20.1 SNPs should allow better stock assignment for foraging green turtles and fisheries bycatch in the Pacific.

MAPPING THE HABITATS OF SEA TURTLES IN FRANCE TERRITORIES : FROM A SWOT REPORT TO A NATIONAL ATLAS

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With 12 overseas territories in all the world’s oceans, France occupies an area of nearly 12 million square kilometers, in which 6 of the world’s 7 sea turtle species can be found. Since the 1970s, knowledge about the terrestrial and marine biogeography of sea turtles in France has increased significantly thanks to activities carried out by the Groupe Tortues Marines France (French Sea Turtle Group – GTMF). As a first step towards visualizing French turtle distribution in order to strengthen conservation efforts, a partnership was established by GTMF with the State of the World’s Sea Turtles (SWOT) program to map the complete nesting biogeography of sea turtles in all the French territories. These maps, along with descriptions of conservation activities in each of the French territories will be published in SWOT Report vol. 13, and the launch of this publication at the ISTS in Kobe Japan (February, 2018) will begin a process of regular data updates to become a permanent element of the SWOT initiative dedicated to improving sea turtle knowledge globally. In addition, based on a recommendation from the second French Sea Turtle Symposium held in Paris in 2015, GTMF will publish a National Atlas which will include mapping of all sea turtle coastal and ocean habitats identified in France, as well as updates on the current knowledge on migration, population genetics, RMUs, and more. This first document synthetizing the large amount of results obtained by French teams during the next national colloquium in La Rochelle, November 12-16, 2018.

GROWTH RATES OF IMMATURE GREEN SEA TURTLES RELEASED FROM MIYAKO ISLAND, JAPAN

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Growth rates of green sea turtles *Chelonia mydas* (Linnaeus, 1758) are known to vary among regions (Suganuma, 1994; Kamezaki et al., 2012). Recent studies have shown that immature green sea turtles foraging around the Yaeyama Islands originate from a variety of breeding grounds in the Western Pacific Ocean, and that the turtles remain in the foraging habitat until they reach maturity (Nishizawa, 2010). Although the growth rates of some Yaeyama green sea turtles have been examined (Kamezaki et al., 1995; Kameda et al., 2013; Kameda et al., 2016), it is still incomplete: no information is available for growth rates of green turtles foraging around Miyako Island, located within the Ryukyu Archipelago.

In this study, we obtained fast-growing immature green sea turtles that were captured by the local fishermen from the coastal areas surrounding Miyako Island. Each turtle was measured [straight carapace length (SCL), straight carapace width (SCW), and plastron length (PL)], weighed, and tagged with identifier tags. The turtles were then released at Miyako Island to investigate their growth rate under natural conditions. Five of these turtles were recaptured between 2013 and 2016 in the waters around Miyako Island. The recapture intervals ranged from 1,114 and 2,316 days, and the annual (average) growth rate (N = 5) during this period was 10.2 mm SCL (range: 6.6 to 15.5 mm), 5.7 mm SCW (range: 3.9 to 8.9 mm), and 9.0 mm PL (range: 6.6 to 14.3 mm), with weight gain of 928 g (range: 485 to 1827 g). The growth rate of the immature green sea turtles inhabiting around Miyako Island was lower than that of turtles in the Yaeyama Islands, which are also part of the Ryukyu Archipelago, and was even lower than that of turtles in the Hawaiian Archipelago and southern Bahamas.

APPLICATION CLOSE-KIN METHOD TO SEA TURTLES AND ESTIMATION OF THEIR POPULATION SIZE

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For conservation and management of biological populations, it is crucial to assess and monitor the population size. Some estimation methods, especially mark-recapture methods using physical tags and stable isotope analysis, have been developed and employed for to unravel status of sea turtle populations. However, for verification of the results, it is useful to attempt to employ other estimation methods which can potentially be applicable to sea turtles. In these days, attractive methods with genetic information have been proposed to estimate the population for fishery resources. Here, we aim at investigating possibility of application of these method to sea turtles to establish another method that is genetic mark-recapture methods, instead of using physical mark-recapture methods, to understand sea turtles' population. Revealing sea turtles' population size leads to developing their conservations and managements.
In this study, we carry out simulation studies under some plausible scenarios. As a simulation procedure, genetic mark-recapture data were generated from multiple loci via an underlying simple population dynamics model, and then the date were analyzed for the estimation of population size. Estimation performance was evaluated in terms of bias and variance by Monte Carlo simulation. The results will be shown on site with details of simulation specification. Also, discussion on applicability to actual fields for sea turtles will be also given.

LOGGERHEAD TURTLE BYCATCH ESTIMATING FROM SPANISH SURFACE LONGLINE FISHERIES OPERATING IN THE MEDITERRANEAN SEA DURING THE PERIOD 2004-2016

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IEO | IEO | IEO | IEO

The western Mediterranean Sea is an important fishing ground for the Spanish surface longline fishery, targeting swordfish, *Xiphias gladius*, bluefin tuna, *Thunnus thynnus*, and albacore, *T. alalunga*. Balearic Islands and surrounding fishing grounds are important feeding areas for thousands of juvenile and sub-adult loggerheads *Caretta caretta* originating from nesting beaches in the Atlantic Ocean and the eastern Mediterranean Sea. Due to the spatial overlap in fishing groundsand loggerhead distribution, early 2000s years was estimated that a minimum of 60,000 loggerhead sea turtles were caught as by-catch in Mediterranean longline fisheries. The Spanish surface longline fleet group companies in competition with each other are continually introducing innovations to improve the economic benefits of the fishery. During the studiedperiod the home base surface longline targeting swordfish métier have been gradually replaced by a semipelagic longline métier targeting the same species.This fishing strategy change showsa significant correlation with the decreasing of the number of loggerhead sea turtle bycatch by Spanish longline fleet from Mediterranean Sea along the studied period. In addition, we update the estimation of loggerhead sea turtle bycatch from Mediterranean Spanish longline fleet by métier. In conclusionthe catches of loggerhead turtles by the Spanish surface fleetsusing different métiers has decreased significantly in the last eight years, however, this decrease is not due to the implementation of actionsto reduce the bycatch, but a collateral effect of the introduction of technical changesin the fishing gears with economic objectives; if new technological changes are implemented in the used gears this situationcould reverse.

LEATHERBACK TURTLE BYCATCH ESTIMATING FROM SPANISH SURFACE LONGLINE FISHERIES FROM MEDITERRANEAN SEA

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IEO | IEO | IEO | IEO

During the period 1999 to 2012 a total to eight leatherback sea turtle (*Dermochelys coriacea*) have been captured by the Spanish longline fleetfrom Mediterranean Sea. Catch and effort data for these fisheries were collected by the on-board observer program of the Spanish Institute of Oceanography (IEO), planned according to ICCAT recommendations.Thus, the observed captureof Leatherback represent 0.001014observed catches / 1000 hooks, which contrasts with 3940 observed catches of loggerhead turtles (0.499 specimens/1000 hooks) in the same period.

The surface long‐line targeting Bluefin tuna (*Thunnus thynnus*) was the gear that concentrated half of the observed leatherback catches, while in the case of the loggerhead, the higher incidence of catches was the surface long‐line targeting Albacore (*Thunnus alalunga*) deployed in more surface waters and using small hooks. These differences are explained by the different depths and habitat preferences of both sea turtle species and the different fishing strategies conducting to different pelagic depthsexploited by each fishing gear.

However, the management measured adopted by ICCAT for the protection of Bluefin tuna from 2006 and the implementation and control of such measures by the Spanish fleet has led to a gradual abandonment of the métier targeting bluefin tuna and their replacement by other longline métier targeting other species. For the latter it was observed a significant reductionin the leatherback turtles' bycatch. However, this decrease is not due to deliberate action in this line, but a collateral fact of the modification of the fishing gears with economic objectives, for these reason new technological changes could reverse this situation.

LAGUNA DE ROCHA, A CRITICAL HABITAT FOR SEA TURTLES IN URUGUAY.

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Karumbé NGO and Hombre y Territorio Association | Karumbé NGO | Karumbé NGO

Five of the seven species of marine turtles are present in Uruguay. The Uruguayan waters represent a key foraging and development area in the temperate latitudes of Southwestern Atlantic Ocean for at least three of these species; leatherback (*Dermochelys coriacea*), green turtle (*Chelonia mydas*) and loggerhead (*Caretta caretta*). Meanwhile, olive ridley (*Lepidochelys olivacea*) and hawksbill (*Eretmochelys imbricata*) are listed as "rare" species (Carreira & Maneyro 2015).
The Uruguayan coast consists of a succession of sandy beaches of variable extension separated by rocky outcrops. These linked habitats conform a relevant biological corridor for marine turtles, finding abundant food resources. One of these spots is the coastal protected area of Laguna de Rocha, where the Karumbé NGO has been recording the presence of sea turtles during the last decade. The aim of this report is to highlight the importance of Laguna de Rocha into this corridor for sea turtles arriving the Uruguayan coast.
These records of sea turtles consist of:

1. Six stranded leatherbacks. The mean curve carapace length (CCL) of the specimens was 131.3 ±0 cm (range 118.0 - 146.0 cm). Thus they were classified as adults. The findings occurred in January and June. This species feeds on large groups of gelatinous organisms in the Uruguayan waters (Lopez-Mendilaharsu *et al*. 2009).
2. The green turtles' records were bycatch (n=1) and stranded alive turtles (n=2). All the measured turtles were determined as juveniles (CCL = 35.20 ± 90 cm; range 33.1 - 38.5 cm). The records of this species were from November to January. These juveniles showed a feeding preference on macroalgae and gelatinous macrozooplankton (Vélez-Rubio *et al*. 2016). Even more, there is evidence that green turtles entering into the lagoon, according to the observations of the local fishermen interviewed.
3. Three stranded loggerhead turtles were recorded. These specimens consisted of juveniles (n=2) and adults (n=1) (CLL = 74.0 ±6 cm; range 64.2 - 95.6 cm). And they were registered from April to June. This species feeds mainly on crabs, snails and other marine invertebrates (Martínez-Souza *et al*. 2013).
4. An olive ridley turtle was recorded stranded dead in Laguna de Rocha in March 2006. This individual was an adult (CCL = 70.1 cm).
5. An unidentified specimen of sea turtle was found stranded dead in the surrounding of Laguna de Rocha in June 2007. After a comprehensive morphological analysis, this specimen was determined as a hybrid of hawksbill x loggerhead. The hybridization between *imbricata* and *L. olivacea* has been reported previously in the region (Proietti *et al*. 2014). In addition, this individual was classified as a juvenile (CCL = 56.5 cm).

We determined the main threat affecting sea turtles in Laguna de Rocha is the incidental capture in different fishing gear operating in the area, including sports fishing, artisanal gill nets and coastal trawls. Moreover, it should be mentioned there is an illegal trade as a consequence of these incidental mortalities. In some cases, carapaces are extracted from the dead turtles and then selling or used as decorative items.
These records might indicate this area supports relative densities of sea turtles. Therefore Laguna de Rocha should be considered as a critical habitat for sea turtles into the biological corridor of the Uruguayan coast. We suggest more effort should be directed to the assessment of the occurrence of marine turtle species in the Laguna de Rocha. Monitoring and systematic surveys along the area and throughout the year should be maintained in order to improve our knowledge on the current distribution of these species in Uruguayan waters.

IMPACTS OF LITTER ON SEA TURTLES AND MARINE FAUNA: AN EVALUATION OF INGESTION AND ENTANGLEMENT AT THE EUROPEAN COMMUNITY AND REGIONAL SEAS CONVENTIONS SCALES

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Marine litter has been reported to interact with species at all trophic levels, affecting them mainly through ingestion or entanglement. These interactions with marine litter often result in fatal or sub-lethal effects, the latter decreasing their chances of survival and reproduction. Sea turtles are of particular concern, since they are prone to ingest marine debris. Due to its extended distribution and the use of various marine compartments, the loggerhead turtle *Caretta caretta* is proposed as a relevant bio-indicator of the marine litter impacts by the Task Group on Marine Litter of the European Marine Strategy Framework Directive (MSFD). In order to implement the indicator "Litter ingested by loggerhead turtle", to assess the relevance of other indicators of litter impacts on biota and to monitor the efficiency of conservation and restoration measures, a global standardized methodological approach and thresholds of Good Environmental Status (GES) are urgently needed. To evaluate the criteria of the indicators and their GES, the consortium of the INDICIT project (http://indicit-europa.eu) carried out a feasibility study on the interactions of marine biota, especially the loggerhead *Caretta caretta* and leatherback *Dermochelys coriacea*, with anthropogenic debris, focusing on the waters of the European Community and the Barcelona (Mediterranean Sea), OSPAR (East Atlantic Ocean) and HELCOM (Baltic Sea) Regional Sea Conventions. The analysis of the existing literature as well as the collected raw data revealed a considerable interaction of litter with marine fauna, in particular turtles. In some areas, plastic ingestion was recorded in 100% of the individuals sampled and showed spatial variations that could indicate sub-regional differences in pollution levels. Inter-individual differences in the quantities of ingested litter were also found. The study also showed the prevalence of entanglement of various biota in marine debris, stressing the emergency of improving the existing knowledge about this harm, which has

been so far insufficiently studied and often confused with accidental and active bycatch. The results of this study confirmed the importance of developing and disseminating a standardized procedure for monitoring litter impacts on sea turtles and other biota. Standardization constitutes not only a major challenge for the ocean conservation and for restoration management measures, but this is also a key approach for improving the knowledge regarding the anthropogenic pressures on sea turtles at a global scale.

INCIDENTAL CATCH OF SEA TURTLES IN NORTHERN PERU DURING THE EVENTS EL NIÑO 1997-1998, 2015-2016 AND EL NIÑO COSTERO 2017

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IMARPE - SEDE SANTA ROSA | IMARPE - SEDE SANTA ROSA | IMARPE - SEDE PISCO

The incidental catch of sea turtles in northern Peru, on the coast of Lambayeque (06 ° 10'S -07 ° 10'S) during El Niño 1997-98, 2015-16 and El Niño costero 2017 is compared. By-catch was done through surveys of artisanal fishers during the period 2015, 2016 and 2017, and compared with Castro *et al*. 2012, in a study on incidental catches of sea turtles front to Lambayeque during El Niño 1997-98. These results were related to the environmental variability during the occurrence of warm events El Niño.

Incidental catches were made with gill nets, with the most frequent being those of 8 inches mesh size. The highest percentage of captured specimens was observed during El Niño 2015-16 with a total of 1285 specimens, with the highest incidence being black turtle (*Chelonia mydas*, N = 844), followed by the head turtle (*Caretta caretta*, N = 403) and leatherback turtle (*Dermochelys coriácea*, N = 38). During this period the thermal anomalies fluctuated between -0,9 ° C and + 3,5 ° C. These results differ markedly from that recorded during El Niño 1997-98, during which a total of 383 specimens were observed, with the largest number being the olive ridley (*Lepidochelys olivácea*, N = 308), these records were associated to positive thermal anomalies reaching their maximum values in december 1997 (+7.7 ° C) and january 1998 (8.3 ° C). During El Niño Costero 2017, the number of specimens captured was significantly lower than that reported in the two previous events mentioned, with a total of 24 specimens being captured. Thermal anomalies during this event reached a maximum value of + 5.1 ° C (march) in front to Lambayeque. These significant differences in the by-catch of sea turtles would be related to the variability of the particular environmental conditions in each event El Niño that differ from each other in intensity and duration.

The vulnerable situation in which sea turtle populations are found necessitates the generation of relevant information to help take actions aimed at the conservation of these marine species.

LITTER INGESTION BY DEAD AND LIVE SEA TURTLES IN THE ATLANTIC AND THE MEDITERRANEAN FRENCH WATERS: LESSON FOR THE IMPLEMENTATION OF THE INDICATOR -DEBRIS INGESTED BY SEA TURTLES-

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The improvement of knowledge to support the implementation of an indicator measuring marine litter ingested by sea turtles, as mandated by the European Marine Strategy Framework Directive (MSFD), is a critical gap. Collection of harmonized data to assess temporal and spatial variations of litter impacts and monitor the efficiency of reduction measures is therefore necessary. Analysis must support the definition of *Good Environmental Status* (GES), using either thresholds or trends, considering also other criteria such as biological constraints. For this, data can be collected through two different protocols based on the inventory of the ingested debris items found (i) in dead individuals' digestive tracts or (ii) in live rescued individuals' faeces. Due to its extended distribution, the loggerhead turtle *Caretta caretta* was first proposed as the indicator species. Because of its greater abundance in the European Atlantic waters, the leatherback turtle *Dermochelys coriacea*, was then also considered. Nonetheless, few standardized data are available to evaluate the spatial and temporal differences in both the percentage of individuals having ingested debris items and the quantities of items per individual.

Data collected since 1988 and 1995 for the French metropolitan Atlantic and Mediterranean waters respectively, was used for dead animals, and after 2006 for live animals in the Mediterranean. After 2013, the MSFD protocol was implemented in order to implement monitoring, involving collectively research laboratories, rescue centres, stranding networks and veterinarian laboratories, often in collaboration with fishermen. To develop good practices to evaluate litter ingestion, we compared the prevalence and the quantity of ingested items between (i) the two species, from dead individuals collected by stranding networks, (ii) the two protocols, using both live and dead loggerhead turtles, (iii) the French metropolitan Atlantic and Mediterranean waters, and (iv) the temporal variation in dead and live individuals. To better understand the harm and its spatial extent, we investigated the cross distribution of litter and sea turtles. We also calculated the digestive transit duration for coloured plastic balls of 1mm (air ball guns type) in the digestive tract of live animals of various stages recovered in rescue centres.

Overall, the occurrence of debris ingested by sea turtles was found to be very high in the French marine waters for both live and dead individuals. The results are discussed considering the influence of biological and environmental constraints.

INTERACTION OF SEA TURTLES WITH FISHERIES IN TUNISIA BASED ON INTERVIEWS WITH FISHERMEN

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Three sea turtle species are observed in the Tunisian sea. The loggerhead *Caretta caretta* is common and reproduces on some beaches while the green turtle *Chelonia mydas* and the leatherback turtle *Dermochelys coriacea* are rare. Sea turtles and especially loggerhead turtles strongly interact with fisheries in Tunisian waters and this problem seems to be the main driver of mortality. So far, information on sea turtle by-catch in Tunisia is limited both in space and time due to logistical problems in data collection requiring on board observations and on a limited number of vessels involved. In the present study, sea turtle by-catch level in Tunisian waters was evaluated by collecting fishermen's knowledge on turtle by-catch through an interview-based approach. Until now 250 interviews were conducted in different ports along the coast stretching from Monastir (Centre of Tunisia) to the Libyan border. Interview results analysis showed that many types of fishing gears are causing incidental catch of sea turtles: bottom and surface longlines, trammel nets, sharks nets and trawls. The fishing gears which show the highest probabilities of marine turtles bycatch are longlines and trawls. The work shows that in case of poor data from other sources, direct questioning of fishermen represents an approach capable of providing useful data to identify the most impacting gears.
At a second stage, we will refine the impact assessment by on board observationsand focusing on the most impacting gears according to the fishermen's interviews. We will then look for mitigation measures, focusing our action on the areas of maximum interaction and targeting the most impacting fishing techniques (highest by-catch and mortality rate). Finally, we plan to create fishing gears prototypes susceptible to reduce sea turtles by-catch. These prototypes will be tested in comparison with non-modified gears by measuring both target species and by-catch. Our ultimate objective being to propose to fishermen alternative fishing gears both commercially efficient and turtle friendly.
Keywords: By-catch, Sea turtles, Fisheries, Mitigation, Interviews, Tunisia, Mediterranean Sea

Thanks ISTS for the travel grant.

SEA TURTLE STRANDINGS AND THREATS PRESENT ALONG THE MAURITANIAN COAST

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To date, data on the general state of sea turtle species visiting and/or inhabiting the 754 km long Mauritanian coastal area remains scarce. In order to begin addressing this issue, we conducted an extensive 8-year long field study with the aim of gathering data about sea turtle stranding events and other possible threats present along the entire Mauritanian coast. Between 2009 and 2016, our team recorded 1799 stranded sea turtles in various stages of decomposition (fresh to late stage) including dry sea turtle carapaces located in or near coastal villages. Among the stranded sea turtles, the most common species was the green turtle (*Chelonia mydas*; 92.4 %), whereas the other sea turtle individuals belonged to the loggerhead turtle (*Caretta caretta*; 5.1%), the leatherback turtle (*Dermochelys coriacea*; 1.6 %), the olive ridley turtle (*Lepidochelys olivacea*; 0.8%), and the hawksbill turtle (*Eretmochelys imbricata*; 0.1 %). During this study, we gathered evidence showing that sea turtles are still being killed by both the native and non-native fishermen. They use sea turtle body parts (i.e. carapace, meat, fat, eggs and claws) as a food resource or a source of ingredients for various traditional medical preparations. For example, the fat of *D. coriacea* is used as an insect repellent, whereas the fat and claws of *C. mydas* are respectively used to treat asthma and muscle pain (i.e. lumbago) and alleviate the irritation of growing teeth in babies. In the past, all sea turtle species were traditionally hunted by the native coastal population. However, today such practices are less frequent and are conducted in secret because of the existing Mauritanian legislation which protects sea turtle species and forbids such activities. In addition, our field investigation revealed that sea turtles in Mauritania are also accidentally caught at sea in nets of artisanal and industrial fisheries. In the end, the collected field data indicates a need to better regulate human fishing and poaching activities that pose a direct threat to sea turtles visiting and/or inhabiting the Mauritanian coast. In addition to these recognized threats, we have also recorded the presence of fibropapillomatosis in ten stranded green turtle individuals found north of Nouakchott city (Mauritania's capital) in the villages near the Banc d'Arguin National Park. This is the first comprehensive study that focuses on the current status and possible threats to different sea turtle species present along the Mauritanian coast. This project was funded by the US Fish & Wildlife Service (Marine turtle Conservation Fund) and the Federal Government Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit; GIZ). The travel grant for attending the ISTS 2018 symposium in Kobe (Japan) was supported by the Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, and the US Fish & Wildlife Service.

WHY HERBIVROUS GREEN TURTLE ENTANGLES ON FISHING LINES ALONG TURKISH COASTS

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The all sea turtle species have been reported entangled in marine debris globally. Each year hundreds of thousands of adult and immature sea turtles are accidentally captured in fisheries ranging from highly mechanized operations to small-scale fishermen around the world. Incidental capture in fishing gear (also known as bycatch) is likely the greatest threat to sea turtles. The behavior of sea turtles makes them particularly vulnerable to entanglement. Adult and juvenile green turtles are unique among sea turtles in that they are herbivorous. In this case, there is no data about green turtle entanglement in Turkish coasts of Mediterranean. With this respect, we collected stranding data along the Turkish coasts of Mediterranean and we obtained a total 26 dead green turtles during 2016 nesting season. These dead green turtles consist of eight females, nine males, two subadults and seven undermined adult turtles. The mean Curved Carapace Lengths (CCL) is measured as 64.42 cm (range: 27.6-96 cm). We could not investigate nine dead green turtles because of decomposition. The causes of death were determined through necropsy in the rest of them. Marine debris, fishing line and hooks and other materials were removed carefully from mouth, esophagus, stomach and intestine and stored in a specific plastic bag labelled with the necropsy data. In the digestive system of 12 of 17 dead green turtles (70%), we found plastics, fishing line and hooks. Pieces of plastics and fishing line was found in five individuals. Fishing hooks was found only two individuals with fishing line which were lodged on esophagus. Fishing lines were observed almost in the digestive system starting from mouth to cloak and also front flippers of two individuals entangled with fishing line. The other reasons of dying are boat crash (2 individuals: 12%) and infections (3 individuals: 18%). According to the results of necropsy, the presence of fishing line and hooks in the digestive system was thought to be the major cause of these deaths and, while not directly marine debris, it could expose these animals to discarded fishing line and hooks.
Keywords: Marine debris, Fishing line, Green turtle, Turkey

USING STRANDING DATA AS A KEY TO MITIGATE THREATS AT ONE OF THE LARGEST OLIVE RIDLEY ROOKERY IN THE SOUTH ATLANTIC

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One of the most important olive ridley nesting colony described for the South Atlantic Ocean is located in northeast region of Brazil. The number of nests observed throughout the beaches of Alagoas, Sergipe and Bahia states has clearly demonstrated an increasing population trend. The number of nests changed from 252 in 1990/1991 to 2,206 nests in 2002/2003 and jumped to 8,438 nests in 2013/2014 nesting season. Over the last years, the number of strandings and dead turtles registered in this region have increased considerably, becoming a great concern for the conservation of this population. The main objective of this work is to assess the possible causes of the strandings in order to address viable solutions. For that, daily beach patrols of 268 Km were performed between August 2009 and July 2014. A total of 4,831 sea turtle stranding events were qualified and quantified. Among them, 1,999 were identified as olive ridley. Females with eggs and males with a developed tail, good muscle mass and large layer of adipose tissue were considered indicators that the death happened acutely. Chronic affections would lead the turtle to a condition of inappetence, thickness or cachexia and, in these cases, the turtles would not be able to reproduce or even conduct reproductive migrations. There were no records of active females during nesting process showing the above described characteristics (n = 6,954 approaches) during the last 30 nesting seasons along the study area. On the other hand, lethargic animals, with atrophied musculature and little or none adipose reserve were associated with chronic pathological conditions (diseases). Turtles with lesions due to constriction, presence of fishing gear fixed on the body or in the gastrointestinal tract were associated with fisheries interactions. Among the 1,999 olive ridley turtles stranded, 1,160 (58%) showed macroscopic finds that indicated the possible causes of death or debilitated condition of turtles. We identified six causes: 1) shrimp trawl fishery (91%); 2) coastal gillnet fishery (6,18%); 3) hook and line fishery (1,15%); 4) ingestion of trash (1,15%); 5) natural predation (0,35%) and 6) diseases (0,17%). Beyond the spatial overlap between the area used by the olive ridley turtles and the bottom trawl boats, there is also a temporal overlap between the peak of the nesting season and the highest fishing effort in nearshore coastal waters. Such facts

explain the high mortality of olive ridley turtles along the study area. Among the 1,160 turtles analyzed, 678 (58%) were adults (males and females). This significant adult loss may result in negative impacts that are still unknown for this population. Despite the use of the turtle excluder device (TED) been mandatory in Brazil, it reaches only boats bigger than eleven meters. Thus, according to this rule, just a short portion of the shrimp fleet (near 20% of the total fleet) fishing in the area fits in TED's rule. The current shrimp fishing seasonal closure goes from December to mid January, which is a period of high nest density. However, it hasn't been enough to reduce the incidental capture and mortality of olive ridley turtles on this important nesting site. An option to minimize this threat and reduce the loss of adults would be to extend the seasonal closure, matching the peak of the nesting season (November – January) for olive ridley turtles in Brazil.

LITTER INGESTION BY LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) ALONG THE ITALIAN COAST

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Loggerhead sea turtles have been chosen by international working group of researchers and technicians to be the most adequate indicator for the monitoring of presence and impact of marine litter in biota within the Mediterranean seas.

The Marine Strategy Framework Directive (MSFD) and the Barcelona Convention (EcAp process) follow to consider this indicator as candidate, due to the lack of data. The INDICIT project aims to standardize the methodologies of analysis on alive and dead sea turtles in European seas, as well as the characterization of ingested macroplastic items.

Since Italian coasts are affected by the constant presence of marine turtles, important data on plastic ingestion by sub-adult and adult loggerhead individuals have been collected at national level with at list one focal point in all of the MSFD Italian sub-region (Western Mediterranean Sea; Adriatic Sea; Central Mediterranean Sea).

A high rate of alive and dead sea turtles retrieving, mainly due to by-catch, boats collision, ingestion of marine litter, was possible thanks to the national networks of Rescue Centres, Scientific Research Institutes and Experimental Zoo-prophylactic Institutes.

A total of 431 loggerhead turtles were recovered through the activity of Italian networks operating in Lazio (N= 61; FO:75,4%), Abruzzo and Molise (N=74; FO:14,8%), Campania (N=61; FO:37,7%), Sicilia (N=70; FO:5,7%) and Sardegna (N=165; FO: 26,6%).

Faecal residual and gastro-intestinal contents were respectively analysed for alive and dead individuals following standardized methodologies elaborated by INDICIT partners modifying the MSFD guidelines.

The present study leads to highlight important data for the strengthening of the indicator (*Caretta caretta*) and to give information on the litter impact assessment in the three different sub-regions within the MSFD.

MEASURING THE IMPACT OF LIGHT POLLUTION ON HATCHLING ORIENTATION

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On sea turtle nesting beaches, artificial lighting associated with human coastal development disrupts orientation of hatchlings. Although the presence of these impacts are well known on many beaches, current data provide limited detail that would allow managers to understand, predict and manage the problem. In the present study, we quantified the accuracy of hatchling orientation and measured light intensity on 12 Florida beaches. The results of the study showed that the frequency of nests that had disrupted orientation varied widely depending on location, from less than 5 % to over 90 %. In order to understand how abiotic factors affected hatchling orientation, we quantified hatchling orientation accuracy of 89 nests at a natural beach along with data on beach slope, distance between dune and emergence location, dune height, moon illumination percentage, cloud cover percentage, and humidity. Among these parameters, the results of generalized linear model analyses favored a predictive model that includes moon illumination percentage, distance from nest to dune, and cloud cover percentage. For light intensity measurement, we used data-logging photometers to simultaneously record light intensities the dune, the ocean, and opposing longshore directions in six beaches. Light intensity dynamics in four directions and how these measures affected hatchling orientation accuracy were modeled. Analyses indicated that the light contrast toward the dune (silhouette), and both directions parallel to the shoreline, influenced the accuracy of hatchling orientation.

OBSERVING SEA TURTLE BYCATCH BY REMOTE ELECTRONIC MONITORING (EM) IN NORTHERN PERU

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Prodelphinus | Prodelphinus | Prodelphinus ; University of Exeter; Universidad Cientifica del Sur | Prodelphinus ; University of Exeter

Quantification of sea turtle bycatch is important in the context of conservation and management of protected species. Hitherto, using on-board observers has been the most reliable and accurate method; however, observer programs can be prohibitively expensive. Our study monitored fishing trips of four small-scale gillnets vessels from San José and Bayóvar ports in northern Peru from March to August 2017 and we analyzed the ability of cameras to identify and quantify sea turtle bycatch in this fishery by comparing its performance to onboard observer reports. The EM provided photographs of target captures and sea turtle bycatch and locations of fishing sets. Thirty-seven fishing trips (237 sets) were monitored. A total of 17 sea turtles (13 green [*Chelonia mydas*], 1 olive ridley [*Lepidochelys olivacea*], 1 leatherback [*Dermochelys coriacea*] and 2 unidentified [released before boarding the boat]) in 14 sets were recorded by the observers as incidentally captured. The photo analyst recorded 11 turtles (6 *C. mydas*, 1 *D. coriacea* and 4 unidentified) reviewing the same trips. Two main problems were identified as the potential cause of the discrepancies between the numbers recorded by the observer and photo analyst: camera failure (n = 3 ind.) and night haul (n = 3 ind.). The camera's ability to detect sea turtle bycatch was 64.7%. Our study shows that electronic monitoring has the potential to be an effective method to detect, identify and monitor sea turtle bycatch in small-scale gillnet fisheries. There is, however, still room for improvement in EM sea turtle detection rates and species identifications. The use of EM could provide a lower cost alternative or supplement to onboard observer programs and can help expand our understanding of the population-level impacts of fisheries bycatch on sea turtles, particularly in small-scale fisheries where at-sea monitoring is exceedingly challenging.

IMPACT OF THE FUKUSHIMA NUCLEAR ACCIDENT ON SEA TURTLES

Shinichi Tanaka | Emi Inoguchi | Takayuki Sato | Hiroyuki Suganuma
Everlasting Nature of Asia | Everlasting Nature of Asia | Everlasting Nature of Asia | Everlasting Nature of Asia

We investigated accumulation of radionuclides in total 132 stranded sea turtles found dead in Kanto area and Miyagi prefecture, Japan from Jun 2012 to October 2014 in order to evaluate impact of the Fukushima Nuclear Accident. The analysis of radionuclides was measured iodine-131, cesium-134 and cesium-137 in muscles of stranded sea turtles using gamma-ray spectra with germanium semiconductor detectors. Cesium-137 was detected in 30 of 132 sea turtles (maximum detection value:6.0Bq/kg, detection lower limit: 0.10-0.28Bq/kg), and cesium-134 was detected in 8 of 30 sea turtles which detected cesium-137(maximum detection value:3.1Bq/kg, detection lower limit: 0.10-0.28Bq/kg). We concluded that cesium-134 detected in sea turtles was originate from Fukushima Nuclear Accident considering cesium-134 has a half-life of 2 years. On the other hand, it was difficult to identify the origin of cesium-137 because cesium-137 has a half-life of about 30 years. Nevertheless, as the radioactivity ratio of cesium-134 / cesium-137 emitted by the Fukushima Nuclear Accident has been reported to be approximately 1 : 1, we speculated that a part of cesium-137 detected together with cesium-134 was likely to be originate from the Fukushima Nuclear Accident. Radionuclides emitted from the Fukushima Nuclear Accident also affected sea turtles, however it is slight compared with other marine products. We considered that the ecological characteristics of sea turtles such as migration caused its low accumulation of radionuclides.

MARINE DEBRIS INGESTION IN THE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*: A BIO-INDICATOR OF THE ENVIRONMENTAL STATUS OF THE WESTERN MEDITERRANEAN.

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The loggerhead sea turtle (*Caretta caretta*) has been selected by the EU Marine Strategy Framework Directive (MSFD) as a relevant bio-indicator for monitoring trends in the amount and composition of marine debris in the Mediterranean Sea. The MSFD has established a standardized protocol for data collection on marine debris from the digestive contents of turtles, and for determining assessment values of plastics for Good Environmental Status (GES). GES values are calculated as percent turtles having more than average plastic weight per turtle, using samples of 50-100 turtles. The goal is to monitor GES over time to analyse temporal trends. So far, six studies have followed the MSFD protocols, but only one provides a GES value (off Italian coasts). However, little information on debris ingestion is available from the Spanish Mediterranean area. In the present study, we quantify marine debris ingestion in 155 loggerhead sea turtles (mean CCL ± SD [Range]: 51.1 ± 14.9 [11.0-80.0] cm) collected in the period 1995-2016 in waters of central Spanish Mediterranean. The study aims (1) to update and standardize debris ingestion data available from this area and (2) to provide new data to compare the only GES value available so far. Marine debris appeared in 78.1% (95% CI: 70.7-83.9) of the turtles analyzed, with total dry mass of 406.930 g. Barely half of total weight (202.231 g, collected in 94 out of the 155 turtles) was accounted for debris of natural origin. Debris of anthropogenic origin were found in 71.0% of the turtles (95% CI: 63.2-77.8) with a total debris weight of 204.699 g. '*Plastics*' was the most prevalent category (69.0%, mean±SD dry weight= 1.113± 2.312 g, range: 0.001-15.175 g), followed by '*Rubbish*' (9.7%, 0.202± 1.189 g, range: 0.045-10.599 g), and '*Pollutants*' (5.8%, 0.006± 0.033 g, range: 0.001-0.307 g). The GES value for sub-adult turtles (CCL> 40cm) in the period 1995-2005 (n= 60) indicated that 30.0% of turtles had more plastics (dry weight) than average (1.47 g). In the period 2006-2016 (n= 54), 27.8 % of turtles had more plastics than average (1.31 g). Accordingly, GES values suggest a slight decrease in amount of plastics ingested in the study area. The GES value in the Italian area for the period 2011-2014 was surprisingly similar (27% of turtles with more plastics than average [1.3 g]) to our second period. Thus, these values could be a validated GES for the Western Mediterranean sub-region defined by the MSFD. Unfortunately, the methodology followed by the other studies using MSFD protocols is not strictly comparable because of important differences in debris quantification. The present study encourages a proper use of the standardized protocol proposed by the MSFD for assessing marine debris ingestion by loggerhead sea turtles.

BANGLADESHI OFFSHORE FISHER'S COLLABORATION FOR BYCATCH REDUCTION.

Mohammad Zahirul Islam
Marinelife Alliance

Fisheries resources declining in Bangladesh and over fishing is one of the major causes of declining marine fish resources. Coastal communities have few opportunities other than fishing for their livelihood due to lack of education and facilities, resulting in large offshore fishing communities as well as we have large pressure from Myanmar originated Rohingya refugee. Indiscriminate fishing, very fragile regulations and enforcement leading to destructive fishing in coastal and offshore fisheries in Bangladesh. As the fishing increases and there is no proper evaluation of gears for sustainability and smart capturing the outcome resulted into huge bycatch of small endangered species in marine megafauna. The conservation of sea turtle and small cetacean is impossible without offshore fishers both on beach and offshore. Marinelife Alliance running the community based sea turtle conservation program where sea turtle are being monitor and ensured safe breeding by conserved hundreds of community people along 400 kms nesting beach. more than 2200 artisanal fishing boats are taken into account for collaborative work for bycatch reduction and helping in protection of nests and nesting turtle.

There are 225 mechanized trawlers, 68 thousand boats and 0.5 million marine fishermen in Bangladesh marine territory, produce 0.6 million metric tons of marine fish, that needs overfish disregarding juvenile or adult. Government also plans to increase harvesting 18% more by 2020. Over-fishing is mainly responsible for juvenile catch as well as non-targeted marine biodiversity essential for maintaining balance of marine ecosystem. Large amount waste harvest observed in marine set bag net(MSBN) fishing offshore by MLA researchers in recent years. The community fishermen are forced to seek financial help from boat owner to feed their family, however this usually has high interest and forced to overfish in order to repay their loans, even in bad weather. This results in the fish market being full of juvenile fish during breeding season. The situation is worsening by the use of destructive MSBN. There is no code of conduct regarding fishing or harvesting followed. The law enforcement and rules are very loose in Bangladesh marine fisheries. That applies to overall Bangladesh marine fisheries resources.

Currently, it is common for the children to believe that small size is usual or normal size. To overcome this situation, fishermen need help from outside to feed their families. They need an opportunity so they don’t need to borrow money from the fishing boat owners. There is no government subsidy, or alternate source from other voluntary organizations yet to help them to overcome the poverty situation. This ultimately resulted into depleted fishing resources in Bangladesh marine fisheries. Marinelife Alliance is working to help fishermen take alternate ways of income other than going to sea for fishing. They can take various income generation activity, like ecotourism, sea cruising, crab farming, handicraft production and business, etc.

RAPID ASSESSMENT: FISHING GEAR CHARACTERISTIC AND SEA TURTLE BYCATCH BASELINE IN WEST NUSA TENGGARA AND NORTH SULAWESI

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Artisanal fisheries in Indonesia consist of several fishing gear types (e.g. gillnet, purse seine, hand line, and other traditional fishing gears). Gillnet fisheries are dominantly used in the coastal waters of West Nusa Tenggara and North Sulawesi and overlap with regions that are utilized by sea turtles, sharks, marine mammals, and other ETP (Endangered, threatened, and protected) species. A rapid assessment of coastal fisheries was conducted during October 2014 and April 2016 in order to obtain an understanding of gear characteristics, location of fishing activities, a baseline of bycatch interactions, and post interaction handling of bycatch .
Surveys were conducted with 369 fishermen in several districts of West Nusa Tenggara - Dompu, Labuan Lalar, Lunyuk, Merpak, Pototano, Rompo, and two districts of North Sulawesi - Sangihe and Talaud Island. Gillnets were most commonly used by interviewers (33%), followed by hand line (30%), other fishing gears (26%), and purse seines (11%). Both monofilament and multifilament gillnets were used frequently by the fishermen. The mesh size of gillnets were between 1 – 4 inches (stretched diagonal) and fishing vessels were 5-10m in length. In case of the purse seine fisheries, the mesh size tends to be similar which is 1,5 inch and the vessel is 12 m in length. The other dominant fishing gear is hand line, that are single and multiple hand lines. Fishing trip typically lasted from one day through a week. In North Sulawesi, the fishing season occurred between April to August and throughout the year in West Nusa Tenggara. The target species were mackerels, scads, tuna, and other commercial fish. Endangered, threatened, and protected (ETP) bycatch consisted of were sharks (70%), sea turtles (20%), dolphins (6%), dugongs (2%), mobulid rays (1%), and whale (1%). The sea turtle bycatch was primarily green turtles (*C. mydas*) (48%,n=69), hawksbill sea turtles (*E. imbricata*) (51%,n=74), and olive ridleys (*L. olivacea*) (1%,n=1). ETP bycatch was either sold (48%), kept consumption (21%), or release back to the sea (31%.)
Based on the study, we estimate that in these two regions the highest sea turtle bycatch was in Merpak (747 individual/year), followed by Rompo (180 individual/year), and Lunyuk (107 individual/year). Understanding the locations of sea turtle bycatch allows for consideration of fishing gear adjustments and development of mitigation technology to reduce sea turtle bycatch in this region. In addition, this work highlights the important roles that local fishermen will need to play in promoting and implementing best conservation practices for sea turtles and other ETP species.
Keyword : Sea Turtle, Bycatch, Gillnet

STATE OF THREAT OF SEA TURTLES IN THE PACIFIC OF COLOMBIA FROM ASSESSMENT IN THE RED BOOK OF REPTILES OF COLOMBIA (2015)

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An evaluation of the risk of extinction of reptile species was conducted and the “Red Book of Reptiles of Colombia (2015)” was produced. Historically, in Colombia the turtles and crocodilians have been the focus of a heavy pressure, principally for consumption. To these threats we must add the loss, transformation, and degradation of their habitats. Due to synergistic effects and increases in these pressures, it is highly imperative to have an updated understanding of the state of conservation of these species. Because the IUCN currently recommends an evaluation of the extinction risks to a species every eight years and the last evaluation for the class Reptilia in Colombia was conducted almost 13 years ago, a new evaluation was conducted using the five current IUCN criteria (2012) for 510 reptile species, including the five sea turtle species that occur in Colombia. In the case of the sea turtles, these were classified in different threat categories based on a variety of reasons, such as the reduced number of populations or mature individuals, and for the reduction and degradation of their habitats. The National Committee on Threatened Species and external evaluators reviewed the results of the categorization. Taking into account the threat level (from highest to lowest), sea turtles were listed as follows: The hawksbill turtle (*Eretmochelys imbricata*) (CR D), the loggerhead turtle (*Caretta caretta*) (CR A2cd; D), the leatherback turtle (*Dermochelys coriacea*) (CR A2cd), the green turtle (*Chelonia mydas*) (EN D), the olive ridley (*Lepidochelys olivacea*) (VU D1). Here, are present the state of threat of sea turtles that occur in Pacific of Colombia from the assessment in the Red Book of Reptiles of Colombia (2015); furthermore of the research and conservation needs and opportunities for these Pacific Ocean populations of Colombia.

CHANGES IN FLIPPER BEAT FREQUENCY AND BODY ACCELERATION OF LOGGERHEAD TURTLES *CARETTA CARETTA* IN A BAG NET OF A SET NET

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Turtle releasing system (TRS) is a method to allow sea turtles to escape out from a submerged bag net of a set net. This system consists of a turtle releasing device (TRD) and a quadratic-prism shaped sloping upper panel of the bag net. When turtles need to breathe, they attempt to swim up toward the sea surface and start pushing their heads up continuously (defined as pushing up). The sloping upper panel guides turtles to the TRD installed at the apex. In this study, flipper beat frequency and body acceleration of loggerhead turtles in the submerged bag net of a set net were examined to assess pushing up behavior and degree of necessity for breathing.
Experiments were conducted in August and November 2013, June 2014, July 2015, and September 2016 in the submerged bag net of a set net in Mie pref., Japan. Fifteen wild loggerhead turtles (SCL: 63.3~89.6cm) were used in the experiments. A video camera (HDR-AS100V, Sony Inc.), an acceleration data logger (W1000-3MPD3GT/ W380-PD3GT, Little Leonardo Co.), and a depth logger (DEFI-D20, JFE Advantech Co., Ltd.) were attached on the carapace of the turtle, and the turtle was put into the submerged bag net. Flipper beat frequency was obtained from video images, and ODBA (overall dynamic body acceleration), an index of exercise intensity, and water temperature were obtained from an acceleration data logger, respectively.
Flipper beat frequency of the loggerhead turtles swimming or pushing up in the bag net varied between approximately 0.2 to 1.5 Hz during thirty minutes' observations, and it tended to increase in ascent leading to pushing up unlike in natural environment. Flipper beat frequency had a positive correlation with water temperature (p<0.0001). Loggerheads alternated series of pushing up and swimming with the lapse of time. Average ODBA in the series of pushing up increased as the number of the series proceeded, that is, pushing up was strengthened with time elapsing without breathing.

USING CHARISMATIC SEA TURTLES TO INFLUENCE POLICY: LOGGERHEAD MARINELIFE CENTERS BALLOON BAN INITIATIVE

Tommy Cutt | Demi Fox
Loggerhead Marinelife Center | Loggerhead Marinelife Center

Marine pollution is widely acknowledged as a significant threat to all sea turtle species. Ingestion of debris and entanglement are often causes for the animals' admittance to Loggerhead Marinelife Center, a sea turtle research, rehabilitation, education, and conservation organization in Juno Beach, Florida. When released, accidentally or intentionally, deflated balloons often ultimately litter the beach and ocean making them one of the deadliest types of marine debris for the endangered species. Today, state law prohibits the intentional release of ten or more balloons in a 24-hour period but does little to prevent incidental pollution. In an effort to promote the protection of marine life, LMC launched a Balloon Ban Initiative focused on the Southeast Coast of Florida in 2016. Using charismatic sea turtles as our platform, we partnered with municipalities to prohibit or discourage the use of balloons in coastal areas. The program provides three levels of participation: distribution of educational materials alone, educational materials and installation of signage, and finally, educational materials, signage, and the adoption of an ordinance or resolution. Upon receiving overwhelmingly positive feedback from local communities, municipalities in other Florida regions began to reach out in the interest of joining the Balloon Ban. Currently, 15 municipalities in five counties participate in the program. We found that communicating directly with leaders in each municipality was a successful strategy to effect change. We are working to expand the reach of the ban across the state by way of individual partnerships that best suit each city or town in the hopes of providing widely-dispersed protection for the state's sizable sea turtle population.

INDICIT: A EUROPEAN PROJECT FOR IMPLEMENTING INDICATORS OF MARINE LITTER IMPACTS ON THE LOGGERHEAD SEA TURTLE *CARETTA CARETTA* AND OTHER BIOTA

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CNRS

The ubiquity and the persistence of marine litter, especially plastics, constitute a major threat to the biodiversity and the ecosystem services provided by seas and oceans. The Descriptor 10 “Marine litter” of the European Marine Strategy Framework Directive (MSFD) is dedicated to this anthropogenic pressure and aims to achieve the *Good Environmental Status* (GES) of the European marine waters by 2020. GES is considered to be reached when “the properties and the quantities of marine litter (items made or used by humans, directly or indirectly and deliberately or accidentally discarded at sea) do not cause harm to the coastal and marine environment”. The European project INDICIT (acronym for Indicator Impacts Turtles; February 2017-January 2019; Grant agreement n° 11.0661/2016/748064/SUB/ENV.C2; http://indicit-europa.eu) intends to support the implementation of the indicators of litter impact on sea turtles and marine biota, in the areas of the MSFD and the Regional Sea Conventions (RSC) OSPAR (North-East Atlantic ocean), Barcelona (Mediterranean sea) and HELCOM (Baltic sea). Ten institutions from European and non-European countries work together on the establishment of a coordinated and harmonized approach, necessary for monitoring the impacts of marine litter and evaluating the efficiency of restoration measures. Three indicators of litter impact are being assessed: 1) “Litter ingested by sea turtles”, for which a GES (threshold/tendency) and criteria (e.g., biological constraints) will be evaluated; 2) “entanglement of biota in litter” and 3) “micro-litter (<5 mm) ingestion by fish and sea turtles”. To achieve its objectives, INDICIT is structured in 5 highly connected Activities, the tasks of which mainly target the feasibility of impact indicators to be used in the European Community and RSCs’ areas, and the acquisition and analyses of standardized data for the evaluation of the indicator criteria. The project also aims to improve the standardization and capacity building, through networking and training of the stakeholders in charge of collecting data. One of the main expected outputs is the establishment and the dissemination of standardized procedures to the international community, such as protocols and tutorials to study litter impact, in particular for rescue centres and stranding networks involved in the monitoring of dead and rescued sea turtles.

PROTORMAR-UAS: COMBINED SEVENTY YEARS OF RESEARCH AND CONSERVATION OF SEA TURTLES IN TWO NESTING BEACHES OF NORTHWEST OF MEXICO

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Anthropogenic activities have different effects on the populations of sea turtles in their different ontogenic periods (eggs, hatchlings, juveniles, females and males in breeding). Predation and loss of habitat are some of the human activities that affect all species of sea turtles. In particular, the olive ridley turtle (*Lepidochelys olivacea*) is considered vulnerable species worldwide and in danger of extinction under Mexican law. There are management and conservation programs for the species in order to mitigate the decrease of populations by humans. The Autonomous University of Sinaloa's Marine Turtle Program (PROTORMAR-UAS) has contributed to the conservation of the turtle for decades, and has two biological stations. In 1976, the first station was installed in Ceuta Beach, Elota, Sinaloa, Mexico, initiating the monitoring and protection of sea turtles at this beach; ten years later, these activities were implemented at Caimanero Beach in Rosario, Sinaloa, Mexico. Thus, PROTORMAR-UAS has logged nesting monitoring information for the olive ridley turtle for 40 and 30 years, respectively, as well as having pursued environmental education work. In this study a retrospective analysis of the monitoring activities for the protection of the olive ridley turtle is carried out in both nesting beaches (i.e. number of nestings per year, protected nests, released hatchlings), as well as trends of indicators of population abundance. Both nesting beaches show a positive trend in nesting numbers through time, Ceuta Beach shows a linear trend ($R^2 = 0.7509$) and Caimanero Beach an exponential trend ($R^2 = 0.4184$), being the year 2005 a watershed for the increase. One of the axes of the program is environmental education and year after year there are visits of pre-school or postgraduate school groups. On the other hand, it has strengthened the research lines in marine turtle ecology, stranding and coastal dynamics.

USE OF PHOTO IDENTIFICATION TO ASSESS SEA TURTLES POPULATION AND THREATS AT PERHENTIAN ISLANDS MARINE PARK IN MALAYSIA

Wan Zuriana Binti Wan Sulaiman | Seh Ling Long | Daniel Quilter | Choe Wai Cheah | James Owen William | Connaugh Patrick Walsh | Rutger Zegveld | Bethanie Johnson | Maisy Fuller | Nicholas Tolen | Katarina Yates | Daniel Read | Alexander Poole | Ramona Pförtner

Perhentian Turtle Project, Ecoteer | Universiti Malaysia Terengganu; Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer | Perhentian Turtle Project, Ecoteer

Perhentian Islands are marine protected areas, which are also important nesting and foraging grounds for green (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*). To better understand the sea turtle populations, the Perhentian Turtle Project started monitoring and collecting data since 2015. We collected sea turtle sightings from 2009 until 2017 and used non-invasive photo identification methods to identify individual in-water and nesting turtles and assess mortalities and threats to the sea turtle populations. We identified 63 in-water individuals from 3057 sightings between 2009 and 2017 and 183 individual nesting turtles from 452 sightings between 2015 and 2016. Of the 63 in-water turtles, 29 individuals were sighted more than once at the same site. The nesting and in-water individual turtles were not the same. From 2015 to 2017, there were 21 dead green turtles and one dead hawksbill turtle. Mortality of eight green turtles was due to boat strike while the cause of mortality for the remaining turtles was undetermined because they were either over-decomposed or there were no external injuries. This shows that as boat traffic increases with tourism development, boat collision becomes a major threat to sea turtles. Besides, there is no boat speed limit imposed within the marine protected area. Such findings can inform local governments of the status of sea turtle populations and threats to develop management plans for sustainable tourism, and conservation in marine protected areas. Hence, photo identification is a reliable method to monitor the sea turtle populations and identify threats. Furthermore, photo identification also enables long-term monitoring where trained and untrained volunteers, villagers and tourists can directly engage in data collection, contributing to the research and conservation of sea turtles in Perhentian Islands.

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INVOLVEMENT OF FISHERMEN IN SEA TURTLE CONSERVATION: A CASE STUDY IN THE FRENCH MEDITERRANEAN SEA

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The Centre for Research and Conservation of Mediterranean Sea Turtles (CESTMed) has been working closely with local fishermen for more than 10 years. Since 2002, the CESTMed rescue centre has received more than 450 sea turtles, mainly after interaction with fishing gear (75%). Trawlers and artisanal fishermen of several fishing ports of the French Mediterranean coast systematically alert the French Mediterranean Stranding Network (RTMMF) when they accidentally catch a sea turtle (dead or alive) in their gear. These animals are brought to the rescue centre where they are identified, examined, treated (if needed), measured, weighed, photographed and sampled for research purposes. Biological samples (blood, faeces, epibionts, etc.) are collected and sent to scientific partner laboratories for analysis (genetic analysis, ecotoxicology, diet analysis, marine litter ingestion, etc.). Some individuals are equipped with satellite linked transmitters to provide insights about their horizontal movements and diving patterns. Behaviour studies are carried out to study sea turtle foraging activities. Dead sea turtles systematically undergo autopsies to identify mortality causes, including anthropogenic pressures which are monitored following the European Marine Strategy Framework Directive (boat strikes, contaminants, marine litter, interactions with fisheries). All information collected is recorded in dedicated databases. In addition, fishermen are involved in the development of bycatch reduction devices and Participatory Action Research programs on marine litter, which is reported to constitute a growing concern for the sea turtle population through direct or indirect impacts. These conservation actions are made possible thanks to the contributions of local fishermen, and to the trusting relationship that CESTMed has built with them over the last 10 years. Consultations, educational tools (videos, leaflets, stickers, etc.), photographic exhibitions, visits of the rescue centre, routine discussions in fishing ports: all these actions highlight the fishermen’s work, increase their awareness and make them part of sea turtle conservation.

CONSERVATION STRATEGIES IN NESTING AREAS

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Tortuguero (Costa Rica) is one of the main nesting areas worldwide for green turtles, with occasional sightings of other species (leatherbacks, hawksbills and loggerheads). Plastic waste, light pollution, nest and hatchling predation by dogs, and vegetation loss have been identified as the main local threats for sea turtles and their habitats. The present work establishes several strategies aimed to minimize the negative impact in Tortuguero by focusing on: light pollution mitigation, waste reduction on the beach, no plastic policies for local businesses (bars, restaurants, hotels, etc.), increase of vegetation density next to the beach, and controlling the dog population through neutering campaigns. To achieve this, we have implemented a specific action plan for each of the identified threats.

Red Light Program: Through monthly light surveys we identified the light sources that had an impact on the beach and could potentially jeopardize sea turtle orientation during the nesting and hatching processes. The establishments identified were informed and lectured about light pollution and its consequences on the sea turtle lifecycle. We facilitated the change process to red LEDs and light deflectors. Moreover, we contacted ICE (Costarrican Electrical Institute, the public company in charge of urban light) to make the switch to “turtle-friendly” streetlight. As a result, we have observed a decrease in light pollution in areas close to the beach. In addition, the participants in this program (small hotels) were rewarded with a diploma to recognize their effort.

‘Desembolsate Tortuguero’ Program: We collaborated with local groceries through meetings and agreements to establish a payment policy for plastic bags. We managed the production and distribution of alternative fabric bags, and cooperated with the groceries’ owners to make the fabric bags available in their stores. As part of the program, more than 450 bags were distributed in the local groceries. The program started thanks to external economic support but currently it is financially independent, yielding a profit that is reinvested in the community.

Veterinary campaigns: We organized veterinary campaigns to make up for the lack of a veterinarian center in the area. These campaigns are mainly focused in neutering dogs and cats to control the population, but also include educational sessions for the community. The campaigns take place at least twice a year with an average of 50 sterilized animals.

Blue Flag Program: This Costarrican governmental program is often met with a lukewarm reaction from the local communities. To improve their involvement, we organized beach clean-ups, and started a tree nursery program with native species aimed to reforest the most degraded areas. As a result, the response of the population improved noticeably.

To sum up, the involvement of the community in actions aimed to the preservation of wildlife is key for the success of any program. All the programs and campaigns must be monitored in order to identify the key successful strategies that would allow to achieve the long-term goals.

MANAGING COYOTE DEPREDATION ON SANIBEL ISLAND

Andrew T. Glinsky | Kelly A. Sloan | Brandt Quirk-Royal
Sanibel-Captiva Conservation Foundation | Sanibel-Captiva Conservation Foundation | Sanibel-Captiva Conservation Foundation

Coyotes (*Canis latrans*) were first documented on Sanibel Island, FL, U.S.A. in 2011. In the years following their colonization of the beach habitat, a sharp increase in sea turtle nest depredation was documented. The depredation rate reached a record high of 23.4% in 2014. Starting in 2015, metal self releasing screens were deployed on all verified nests for the duration of their incubation to protect eggs and pre-emergent hatchlings. Additionally, motion activated camera traps were mounted behind sea turtle nests from 2015-2017 to characterize the distribution and behavior of Sanibel's resident coyotes.

Five Recoynx PC900 cameras were set to take 5 photos per trigger between 19:00 and 07:00. Five zones of equal length (3.2 km) were established and a camera was mounted behind one nest per zone within 24 hours of oviposition. Cameras were shifted among nests within their assigned zones as nests hatched and used non-invasive photography methods.

An inverse relationship between the percentage of screened nests and the percentage of coyote depredation events has been documented since nest screening was implemented as a management technique. As the percentage of screened nests increased (2015:60.2%, 2016:85.7%, 2017:88.2%) coyote depredation rates have decreased considerably (2015:15.5%, 2016:8.6%, 2017:1.8%). A corresponding trend was also recorded by the camera traps. A decrease in overall coyote activity on the beach was observed, with an average of 6.1, 3.0, and 0.4 photos/day documented in 2015, 2016, and 2017, respectively.

Using protective screens on sea turtle nests for three consecutive seasons has yielded positive results and should be continued into the future on Sanibel Island. With camera trap data showing a decrease in coyote presence on the beach, our data suggest that metal screens could potentially act as both a preventive measure and ultimately a deterrent, necessitating coyotes to search elsewhere for easier prey.

These results have contributed to the development of a coyote management plan focused on the protection sea turtles on Sanibel Island.

ESTABLISHING A SEA TURTLE MONITORING PROGRAM ON THE CARIBBEAN ISLAND OF BARBUDA…BEFORE AND AFTER HURRICANE IRMA

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Since 2010, the Barbuda Ecological Research Group has been systematically monitoring 8 beach sites around the island for nesting activity of hawksbill and green sea turtles. As a result of this work, we have been able to determine that the entire perimeter of the island contains suitable nesting habitat, and development of a comprehensive monitoring program on the island is critical. We have begun working with Codrington Lagoon National Park staff to create a sustainable monitoring program for the island, using SWOT guidelines. In the summer of 2017, 4 of the 8 beaches were selected based on higher nesting usage by (primarily) hawksbills: 17 mile (western coast), Palmetto (south-western coast), Coral Bay (mid-southern coast) and Princess Diana (south-east coast). GPS coordinates were taken at each beach site indicating the access point, start, and end patrol points. Geographic Information System (GIS) maps were created for each site. The field team patrolled each beach for specified intervals during nesting hours of 8:00pm – 6:00am. At some sites, larger intervals were necessary in order to allow uninterrupted time for females to approach and begin nesting. Once nesting, information was documented on morphometrics, carapace health, and crawl width. This season was clearly the beginning stage for development of a much needed and sustainable monitoring program, yet there are still some challenges to overcome. In particular, resources need to be put in place to enable entire nesting season monitoring of the 4 sites by park staff and volunteers. However, a "glitch" in the plan occurred when on September 6th - only 4 weeks after returning from our field season - Barbuda was hit by a Category 5 storm, Hurricane Irma. Some of the turtle nesting beaches that we have been studying for years have now been damaged or destroyed, and many nesting turtles were stranded, some requiring rescue by park staff as they became entangled in debris along nesting beaches. Despite widespread damage to beaches, turtles are still emerging to nest. The island is slowly recovering from the devastation, and Barbudans are beginning to rebuild their homes and their lives. During the 2018 hawksbill nesting season, these same beaches will be surveyed to understand how the beach topography has changed, and together with Lagoon Park staff, we hope to establish this much-needed monitoring program on the island. We plan to continue assessing nesting populations on the island as they recover from natural disasters such as hurricanes, and in the face of global climate change.

UNIVERSITY OF HAWAI'I MAUI COLLEGE MARINE TURTLE STRANDING RESPONSE PROGRAM: AN ASSESSMENT OF MARINE TURTLE STRANDINGS OVER TIME

Caroline Sabharwal
University of Hawai'i Maui College Marine Option Program

The Marine Turtle Stranding Response Program (MTSRP) at the University of Hawai'i Maui College has provided students with the opportunity to gain first-hand experience in marine turtle conservation for over 20 years. This program is possible due to partnerships with both the National Oceanic and Atmospheric Administration and the Joint Institute for Marine and Atmospheric Research. Participating students are responsible for fielding, responding to, and documenting all turtle stranding calls. These calls are classified by type and students are prepared to respond to a range of situations including sick, injured, basking, fibropapillomatosis tumor affected and deceased turtles on the beach. Thanks to state-wide conservation efforts, marine turtle population numbers are on the rise and the climate surrounding conservation is evolving. With this population increase the MTSRP has seen major changes. We present data collected on the number, location, type and outcome of all MTSRP strandings on the island of Maui over the past 10 years. Analysis shows year-by-year comparisons of the differences observed in strandings in order to assess current marine turtle activity. Included is a student perspective on MTSRP activities, responsibilities, student opportunities and how the program has evolved over the years. Data driven approaches for program advancement, including an increased role in public awareness, outreach and education, are offered.

NEST DISGUISING AS AN IN SITU PROTECTION TECHNIQUE AGAINST SEA TURTLE NEST POACHING IN PLAYA NORTE, COSTA RICA

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Canadian Organization for Tropical Education and Rainforest Conservation | Sea Turtle Conservancy | Sea Turtle Conservancy

Playa Norte is located to the north of the largest green sea turtle (*Chelonia mydas*) rookery in the Atlantic basin: Tortuguero, Costa Rica. Poaching is one of the main threats to the survival of the four species of sea turtles it hosts (*Dermochelys coriacea*, *Chelonia mydas*, *Eretmochelys imbricata* and *Caretta caretta*). Different sea turtle management and conservation manuals propose nest disguising as one of the techniques that can be applied to reduce the number of poached nests. In Playa Norte, this technique helped to reduce the number of poached nests since its implementation in 2006, from 159 (51.96%) green nests poached that year to 39 (23.21%) in 2009. The Sea Turtle Monitoring and Tagging Program of the Caño Palma Biological Station has applied this methodology for over ten years, therefore, it was relevant to evaluate the performance of this technique and dismiss possible counterproductive effects on the hatchling development of the disguised nests. We analyzed nest data from the past seven years (2010 – 2016) from Playa Norte and Tortuguero, neighboring beaches where the same nest marking and excavation methodologies are used, the only difference being the use of the nest disguising technique. We compared the averages of hatching and emergence success using a T student test. The analysis of more than 800 nests showed no significant difference between treatments. Hence, the nest disguising technique represents a viable option for sea turtle conservation projects to reduce poaching rates in nesting beaches when they lack resources to apply one of the other techniques used, such as hatcheries or nest relocations, and avoids some of the common problems these techniques have exhibited. Even though our study shows the technique is not harmful for the amount of hatchlings produced, more studies are necessary to determine if the quality of these hatchlings is also not being affected (sex ratios, deformities, etc.).
We would like to thank Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, US Fish & Wildlife Service and the International Sea Turtle Symposium since without their support our participation could not have been possible.

IS MARINE TURTLE CONSERVATION A LOSING ENDEAVOR IN BANGLADESH?

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Information on the marine turtles in Bangladesh is now accessible than prior to the pioneering studies carried out by CARINAM in 1996 at the St. Martin's Island, Bangladesh. People are now aware of the plight of the marine turtles and many researchers and NGOs, even government institutions are contributing towards information generation. Yet when it comes to conserving the habitats, like island and mainland beaches that are used by the marine turtles, development activities get the priority. Many of these development projects are financed by multi- or bi-lateral financial institutions that publicize conservation of biodiversity for 'keeping up their appearances'. Voices raised by NGOs and researchers fall on deaf ears. The question arises about the future of marine turtles and their nesting habitats in Bangladesh.

Two major islands – St. Martin's Island and Sonadia Island – and the mainland beach from Cox's Bazaar to Badar Mokam are in jeopardy from human induced developmental activities and natural processes like erosion aided by the impacts of climate change. Three of the five species – *Lepidochelys olivacea*, *Chelonia mydas* and *Eretmochelys imbricata* - occurring in the Bay of Bengal nest in these two islands. Recent addition to the list of threats is the huge numbers of refugees from the neighboring Myanmar where some sneak out of the designated camps and exploit the beaches.

Mega-projects are planned along the coastline and the islands that include deep-sea port, land-based liquefied natural gas terminals, reclamation of estuarine beaches, coal-fired power plants, etc. The cumulative impact of the existing and planned projects will leave little space for aquatic animals including the marine turtles and cetaceans. Increased artisanal and deep sea fishing and sea traffic are also a source of disturbance. Environmental impact assessments are carried out suggesting mitigation measures but weak monitoring does little good for the protection and conservation of biodiversity and their habitats.

Donor-funded projects involving both NGOs and government initiatives are at risk due to contradictory government decisions to declare the Sonadia Island as an Exclusive Economic Zone (EEZ). Sonadia Island is one of the most important nesting sites for the marine turtles.

The onuses lie on the government and the people of Bangladesh to conserve the natural heritage. It requires a change in frame of mind geared towards a new dimension of conservation.

ASSESSING THE CONSERVATION VALUE OF HATCHERIES; A STUDY OF THEIR IMPACTS ON GREEN TURTLE HATCHLINGS IN KOSGODA, SRI LANKA

Carmen Mejías | Ian Bride
Sea Turtle Conservancy | Durrell Institute of Conservation and Ecology, University of Kent

Hatcheries are a common conservation strategy used to protect sea turtles' eggs. However, the effectiveness of these programmes has been questioned, as they have serious limitations that can negatively affect turtle populations. Since the closure of hatcheries in countries such as Sri Lanka would be impractical, there is a need for improving the poor practices employed in most of them. One such practice is to retain the hatchlings for several days as a tourist attraction. In nature, hatchlings emerge in a frenetic state and crawl to reach the sea and get away from shore as quickly as possible to avoid predators. Hatchling retention in hatcheries may result in a depletion of their energy reserves, thereby reducing their chances of survival. This study investigated the effects of such retention on locomotor performance of green turtle (*Chelonia mydas*) hatchlings. Crawling speed and swimming power stroke were examined at intervals during the hours of retention. The results indicate a detrimental effect on locomotor performance. Average hatchling speed was reduced by 28% after 24 hours, and 35% after 48 hours of retention. Power stroke rate also decreased by 12% after 12 hours, 14% after 24 hours and up to 17% after 48 hours. The results of this study provide experimental evidences of the importance of hatcheries releasing hatchlings immediately after emergence to maximize their chances of survival. These findings can be used to improve practice in Sri Lanka and indeed, in hatcheries worldwide, in respect to their contribution to sea turtle conservation. However, they should also be considered in the light of the other contributions hatcheries might make to sea turtle conservation through nest protection, public awareness, education and conservation revenue generation.

ESTABLISHING A TARGET HATCHING SUCCESS FOR SEA TURTLE HATCHERIES

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Hatcheries are often employed as an *ex situ* conservation strategy when threats to *in situ* sea turtle nests and hatchlings (including poaching, predation, erosion, inundation, and disorientation by lighting) are deemed as being too high or too difficult to manage. In some regions, a high proportion of all sea turtle nests are relocated to hatcheries for protection. Therefore, hatchery management practices, including the time interval between oviposition and reburial of eggs, methods of handling and transporting eggs, nest depth and density, and/or nest substrate replacement or treatment, are likely to be major influential factors on the number of hatchlings entering a population. Success of the hatchery is often reported by the total number of eggs transferred to the facility and/or the total number of hatchlings released instead of a measure such as hatching success (proportion of total eggs that hatch) or emergence success (proportion of total eggs that produce hatchlings that emerge from the nest). Thus, it can be challenging to assess the contribution of hatcheries to sea turtle conservation.

The initial outcome of this study, an assessment of worldwide data, shows that the hatching success at some hatcheries is below that of *in situ* nests in the same region; this result suggests that hatchery management practices do not meet the recommended standards and hatcheries may not be functioning as a successful conservation strategy. To encourage more critical self-analysis of hatchery success, a two-step comparison is suggested in which hatcheries first ensure their hatching success is above that of *in situ* nests from beaches where nests are collected and, second, aim to achieve a long-term target hatching success. Hatcheries unable to achieve these goals, in the absence of any unavoidable, confounding factors, should review their egg handling, holding, and incubation parameters and identify potential practices to improve. Only with relatively high, long term hatching success and maintenance of natural sex ratios can hatcheries fulfill their potential as an *ex situ* conservation strategy and build resilience in sea turtle populations that must overcome diverse threats at multiple life-stages.

SEAGRASS (THALASSODENDRON) HABITATS IN THE WESTERN INDIAN OCEAN: TOWARD A REGIONAL SURVEY NETWORK

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French Agency for Biodiversity | CEDTM | Kelonia | AFB | IFREMER | Island Conservation Society | Swansea University | Deakin University | CEDTM-Kelonia

The Western Indian Ocean region is one of the most species-rich seagrass areas in the world. Seagrasses provide forage for endangered species such as the green turtle (*Chelonia mydas*) and the dugong (*Dugong dugon*), and feeding habitat for hawksbill turtles (*Eretmochelys imbricata*). In the framework of a new project to reinforce seagrass conservation in the Southwestern Indian Ocean, we propose to federate actors involved in seagrass conservation and monitoring, and build a seagrass regional advisory and monitoring network of scientists and protected area managers. It would aim to i) facilitate regional cooperation programs, and ii) standardize monitoring protocols in order to provide a regional perspective on the status of seagrass habitats, in consistency with worldwide networks and reports. This project aims also to assess the functional role of seagrass resources for sea turtles and their contribution to habitat diversity. In particular, the value of *Thalassodendron ciliatum* has recently been highlighted as a suitable habitat and food item for the green turtle in Glorieuses Archipelago, in the Seychelles and in the Great Chagos Bank. At the same time, *T. ciliatum* meadows are declining in other areas. This insight enhances our knowledge of the ecosystem services that this poorly documented but even abundant seagrass species provides for sea turtles.

COLLABORATIVE APPROACH IN CREATING KNOWLEDGE AND MONITORING INDICATORS FOR SEA TURTLE CONSERVATION: CASE STUDY OF RASTOMA IN CENTRAL AFRICA.

Ngafack P. Rodrigue | Guilleux Alexis | Ayissi Isidore | Missilou B. Roland | Mbungu N. Samuel | Girard Alexandre

Central African network for sea turtles conservation actors (RASTOMA) | Central African network for sea turtles conservation actors (RASTOMA) | Central African network for sea turtles conservation actors (RASTOMA) | Central African network for sea turtles conservation actors (RASTOMA) | Central African network for sea turtles conservation actors (RASTOMA) | Central African network for sea turtles conservation actors (RASTOMA)

Research and conservation efforts over the last decades, although hampered by technical, financial and logistical difficulties, have revealed that Atlantic coast of Africa is home of 5 out of 7 existing species of marine turtle: The green, olive ridley, leatherback, loggerhead and the hawksbill. Nevertheless, there are very few data available on marine turtle status in Africa and most of the existing data are outdated and need to be updated. As a result, Africa's marine turtles remain of the least well known populations in the world. Numerous marine turtle research and conservation programs have been initiated across the Atlantic coast of Africa to fulfill this data gap and improve the conservation status of marine turtles in the region. However, since marine turtles are migratory species with no frontier limits, isolated researches and conservation efforts remain insufficient to protect these species especially in Central Africa were marine turtle research and conservation are yet embryonic and inconsistent across the subregion despite his exceptional potential. Initiated in 2012, the Central African network for sea turtles conservation actors (RASTOMA) aims at bringing together marine turtle researchers and conservationists as well as non-profit and governmental organizations to implement coordinated conservation actions at the level of the subregion, facilitate communication and experience sharing among members and enlighten local conservation actions for global impacts. To date, the RASTOMA is based on 9 NGO's and 30 individuals from 6 countries in Central Africa (Democratic Republic of Congo, the Republic of Congo, Gabon, Equatorial Guinea, Sao Tome & Principe and Cameroon).

The first challenge of the RASTOMA was to bring together a diverse community of marine turtle conservation stakeholders among the 6 countries covered by the RASTOMA network. It was done in the first RASTOMA congress in June 2016 in Sao Tome. Then RASTOMA compiled a well-structured and comprehensive illustration of existing knowledge on marine turtle in Central Africa to produce the first comprehensive maps of sea turtle nesting biogeography and satellite telemetry in Africa. It has been published in the Volume XII of SWOT report special feature Africa. Thanks to the RASTOMA efforts, Central Africa was the region of Africa exhibiting the most comprehensive coverage in Africa.

This collaborative approach is also a mean for the Scientific Council of the RASTOMA to identify data gap in countries database and provide well targeted advices as well as refine the knowledge management strategy.

RASTOMA is now looking forward to go further with its participative and inclusive approach with a bunch of diverse stakeholders during the upcoming Congress to be held from November 27th - December 2nd, 2017 in Cameroon. The RASTOMA Congress, gathering about 60 marine conservations practitioners from all over the subregion with experts from around the world is a wonderful opportunity to go further with the participatory approach. All actors will be around the table and will work together to produce two deliverables:

a scientific article updating the sea turtle information and their threats. Contributions from the field and from academic experts, the results will be a scientific paper to be published. This exercise will be pedagogical and product oriented.

A reporting for MTSG for the 6 nations in Central Africa, under the lead of Paolo Casale, Co-chair of IUCN MTSG.

CAN WE BRING BACK THE THIRD DAUGHTER OF OCEAN GOD RETURN TO JEJU ISLAND?: 2012-2017 SEA TURTLE STRANDING·BYCATCH AND DISCUSSION OF USING THE CULTURAL IDENTITY OF SEA TURTLES FOR CONSERVATION.

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Sea turtles could be found year-round at the inshore of Jeju island, Republic of Korea, however the last eyewitness of egg laying sea turtle mother at a jeju beach was over 10 years ago. It is very important to understand the ecology of sea turtle population found in Jeju Island and start a conservation project. As a start, the bycatch and stranding of sea turtles were recorded between May 2012 and October 2017. There was a total of 32 bycatch individuals during the study period. Majority of bycatch incidents occurred due to open set-net with an open top; therefore most of the bycatch (87.9%) were returned to the wild immediately and others were either sent to a rehabilitation center (9.0%) or found dead inside a closed fishing net (3.0%). All identified bycatch sea turtles were *Chelonia mydas* except one *Caretta caretta* (25 individuals), and there were 7 unidentified individuals. There was a total of 47 stranded sea turtles in the shorelines during the study period. The most of the stranded individuals (93.6%) are found dead on the shoreline, and others were found injured (8.4%) and these individuals were sent to a rehabilitation center for recovery. Among stranded sea turtles 3 individuals had injuries from an impact and 8 individuals were found entangled in ghost nets, and the reason for others was not clear. Three species were found stranded: 1. *C. mydas* (55.3%), 2. *C. caretta* (27.7%), 3. *Eretmochelys imbricata* (19.4%) and 4. Unidentified (2.1%). The trend for both sea turtle bycatch and stranding is decreasing, however, the data is insufficient to calculate the trend. Also, the data of the bycatch is not reliant as the data heavily depends on the participation from the local fishermen. Eyewitness statement of fishermen in charge of open set-net describes small to very large (>100cm) sea turles being caught by the set-nets and they are caught all year around. Therefore, the current bycatch result does not represent a reality. The participation of fishermen in charge of open set-net is absolutely necessary to collect a meaningful data for research To understand sea turtke population in Jeju waters.
There is a sea turtle folktale from indigenous people of Jeju Island who heavily depended on the Ocean for their livelihood. Jeju people worshiped the Ocean god “Yong Wang” and people wished for their safety in the ocean and fruitful fishing season. As God’s third daughter, sea turtle should not be harmed in anyway and if found dead it should be returned to the God via traditional offering ceremony. The cultural identification and understanding the meaning of sea turtles to the Jeju people as a sacred animal of the sea could help develop a stronger conservation plan and help conduct a basic research for a necessary background knowledge of the sea turtle population found in Jeju Island. There are still many unknowns about sea turtles in Jeju island, and the participation of Jeju People will be crucial in building a meaningfuk data. Hopefully, using the cultural identification of the sea turtle in Jeju will help get more people involved with the research and conservation effort.

SCIENTIFIC EXPEDITION SEAFLOWER: CURRENT STATUS OF SEA TURTLES IN ISLAND CAYO SERRANILLA, CARIBBEAN COLOMBIAN

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This expedition is part of the comprehensive strategy for the exercise of sovereignty over San Andrés y Providencia, designed by the Presidency of the Republic to strengthen the management and conservation of the Biosphere Reserve "Seaflower".
In Colombia, there are five of the seven living species of sea turtles, all of them under some risk of extinction. Of these, four are in the Colombian Caribbean and three have been reported in Cayo Serranilla.
No studies have been conducted on sea turtles on the Island ignoring the current status of these species. Due to this lack of knowledge, research initiatives assessing the current status of sea turtles, reported for nesting beaches and the Serranilla marine habitat, become highly relevant to raise awareness, Contributing to the current recovery and conservation efforts in the Greater Caribbean.
This project was carried out within the framework of the IV Seaflower expedition. It represents the first comprehensive study at the national level in this area which will provide novel information on the distribution, abundance of sea turtles in nesting and foraging areas.
[Note: The results are presented during the congress, but the deadline for the summary is before the data analysis, because we have just arrived from the Expedition]

SEA TURTLE EMERGENCES AND BEACH PRESERVATION IN "IRABU BRIDGE" CONSTRUCTION PROJECT

Hiroshi Takeda | Hidenobu Ishimizu | Noritoshi Fujinuma | Shigeo Tabata | Chizuko Oyakawa | Yasushi Uehara
IDEA Consultants | IDEA Consultants | IDEA Consultants | IDEA Consultants | Okinawa Prefectural Government | Okinawa Prefectural Government

Nagayama Beach is a sea turtle nesting beach approximately 1.2km in length, located in the southeastern area of Irabu Island, Miyakojima City, Okinawa, Japan. Located at the center of the beach is the attachment point of Irabu Bridge, which connects Irabu Island and Miyako Island. Two reclaimed sections adjacent to the bridge attachment point resulted in substantial topographic changes to the sandy beach during construction. Okinawa Prefectural Government, which was the agency responsible for the bridge construction, implemented a beach restoration project by constructing groins and conducting beach nourishment using shifted sands. As part of the Irabu Bridge construction project, sea turtle nesting surveys at Nagayama Beach were conducted in 2002–2004 before construction, in 2006–2014 during construction and 2015–2017 after construction. Patrols looking for tracks and body pits were conducted once or twice a month from April to October during the nesting season in each year.
Annual numbers of emergences and body pits at Nagayama Beach were 0–22 (mean 7.1) and 0–30 (mean 8.0), respectively. Green turtles contributed most to these annual variations at the beach, and the annual trends were similar to annual regional variations (2011–2016) of green turtle nest count trends in Ryukyu Islands, as reported in the Proceedings of 27th Japanese Sea Turtle Symposium in Muroto. Focusing on the location of sea turtle emergence within the beach, the portion of the beach that eroded during bridge construction corresponded to an area with a higher concentration of tracks and body pits before construction. During the construction period in which sand from this portion of the beach disappeared due to erosion, tracks and body pits were concentrated on both side of the eroded area where some sand remained. After the eroded portion of the beach was restored following groin placement and sand replenishment, most of the tracks and body pits were found in this area again. Hatchling emergence was also observed the restored portion of the beach. This suggests that emergence and nesting location preference remained consistent throughout the observation period.

A NEW APPROACH TOWARD SEA TURTLE CONSERVATION: RELOCATION OF EGGS FROM A CAPTIVE BREEDING PROGRAM TO A NATURAL BEACH

Yusuke Ando | Tsuyoshi Matsuda | Hitoshi Okamoto | Kiyoshige Kobayashi | Takashi Kasugai | Masanori Kurita | Hiroshi Nitto | Tomomi Saito | Yuzi Tanaka | Kazushi Imamura

Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Port of Nagoya Public Aquarium | Kochi University | Omotehama Network | Omotehama Network

Port of Nagoya Public Aquarium has had confirmed breeding of loggerhead turtles (*Caretta caretta*) every year since 1995 (with the exception of 2011), the year of first successful breeding at the Aquarium's indoor captive facility. The total number of eggs confirmed over this period is 15,820 eggs, and the number of emerged hatchlings has reached 9,444. The Aquarium has conducted various education programs utilizing these eggs and hatchlings, such as through nesting observation programs, nest excavation programs, "meet the hatchling" programs, and hatchling release programs. The Aquarium has also released most of the juvenile turtles back into the wild from beaches and vessels for the purpose of researching their migratory pathways.

However, there has been considerable discussion regarding the approach to sea turtle conservation programs in recent years, especially with respect to hatchling release programs. The Aquarium has received concerns that these release programs are not suitable considering the natural ecology of sea turtles immediately after their emergence. As a result, we conducted a trial project from 2008-2010 and in 2012 in collaboration with local conservation groups and a middle school with the aim to reassess the approach to conservation. A portion of the loggerhead turtle nests from the Aquarium's captive breeding facility was relocated to a loggerhead nesting beach (Omotehama Beach in Toyohashi City), where eggs were incubated and hatched under natural conditions. The average hatching success was 50.6%, which was not substantially different from nests left at the captive breeding facility, confirming that the approach would be a valid method for returning captive turtles back into the wild. Additionally, the project provided some benefits for community relations and outreach through local organizations' involvement in patrolling the relocation site, environmental monitoring, and conducting hatch success surveys. Participation from educational perspective was also enhanced through field trips to the Aquarium and presentations by Aquarium staff. These activities provide alternative education and conservation opportunities to replace hatchling release programs.

EFFECTS OF WAVE-BREAKING BLOCKS ON LANDING BEHAVIOR OF LOGGERHEAD SEA TURTLES

Yuji Tanaka | Tomoko Shimura
Omotehama Network | The Nature Conservation Society of Japan

Beaches in Japan are important nesting sites for loggerhead sea turtles in the Pacific Ocean. Coastal armoring and development for tourism led to decreases in the number and area of nesting beaches. Additionally, noise and lights from roads and buildings constructed near the coastline avert female sea turtles from nesting, threatening the survival of the population. For these reasons, loggerhead sea turtles are included in the IUCN endangered species list.

A nesting sea turtle leaves a conspicuous track because of its weight. Our association, the Omotehama Network, has been recording the position of turtle tracks using Global Position System. Accumulated data were used by this organization and Nature Conservation Society of Japan to investigate the area where block revetment improvements would increase the success rate of nesting.

Omotehama beach in Toyohashi-shi on Atsumi peninsula was used as the research site. The length of the beach subjected to study was approximately 11 km. The relationship between recorded turtle tracks and location of block revetment were investigated using turtle track position GPS data, pictures of the site, and past images of the beach extracted from Google Earth. The results suggested that sea turtles that encountered block revetments had difficulty emerging and landing, compared to those without interactions. Setback construction was conducted at Atsumi peninsula between 2008 and 2012 to move the block revetments 880 m landward. As a result, drastic improvement in landing success was recorded. Revetment blocks still remain at the middle part of the beach in some areas of the peninsula. Relocation of those blocks and construction of sand hedge should be conducted urgently in areas with high nesting density to create an optimal environment for sea turtle landing and nesting.

LOGGERHEAD TURTLE NESTS PREDATION CONTROL AT MINABE-SENRI BEACH, WAKAYAMA

Kento Fujita | Kentaro Matsuguchi | Yuji Tsuruta | Shigeyuki Hirata | Yoshimasa Matsuzawa | Kiyoshi Goto | Osamu Hirozane | Masaharu Nishimoto | Takahisa Yamasaki
Osaka Prefecture University / Kyoto University | College of Osaka ECO & Animals | Osaka Prefecture University | Teikyo Science University | Sea Turtle Association of Japan / Suma Aqualife Park | Minabe Sea Turtle Research Group | Lion Co. Osaka Plant | Lion Co. Osaka Plant | Lion Co. Osaka Plant

Osaka Prefecture UniversityAt Minabe-Senri Beach, which is among the largest loggerhead turtle nesting beach in Honshu, egg depredation by unidentified mammal would be found from the beginning of conservation project there in 1980's. The slaughter has some typical features: 1) nests are excavated around the time of hatchling emergence, 2) some hatchlings on their way to the sea from their damaged nests are found dead with deep bites, and 3) it occurs only at night. A total of 246 clutches (41.6%) were damaged in the three years from 1993. But after then it decreased dramatically with decreasing in nesting number before we can hammer out effective measures. After a decade of calmness, it resumed in late 2000's with recovery of the nesting population. Thirty-three (12.5%) and 53 (30.1%) nests were damaged in 2008 and 2009, respectively. Then as precautions against predation, the surface of the nest sites were screened with bamboo grids (1x1m, 10 cm mesh) and stainless steel cages (60x60x30 cm, 5 cm mesh), and animal repellent such as habanero pepper powder and pyroligneous acid were sprinkled on the ground. It resulted in a reduction of predation rate down to 10-20%. Also, predators were identified as Japanese raccoon dogs (*Nycterutes procyonides*) by direct observation, infra-red shooting, and footprint analysis. From 2014 modified cages with much deeper side-fences were buried above egg chambers to prevent predators from attacking from side of egg chambers. Then finally, zero predation was achieved in 2016. The future challenge is to minimize effect of typhoons which can wash screens away. Relocation of eggs to a protected hatchery is a popular and easy answer to protect eggs from any threats on the rockeries. It has rather negative effects such as screwed sex ratio and high mortality of eggs and hatchlings. Then IUCN Marine Turtle Specialist Group recommends strongly in situ protection. Our success at Minabe-Senri would be a good model for other nesting beaches in Japan where people become aware of and suffer from serious egg predation.

SEA TURTLE PARENTING EDUCATION IN TAIWAN

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Environmental education is to teach everyone to care and perceive the overall environment and its related issues so that it has a keen sense and insight of nature. But most of the environmental education object most focus for more than 8 years old children, less to care who below than 8. But early childhood education is the basic of individual growth and learning. While children often develop observe and explore skill in daily life. So, it's important to create an appropriate learning environment, not only that children develop the natural intelligence, but also learn how to cherish and protect the environment. We designed a series of Sea Turtles Parenting Education class for children (under the age of eight) and parents, and the course contains three major parts. First of all, the use of digital images to introduce the sea turtles, threats and how to protect the turtle. Followed use paper clay that children to create their own turtles. Finally, the experience education course, through the actual observation and assistance to take care of the injured sea turtle. A total of 34 childs (22 families) were joined, with an average age of 6 years (6.1 ± 2.5, 3 to 13, $n = 34$). The questionnaire after the course showed that all parents agree with the design and get good advice and feedback. We hope that this Sea Turtles Parenting Education class will allow young children and parents to know the sea turtles and learn how to protect the environment.
keyword: environmental education, parenting education, childhood education, sea turtles, natural intelligence

INTRODUCTION OF TAIWAN SEA TURTLE CONSERVATION SOCIETY

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The sea turtle research in Taiwan has conducted since 1981., However, most people still do not have enough knowledge on this subject., In order to implement the public awareness on sea turtle conservation, rescue/rehabilitation, marine environmental protection etc., Marine Ecology and Conservation Lab of National Taiwan Ocean University establish the Taiwan Sea Turtle Conservation Society in 2017. The purpose of this society is to promote sea turtle and marine conservation education through the relevant activities, such as extracurricular lecture, first-hand experience on the care of sick/wounded turtles, etc. These activities can arise the passion of the people to care sea turtles and ocean, and then concern the issues of marine ecology. In the future, we hope to provide the useful recommendations and supports on sea turtle conservation and relevant policies to the government.

USING ART TO RAISE AWARENESS TOWARDS ZERO WASTE ON A 6.8 SQ KM ISLAND SW OF TAIWAN, HOME TO OVER 150 GREEN TURTLE INDIVIDUALS

La Benida Hui
rareawareness.com

Xiao Liu Qiu is one of seven coral islands in the world with human inhabitants. It has a population of 13,000 residents, divided in eight villages and five schools, it is an 18 minute boat ride away from the main island. It boasts one waste water management facility, one recycling collection station, one "dump" site, all run by three government branches. The residents main commercial activity used to be fishing, but in the last five years the green turtle population has grown and tourism has taken over with an estimated 150,000 visitors per year. Trash is regularly shipped off the island, but illegal dumping still can be seen in three evident locations.

Our primary goal was simple, having World Turtle Day recognised and raise the residents awareness to "Being Green" through the use of art. 2014 we teamed up with two non-profit organisations and ran an environmental film festival. The following year, we conducted a "Green" survey with junior high school students and local residents to better understand local habits. During that time we have also started our environmental art education program between the period of World Turtle Day and World Ocean Day.

After four years we feel confidant that we have achieved our initial goal. In Taiwan, World Turtle Day has been actively featured in environmental news, parks and aquariums. In addition, events have been hosted and promoted by our old partners, the Ping Dong Environmental Protection Bureau and various other local environmental organisations. Art today now plays a tangible part in public communication. In the touristic areas of Xiao Liu Qiu, new turtle sculptures, small ocean exhibits and ocean murals have prominently appeared.

Our 2017 year to our newly developed "Plastic Free/Be Green" art based Project includes the following accomplishments : The completion of our"Plastic Awareness" art information stand used at certain events. The establishment of an environmental club at the junior high school named "Gui Bao Bao" (Protector of Precious Turtles). Art installation (using trash) titled "Land and Ocean" visible in a small neighbourhood park. A publication of our first "Gui Bao Bao" Island newsletter. The 46th international Children's Exhibition of Fine Art Lidice competition translated into Chinese and released at all five schools. Completion of two murals and featured video (for boat release). The Inception of two college student programs to create art sculptures from waste in collaboration with a local drift wood artist. An ICC clean up survey in collaboration with Society of Wilderness (see results).

Based on the survey results from the beach clean ups, the fact that Xiao Liu Qiu needs to ship their trash to the main island, and the photographic images from local divers, and the response to our cause, we have come to the decision of first focusing on three areas in a single location ("Da Fu" Village; meaning "Big Blessings") in order to begin our achievements towards our "Plastic Free Island" dream:

1. The urgent need to refuse, reduce and reuse (mainly plastic)
2. Protect your health, your "Home" and your wildlife neighbours.
3. Environmental Art Education and Awareness

Overall, RARE is mainly self-financed with generous donations provided towards certain events and project periods. Volunteer support for our programs have been key to our success. We continually explore new partnerships and collaborations in order to grow and promote awareness.

Thank you to Oceanus Honours Gaia, and The Society of Wilderness, Taiwan

CREATING AWARENESS IS KEY.

Sabine Berendse
Sea Turtle Conservation Curacao

Sea Turtle Conservation Curacao aims to protect sea turtles around Curacao. The organisation focusses on research, conservation, education and outreach. For the outreach part the organisation uses traditional and social media and other creative alternatives to reach as many people as possible.
A problem for many conservation organisations is that they only reach a limited number of people with their outreach activities. These people usually have a mindset that is compatible to that of the organisations mission. Although it is great to have likeminded people following and supporting you, to make a real impact, it is important to also reach people with completely different ideas and interests, make them more aware and ideally get them on board with 'turtle friendly' behaviour.
Since not everybody cares about sea turtles, this is a challenging task. You have to take into consideration that background, priorities and interests are different and that different groups of people that could make a positive change for sea turtle conservation ask for a specific approach.
Sea Turtle Conservation Curacao identified different groups of stakeholders. Several successful custom made outreach projects were executed.
We are proud to present:

- A sea turtle exposition in Savonet Museum
- Informative signage at Playa Piskado & Klein Curacao
- Social media: 25k + followers
- Traditional media: weekly free exposure
- School presentations: kids are the future!
- Petition to ban single use plastic items: collaboration with recycling NGO’s and government.
- Turtle Buddy’s: making souvenirs from marine debris
- Using social media to gather data
- Can you see what I sea - Song by local musicians to create awareness

CAN CITIZEN SCIENCE HELP US FILL THE GAP? AN EXAMPLE FROM THE EGYPTIAN RED SEA

Agnese Mancini | Micol Montagna | Abdullah Taher | Ahmed Fouad | Mahmoud Hanafy | Islam Elsadek

Boomerang For Earth Conservation, HEPCA | Dive the Red Sea | Dive the Red Sea | HEPCA | HEPCA, University of Suez Canal | Egyptian Environmental Affairs

Five species of marine turtles are known to inhabit the Egyptian Red Sea, endangered green and critically endangered hawksbill turtles being the most commonly observed species. Nevertheless information on important aggregations sites, population structure and population abundance are still quite scarce. An intensive scientific monitoring has been conducted between 2010 and 2013 but such an effort had to be limited in time (3 years) and space (Southern Egyptian Red Sea), due to the limited human and financial capital available. The Egyptian Red Sea coast extends for more than 1,000 km (including the Suez Canal and the South Sinai peninsula) and includes various off-shore islands. Therefore an extensive scientific monitoring program would require considerable funds and a relatively big team, making such an event practically impossible on the long run. For this reason, between 2011 and 2013 we tested a citizen science based monitoring program, called TurtleWatch Egypt that was aimed at collecting information on marine turtles in their feeding grounds. Dive centres were approached through the Hurghada Environmental Protection and Conservation Association (HEPCA), an Egyptian NGO created 20 years ago by dive centres. During the study period 2,448 surveys were completed at 157 sites and a total of 1038 sightings of turtles were reported. Hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) turtles made up to 68% and 28% respectively of the total number of sightings; however rare species like loggerhead (*Caretta caretta*) and olive ridleys (*Lepidochelys olivacea*) were also detected (less than 1% of total sightings respectively). Some of the monitored sites were classified as important for turtles, due to the high probability to spot at least one individual; while in other sites no turtles were observed over multiple monitoring occasions. Most participants reported adult sized turtles, although many size classes were observed (range of straight carapace length SCL for green turtles: 30-150 cm, range of SCL for hawksbill turtles: 30-100 cm). 34% of the observed turtles were classified as adult males, providing important input on the distribution of males during nesting and non-nesting seasons. Furthermore, behaviours like mating and courtship were reported from sites where these activities hadn't been previously detected. The results obtained from the citizen science project were compared to observations collected by researchers during the same time frame, specifically at three monitoring site. Species identification from citizen scientists seemed correct in 98% of the occasions (for this comparison we used well known individuals and pictures sent through the TurtleWatch reporting form), while estimated SCL was correct in 48% of the occasions (generally sizes estimated by citizen scientists were larger than those estimated by the research team). This means that the number of adults/larger individuals could be potentially biased. Nevertheless, results from this initiative provided important new knowledge of marine turtles in the Red Sea, especially from largely understudied feeding grounds. This shows the great potential for using citizen science monitoring programs to collect basic information on endangered species in the Red Sea thanks to the presence of large numbers of safari boats and dive centers going at sea daily. Engaging with the tourist sector in a systematic way to promote the use of simple data collection protocols could be a win-win approach as the tourist sector would be able to offer a different activity to its guests, while researchers could access sighting information over a wide geographical area and longer periods.

We would like to thank Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, the US Fish & Wildlife Service and the International Sea Turtle Symposium for awarding a travel grant.

ENCOURAGING SEA TURTLE CONSERVATION IN THE NORTHERN COAST OF PERU

David Sarmiento | Evelyn Luna-Victoria | Vanessa Bachmann
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Fisheries interaction is the main threat for sea turtle population inhabiting Peruvian ocean. In fact, during the course of March of 2015 and May of 2016 a total of 1285 entangled sea turtles were registered in the coast of Lambayeque, of which 1244 were released alive and 41 dead. In this context, an awareness camping for artisanal fishermen had been done with material and expertise provided by WWF,PRO DELPHINUS and IMARPE with the aim of raise consciousness about the ecological role and the importance of these species, as well as the main threats their populations face in the Peruvian seashore. For that purpose, public speeches on local schools and artisanal coves were performed in several localities of Lambayeque. The tools employed for this goal were multimedia presentations, videos, flyers and pictures regard to the species inhibiting Peruvian waters, the appropriated manipulation and liberation of sea turtles entangled or tapped in fishhooks, and the importance of the conservation of their populations. Since 2015, radial media had being used for this objective. Moreover, a radial sea turtle song had being broadcasted, the song explained how to manipulate and release sea turtles trapped on fishing gear. Additionally, social networks were being used in order to spread the message of sea turtle rescue through videos and pictures. As a result, the knowledge of the ecological key role of sea turtles and their conservation had increased in fishermen communities of the coast Lambayeque. Indeed, sea turtles release techniques had improved over time and more fishermen of this region are liberating them.

Key words: sea turtles, conservation, awareness, artisanal fishermen, release, Lambayeque.

ECO-LABEL AS A SEA TURTLE CONSERVATION TOOL

Silvia Arriscado | David Aparici
Sea Turtle Conservancy | Sea Turtle Conservancy

Eco-labels are tools that businesses can implement under the assessment of environmental agencies and conservation institutions as an evidence of their care for the environment and their conservation efforts. Our team proposed the creation of a new eco-label at the micro-scale based on a number of actions involving the local small enterprises.
We suggest this tool to actively involve the owners of small hotels and restaurants in the nature conservation programs in the Tortuguero area. Tortuguero is a village located in the caribbean coast of Costa Rica
The focus of this eco-label is the contribution of a given business in the elimination/reduction of the anthropogenic impact on the nesting sea turtle population of Tortuguero.
The establishments that join this initiative will be rewarded with an eco-label that identifies them as a responsible business with nature. Some of the proposed actions that would qualify for the awarding of such eco-label are: reforestation with native species along the coast line, waste separation, reduction of single use plastics, changing white lights to turtle friendly alternatives, etc.
This program is expected to lead to a significant involvement of the local enterprises in helping the Sea Turtle Conservancy (STC) achieve their short and mid-term goals in the area such as: reducing the number of light sources close to the beach that may affect the orientation of nesting individuals, increasing the vegetation density in the path along the beach, decreasing the use of non-reusable plastic items (bags, straws, etc.), more recycling bins, and setting up regular beach clean-ups.
Finally, once the eco-label is implemented, we will assess the commitment of the local businesses of Tortuguero regarding the protection of the natural resources which they rely on. At the current stage of the program, we have undertaken an informative campaign within the local business owners to explain what the main sources of anthropogenic impact in the Tortuguero area are (light pollution, plastic waste, etc.), and how can they be detected and mitigated. We have already experienced a good response from the participants and the eco-label is seen positively as it would set a difference against their competitors.
In this first edition of the program, 12 hotels have participated and 10 of them have won the "gold award" and 2 the "silver award" for their involvement in the project.

OUTREACH PROGRAM FOR CONSERVATION EDUCATION USING SEA TURTLES IN OKINAWA CHURAUMI AQUARIUM

Konomi Maeda | Mariko Omata | Masakatsu Kino | Mizuho Suzuki | Shingo Fukada | Ken Maeda | Isao Kawazu

Okinawa Churashima Research Center | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churashima Research Center | Okinawa Churaumi Aquarium | Okinawa Churaumi Aquarium | Okinawa Churashima Research Center, Okinawa Churaumi Aquarium

Sea turtles are popular organisms that require conservation, and are used for education. Okinawa Churaumi Aquarium has performed learning activity using captive sea turtles since 2007. The purpose of this activity was to understand environmental problems and ecosystems of sea turtles throughout the year. During 2007 to 2016, the program was performed in five elementary schools neighboring our aquarium, with total 473 children from second grade to sixth grade.

The program was carried out in four stages, as follows.

1. Preliminary Learning: Children played the game simulating the life history of the sea turtle.
2. Wild nesting beach observation: Children observed the sea turtles nesting beach neighboring our aquarium and school. The aim of this exercise was to let children think about the environment suitable for nesting by sea turtle.
3. Rearing in captivity: Children reared sea turtle hatchlings, including those of loggerheads (*Caretta caretta*), green sea turtles (*Chelonia mydas*), and hawksbill turtles (*Eretmochelys imbricata*) in captivity until they were one-year old. This activity included feeding, cleaning of carapace and tank, and measuring of air and water temperature, straight carapace length and width, and body mass of the turtle every month. The aim was to evoke greater interest in sea turtles.
4. Presentation of results: Children discussed about learning achievements throughout a year and expressed their opinions.

Because of this learning, the information on nesting and stranding of wild sea turtles provided by children and local communities to Okinawa Churaumi Aquarium has consistently increased, indicating increasing interest in sea turtles. We suggest that our outreach program using captive breeding of sea turtles would be effective for improving children’s interest in sea turtle conservation and environmental problems.

"BARBUDAFUL, ONCE AGAIN" SEA TURTLE RESEARCH LEADS TO HUMANITARIAN EFFORT

Wendy McFarlane | Maxine Montello | Melissa LaCroce | Nancy Todd

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Our Barbuda Ecological Research Group has been studying sea turtle nesting on the island of Barbuda for the past 8 years. Over this time, we have studied the extent to which the islands beaches are being used as nesting habitat, the physical and ecological features of these beaches, and the weathering of tracks. We are in the process of developing a sustainable monitoring program for the island. Simultaneous to our work, we have forged very strong relationships with many Barbudans – both as colleagues, and as friends. These relationships have allowed us to be able to return to the island season after season, to continue our conservation work. We have also conducted educational programs in the island schools and summer camps to teach the island's children about biodiversity, ecosystems, and species conservation. September 6, 2017 was a devastating day for this small island. As Hurricane Irma tore across the relatively flat, limestone-based landscape, it left nothing but a trail of destruction behind it, both for the people that live there, but also for the other species that live on, and around, the island. Miraculously, there was but one human mortality, and minor injuries to others. Greater than 95% of the housing stock on the island was destroyed, cars were overturned, land and buildings flooded, vegetation uprooted, beaches eliminated, water sources contaminated, and livestock killed. The island was deemed uninhabitable, forcing a full and mandatory evacuation to Barbuda's sister island, Antigua. Families are currently living in shelters, and Barbudan children have been squeezed into Antiguan classrooms. It is now a community uprooted, waiting to rebuild and return home. Our research team has started a fundraising effort through Go Fund Me, entitled "Barbudaful, once again". We have already raised a substantial amount of money, however the need is enormous. Our goal is to raise money to support families as they re-settle on the island, and to purchase materials for the two schools in an effort to get kids back into a learning environment, on their own island, as soon as possible. Our focusing on children and families stems from the realization that these children hold the promise for future protection of the island's natural resources. This is crucial in a culture that has historically harvested sea turtles and their eggs as food sources. Hurricane Irma significantly damaged many of the island's most heavily nested beaches, and our upcoming field season will allow us to carefully document the changes to nesting habitat. A great deal of effort will be directed to aid in the resettlement of Barbuda families on the island, and develop additional programs for island youth. Our ultimate goal is to continue to educate all members of the community on the importance of sea turtle conservation both for maintaining island biodiversity, and supporting future ecotourism.

TURTLESPOT TAIWAN: NEW INTERACTIONS, NEW RECORDS AND THE EMERGING POWER OF DIVERS

Chialing Fong | Huai Su | Pengyu Chen | Daphne Z. Hoh | Marco Chang

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“TurtleSpot Taiwan” is a citizen science project that began in June 2017. It was initiated by a group of divers using social media as a platform to collect sighting and photograph records of sea turtles. Photographs are used to identify individual turtles by their facial scute pattern. The collected information was then used to establish an online open database and to apply on sea turtle educational outreach. We have received 275 records, identifying 123 individuals (113 of *Chelonia mydas* and 10 of *Eretmochelys imbricata*) since June 2017 to November 2017 (data collection ongoing). Liuchiu Island comprised of 86.6 % of the sightings reported with the largest amount of sightings from one dive resulting in 43 individuals spotted. Sea turtles with severe shell injury and fibropapillomatosis (FP) have been reported and with the participation of local divers, these injured individuals have been monitored in situ and their recovery progress have been recorded. Other sightings were spread out over different locations around Taiwan, including Kenting, Penghu Islands, Lyudao and Kinmen. In order to maximize the value of this data and make logging records both more interactive and educational, we aim to continue updating the current online database and share the knowledge of sea turtle by monthly reports and workshops. In the monthly report, we introduce turtle superstars from various dive sites, highlight special cases and share scientific knowledge of sea turtles. Marine conservation awareness talks and underwater photography workshops have also been held. New interactions through social media and public workshops allow us to learn the first-hand experiences from local divers. To increase the speed of data collection and explore the potential of new research sites, the immediate information exchanged on sea turtles will help to raise conservation needs and the awareness of sea turtles in Taiwan.
Turtlespot Taiwan: https://www.facebook.com/groups/turtlespotintw

COMMUNITY OUTREACH TOWARDS SEA TURTLE CONSERVATION AT KALPITIYA PENINSULA OF SRI LANKA

Lalith Ekanayake | Y.K. Karunarathna
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Of the seven species of sea turtles in the world, five come ashore to nest in Sri Lanka while their feeding habitats & migratory routes located around the island. The species are namely green turtle, leatherback, olive ridley, loggerhead and the Hawksbill. Kalpitiya peninsula located in the Gulf of Mannar at Northwestern coast of Sri Lanka. The fishing communities in the Kalpitiya Peninsula depend on seasonal, artisanal gill net fisheries targeting pelagic shoaling fish. Sea turtles often get entangled in the sea and lagoon causing damage for fishing nets. In response, fishers either beat the turtles' heads until they rendered unconscious, or hack off the turtles' body parts to make disentanglement easier. The turtles are then either discarded at sea, or brought back to shore for illegal processing of their meat for local consumption. Fauna and Flora Protection Ordinance (FFPO, 1972; amendment 1993 and 2009) prohibit harming and killing the turtles, or possessing their body parts. So coastal communities must be educate about the importance of conserving the sea turtles and coastal ecosystems including various habitats such as coral reefs, mangroves, sea grass beds etc. The aims and objective of this programmes was to increase the education and awareness on sea turtle biology & conservation, legislation and law enforcement among the coastal communities such as fishers, school children and other coastal resource users. Awareness programmes were conducted at schools and villages for the school kids and community members. The programme was conducted from January to December 2017. An awareness leaflet was printed and distributed among the participants. Several field activities such as beach cleaning and tree planting at home gardens was conducted. The community members (both adult & schoolchildren) were actively participated for the above field activities and they were highly enthusiastic to do the field activities. Many newspaper articles were published in three local newspapers and approximately 300,000 copies of newspapers were distributed throughout the island with the news. Therefore, a larger group has read the conservation message. Most of the community members were very interested about the awareness programmes and got information on coastal biodiversity conservation. They understood how they get benefit from conservation of coastal biodiversity including sea turtles. The active participation of coastal community (both adult and children) increased on coastal biodiversity conservation. This was the major outcome and need to conduct more fieldwork in order to get attention of eh community towards nature conservation. Acknowledgement: We would like to acknowledge International Sea Turtle Society, Suma Aquiline Park, Mitsubishi, Osaka Eco, Sea Turtle Association of Japan, Organist, Nescafe, NYK line, Hikari, Sysmex, OCF Japan, Okinawa Churaumi Aquarium, Chobu Doboku, the US Fish & Wildlife Service and International Sea Turtle Symposium for their support to attend the symposium. Moreover, we would acknowledge Rufford Foundation, U.K. for the financial support for the project.

PORTS CONSTRUCTION AND MARINE BIODIVERSITY, A DILEMMA: CASE OF SEA TURTLES AROUND THE DEEP SEA PORT OF KRIBI (CAMEROON-WEST AFRICA).

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Four species of sea turtles are common at the coastline between Kribi and Campo: *Lepidochelys olivacea* and *Dermochelys coriacea* female adults which carry out nesting(more rarely *Chelonia mydas*), *Eretmochelys imbricata* and *Chelonia mydas* juveniles which feed and grow on the site according to former studies. The construction works and operation of the Port complex of Kribi affect important protected marine species whose coastal habitats are found in the project site and its immediate vicinity. Considerable damage was done during this project, as many beaches of high value which serve as nesting sites were destroyed by the digging and transportation of sand. The migration corridos of sea turtles were disturbed, causing the animals to lose their orientation on the littoral. Coastal erosion was accentuated by the quick change of the coastal facade. Many sacred sites were destroyed in the locality of Lolabé such as the stone tools and pottery whose history dates back from the Neolithic era (5000 at 2500 BP) and from 2500 at 1500 BP for old iron. The residents also observed decreased productivity of fishing areas during the last years since the advent of the complex. In the light of this situation, many attenuation measures must be taken, such as :

- Ecological and socio-economic monitoring to evaluate the dynamics of the impacts of this project;
- Finalization of the “Mayange Na Elombo-Campo” Marine Protected Area project as environmental compensation;
- Creation of an Oceanographical Observatory to evaluate the various environmental changes.

Key words: Marine Protected Area, deep sea port, nesting beaches, sea turtles, ecological monitoring.

PARTNERING WITH PERUVIAN SMALL-SCALE FISHERS TO MITIGATE AT-SEA SOLID WASTE PRODUCTION AND PROTECT SEA TURTLES

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The increase in debris found in the marine environment is of growing global concern due to its potential damage to marine ecosystem and therefore to many endangered marine species. Marine debris ingestion affects a multitude of species and can have lethal, sublethal and toxic effects on development and population dynamics. All seven sea turtle species are affected by marine debris either through ingestion or by the degradation of key habitats. In Peru, artisanal fisheries generate large amounts of marine debris (plastic, wood, metal, etc.) which are typically discarded at sea. Additionally, there is limited knowledge and awareness in many coastal communities about the impacts of solid waste on ocean health. The town of San Jose is a fishing community where we have implemented a program to reduce fisheries bycatch of endangered marine fauna, with an emphasis on sea turtles. As part of a more holistic approach towards sustainable fisheries we assessed the solid waste produced by the small-scale net fishery in San Jose and proposed ways to reduce it. Twenty-two trips were monitored from March to September 2017 and all solid waste generated aboard fishing boats was segregated and collected by fishers, returned to shore and categorized. Six types of solid waste were identified: organic, plastic (bags, bottles), paper, cartoon, metal and fishing nets. We estimated a daily production of solid waste of 4.05 kg/vessel. The most abundant waste produced were organic residues (76.84 gr/day*crew) and registered in 83% of trips monitored. The second most abundant solid waste were fishing nets (45 gr/day*crew) despite the fact that these were only recorded from 5 monitored trips. Our estimation for the total number of vessels was 63 225 kg/year of solid waste generated just in San Jose. It is noteworthy that San Jose is home to only about 4% of artisanal fishing vessels registered for Peru. Additionally, surveys were conducted to gather information about current solid waste management practices and community perceptions of the topic. Despite the lack of a solid waste management plan in San Jose, however 93%, from all those interviewed, reported a willingness to participate in the implementation of one. The information gathered at sea, as well as through community surveys and workshops will be used toward developing a solid waste management plan proposal for San Jose. It is also clear, however, that further efforts are needed to raise awareness of solid waste issues in coastal fishing communities.

FISHERMEN BEHAVIOR AND PERCEPTIONS: A KEY KNOWLEDGE TO IMPLEMENT ON-BOARD HANDLING OF SEA TURTLES IN THE ARTISANAL PERUVIAN LONGLINE FISHERY

Nelly de Paz Campos | Pedro Diaz Meza | Evelyn Luna Victoria | Peter Dutton | Elizabeth Gutierrez | Willy Alvarez Boycochea
ACOREMA | ACOREMA | WWF Peru | NOAA SWFSC | ACOREMA | ACOREMA

As interactions with fisheries are the main threat to sea turtles in Peruvian waters, several studies are shedding light in the identification of fisheries and localities considered critical for recovery of sea turtles present in both coastal and oceanic waters. Based on this information, some mitigation strategies have been tested.

Present study is focused on mitigation of the bycatch without retention of sea turtles in the longline fishery in key ports of Peru. Post capture survival of sea turtles mostly depends of fishermen’s practices before releasing the animals and their willingness to participate were compiled and evaluated. A total of 214 interviews to artisanal longline fishermen were applied. Of these, 48.33% were boat captains and 49.76% were crew members in seven Peruvian fishing localities. Regarding fishermen’s perceptions, 49.06% consider that sea turtle incidental fishery is a problem, while for 76.89% of the fishermen interviewed is important to recover their fishing gear. However, 82.05% showed interest in receiving recommendations to mitigate incidental fishery if this did not affect their activity.

Participant fishermen provided detailed information about on-board sea turtle handling, from lifting to release, what tools could be useful for handling and releasing according to the fishing operation, maneuvers and gear used. With this baseline data a first approach to recommendations for reducing sea turtle injures during fishing operations was developed. This approach will be tested in future fishing trips, thanks to the support and participation of fishermen. The study also seek to measure possible changes or acquisition of new practices generated by sensitizing strategies to bring together more fishermen for a change of attitude, with the benefit of sea turtle populations.