# An Analysis of Anthropogenic Effects and Conservation Project on Olive Ridley (*Lepidochelys olivacea*) in the Mexican Pacific Coast

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**Abstract**

The Olive Ridley sea turtle (*Lepidochelys olivacea*) population has been in decline for the past decades, although it was once one of the most abundant of eight known sea turtle species it is now one of the species with a low specie population. With one out of 1,000 sea turtles surviving to adulthood and reproduce, it is a high priority to protect this specie. Mexico once used to be one of the countries were Olive Ridleys would nest by the tens of thousands and now the population of Olive Ridley is under threaten species by the IUCN. Anthropogenic effects have been associated with the low survivorship of this specie. The focus of this analysis will be to address anthropogenic effects and conservation programs on *Lepidochelys olivacea* in the Mexican Pacific Ocean. The goal will be to analyze and evaluate in detail the stressors that affects the decline of the specie in both open ocean and on land. The findings of the analysis shows us that the ban harvest of sea turtles in 1990 and the implementation of conservation camps (rookeries) has seen an increase in the population of Olive Ridleys in the Mexican Pacific Ocean.

## Introduction

For decades, sea turtles have experienced a decrease in their population globally and the declining trend seems to continue. The decrease of population of sea turtles has been so alarming that all turtle species have been placed in vulnerable, endangered, critical endangered, near threaten, or unclassified (Lack of data to categorize.) categories of endangerment (IUCN, 2018). Seven species of sea turtles are distributed across the ocean, including Olive Ridley (*Lepidochelys olivacea*), flatback (*Natador depressus*), green turtle (*Chelonian mydas*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and loggerhead (*Caretta caretta*) (National Ocean Service, 2018). Most sea turtles share the same habitat except for the flatback turtle, which is only endemic to Australia. Olive Ridleys can be found in 80 countries around the globe and nest in 60 countries (IUCN, 2008). Despite being one of the most abundant sea turtles species, its population has dramatically decline in the last decades. All the countries where Olive Ridley nested or could be found are experiencing an alarming rate of decrease from 30-50%, making their population vulnerable. The country of Mexico is of special interest in the conservation of Olive Ridley as at one point it was the world's highest population of nesting Olive Ridley. Currently the population of Olive Ridleys turtles is showing signs of grown and stable, but the population is still threaten.

In many countries like in Mexico, the legal hunting and harvesting of Olive Ridley turtles and other turtles push the population to be at the blink of extinction. Mexico was once the mecca for six species of sea turtles, and just in a few decades, their population decreased to almost extinction. During the 1960's and 1980's the Mexican government made it legal to harvest sea turtles. The population of all sea turtles quickly declined as the consumption of sea turtle eggs quickly gained fame as it was said to be an aphrodisiac. The consumption of sea turtle eggs and a

soup made from turtle meat became popular in bars and street markets from tourists who visited coastal towns. A myth arose that by consuming sea turtle eggs and turtle soup the person would reach a higher sexual potency. The myth created a rapid increase in demand for the sea turtle eggs. In addition, adult sea turtles were hunt for meat and the reproductive tissues to make an oil that it is rumor to have medicinal properties to treat asthma and dermal diseases. Many turtle campsites started appearing along the coast to harvest the turtles to process them and extract the oil to satisfy the demand. In addition, in the middle of the 1960's, Mexico established turtle leather trade with Europe and accelerated the harvest of adult turtles (NMFS & USFWS, 1998). Sea turtle populations declined from hundreds of thousands of turtles to just a few hundred nesting turtles.

It was not until May 31, 1990, that the Mexican government permanently banned sea turtle harvesting, consumption, and extraction. In addition, sea turtle nesting areas were protected (GOB.MX, 1990). Under this ban, the Mexican government has worked with many non-profit organizations, communities, and universities to establish sea turtle conservation camps along the beaches of Mexico where there are large populations of sea turtles that nest. Sea turtle conservation camps (rookeries) protect nesting sea turtle females from poachers and predators. They also protect the eggs by extracting them from the nests and transporting them to a protected area in the rookeries where they are placed in a man-made nest in the sand. Once hatchlings emerge, they are released to the ocean. These rookeries play a key role in decreasing the negative effects of anthropogenic impacts that are associated with climate change such as sea level rise, higher ocean temperatures, and drought during the rainy season. Other anthropogenic impacts in the sea turtle population is accidental bycatch, coastal development and plastic pollution in the nesting beaches that the Olive Ridley use for nesting.

## Biology

Olive Ridleys are the smallest sea turtles out of the seven turtle species with a carapace measuring between 60 to 70 cm long, and weighing less than 50 kg. as adults (NMFS-USFWS, 1998). Little is known about the exact life span of the Olive Ridleys, but the average life span in the wild is estimated to be 50 years. Olive Ridleys historically were confused with loggerhead turtles and Kemp's Ridley sea turtle species (Frazier, 1985; NMFS-USFWS, 1998). Olive Ridleys and Kemp's Ridleys are for the most part very similar, but have very different number of lateral scutes in the carapace. In addition, Kemp's ridley are endemic to the Atlantic Ocean and cannot be found anywhere else (NMFS-USFFWS, 1998).

Olive Ridleys have an olive color and a grayish green carapace, and a greenish white plastron in younger turtles. As Olive Ridleys get old, the greenish white plastron turns to a creamy yellow color (Figure 10). Hatchlings are all black when wet and dark gray when dry (Figure 11) and measure no more than 34.7-44.6mm, with a body weight of 12-22.3 mg. (NMFS-USFWS, 1998 & Marquez, 1990). Olive Ridleys have four scaly flippers, two frontal and two rear, and all flippers have a similar singular claw. Adult males are physically different from females, as they have a longer and thicker tail, the front flippers claws are larger, and have a concave plastron, along with a tapered carapace. These Sexual Dimorphic difference have evolved different from females to use during copulation.

## Range/Distribution

Olive Ridleys have a circumtropical distribution that occurs in the Atlantic, Pacific, and in the Indian Ocean (Pritchard, 1969; IUCN, 2008). Even though, sea turtles are found in 80 countries throughout the world, nesting only occurs in tropical and subtropical waters (NOAA, 2014). Based on the information of the Olive Ridley on the IUCN website Ridleys only nest

between latitude $35^0$ N and $35^0$ S. Olive Ridley turtles migrate hundreds of miles to forage both lateral and horizontal to continents. In Mexico, solitary nesting occurs along the entire Pacific Ocean with key arriaba nesting beaches in Ixtapilla, and La Escobilla, Mexico. (NOAA, 2014). For more information, about range and distribution please refer to figure 1.

**Diet**

Olive Ridley sea turtles are omnivores and can dive to the depths of over 150 meters to find food. Ridleys primarily feed on lobsters, tunicates, fish, fish eggs, jellyfish, shrimp, snails, and crabs. In addition, Olive Ridleys also ingest algae, seaweed, and seagrass (Olive Ridley Project. 2018 & Platanitos Sea Turtle Conservation Camp. 2018).

**Predators**

Predation occurs in all life stages for Olive Ridley turtles with the highest predation levels occurring during the hatching and juveniles stages. As Olive Ridleys grow in size predators decrease and only large species like sharks and killer whales are the known predators. Due to the size of hatchlings and juveniles, the number of predators is higher than of adults. Killer whales, sharks, billfish, crabs, and other bigger fish pray on juveniles and hatchlings (Platanitos Sea Turtle Conservation Camp, 2018; National Geographic, 2018). Predation by avian species occurs in nests that are opened by dogs, mammals, stream erosion or tidal erosion by picking and eating the exposed eggs. In addition, avian also devour hatchlings when emerging from the nests and crawl to the ocean. Avian predation also occurs away from the shore by snatching hatchlings that emerge from underwater to breathe as the hatchlings swim towards the open ocean (Burger, 2014). On the beach, raccoons, dogs, and wild pigs predate on the nests by eating and destroying the sea turtle nests (Platanito Sea Turtle Conservation Camp, 2018; National Geographic, 2018). The predation of sea turtle nests by avian and mammals has a high

impact in survivorship of sea turtles and the population as this threats can result in a as 95% of mortality of eggs (Engemal et al, 2003).

**Habitat**

Olive Ridley turtles spend most of their lives living in oceanic waters except when they are born or nesting, which is exclusively only for female turtles. So far, there has been no documentation of male Olive Ridley sea turtles adults or juveniles in beaches other than when they are born. Olive Ridley tend to migrate and spend most their non-breeding life cycle in the oceanic zone (Beavers & Cassano, 1996). Olive Ridleys may move between the oceanic zone and neritic zone for foraging or mating (Plotkin, 1995). In addition, Olive Ridleys are not known to move between or among ocean basins (NOAA, 2014). In the Eastern Pacific Olive Ridleys are often associated with a highly productive area called the Costa Rica dome which is an area with a shallow surface thermocline rich in pray species (located between 8 to $10^0$ N and 88 to $90^0$ W) (Swimmer et al. 2009). In the Mexican Pacific Ocean sea turtles are also found foraging in productive areas near the state of Sinaloa, Isla de Espiritu Santo (Baja California Sur), Bahia Magdalena (Baja California Sur) and Bahia de Ulloa in Baja California Sur (Iacseaturgle.org, 2018) . Olive Ridleys have also been found in large groups (Flotillas) near floating debris throughout the eastern Pacific Ocean. Ridley's have been seen to congregate with floating objects or vegetation where it might provide them with shelter, food, and orientation in the open waters (Arenas, 1992).

During breeding season, Olive Ridleys migrate from the oceanic zone and migrate to the neritic zone. During mating season, the female and male Olive Ridley turtles migrate towards the coast and aggregate near the shore breeding grounds near nesting beaches (Pritchard, 1969 & Plotkin, 1995). It was discovered that a significant amount of breeding also happens in oceanic

water away from the breeding aggregations. A good percentage also happens away from breeding areas as some males intercepted females for copulation on their way to breeding grounds and nesting beaches (Kopitskey et al, 2000)

**Mating, Gestation Period, Nesting**

Olive Ridley sea turtles reach maturity at the age of 10 to 18 years with a median of 13 years (USFW, 2018). Nesting season for Olive Ridleys happens between June and December (Paot.org, 2000). During this period males and female turtles migrate from foraging areas in pelagic zones to neritic zones. The copulation occurs when the male sea turtles mounts the female turtle and using his frontal flippers and claw attach themselves in the back of the female and may last a few minutes to  a few hours (Marquez, 1990). After the copulation, the gestation period varies, depending on the nesting aggregations, which can be arribadas or solidarity nesting. Arribadas have a gestation period of 28 days and 14 days for solitary nesters (USFW, 2018). There is no information about why this happens, only suggestions that it might be associated with moon phases, but it has not been proven.  Nesting occurs in three different types; arribada, dispersed or solitary nesting or a mix of both (Bernardo & Plotkin, 2007). The arribada nesting strategy is when hundreds or even thousands of sea turtles aggregate in one night and nest in the same beach (Figure 2 & 3). A solitary nest strategy is when one or a few turtles at a time make it to the beach to nest. A mix strategy is when there is a mix of arribada and solitary nesting. Female Olive Ridley sea turtles can nest one, two, or three times per season and lay an average of 100-110 eggs per clutch (Marquez, 1990). The number of eggs per clutch depends on the size of the female, with smaller female turtles producing fewer eggs per clutch (Harfush et al, 2008). After the gestation period, female Olive Ridleys make their way to the beach to find a suitable place in the sand. Using their back flippers and flipper claw it digs a

whole in the sand and it lays the eggs. After the sea turtle lays the eggs it covers the nest and using its plastron it compacts the sand and tries to camouflage the nests by using the sand around (Platanitos and Nuevo Vallarta Sea turtle Conservation Camps, 2018). The eggs are incubated in the nest for a period of 45 to 65 days. The incubation time is highly dependable on temperature and humidity. When the weather is dry and cold, the egg clutches take longer than when is warm and moist (Marquez, 1990).

**Methods**

For this project, information was collected through extensive peer-reviewed scientific literature, library research, and government publications. In addition to the extensive literature research information, I spent 186 hours participating in two Mexican sea turtle conservation camps in Nuevo Vallarta and Platanitos in Nayarit, Mexico in November 2017 and June 2018. I also interviewed conservation camp directors, staff, and community volunteers. The information collected by both peer-review papers and direct observations will be used to analyze the population of Olive Ridley and conservation efforts in the Mexican Pacific Coast.

**Anthropogenic Threats**

**Direct take**

The harvest, poaching, and illegal egg use is still widespread throughout Mexico despite Mexican prohibition of these activities. Prior to the 1990 ban, is estimated that around 75,000 turtles were taken per year for two decades prior to 1990 (NOAA, 2014). Turtle egg consumption is still common in Mexico. Eggs are taken directly from the nests or even when the turtle is laying the eggs and then sold in the nearby communities for as much as 3 pesos per egg (+/-16 cents of an American dollar) (Platanitos Sea Turtle Camp. 2018). During high nesting season, the Platanitos sea turtle poachers compete with the camp staff to collect eggs, as the

camp is understaff and cannot protect all nests. Foot patrolling poachers come out at night to poach on the turtle eggs. There have been times when poachers drag a sea turtle away from the beach to extract the eggs from the turtle to avoid being seeing by the camp patrol staff. In some coastal towns in Mexico, turtle meat is considered a delicacy and the harvest of sea turtle persists, even when it's prohibited. In the Northwest of Mexico an estimated 30,000 sea turtles are killed for consumption (Nichols, 2003).In addition, direct intake of sea turtles is used to make sea turtle oil, which is believed by its users and sellers to have medicinal properties for cardiovascular, arteritis, cancer, Parkinson among other illnesses. A 40 Kg. sea turtle can produce up to 4 litter of oil (El angel de la salud, 2018). After intense investigation of review papers and published papers, there was no data found on the health and curing benefits that have been associated with sea turtle oil.

**Global Warming**

Based on information on global warming, climate change will negatively affect Olive Ridley's habitat and biology. (NOAA, 2014; IPCC, 2007). The direct effects from global warming would be sea level rise which affects nesting beaches, higher temperatures affecting hatchling survivorship and sex ratios, rain and moisture in the sand, as well as changing the salinity, oxygen levels and circulation of the ocean shifting the changes in algal, planking and fish abundance that Olive Ridley pray depend for foraging.

**High Temperatures**

Sea turtles are temperature-dependent sex determination, and warmer incubation temperatures will produce more females than males. (Wibbel et al, 1998). With high temperatures associated with global warming, it is expected that the sex ratio of sea turtles will skew to more females than males. The sex of the sea turtle is determined in the third incubation

period when the embryo's sex determination is sensitive to temperatures (Merchant-Larios et al, 1997). Below the temperature of $29^0$ C, hatchlings will be mostly males. At around $29.95^0$ C it will produce 50% males/females. At 30-$31^0$ C, and above $31^0$ C it will produce mostly female (Sandoval Espinoza 2011 as cited in Hernandez-Echeagaray et al. 2012). Above $35^0$ C is the upper lethal limit for embryo development where hatching success is as low as 2% (Valverde et al, 2010). The threat of higher temperatures will play an important role on the nest hatchling survivorship, sex ratio, and possibly the loss of genetic diversity, as there will be less males, because of high temperatures.

**Lack of Moisture**

Due to climate change, sand has become less moist due to lack of rain during the rainy season and higher temperatures drying the sand. Eggs require the sand to have a certain level of humidity so the sea turtle eggs do not dry up or over heat with the sand temperature (Platanitos Conservation Sea Turtle Camp, 2018).

**Sea Level Rise**

Sea level rise associated with global warming will decrease suitable areas in beach to nest (NOAA. 2014). Sea turtles tend to nest a short distance away from the ocean waves between the mid-beach slope and the vegetation line (Platanitos Sea Turtle Camp, 2018). As sea levels rises, wave action/surf will disturb the nests by excess moistures, exposing the eggs to predators or direct sunlight (Fowler. 1979; Platanitos Sea Turtle Camp, 2018).

If inputs of CO2 into the atmosphere continue it is expected that sea level will rise from 8 inches to more than 6 feet by 2100 (Melillo. Et al, 2014). Some coastal communities, especially tourist cities, are countering sea level rise by constructing sea walls to avoid the impacts of waves. Many hotels in Puerto Vallarta have already begun constructing walls to protect hotels

(Puerto Vallarta Sea Turtle Camp. 2018). Sea wall construction will destroy suitable nesting habitat and increase beach erosion (NOAA, 2014). In addition, it will affect nests that are left in situ and will be lost by wave action or washed up to sea. Sea turtle Conservation camps such as Nuevo Vallarta leave a portion of the nests in situ because poaching in this location is low to non-existent as a hotel resort area. If sea level rises this camp will not be able to leave the eggs in site affecting the workload of the camp.

**Coastal Development & Artificial Lighting**

Around the world, coastal development on sea turtle nesting beaches has affected the natural behavior of sea turtle nesting and hatchling survivorship. Coastal areas in many parts of the world are considered prime real estate and in the last decades beaches been heavily developed (Sea Turtle Conservancy, 2018). The developed structures often prevent sea turtles from reaching the upper portion of the beach, causing sea turtles to nest in unsafe and vulnerable suitable places, and exposing susceptible nests to wave action. According to the Sea Turtle Conservancy (2017) studies show that turtles who emerge in front of seawall often return to the water without nesting because of lack of a suitable location to nest. For many decades, Puerto Vallarta has seen an increment of coastal development especially between the coastal state lanes of Nayarit and Jalisco known as Nuevo Vallarta. This particular location where sea turtles used to nest in abundance is now full of beachfront hotels. These hotels were building a few hundred feet away from the wave break with sea walls that are as closed as 21 meters. The interaction of sea turtles with beach tables, chairs, and walls is noticeable when turtles emerge in these locations. In addition, coastal development attracts tourists, which interfere with nesting turtles especially at night when turtles nest. The noise, lights, and people walking at night often scare

the nesting turtles and will not nest known as a false crawl (Puerto Vallarta Sea Turtle Camp, 2018).

Artificial lighting in nesting beaches affects the behavior in nesting adults and most of the times is fatal to emerging hatchling as they are attracted to light sources (Witherington, 1992; Puerto Vallarta & Platanitos Sea Turtle Camps, 2018; NOAA, 2014). Artificial lighting disorients emerging hatchlings as disrupts the ability of hatchlings to find the sea. Sea turtle hatchlings have an inborn tendency to move to the brightest direction, which is during the night is the sky that is reflected by the ocean (Whiterington et al, 2014). Hatchlings that follow artificial lighting die because of exhaustion or are eaten by predators as they move away from the ocean. If turtles survive in the morning they will perish due to overheat or eaten by predators. Disorientation also causes the sea turtle to consume nutrients from the placenta. This placenta provides food for the hatchling for 8 days leaving the hatchling with less food to survive in the ocean (Puerto Vallarta & Platanitos Sea Turtle Conservation Camp, 2018).

**Plastic Pollution Beach/Ocean**

About 8 million metric tons of plastic enters the ocean annually and the amount of plastic that enters the ocean is set to increase in the upcoming decades (Jambeck et al, 2015). Ocean plastic pollution affects an array of marine species and birds that ingest it (Kühn, et al, 2015). Ingestion of debris and plastics is lethal for marine turtles as it brings health impacts in the intestines such as blockage, poor body condition, and lacerations (Clukey et al, 2017). Olive Ridleys are not an exception to plastic ingestion and it has been extensively documented that Olive Ridleys are one of the species that ingests more plastic and debris.

Plastic pollution in the ocean is a threat not only in adult sea turtles but also to young sea turtles. Sea turtles ingest plastic bags, microbeads and die due to plastic pollution and ingestion. Plastic pollution and debris on beaches are a threat to hatchlings as they get caught/trapped and die of exhaustion, heat, and predators. Removal of debris and trash can be beneficial to hatchlings as it reduces the time to reach the sea avoiding predation, reducing stress, exhaustion, and exposure to the high temperatures (Burger, 2014).

**Bycatch**

Possibly the greatest threat to sea turtles is incidental bycatch. Incidental bycatch happens when fishing technology specific species attracts sea turtle to the bait or target catch and get caught or entangled in the fishing device. It has been well documented that sea turtles are incidental bycatch by fisheries who use shrimp trawl nets, long line hooks, and gillnets (NOAA. 2014). Bycatch is a serious threat to not just sea turtles but also other marine species. In the Mexican Gulf of California, it said that for every shrimp that is caught by shrimp trawls, over four times the shrimp weight is bycatch (Consortium for Wildlife Bycatch Reduction, 2014). Even though, the Mexican governments has made it illegal for fisheries to not use TEDs (Turtle Exclusion Devises) many small fishermen are still using fishing gear without TEDs. Turtle exclusion devices are fishing devices (specially trawling nets) that have collapsible trap doors so turtles can escape if they are caught on trawl nets. Long line hooks also poses a danger to sea turtles as they are caught on the hooks and drown when trying to take the bait from the hooks. In Costa Rica alone, 699,600 adult Olive Ridleys were caught between 1999 and 2010 by long line hooks in the pelagic zone (Dapp et al, 2013). In addition, bycatch also occurs when gill nets are used as a fishing device. Sea turtles tend to get tangled in gillnets and drown. The practice of gillnets its implemented by large companies and also artisanal communities in both pelagic and

near the beach zones. Both poses great danger to sea turtles as well as other marine species. Even though, artisanal fisheries tend to fish in a much smaller operation than large companies artisanal fisheries make a vast number of artisanal fishermen and should not be overlooked (Koch et al, 2006).

**Ghost Fishing Nets**

Ghost nets are a huge problem not only for sea turtles, but also for many marine species that are large enough to be caught on the nets or ingest them. Ghost nets are nets that are lost by fisherman and are left in the ocean and drift. Most of the ghost nests in Mexico are associated with artisanal fisherman who fish in small boats (Platanitos and Nuevo Vallarta Sea Turtle Camps. 2018). Mexican authorities found a ghost net with more than 300 dead sea turtles floating off the coast of Oaxaca (Figure 5) (New York Post. 2018). This happen a weak after Mexican authorities found another drift/ghost net located an illegal net with 102 olive ridley sea turtle. Ghost nets drift in the ocean and only a few of the fishing nets wash ashore (figure 5) as others drift in to the open ocean becoming a threat to marine life.

**El Niño**

The atmospheric phenomenon known as El Nino has brought some impacts to Olive Ridley sea turtles. El Nino it's an atmospheric phenomenon that happens every two to seven years and can last for one year to many years. El Nino brings hotter oceanic temperatures along the central equatorial Pacific and it is associated with a low productivity in marine ecosystems (NOAA, 2018). The low productivity affects Olive Ridley sea turtles, as they have to migrate to forage to different locations. In addition, the higher temperatures and low productivity has caused many female olive turtles to decrease the number of female turtles that nest (Marquez, 1990).

**Protection and Sea Turtle Conservation Camps in Mexico**

Under the protection of sea turtle in Mexico, the government has established more than 18 sea turtle conservation camps along the pacific coast (NOAA, 2014). These conservation camps protect all sea turtles that are found in Mexico There are now more than 18 sea turtle conservation camps in the Mexican Pacific beaches that work directly with the government and other NGO's and Mexican Universities. Government agencies that are part of the conservation camp are The National Commission of protected Natural Areas (CONANP) and the office of Secretary of Environment and Natural Resources (SEMARNAT). State universities also are part of the conservation efforts such as State University of Guadalajara, State University of Baja California, State University of Nayarit, among other universities. There are also non-governmental organizations that provide funding to some of the conservation camps such as Selva Negra. Selva Negra is a foundation by Mexican rock band Mana. In addition, business also provide funding to conservation camps. Some of the conservation camps would not be able to operate if it was not for the participation and donations from non-profit organizations and the help of universities. In instances, the funds from the Mexican government are not enough to cover the expenses and material needed to run the camp (Nuevo Vallarta & Platanitos Sea Turtle Conservations Camps, 2018).

Conservation camps (rookeries) help protect the nesting turtles, nests, eggs, and hatchlings throughout the year and nesting seasons. These camps are placed in the beach at a safe location that is usually no more than 150 ft. from the water. Most rookeries use the same methods to protect the sea turtle species, which need to follow the protocols established by the Mexican government (NOM-162-SEMARNAT, 2012). Under the protocol, the campsites have

to conduct night and evening patrols along the beach every night to reduce poaching during the nesting season. If the beach is impacted by poaching, the eggs that are nested by sea turtles need to be relocated to a protected corral that meets the requirements under the protocol. The eggs need to be replanted in the same beach that the eggs were nested no later than 4 hours after they were nested, and will remain there until the end of the incubation period. For every nest that is replanted camp officials need to keep records of the date, number of eggs nested, and number of eggs hatched and at the end of each nesting season an annual report needs to be submitted to the governmental agency that over sees the conservation camp.

Following the protocol, conservation camp staff monitors the incubation period from threats of predators and controlling temperature and humidity to increase that hatchling success of the nests. Once the hatchling emerge from the nest, camp staff collects the hatchlings and surveys the nest. Once hatchlings emerge and are survey they are to be released as soon as possible following the protocols. For more information about sea turtle conservation camps protocols please search for (NOM-162-SEMARNAT, 2012).

Some rookeries have implemented a new strategy to incubate sea turtle eggs from the conventional and natural way. The new strategy being utilized is placing the clutches of eggs in styrofoam boxes (Figure 6). Some rookeries are moving to this technique because the lack of space in the corrals and it said that the hatching of eggs surpasses 90% hatching success (Platanitos Conservation Sea Turtle Camp, 2018).

## Results

### Conservation Accomplishments in Mexico

Mexican government, sea turtle conservation camps, non-profit organizations, and universities have worked together to protect the Olive Ridley and all sea turtles from going

extinct. After the ban in 1990 the specie of Olive Ridley has increase in number of female nesting, conservation of eggs, and increase of rookeries, but the species is still a threaten specie by the IUCN. Sea turtle conservation camps has help to increase the number of protected nests and has seen an increment of nesting sea turtles. Prior to the ban by the Mexican government, sea turtle abundance in Jalisco and Nayarit, Mexico was low as 50-300 sea turtle nest for the entire season in the Platanitos beach, now there an average of 5,000 sea turtle nests sea per season (Platanitos Sea Turtle Camp, 2018).

In addition, some of the sea turtle conservation camps use a percentage of their funding to hire member of the community to do work in the maintenance of the conservation camps and do patrolling at night (Platanitos Sea Turtle Camp, 2018). When students from universities participate in the conservation camp, they provide informational workshop to communities and schools regarding the importance of conservation of sea turtles and the environment. This has brought more awareness to communities to protect sea turtles and inform them about the fallacies of the myth that is associated with the consumption of turtle products. In addition, sea turtle conservation camps are a new attraction to tourists brining more income to the communities (Platanitos Sea Turtle Camp, 2018).

The reporting and data information from rookeries is extremely hard to acquire and most of the time is incomplete, and most of the times it has discrepancies. According to the protocols of SEMARNAT, each conservation camp has to submit an annual report, but most of the conservation camps do not submit a report making it difficult to gather data. Data of the number of nests, eggs, and hatchlings is not always reported to governmental agencies. In addition, it is extremely hard to locate this information even though Mexican government has an open access to data collected by its agencies. From 1993 to 2009, Mexican conservation camps in the Pacific

Ocean have protected 3,689,651 nests, 222,064,332 eggs, and released 123,370,003 hatchlings into the sea (Figure 7).

**Survivorship of Sea Turtles**

According to the current analogy of the survivorship of sea turtles, only one out of 1,000 eggs hatches and survives to reproduce (TED-ED, 2012). The analogy is a projection of a sea turtle that nests 1,000 eggs in one season. Out of the 1,000 eggs, 20% do not hatch leaving 800 eggs. The rest of the eggs will hatch and make their way to the water, which at this point 50% of them will not make it to the water because of predators, leaving only 400 turtles that make it to the water. Out of the 400 sea turtle hatchlings, only 200 survive for adulthood due to predation in the water by fish and birds. Out of the 200 surviving sea turtles, only 20 will make it to reproduce without human interference. It is the human interference has threaten all sea turtle population to all a decline. Human interference is plastic in the ocean, poaching, long lines, gill nets and other anthropogenic effects that threaten the survivorship of the sea turtles. The human interference drops the survivorship to only one out of the 20 sea turtles that would have reached maturity to reproduce (TED-ED, 2012).

If we use the analogy of survivorship of sea turtles of one out of 1,000 with the numbers of hatchlings that SEMARNAT has published. This means that in the expand of 17 years of Mexican conservation efforts, only 123,361 have survived to reproduce , out of the 123,370,003 released hatchings (Figure 7).

**Discussion**

**The Disappearance of Arribada Beaches**

It is important to take into consideration that the disappearance of arribada beaches might be a natural process due to density-dependent factors. Arribadas are becoming less common in

nesting beaches where arribabas used to happen, because of the over-use of Olive Ridley sea turtles during the phenomenon of arribadas. When thousands of Olive Ridleys nest during the arribada, they share the same beach. Due that, there is only certain space for the turtles to lay their eggs after the second arribada turtles damage previous nests when making new ones leaving the eggs exposed to predators (Figure 3). The nest success in arribadas are less successful than in beaches where solitary nesting occurs. Hatching success are very low in arribadas with a 0-32% and high in solitary nesting occurs with a 74-81% hatching success (Bézy et al, 2015). The low percentage of hatching success might be the factor of the decrease and disappearance of the arribada phenomenon on certain beaches.

**Conservation Camps Increase Survivorship of Sea Turtle Hatchlings**

After the sea turtle ban by the Mexican government and funding sea turtle conservation camps (rookeries), there has been an increase in the population of almost all sea turtles that reside in Mexico, especially the Olive Ridley, as is the most common in Mexico. By collecting the eggs from the nest and placing them in a protected location where the sand is monitored for temperature and moisture it increases the survivorship of hatchlings. In addition, when the hatchlings are released to the beach the camps monitor that there are no birds or other predators near the beach to increase the survivorship. Some rookeries like the Platanitos and Nuevo Vallarta wait until the late evening to release the sea turtles, as there are no birds at the time that would predate on the turtles. Without the efforts of the rookeries, the sea turtle survivorship would be low, for example last year there was a high number of nesting turtles in Platanitos. The camp did not have enough space in the corrals that had protective sun mesh shade, so they placed them in an adjacent corral that had no protection against the sun and 100% of the nests (35,000 eggs) did not hatch because of the sand temperature and the lack of moisture (Figure 8). Per the

SEMARNAT Protocols sea turtle, conservation camps need to have protect sun mesh shade to reduce sand temperatures (Figure 9). Conservation efforts will decrease the mortality rate in land by protecting the sea turtles nests when nested, during incubation, and when releasing the hatchlings increasing the survivorship to adulthood. Protecting the sea turtles while being release will increase the survivorship of hatchings by 50% as per the analogy of TED-ED 50% of hatching turtles are predated on their way to the ocean.

**Styrofoam Incubation**

The practice of incubating Styrofoam incubation is starting to be a trend in some of the rookeries in the pacific coast as it is easier to protect and it requires less space (Platanitos & Nuevo Vallarta Conservation Camp, 2018). Some rookeries say that the hatching success is greater when eggs are incubated in styrofoam boxes, but no information has been recorded. What has been recorded is that it takes up to 5 days or longer for eggs to hatch as the temperature in the styrofoam stays constant and does not fluctuate as incubated in the sand. The incubation in styrofoam practice should be studied more in depth as the sex of sea turtles is determent by temperature. Depending the temperature inside the Styrofoam ice chest the hatchling might be all females or males. This practice might beneficial if one of the sexes is low and is needed for recruitment, but prior to that it should be studied.

**Poaching**

Poaching in still a problem in most of the beaches in Mexico. During my study in Platanitos Sea Turtle Camp, for 90% of my stay there were poachers roaming the beaches at night. In many cases even, after a camp staff heavily patrolled the beach some of the nests were poached. Camp staff cannot arrest or detain any poachers as they do not are not permitted by law. In most of the cases and most of the time, the police does not participate in the protection of

sea turtles. Hardly ever the national coast guard will participate in these activities. In addition, camp staff do not confront poachers because of the fear of retaliation and for safety reason of staff members. Poaching would probably decrease if the police or the national coast guard would participate more in the protection of sea turtles both inland and in the ocean. In addition, if conservation camps could detain poachers until law enforcement arrive would also be beneficiary in decreasing poaching.

**Anthropogenic Effects & Global Warming (Sea level rise & higher temperatures)**

Sea level rise and higher temperatures caused by human activity by releasing carbon dioxide into the atmosphere will have negative effects to sea turtles and most of the marine life. Higher temperatures, and direct sunlight in sea turtle nests have been shown to reduce the survivorship of hatchlings as sea turtles and eggs cannot survive after a sand temperature of about 35°C. In addition, sea turtle eggs incubated in higher temperatures will be female; meaning that if higher temperatures continue to increase there will be less males and more females. Rookeries might be needed to cool down the sand to mitigate the effects of higher temperatures and control the hatchling sexes. Sea level rise will directly affect the beaches where sea turtles nest decreasing the suitable area where they nest. In addition, higher sea level will uncover the nests leaving them exposed to predators. To avoid the impacts of sea level rise, rookeries will have to move more inland to avoid being affected by the waves especially during storms. Another problem will rise as rookeries move away from the ocean there will not be any sand and the sand would need to be transported.

**Accidental Bycatch**

Accidental bycatch accounts for the number one human interaction mortality with Olive Ridley sea turtles as well as most sea turtles. Gill nets, long line hooks, and trawling are the main

contributors of the mortality. Prior to establishing regulation in the United States alone, there was an average of 71,000 annual deaths of sea turtles due to bycatch (Finkbeiner et al, 2011). Banning and implementing new technologies seems to be successful as it decreased the mortality in sea turtles. After the implementation of new technologies such as TEDs sea turtle mortality was 60% lower (Finkbeiner et al, 2011). Implementing new technologies in countries that are undeveloped or when governments do not prioritize it is a challenge especially if they are not enforced. In Mexico, there are regulations to avoid bycatch by implementing TEDs, but its not strongly enforced by Mexican law enforcement. In addition, there are more fishermen that use artisanal fishing gear than big fishing companies making it harder to enforce regulations and laws. With little to no enforcement it is easier for fisherman who use artisanal fishing nets and not report the missing nets in the ocean to authorities or recover them (Platanito & Nuevo Vallarta Sea Turtle Conservation Camp, 2018).

**Conclusion**:

Conservation efforts by the Mexican government has shown to be fruitful in bouncing back the once almost extinct Olive Ridley sea turtle to a more stable population size. The contribution of non-profit organizations, universities, and communities should not be overlooked, as it sometimes is the only fund that some of these conservation camps are able to operate. We can clearly compare the increase in nests, eggs, and released sea turtles has increase year by year (Figure 7)

Except for the years, that rookeries did not submitted any data, but other than that, it appears the population of Olive Ridleys is growing and stable. Anthropogenic effects should not be overlooked and should be of important concern, as it has the area and phase where most of the mortality happens. Natural predation would be extremely difficult to mitigate but, human

interaction like accidental bycatch, beach development, and global change can be mitigated. One of the keys for the increase in population of Olive Ridley as well as most of the sea turtles is to decrease the interactions with sea turtles in the ocean such as bycatch, ghost nets, and ocean plastic pollution. The less human interactions in the ocean will assure good percentage sea turtles to reach maturity. If this does not happen the conservation efforts will be in vain as only a small percentage of sea turtles reach maturity to reproduce. Rookeries are doing an excellent job at protecting sea turtles inland, but there should be more protection against human interactions in the sea to fully bounce back the population of Olive Ridley sea turtle.

## Figures

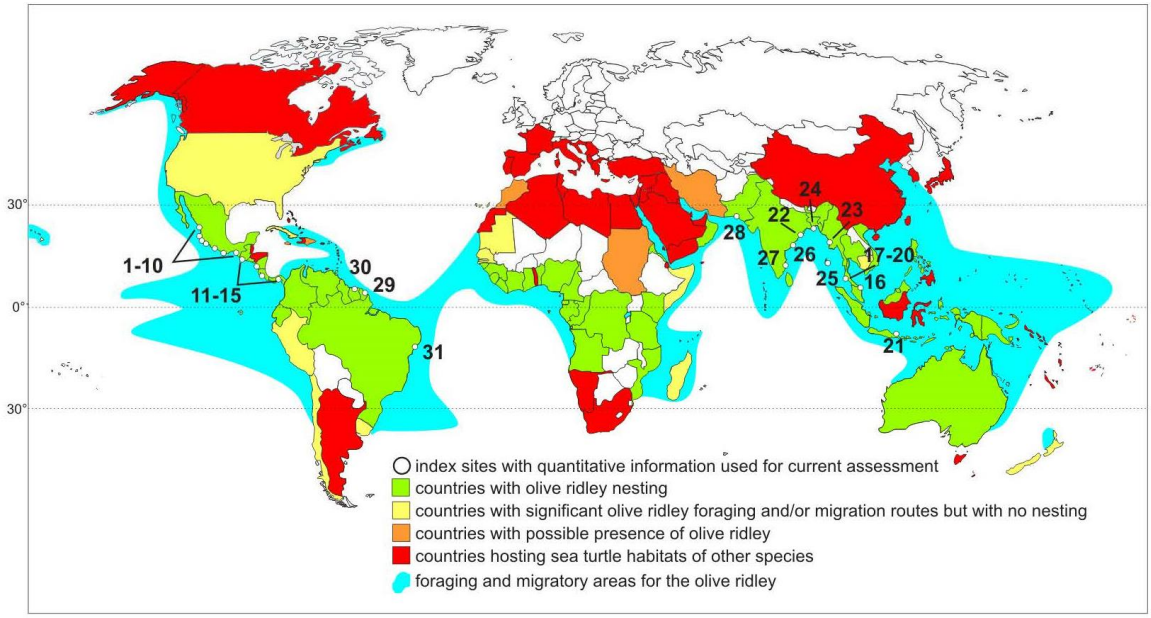


Figure 1. Distribution, nesting, foraging, and migratory areas of Olive Ridley. (ICUN, 2008)

Figure 2. Arribada in La escobilla – Olive Ridleys, Oaxaca (Matutinazo, 2018)

Figure 3. Arribada in La Escobilla, Oaxaca. (Verdebandera, 2015)

Figure 4. Over 300 Olive Ridley Turtle died due to entanglement with ghost nets. (New York Post. 2018)

Figure 5. Ghost nest that washed in front of Platanitos Sea Turtle Camp.


Figure 6. Olive Ridley sea turtle eggs are incubated in styrofoam ice chests. (Platanitos Sea Turtle Conservation Camp, 2018)

| Year | # of Nests | # of Eggs | # Of Hatchlings | *Survivorship 1 out of 1,000 |
|---|---|---|---|---|
| 1992 | 7,670 | 140,555 | 176,867 | 176 |
| 1993 | 22,013 | 816,923 | 665,507 | 665 |
| 1994 | 6,721 | 573,944 | 264,017 | 264 |
| 1995 | 8,736 | 682,592 | 409,258 | 409 |
| 1996 | 6,046 | 553,380 | 338,516 | 338 |
| 1997 | 7,736 | 682,290 | 424,063 | 424 |
| 1998 | 9,739 | 872,866 | 728,070 | 728 |
| 1999 | 7,221 | 459,588 | 339,627 | 339 |
| 2000 | 8,289 | 772,345 | 548,487 | 548 |
| 2001 | 4,937 | 500,366 | 346,373 | 346 |
| 2002 | 38,216 | 3,788,926 | 1,326,658 | 1326 |
| 2003 | 487,779 | 48,670,765 | 14,998,823 | 14,998 |
| 2004 | 1,223,785 | 122,299,541 | 37,522,253 | 37522 |
| 2005 | 309,154 | 30,877,042 | 9,398,968 | 9398 |
| 2006 | 1,442,875 | 1,864,050 | 48,787,053 | 48787 |
| 2007 | 23,469 | 1,931,525 | 1,829,976 | 1829 |
| 2008 | 65,090 | 5,832,679 | 4,855,030 | 4855 |
| 1999 | 7,221 | 459,588 | 339,627 | 339 |
| 2009 | 2,954 | 285,367 | 70,830 | 70 |
| Total | 3,689,651 | 222,064,332 | 123,370,003 | 123,361 |

Figure 7. Data collected by SEMARNAT from 1992-2009. Not all conservations camps are present. Only Campsites that are present in the Pacific Coast are present. In some campsites, the number of nests/eggs/hatchlings are mixed with 1-2 other turtle species along Olive Ridleys. (SEMARNAT, 2010)

*1 out of 1,000 nested eggs survives to adulthood and reproduction (TED-ED, 2018)

Figure 8. 350 nests (Approximately 35,000 eggs) did not survived due to direct sunlight, high temperatures, and low moisture (Platanitos Sea Turtle Conservation Camp, 2018)

Figure 9. Protective sun mesh to reflect the direct sun light away (Nuevo Vallarta Conservation Camp, 2018).

Figure 10. Olive Ridley Sea Turtle. (WWF, 2018)

Figure 11. Olive Ridley sea turtle hatchlings (Platanitos Sea Turtle Conservation Camp, 2018)

## References


Arenas, P., Hall, M. (1992) The association of sea turtles and other pelagic fauna with floating objects in the eastern tropical Pacific Ocean. Salmon, M., Wyneken, J. (compilers). Proceedings of the eleventh Annual Workshop on Sea Turtle Biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-302.7-10.

Beavers, S., Cassano, E. (1996). Movements and Dive Behavior of a Male Sea Turtle (*Lepidochelys olivacea*) in the Eastern Tropical Pacific. Journal of Herpetology, *30*(1), 97-104. doi:10.2307/1564720

Bernardo, J., Plotkin, P. T. (2007) An evolutionary perspective on the arribada phenomenon and reproductive behavioral polymorphism of olive ridley sea turtles (*Lepidochelys olivacea*). Biology and conservation of Riley Sea turtles. Johns Hopkins University Press. 59-87.

Bézy, V. S., Valverde, R. A., & Plante, C. J. (2015). Olive ridley sea turtle hatching success as a function of the microbial abundance in nest sand at Ostional, Costa Rica. PloS one, 10(2), e0118579. doi:10.1371/journal.pone.0118579

Burger, J., Gochfeld, M. (2014). Avian Predation on Olive Ridley (*Lepidochelys olivacea*) Sea Turtle Eggs and Hatchlings: Avian Opportunities, Turtle Avoidance, and Human Protection. *Copeia*,*2014*(1), 109-122. Doi: 10.1643/CE-13-006

Clukey, K. E., Lepczyk C. A., Balazs, G. H., Work, T. M., Lynch, J. M. (2017) Investigation of plastic debris ingestion by four species of sea turtles collected as bycatch in pelagic pacific longline fisheries. Marine Pollution Bulleting. 120. (2017) pp. 117-125. Doi: 10.1016/j.marpolbul.2017.04.064

Convención Interamericana para la Protección y Conservacion de las Tortugas Marinas (Iacseaturtle.org) (2018). Informe Anual 2018 México. Pero-Tempore & USFW. Accessed on December 1, 2018. Retrieved from: http://www.iacseaturtle.org/contacto.htm

Consortium for Wildlife Reduction (2014) Consortium for Wildlife Bycatch Reduction. Acessed on November 7, 2018. Retrieved from: http://www.bycatch.org/about-bycatch.

Dapp, D., Arauz, R., Spotila, J., O'Connor, M. (2013). Impact of Costa Rican longline fishery on its bycatch of sharks, stingrays, bony fish and olive ridley turtles (Lepidochelys olivacea). *Journal of Experimental Marine Biology and Ecology*, [online] 448. 228-239. Doi: 10.1016/j.jembe.2013.07.014

El Angel de la Salud (2018) Radio La Voz del Angel de tu salud. Kahuana & wordpress. Acessed on November 13, 2018 Retrieved from: https://radiolavozdelangeldetusalud.mx/2017/08/12/aceite-de-tortuga/

Engeman, R. M., Martin, R. E., Constantin, B., Noel, R., Woodlard, J. (2003) Monitoring predators to optimize their management for marine turtle nest protection. Biological Conservation 113. 171-178. Doi: 10.1016/S0006-3207(02)00295-1

FGOB.Mx. (1990) Acuerdo por el que se establece veda para las especies y subespecies de tortuga marina en aguas de jurisdicción Federal del Golfo de México y Mar Caribe, así como las del Océano Pacifico, incluyendo el Golfo de California. Diario Oficial de la Federación. Secretaria de Gobernación de México. http://www.dof.gob.mx/nota_detalle.php?codigo=4658226&fecha=31/05/1990

Finkbeiner, E. M., Wallace, B. P., Moore, J. E., Lewison, R. L., Crowder, L. B., & Read, A. J. (2011). Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation, 144(11), 2719-2727. doi:10.1016/j.biocon.2011.07.033

Fowler, L. (1979). Hatching Success and Nest Predation in the Green Sea Turtle, *Chelonia Mydas*, at Tortuguero, Costa Rica. *Ecology, 60*(5), 946-955. Doi: 10.2307/1936863

Harfush, M., Mendez, Y. O., Lopez Reyes, E. M., Padilla, E. A., Abreu-Grobois, F. A., (2008) Evaluation of the Olive Ridley sea turtle (*Lepidochelys olivacea*) size and fecundity and hatch success percentage from their eggs transferred to a protection corral on Escobilla beach, Oaxaca. NOAA Technical memorandum NMFS-SEFSC-582.

Hernandez-Echeagary, O. E., Hernandez-Cornejo, R., Harfush-Melendez, M., Garcia Gasca, A. (2012) Evaluation of sex rations of the olive ridley sea turtle (*Lepidochelys olivácea*) on the arribada nesting beach, La escobilla, Mexico. Marine Turtle Newsletter. 133:12-16 http://dof.gob.mex/nota_detalle_popup.php?codigo=5286506

International Union for Conservation of Nature and Natural Resources (IUCN) (2008) *Lepidochelys olivace*. The IUCN Red List of Threatened Species. Access on: September 23, 2018. Retrieved from: https://www.iucnredlist.org/species/11534/3292503

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., Law, K. L. (2015) Plastic Waste Inputs from Land into the Ocean. Science, 347 (6223), 768–771. Doi:10.1126/science.1260352.

Koch, V., Wallace, J. N., Peckham, H., De la Toba, V. (2006) Estimates of sea turtle mortality from poaching and bycatch in Bahia Magdalena, Baja California Sur, Mexico. Biological Conservation. 128, 327-334. Doi: 10.1016/j.biocon.2005.09.038

Kopitsky, K., Pitman, R. L., Plotkin, P. (2000) Investigation on at-sea mating and reproductive status of olive ridleys, Lepidochelys olivacea, capturedin the easter tropical Pacific. Proceedings of the Nineteenth Annual symposium on Sea Turtle Biology and Conservatio. NOAA Technical Memorandum NMFS-SEFSC-443. 160-162. https://repository.library.noaa.gov/view/noaa/3239/noaa_3239_DS1.pdf?

Kühn S., Bravo Rebolledo E.L., van Franeker J.A. (2015) Deleterious Effects of Litter on Marine Life. In: Bergmann M., Gutow L., Klages M. (eds) Marine Anthropogenic Litter. Springer, Cham. Doi: 10.1007/978-3-319-16510-3_4

Marquez, M. R. (1990) FAO Species Catalogue. Instituto Nacional de La Pesca. FAO. ISBN 92-5-102891-5. Retrieved from: http://www.fao.org/docrep/009/t0244e/t0244e00.HTM

Matutinazo Noticias (2018) Implementan operativo de protección de tortuga marina en Playa de Escobilla. Noticiero Televisa. Access on December 5, 2018. Retrieved from: http://matutinazo.com/2018/07/12/implementan-operativo-proteccion-tortuga-marina-en-playa-escobilla/

Melillo, J. M., Richmond T., Yhoe, G. W, Eds., (2014) Climate Change impacts in the United States: The Third National climate Assessment. U.S. Global Change Research Program. pp. 8-10. Doi: 10.7930/JOZ31WJ2

Merchant-Larios, H., Ruiz-Ramirez, S., Moreno-Mendoza, N., Marmolejo-Valencia, A. (1997) Correlation among thermosensitive period, estradiol response, and gonad differentiation in the sea turtle *lepidochelys olivacea*. General and Comparative endocrinology. Science Direct. 107.3. (1997). Doi: 10.1006/gcen.1997.6946

National Geographic (2018) Olive Ridley Sea Turtle. National Geographic Society. Accessed on September 8, 2018. Retrieved from: https://www.nationalgeographic.com/animals/reptiles/o/olive-ridley-sea-turtle/

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS & USFWS) (1998) Recovery Plan for the U.S. Pacific Populations of the Olive Ridley Turtle (Lepidochelys olivacea). National Marine fisheries Service, Sillver Spring, MD. ftp://ftp.library.noaa.gov/noaa_documents.lib/NMFS/OfcProtectedResources/Recovery_Plans/turtle_oliveridley-ACCESSIBLE.pd

National Ocean Service (2018) Endangered Ocean: Sea Turtles. National Ocean Service-NOAA-Department of commerce-USA.gov. Accessed on September 9, 2018. Retrieved from: https://oceantoday.noaa.gov/endoceanseaturtles/

National Oceanic and Atmospheric Administration (NOAA) (2014) Olive Ridely Sea Turtle (Lepidochelys Olivacea) 5-Year Review: Summary and Evaluation. National Oceanic and Atmospheric Administration. https://repository.library.noaa.gov/view/noaa/17036

National Oceanic and Atmospheric Administration (NOAA) (2018) What are El Niño and La Niña?. National Ocean Service Website. Retrieved from: https://oceanservice.noaa.gov/facts/ninonina.html

New York Post (2018) More than 300 sea turtles found ead off coast of Mexico. James Rodgers. Fox News. Retrieved from: https://nypost.com/2018/08/30/more-than-300-sea-turtles-found-dead-off-coast-of-mexico/

Nichols, W. J. (2003) Biology and conservation of sea turtles in Baja California, Mexico. PhD Dissertation, University of Arizona, Tucson., pp. 158. http://www.hawksbill.org/wp-content/uploads/2014/05/Nichols_2003_small.pdf

Norma Oficial Mexicana NOM-162-SEMARNAT-2012 (NOM-162-SEMARNAT-2012) (2012), Que establece las especificaciones para la protección, recuperación y manejo de las poblaciones de las tortugas marinas en su hábitat de anidación. Secretaria de Medio Ambiente Y Recursos

Naturales. Gobierno Mexicano. Accessed on November 21, 2018. Retrieved from: https://dof.gob.mx/nota_detalle.php?codigo=5286506&fecha=01/02/2013

Olive Ridley Project (2018) Olive Ridley Turtle. UK Charity. Accessed on September 8, 2018. Retrieved from: https://oliveridleyproject.org/olive-ridley-turtle

Platanitos Sea Turtle Camp (2018) Sea Turtle Conservation Camp. Platanitos, Nayarit, Mexico. Comisión Nacional de Áreas Naturales Protegidas (CONAP) & Secretaria de Medio Ambiente Y Recursos Naturales (SEMARNAT). Miguel Flores. Camp Director.

Plotkin, P. T (1995) National Marine Fisheries Service and U.S. Fish and Wildlife Service Status Review for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Marysland. https://www.nrc.gov/docs/ML1409/ML14094A329.pdf

Pritchard, P. C. H. (1969) Studies of the systematics and reproductive cycles of the genus Lepidochelys. PH. D. Dissertation, University of Florida, Florida. http://ufdcimages.uflib.ufl.edu/UF/00/09/77/74/00001/studiesofsystema00pritrich.pdf

Pritchard, P.C.H,. Trebau, P. (1984) The turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Contrib. Herpetol. 2. 353-375.

Procuraduría ambiental y del Ordenamiento Territorial de la Ciudad de México (Paot.org) (2000) Resultados de Actividades de Protección y Conservación de tortuga Marina en Los Campamentos Tortugueros Que operan Actualmente por Entidad Federativa, Ultimo Año Disponible. Gobierno Mexicano. Date Accessed December 4, 2018. Retrieved from: http://www.paot.org.mx/centro/ine-semarnat/informe02/estadisticas_2000/compendio_2000/03dim_ambiental/03_04_Biodiversidad/data_biodiversidad/CuadroIII.4.5.12_a.htm

Puerto Vallarta Sea Turtle Camp (2018) Puerto Vallarta Sea Turtle Camp. Nuevo Vallarta, Nayarit, Mexico. Comisión Nacional de Areas Naturales Protegidas (CONAP) & Secretaria de Medio Ambiente Y Recursos Naturales (SEMARNAT). J. Hermilo Esparza Venegas. Camp Director.

Sea Turtle Conservancy (2017) Sea Turtle Conservancy. Retrieved from https://conserveturtles.org/information-sea-turtles-threats-coastal-armoring/

Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT) (2010). Resultado de actividades de protección y conservación de tortuga marina en los campamentos que operan actualmente. Mexican Government. Accessed on November 21, 2018. Retrieved from: https://docplayer.es/67208396-Resultados-de-actividades-de-proteccion-y-conservacion-de-tortuga-marina-en-los-campamentos-tortugueros-que-operan-actualmente.html

Summary for Policymakers. In: Climate Change (IPCC) 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B.

Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Swimmer, Y., McNaughton, L., Foley, D., Moxey, A. N.(2009) Movements of olive ridley sea turtles *Lepidochelys olivacea* and associated oceanographic features as determined by improved light-based geolocation. Endangered Species Research 10: 245-254. Doi: 10.3354.esr00164

TED-ED (2012) The Survival of the Sea Turtle. Accessed on December 1, 2018. Retrieved from: https://www.youtube.com/watch?v=t-KmQ6pGxg4

U.S. Fish & Wild Life (USFW) (2018) Olive Ridley Sea Turtle (*Lepidochelys olivacea*). North Florida Ecological Services Office. https://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/olive-ridley-sea-turtle.htm

Valverde, R. A., Wingard, S., Gomez, F., Tordoir, M. T., Orrego, C. M. (2010) Field lethal incubation temperature of olive ridley sea turtle Lepidochelys olivacea embryos at mass nesting rookerly. Endangered Species Research. 12. 77-86. Doi: 10.3354.esr00296

Verdebandera (2015) Mas de 45 mil tortugas llegaron a anidar en Escobilla, Oaxaca. Verdebandera Periodismo Ambiental. Accessed on December 5, 2018. Retrieved from: http://verdebandera.mx/mas-de-45-mil-tortugas-llegaron-a-anidar-en-escobilla-oaxaca/

Wibbels, T., Rostal, D., & Byles, R. (1998). High Pivotal Temperature in the Sex Determination of the Olive Ridley Sea Turtle, Lepidochelys olivacea, from Playa Nancite, Costa Rica. *Copeia, 1998*(4), 1086-1088. doi:10.2307/1447364

Witherington, B. E., Martin, R. E., Trindell, R. N. (2014) Understanding, assessing, and resolving light pollution problems on sea turtle nesting beaches, revised. Florida Fish and World Wild Life (2018) Olive Ridley Turtle. World Wildlife Fund. Accessed on December 9, 2018. Retrieved from: https://www.worldwildlife.org/species/olive-ridley-turtle