MARINE TURTLES OF THE GULF OF MEXICO. ABUNDANCE, DISTRIBUTION AND PROTECTION

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BACKGROUND

Marine turtles have been used since prehispanic times as a traditional food. Up to 1960 they have been a common food source used by many Mexican coastal communities (Marquez-M. 1996). Until the first half of the 1960s, the exploitation of turtles on the Atlantic and Pacific coasts was very similar, but in following years the exploitation of some of the Pacific species increased to such degree that in 1968 Mexico supplied a little over 14,500 tons, almost 80% of the world market production. The main species captured was *Lepidochelys olivacea,* from the Pacific. Obviously this exploitation could not be maintained for long and the populations collapsed to such a degree that in mid-1971 it was necessary to declare capture prohibition until December 1972. This was prolonged until June 1973, when capture was resumed, but exclusively by fishing co-operatives and regulated by quotas. The regulations were seldom respected, illegal exploitation went on and populations continued to dwindle. As a consequence, on June 1, 1990, total prohibition of the capture of all species was declared (D.O.F. 1990), which is still in place today.

Marine turtles are very vulnerable to natural predation at all stages of their development. Legal and illegal capture, in addition to incidental capture during other fisheries activities, affects them from the egg through juvenile and adult stages. They are also very vulnerable to environmental deterioration caused by urban and tourism development, roads, industrial waste, trash, and so forth, as well as natural phenomena such as hurricanes, drought, excessive rain, etc.

INTRODUCTION

The first studies on marine turtle fisheries and nesting in Mexico were initiated in 1962 by the Instituto Nacional de Investigaciones Biológico Pesqueras (INIBP ; National Institute of Biological and Fisheries Research) on both coasts of the country (Solorzano 1963). In 1963 Centro de Quelonicultura (Center for Turtle Culture) opened on Isla Mujeres, Quintana Roo, where the initial activities included the separation of mature female green turtles (*Chelonia mydas*) from the commercial catch, and their transfer to holding pens built between the sea and the shore. During their confinement each turtle could nest several times, and the nests were taken care of until the eggs hatched and hatchlings were released (D. Fuentes, Freelance Fisheries Researcher, pers. com.). After reproduction took place the female turtles were returned to the fishermen from Isla Mujeres, Cozumel and Puerto Juarez, and were then sold within the region or exported to Florida, USA (Marquez-M. 1994). Exportation was stopped and commercialization in the region was halted before the end of the 1970s. Conservation continues to the present day with the help of a non-governmental organization (NGO).

In 1964 the “Marine Turtle Program” was formed, and in 1966, with the support of the military and fisheries inspectors, “turtle camps” were established for the first time: one in the Gulf of Mexico at Rancho Nuevo, Tamaulipas, and 3 on the Pacific coast at Playon de Mismaloya, Jalisco, Boca de Pascuales, Colima, and Tlalcoyunque, Guerrero. These activities

have increased since then. In 1978 marine turtles were included in the collaboration program, MEXUS-Gulf between the Instituto Nacional de la Pesca (INP; National Fisheries Institute, Mexico), the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Services (NMFS) of the USA. From the 1980s onwards, university students, state organizations and NGOs have supported these activities and contributed substantially to the preservation of marine turtle populations. Conservation work was later enhanced with help from the Instituto Nacional de Ecología (INE; National Institute of Ecology) in Mexico. Nowadays more than 40 camps are established annually (Briceño-D. and Abreu-G. 1994; Marquez-M. 1996). Since 2001, when changes in the INP and INE programs were implemented by the Dirección de Vida Silvestre (Wildlife Department) of the Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT; Secretariat of Environment and Natural Resources), research is no longer an essential part of the work, and the personnel who originally worked in the program is currently assigned almost exclusively to conservation activities in the turtles camps.

A recent important development in the program was the marking of turtles with stainless steel tags. More recently, as part of the joint program between Mexico and the USA, some species such as *Lepidochelys kempi* have been marked with electronic tags (PIT, Passive Integrated Transponder) consisting of a chip within a glass capsule, which is injected underneath the skin, generally in the left fore flipper. High frequency sound tags have also been used successfully in joint projects (Mexico-USA) to monitor turtles via satellite.

REGIONAL SPECIES

There are 8 species of marine turtles, of which five inhabit the Gulf of Mexico. Each species has particular biological characteristics, abundance and geographical distribution. The following descriptions were adapted from Marquez -M. (1990, 1996).

GREEN TURTLE (*Chelonia mydas* Linnaeus 1758).

This species is distributed widely throughout coastal continental waters and insular waters, with limited latitudinally by the seasonal displacement of the 20ºC isotherms. There are records of this species outside these boundaries, which generally correspond to solitary individuals in a non-reproductive phase. It is a typically neritic species, which aggregates in shallow waters with abundant seagrasses and marine algae. Some populations migrate long distances from feeding grounds to reproduction locations. Important nesting beaches are located around the world. In Mexico they nest from Tamaulipas to Quintana Roo, but the most important beaches include those at Isla Aguada, Río Largartos, X'cacel and Isla Cozumel, all on the Yucatán Peninsula. They nest from May to September with major abundance between June and August.

LOGGERHEAD TURTLE (*Caretta caretta* Linnaeus 1758)

This species occurs in tropical and subtropical coastal waters, oftentimes within bays and mouths of rivers, where they can remain on muddy bottoms throughout winter. Some individuals have been observed following ocean currents that can take them across the Atlantic, possibly to European shores. Crustaceans and mollusks are the main food source of this neritic species, which undertakes extensive migrations between feeding and reproductive grounds. Nowadays

they are not found frequently within the Gulf of Mexico, although they sporadically nest on some beaches. They are more abundant in the north and east of the Yucatan peninsula and nest from Holbox to the border with Belize. This species is more common on the eastern coast of the USA. Reproduction takes place between May and September.

HAWKSBILL TURTLE (*Eretmochelys imbricata* Linnaeus 1766)

This species may be found alone or in small groups around almost all rocky or coralline coasts. Its distribution area is limited by the 25ºN and 35ºS parallels. It is the most coastal of all species, living in environments with abundant coral reef benthic fauna and banks of marine vegetation, which are their food source. Nesting is nocturnal, solitary or in small groups. The reproduction period varies at different locations: in Mexico it is carried out from April to August. The most important reproduction areas are the islands of Carmen, Aguada, Sabancuy and Champoton, in Campeche, and the beaches of Celestún and those between Río Largartos and Isla Holbox, in Yucatán. A small amount of nesting can be observed at some beaches of Quintana Roo.

KEMP'S RIDLEY TURTLE (*Lepidochelys kempi* Garman, 1880)

This is one of the species with most restricted geographical distribution. The majority of adults are found within the Gulf of Mexico. However, a small part of the juvenile and pre-adult population reaches the eastern coast of the USA, whilst some individuals can reach European waters by following the Gulf Stream. This species is usually found in coastal regions with sandy or muddy bottoms where crustaceans are abundant. Juveniles have been recorded in bays, coastal lagoons and estuaries of the northern Gulf and east coast of the U.S.A, whereas adults congregate in feeding grounds to the west of Florida, the mouth of the Mississippi River and Campeche Bank (Marquez-M. 1994). Reproduction takes place from March to July and nesting occurs mainly between the Río Soto la Marina and Punta Jerez, with higher abundance in front of Rancho Nuevo, Tamaulipas. Nesting sites of lesser importance are located on the north coast of Tamaulipas, and between Cabo Rojo and Tecolutla, Veracruz. Recently, an increase in nests has been registered in south Texas, USA (Shaver and Caillouet 1998) and Florida (Johnson *et al*. 1999), which can be considered an indicator of the recovery of this population. These organisms tend to form groups to lay their eggs concurrently. It is the only species that lays eggs during the day.

LEATHERBACK TURTLE (*Dermochelys coriacea* Vandelli 1761)

This species is adapted to support lower temperatures than the other marine turtles (up to 10 °C), for which reason it is also distributed in a great part of the temperate zones. They make long migrations (Eckert and Sarti 1997). In the Gulf of Mexico the species is less abundant than in the Caribbean Sea and nesting is also more sporadic. In the Caribbean, feeding grounds are distributed throughout the whole length of the Antilles Archipelago, but reproduction only takes place in certain locations, such as Trinidad, Dominica and the Dominican Republic. In the open sea they can form small groups, generally in the vicinity of whirlpools, marine frontal systems and upwelling areas, where there occur aggregations of organisms they feed on, particularly jellyfish.

NESTING

During nesting certain turtles, such as the *Lepidochelys* genus, arrive at beaches in large groups. Such behavior is thought to be an evolutionary adaptation against predation because these events are spaced in time and have short duration, which interrupts the continuity of their availability to predators. Moreover, due to this abundance it is very likely that a good proportion of the eggs and offspring will survive. However, other turtles nest in smaller groups or alone, probably due to a lower pressure exerted by predators or a decrease in their populations as a result of excessive capture. Figure 6.1 is an historic photograph of a mass arrival of a more than 5,000 *L. kempi* turtles at Rancho Nuevo, Tamaulipas, on May 24, 1968.

NESTING GROUNDS

Depending on the species and the characteristics of the beach, nests are dug at different distances from the tide line. The consistency of the soil affects the depth of egg laying, and the shape of the nest depends on the species' size. Hence, the effects of meteorological phenomena such as hurricanes, high tides, temperature and humidity extremes, affect the survival of nests and offspring in different ways.

On a typical beach of medium energy, as commonly used by marine turtles, *D. coriacea* nests at the beginning of the beach slope, *L. kempi* and *C. caretta* nest a bit higher, generally near the crest of the first dune, *C. mydas* commonly makes longer trips, beyond the first dune, and *E. imbricata* oftentimes penetrates the vegetation.

Figure 6.1. Arrival of Kemp's ridley turtles at Rancho Nuevo Beach, Tamaulipas. From Marquez-M (1996); Photographer: A. Montoya.

EXTENSION OF NESTING

The historical evolution of the abundance of marine turtle populations has been influenced not only by direct or indirect exploitation but also by changes in the habitats where they develop. These changes in many cases have been so drastic that they make impossible the partial or complete recovery of these populations. Their abundance is limited, by instance, by the loss of nesting sites, destruction of feeding grounds, contamination of several types, etc. On the other hand, there are cases of exaggerated extrapolations referring to exaggerated historical abundance of some populations, which makes recovery goals seem unachievable and keeps them in the endangered species list.

Marine turtles in Mexico occupy a very special position due to the presence of several of the most important populations, such as *L. kempi*, *C. mydas*, *E. imbricata* and *C. caretta*, according to information obtained through surveys taken in 12 different Caribbean countries (Cuba, Dominica, The Dominican Republic, Grenada, Mexico, Nevis, Nicaragua, St. Kitts, St. Lucia, St. Vincent, Trinidad and Venezuela) for the Grupo Regional para la Investigación y Manejo de las Tortugas Marinas del Caribe (CTMRG; Caribbean Turtle Management and Research Group), during 1998 and 1999, and presented at a workshop for the development of a Regional Turtle Management and Research Program, held in Havana, Cuba on February 15, 2001. These surveys, which are broken down into minimum and maximum values of nesting, indicate that there are countries where turtles are scarce on the beaches, although abundant at sea. Table 6.1 provides average values to give a general idea of levels of abundance by species for the region. The only species which does not reproduce in the Caribbean is *L. kempi*, which only nests in the western Gulf of Mexico (Marquez- M. 1990). According to available information, it is very possible that nesting of all species has decreased at least two orders of magnitude in the majority of countries, as most reports mention the existence of less than 100 nests per season. Only Cuba, Mexico, Trinidad and St. Vincent registered relevant numbers of nests of *E. imbricata*, *C. mydas* and *C. caretta*. In the case of *D. coriacea*, only Trinidad exhibits a colony of certain magnitude (Table 6.1). It is strange to find that the abundance of nesting, for instance in the case of *E. imbricata* in the Dominican Republic, is classified as scarce, with values between 10 to 25 nests per season, when products made from turtle shells are for sale in a great number of tourist shops, including the international airport. Moreover, generalized exploitation of eggs of this and other species is allowed. However, neither currently nor in the past, has the magnitude of exploitation been registered, which is a shortcoming in most of the countries included in this survey.

SPECIES ABUNDANCE

The number of nests registered for each species between 1993 and 2002 on the beaches of Tamaulipas (Rancho Nuevo, Tepehuajes, Barra del Tordo, La Pesca, Altamira and Tampico), Veracruz (Tecolutla-Santander, Lechuguillas and Alto Lucero), Campeche (Isla Aguada, Chencan and eight other beaches), Yucatán (Celestún, Las Coloradas-Río Lagartos and El Cuyo) and Quintana Roo (Isla Mujeres, Isla Holbox, Xcacel, Mahagual, Xcaret [12 beaches] and Isla Cozumel) presented the following percentages (Table 6.2).

Statistical analysis of abundance of nests by species in the years mentioned (1993 -2002) is presented in Table 6.3. An interesting observation is that *L. kempi* is considered the most threatened species; however, in the following data their abundance is lower than that of *E.*

Table 6.1. Frequency of countries according to the annual magnitude of nesting (>1, >3, >11…..>5001) of each species.

Species	Number of nests										
	>1	>3	>11	>26	>51	>101	>201	>501	>1001	>5001	Average
C. mydas	0	3	1	0	1	0	0	1	1	0	3,864
C. caretta	1	4	1	0	0	0	1	0	1	0	3,396
E. imbricata	1	2	3	2	0	0	1	0	2	0	6,491
D. coriacea	2	4	2	2	1	0	0	0	1	0	3,787
L. kempii	0	0	0	0	0	0	0	0	0	1	5,000
Total											22,538

Table 6.2. Average percentage of nesting by species on 39 beaches. Data from 1993 to 2002.

L. kempi	*C. mydas*	*C. caretta*	*E. imbricata*
30.2	29.3	28.4	12.1

Table 6.3. Analysis of nest abundance by species: *L. kempi* and *C. mydas* from 1993 to 2002; *C. caretta* and *E. imbricata* from 1993 to 2001.

	L. kempi	*C. mydas*	*C. caretta*	*E. imbricata*
Years evaluated	10	10	9	9
Mean	3,544.00	3,332.00	1,574.00	3,817.00
Standard deviation	1,931.20	2,362.10	686.4	1,605.40
Minimum	1,567.00	935	567	1,300.00
Maximum	6,434.00	7,437.00	2,649.00	5,689.00
Nest quantity	35,439.00	33,317.00	14,162.00	34,349.00
Reliability level 95%	1,381.50	1,689.70	527.6	1,234.00

imbricata. This is probably because the recording of nesting of *L. kempi* has been more detailed than that of the other species. Moreover, data for the latter do not include several beaches which are either not protected or do not have appropriate information available. It is very interesting that *C. mydas* exhibits the maximum number of nests at various nesting seasons, whereas, their average is lower than those of *L. kempi* and *E. imbricata*. This is due to the fact that this species alternates between years of higher and lower abundance.

The importance of nesting over the last 10 years, considering the average value of nest abundance per species and federal unit, is emphasized in bold on Table 6.4, and exhibits the following order: *C. mydas* and *C. caretta* in Quintana Roo, *L. kempi* in Tamaulipas, *E. imbricata* in Campeche and *D. coriacea* in Veracruz. On the same table, average yearly abundance analyzed per species is as follows: *L. kempi* with 3,447 nests, *E. imbricata* with 2,761, *C. caretta* with 1,482, *C. mydas* with 1,430 and *D. coriacea* with less than 1 nest per year (0.88). The same table shows that *C. mydas* nests throughout the Gulf of Mexico and on the Yucatán Peninsula, but mainly in Quintana Roo (41.20%); *E. imbricata* nests throughout the Yucatán Peninsula with greatest abundance in Campeche (62.72%); *C. caretta* nests almost exclusively on the coast of Quintana Roo; *L. kempi* mainly in Tamaulipas (96.62%) with a small percentage in Veracruz; and *D. coriacea* is almost absent from Mexican beaches, with less than 1 nest per year in Veracruz (41.5%) and one every 2 or 3 years in the remaining units.

In Figure 6.2 the curves show the tendency of nesting abundance from 1993- 2002 for the species analyzed. We can observe that all tendencies are positive and *L. kempi* is recovering the most rapidly, followed by *E. imbricata*, *C. mydas* and finally *C. caretta*. This recovery is due to the combination of conservation activities at beaches, the total prohibition of turtle hunting since 1990 and the use of turtle excluder devices in shrimp fisheries. The results of the linear analysis of nest abundance of each species are shown in Table 6.5. All the tendencies are positive, although the correlation value (R^2) is only appropriate for *L. kempi* and *E. imbricata*. In the case of *C. mydas* the annual variation of nesting is very broad, for which reason the correlation is very low, although it increases if years of maximum and minimum nesting are analyzed separately.

In addition to broadening biological knowledge, research carried out in Mexico is useful for the improvement of wild populations. As a result of these activities it has been possible to stabilize or even improve some populations such as *C. mydas* and *E. imbricata* or avoid the extinction of *L. kempi*, as can be seen in the abundance curves presented in Figure 6.2. During the whole period (1993-2002) *L. kempi* shows a constant increase (more than 10% annually), as does *E. imbricata*. Data for the last two years for *E. imbricata* and the other species are not very reliable, due to a decrease in studies or lack of complete information at some beaches.

CONSERVATION

The causes for species deterioration are varied, including pollution, incidental capture, illegal commercial capture and, finally, the effect that climate change can have on the sex ratio of turtles, which is determined during the incubation of eggs. Extreme phenomena cause direct problems to populations, such as hurricanes, lack or excess of rain, the El Niño phenomenon, etc.

To try to offset at least the legal and illegal capture, regulations have been implemented on sea activities, including prohibition of the capture of turtles and employment of turtle excluder devices (TED), and on the beaches, for the protection of nests and survival of females, eggs and offspring, through turtle camps. Finally, experimental culture also adds a contribution, as in the case of the Mexico-USA program for *L. kempi*.

Table 6.4. Total and annual nest abundances with percent by species and state (1993-2002).

	Total	Annual	%
C. mydas			
Tamaulipas	1,272	141	4.1
Veracruz	6,572	730	21.0
Campeche	4,817	535	15.4
Yucatán	6,338	633	18.3
Quintana Roo	14,229	1,430	42.2
C. caretta			
Tamaulipas	28	3	0.2
Veracruz	8	1	<0.1
Campeche	1	<1	<0.1
Yucatán	13	1	0.1
Quintana Roo	13,341	1,482	99.6
D. coriacea			
Tamaulipas	5	1	23.7
Veracruz	7	1	41.5
Campeche	3	<1	15.8
Yucatán	4	<1	18.9
Quintana Roo	0	0	0
E. imbricata			
Tamaulipas	7	1	<0.1
Veracruz	20	3	0.1
Campeche	19,325	2,761	62.7
Yucatán	12,508	1,251	28.4
Quintana Roo	3,482	387	8.8
L. kempi			
Tamaulipas	34,472	3,447	96.6
Veracruz	959	120	3.4
Campeche	8	1	<0.1
Yucatán	0	0	0
Quintana Roo	0	0	0

Table 6.5. Linear analysis of the trends in nest abundance in four species.

Species	Linear Equation	R^2
E. imbricata	y = 483.40x + 916.10	0.68
L. kempi	y = 598.59x + 345.12	0.882
C. mydas	y = 116.18x + 2721.6	0.023
C. caretta	y = 175.07x + 523.16	0.488

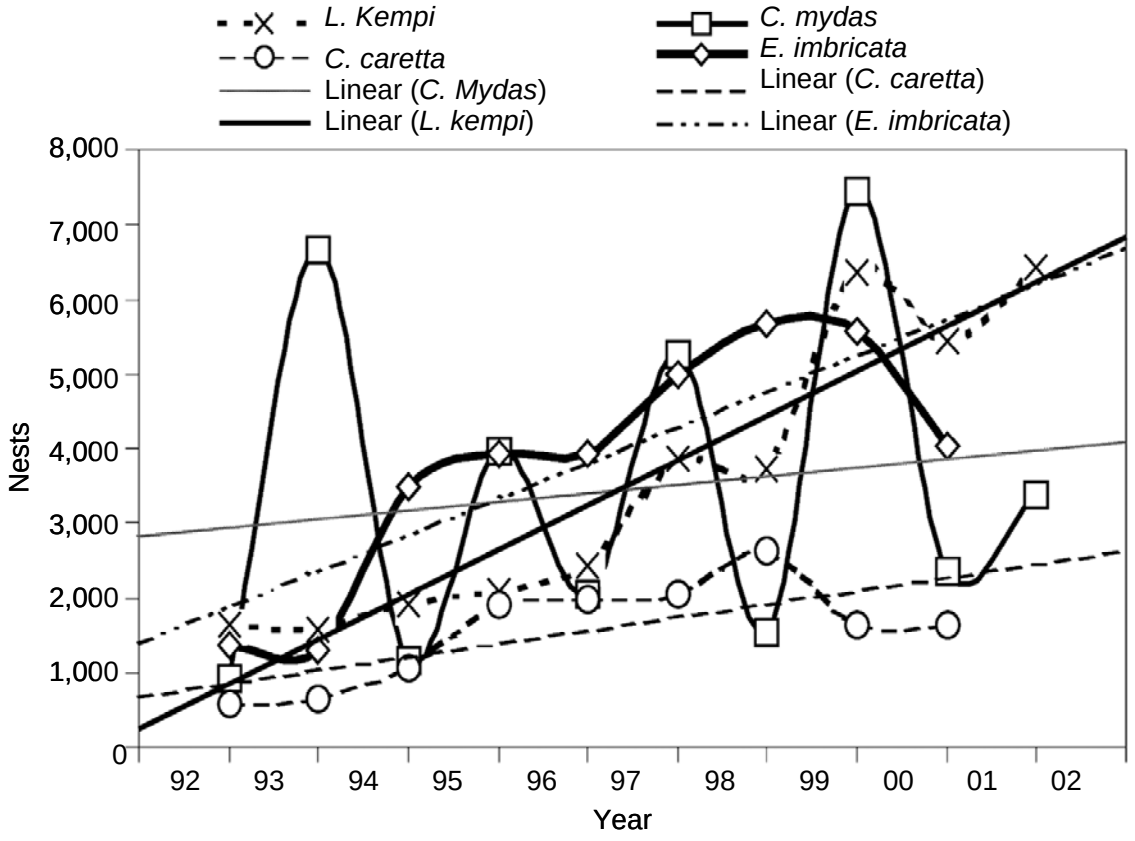

Figure 6.2. Abundance and trend of marine turtle nesting.

CULTURE

A commercial culture of marine turtles has not been developed in Mexico. Offspring have only been kept for a few days and in some cases for a year before being released into the wild. This informal "culture" has been developed within protection programs taking place at several beaches within the country. However, on most occasions this has been implemented with the aim of publicizing the results of protection activities, so that an appropriate methodology and the animals' health have not been considered. Small turtles are frequently released with mutilations, traumas or skin infections. There is also the erroneous idea that with relative growth, turtles will avoid predation more easily. However, in the majority of cases the natural distribution areas of turtles of similar sizes are unknown and frequently they are released at inappropriate times and places, for which reason it is impossible for them to find other organisms of their size, which would allow them to join a wild population and enhance survival. Therefore, it has been reiterated that offspring should not be kept in captivity without an adequate rearing facility and enough knowledge about the species' habits and distribution to guarantee appropriate release of juveniles; otherwise it is better to release them immediately after hatching in the most natural manner possible.

EXPERIMENTAL CULTURE

In order to broaden the nesting area and help the recovery of the Kemp's ridley turtle population (*L. kempi*), the INP began working in collaboration with the USFWS and NMFS in 1978. From this year onwards nesting activities on the beach of Rancho Nuevo were supported and, in return, 2000 eggs or offspring were donated yearly until 1992 (Marquez- M. in press), for incubation in the facilities at Padre Island, Texas. To enable offspring to recognize this beach, it was released there and recaptured after advancing a few meters into the sea, and then taken to the facilities of NMFS at Galveston, Texas for further culture. After 9-10 months the turtles that survived were marked and released into the sea. These activities were partially suspended in 1992 and the donation reduced to 200 offspring annually due to the fact that the culture was very expensive and the expected results were not achieved. However, records up to the year 2000 documented the nesting of nine turtles derived from this experiment on the Texas coast (Shaver 2000). Twelve nests of this species were recorded that year and two turtles marked in the experiment were identified nesting. The number of nests continues increasing slowly, having reached 38 nests on the Texas coast in 2002 (Donna Shaver, US National Park Service, pers. comm.). Therefore, the formerly negative perception has changed.

Due to the precarious situation of *L. kempi*, which decreased to an average of 740 nests, annually recorded in the beach between 1985-1987, it was decided to transport a certain number of turtles to the Cayman Turtle Farm on the island of Grand Cayman as "reserve stock", with the support of a Dutch investor and the supervision of doctors Peter Pritchard, Leo Brongersma, James Wood, and René Marquez. This was done as a precaution in case the population continued to decrease. The shipment of 100 nine-month old juveniles cultured in Galveston Texas and 100 offspring born at Rancho Nuevo took place on July 4, 1980. Within five years, two females of the 1979 group nested and laid eggs (in 1984), and by 1989 the nesting had regularized. Therefore, the original stock started to increase and by 1994 there were 446 additional turtles of 5 year classes (1989-1993). Given the recovery of the wild population, in 1998 the possibility of bringing 100-200 individuals from the farm for release in their natural habitat, after quarantine,

was considered. The support of the authorities of the Eco-Archaeological Park at Xcaret was obtained for this purpose. The park built new installations to accommodate these turtles, where nearly 100 individuals of both sexes can currently be found.

CULTURE FOR ECOTOURISM

The Eco-Archaeological Park at Xcaret, Quintana Roo, is developing a culture similar to the one mentioned above, for the green turtle (*C. mydas*) and the loggerhead turtle (*C. caretta*). In addition to the interests in recovering these species, there is an exhibit of turtles in specially designed installations. Eggs are collected on local nesting beaches, where conservation work is carried out, and then transferred to the installations at Xcaret where they are incubated in polyurethane boxes. The majority of hatchlings are released at their beaches of origin. The remainder is cultivated for approximately one year, after which they are tagged and released in the same region, generally with the participation of tourists.

COMMERCIAL CULTURE

In the 1960s and 1970s, marine turtle culture was considered a possibility with a great future (Carr 1967; Hirt 1971). For this reason, culture was attempted at several places (*e.g.*, Reunion Islands in the Indian Ocean, Grand Cayman in the West Indies, and Torres Strait between New Guinea and Australia). In each case the green turtle (*C. mydas*) was used. The methodology has been mastered, but commercial culture of marine turtles has not prospered due to their classification as endangered species by the World Conservation Union (IUCN) and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

The culture of turtles according to CITES has two variants. 1. “Farm culture”, which has been developed preferably using prepared food, since fresh food decomposes more quickly and contaminates the water in the stock ponds and it is self sustained; and 2. “Ranch culture”, which has been developed using fresh food, including several animal and vegetable species depending on their availability, or prepared food if the former becomes scarce and depends on a wild stock.

Farm Culture

This type of culture is developed at a turtle farm on Grand Cayman. It is an enclosed culture, commenced with the capture of several adult specimens and the introduction of eggs and offspring (Marquez-M. *et al.* 1991, 1992). For commercialization, the farm has to be self-sustainable and turtles to be used for this purpose should be obtained through the reproduction of the second generation (F2) within the farm. The farm started its activities in 1968 and, since sexual maturity in captivity can be achieved within five years, this requisite has already been met. However, in addition to the CITES regulations, there is a great amount of opposition from conservation groups, which has prevented the exportation of the product, forcing it to be used exclusively for local consumption. The commercial size is obtained within 3 to 4 years, at which time turtles reach a weight of up to 40 kg. The excess offspring obtained each season is cultured for a year and then released.

Ranch Culture

In this case eggs and offspring are collected every season from beaches in the vicinity of the installations and kept in captivity for 3-4 years, until they reach commercial size. This culture

always depends on wild production. Supposedly the eggs or offspring come from nests which are selected because it is certain that they will be doomed to failure due to natural causes, such as erosion, inadequate temperature and humidity, compact or large grain size substrate, excessive organic material, vulnerability to predators or tides. Their extraction must not affect the natural equilibrium of the population's abundance.

FISHERIES

Marine turtles were exploited in Mexico until 1990, when a total ban was introduced for an indefinite period of time (D.O.F. 1990). The development of this fishery on the east coast was more conservative compared to that of the Pacific, which developed in less than a decade, reached its peak and, due to over-exploitation, collapsed in less than three years. On the other hand, on the east coast fluctuations were slower and of smaller amplitude. Moreover the capture was recorded inefficiently and without species distinction, although it can be asserted that most turtles captured belonged to the species *C. mydas*, *C. caretta* and *E. imbricata*, which in great part were consumed regionally, with the remainder exported to the USA. With the exception of the leatherback turtle, all species were commercialized to a greater or lesser extent. Nowadays the illegal capture continues in the region, and although the volume is unknown, it is believed that it may reach several thousands of turtles per year by intentional capture or incidental fishing. The main species included in this capture are *C. mydas*, *C. caretta*, *L. kempi* and *E. imbricata.* The same species appear in the incidental capture, but in different proportions. The zones with highest incidental capture encompass the states of Tamaulipas and Veracruz, and the Sound of Campeche. The annual volume of this capture is unknown.

Marine turtles and their eggs were exploited for several centuries in a sustainable way. They formed part of the regular diet of coastal villagers, especially *C. mydas*, which was even exported to the American Union. The meat, skin and oil of this species, as well as that of *C. caretta*, were commercialized widely in the region, and crafts elaborated with the shell of the hawksbill turtle had great acceptance. Commercial exploitation was performed using turtle nets and harpoons, as well as trapping during nesting. Between 1964-1981 the proportion of captures registered was: 67.9% *C. mydas* in 17 years, 24.8% *C. caretta* in 13 years, 1.13% *E. imbricata* in 9 years, 5.56% skin in 8 years, and 0.6% oil in 7 years (Table 6.6). There was no capture or there are no records for the remaining years. Distribution of the total capture by state, during the same years was: 0.08% in Tamaulipas, 2.29% in Veracruz, 0.23% in Tabasco, 14.01% in Campeche, 6.1% in Yucatán and 74.73% in Quintana Roo (Table 6.7). Due to over-exploitation, by 1970 all populations had been decimated. During 1972-1973 there was a total capture ban. Commercial capture in this region has not been recorded since 1982, when permits stopped being granted. Figures 6.3 and 6.4 present plots of the recorded proportions of species capture and their products. Data were separated in two figures because hawksbill turtles and oil were recorded in a very small proportion when compared with *C. mydas* and *C. caretta*; the shell was only recorded for a year and it is not clear to which species it corresponds, although it could possibly correspond to the hawksbill turtle, due to its commercial value.

Table 6.6. Percentage of commercial capture of each species in the region and years in which they appear in statistical records. Period: 1964 to 1981.

Species	%	Years
C. mydas	67.89	17
C. caretta	24.81	13
E. imbricata	1.13	9
Skin	5.56	8
Oil	0.6	7

Table 6.7. Average annual percentage of commercial capture by state, from 1964-1981.

State	%
Tamaulipas	0.085
Veracruz	2.292
Tabasco	0.228
Campeche	14.013
Yucatan	6.060
Quintana Roo	74.734
Total	97.41

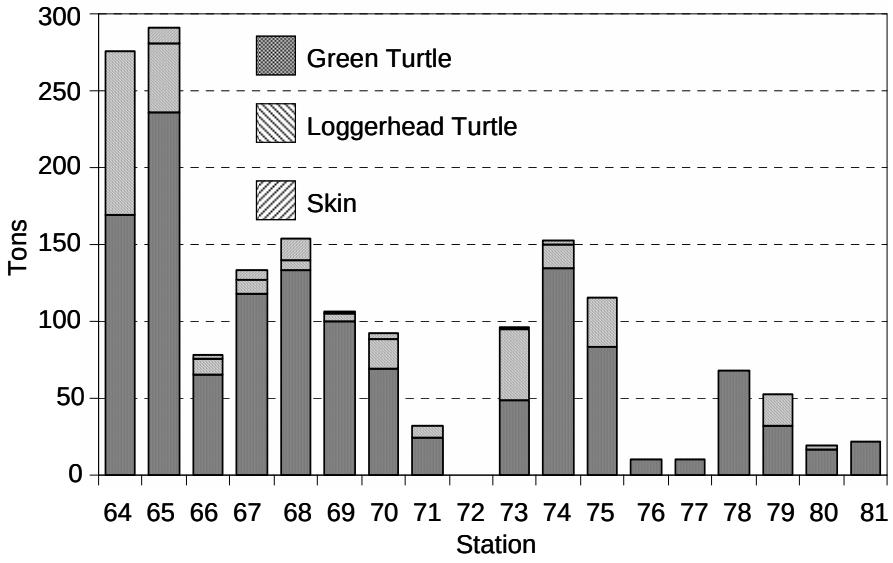

Figure 6.3. Commercial capture records for green and loggerhead turtles, and skin.

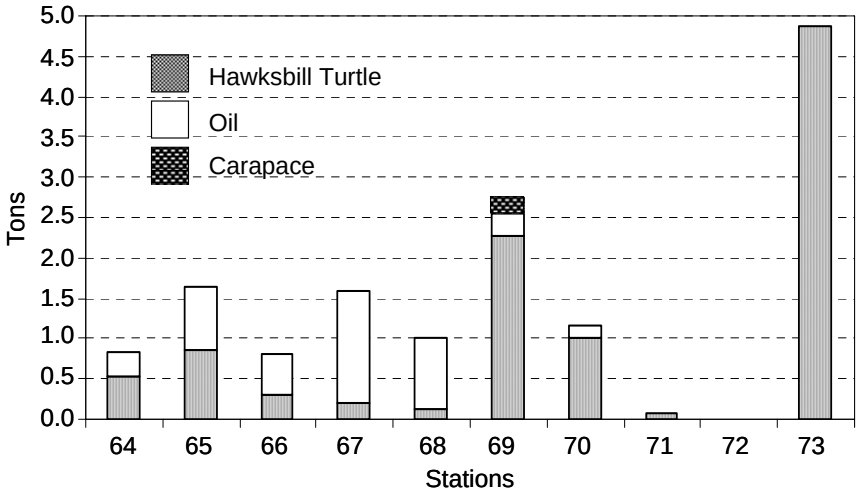

Figure 6.4. Commercial capture records for hawksbill turtles, oil and shell.

INCIDENTAL CAPTURE

Use of Excluders

Shrimp fishing is one of the least selective currently undertaken. For every ton of shrimp, approximately nine tons of other species are also extracted, 80-90% of which are considered of no commercial value. The accompanying fauna includes fish, sharks, rays, crabs, mantis shrimp, slipper lobster, snails, clams, octopus, squid, jellyfish, sea fans, starfish, sea urchins, etc. However the majority of organisms that could have had any commercial value is not of acceptable size and, therefore, is retuned to the sea. Unfortunately, more than 95% die during manipulation. In some areas marine turtles can also be captured frequently and the stress and anoxia experienced during the capture can have effects ranging from mild injury to death.

In the U.S.A the controversy over incidental capture of marine turtles during shrimp fishing started several decades ago. Calculations made by NMFS until 1983 for the U.S. Atlantic region, indicated that by the end of the 1970s an annual incidental capture (by a fleet of 17,200 vessels operating at a depth of more than 2 fathoms) of approximately 47,970 turtles, of which it was estimated that 11,180 would die of drowning (Henwood and Stuntz 1987). In order to significantly reduce this capture, the NMFS compiled fishermen's experiences and, in 1978, initiated studies for the development of a device that would allow the exclusion of turtles with minimum injuries and the least amount of shrimp loss (Webber *et al.* 1995).

The first TED (Trawling Efficiency Device) was created in 1981, which was later named Turtle Excluder Device (Webber *et al.* 1995). The efficiency of these devices has been variable. Even though they can be perfectly adapted to the type of net, ship and place of trawling, the result also depends on other circumstantial factors that can cause considerable loss of shrimp.

Since April 1, 1993 the use of TED became compulsory on the Mexican Atlantic coast (Márquez-M. 1994). In order to adapt these devices to the Mexican needs, especially considering the possible use given to certain parts of the accompanying fauna, investigation programs were developed within the INP. Seminars, update workshops and fishermen training programs were carried out at the same time, with the support of NMFS.

REGULATIONS

Marine turtle fisheries were characterized by a rapid development in the 1960s, followed by a plunge during the next decade. Therefore, restrictions had to be decreed, such as: definition of minimum size, capture quotas, partial and total bans, etc. The international commerce is ruled by CITES and by the IUCN, and the Interamerican Convention for Protection and Conservation of Sea Turtles was recently created to improve administration and conservation. Many measures have been put into effect in Mexico, some of which are included in Table 6.8.

INTERAMERICAN CONVENTION FOR PROTECTION AND CONSERVATION OF SEA TURTLES.

In recognition of the regional distribution of different marine turtle species that occur on the American coasts, their vulnerability to different types of fisheries and their habitat modification, it was considered necessary to develop an international campaign. Therefore, the «Hemispheric Convention» was signed with the objective of preserving, and in some cases, increasing the populations of these reptiles, in addition to conserving their biodiversity and the future possibility of establishing a sustainable level of capture. This Convention, established in December 1998, acknowledged all of the mentioned aspects. It included commitments and obligations by the signing countries regarding conservation and, in some cases, sustainable use. The creation of consulting and scientific bodies has been considered to follow and support the Convention's activities. The meetings to shape the convention and the consulting and scientific committees commenced in 2003.

EDUCATION

The Sea Turtle Program is characterized by its extensive reach, encompassing biology, fisheries, habitat, distribution, and interaction of turtle populations with coastal inhabitants. This is the reason why priority has been given to educational activities in the area of influence of the turtle camps, in addition to encouragement and development of species' studies. Frequently, the same technical and scientific personnel give lectures regarding conservation projects and wildlife vulnerability. Additional activities include presentation of videos, infant drawing contests, games, etc. Within the most relevant activities, elementary students are frequently invited to participate in turtle release when the most numerous hatchlings occur.

Universities and civil societies take part in conservation activities, organizing brigades that visit the local communities with information on work objectives and promoting active participation in these programs. In many cases occupational alternatives that allow an increased income are presented to communities that depended on turtle exploitation.

Campaigns at the national level are promoted through government departments, for reduction of the consumption of eggs and turtle derived products, trying to raise public awareness to the need to protect these species. The campaigns are carried out using mass communication media such as newspapers, television, movies, popular parades, and exhibits at fairs, public conference halls, social clubs, museums and aquariums. On the other hand, environmental education programs have also been developed with university students, conservation societies, and state fisheries departments. At the student level, inter-university

Table 6.8. Administrative acts adopted in Mexico for the management and protection of marine turtles. Most acts have been published in the Federal Register of the Nation (Diario Oficial de la Federación) as decrees, norms or circulars. Adapted from Marquez-M. *et al.* (1998).

Act	Years
Enactment of temporary fishing bans, temporary prohibition of egg collection and minimum size of capture decree.	1925-1946
Definite ban of collection and sale of eggs.	1963
Initiation of protection activities at the beaches of Rancho Nuevo, Piedra de Tlalcoyunque, Boca de Pascuales and Playon de Mismaloya.	1966
Initiation of protection activities at La Escobilla beach.	1967
Total ban of turtle capture.	1971-1972
Granting of capture permits exclusively for cooperative societies of the fishing industry.	1973
Total ban of exploitation of Kemp's ridley turtles.	1973
Natural Reserve Zone of 17.5 km on the beach of Rancho Nuevo, Tamaulipas, was decreed.	1977
Total ban on capture of Kemp's ridley, green, loggerhead and hawksbill turtles.	1978
Incorporation of the Marine Turtle Program into the MEXUS-Gulf and MEXUS-Pacific bi-national programs.	1978
17 nesting beaches for marine turtles all over Mexico were decreed as Reserve Zones and Refuges.	1986
Publication of the General Law of Ecological Balance and Environmental Protection, which includes measures for the protection of turtle habitats.	1988
Incorporation of capture to a quota and franchise regimen exclusively for cooperative societies of fishery production of the States of Michoacán and Oaxaca.	1988
Decree on total and permanent ban of all species and subspecies of marine turtles.	1990
Penal Code modification to penalize capture, collection and commercialization of endangered species, particularly dolphins and marine turtles.	1991
Reforms and derogations to the Penal Code relating to the federal law code to penalize the capture, collection and commercialization of endangered species such as marine turtles, their products and derivatives. Chapter on Environmental crime, article 420.	1996
Mexico's signing and ratification of the Interamerican Convention for the Protection and Conservation of Marine Turtles.	1998
Agreement to determine as Protected Natural Areas, within the category of Sanctuaries, the reserves and refuge sites for protection, conservation, repopulation, development and control of the several species of marine turtles located in the states of Chiapas, Guerrero, Jalisco, Michoacán, Oaxaca, Sinaloa, Tamaulipas and Yucatán, identified in the decree published in October 29, 1986.	2002
First meeting of the Interamerican Commission for the Protection and Conservation of Turtles. Constitution of committees and scientific commissions.	2003

meetings were organized until a few years ago, where investigation, conservation and education advances were presented. It would be worth continuing to promote such meetings.

CONCLUSIONS

Due to the problems turtles face and their status as endangered species, as a result of over-exploitation and bad ecosystem management, it is very important to strengthen the current protection programs through research, conservation and educational activities, oriented towards the development of new alternatives and management plans of these valuable resources.

Nowadays, marine turtle populations continue to decline at many beaches due to insufficient support of conservation and enhancement activities. However, on other beaches there has been a positive response as a result of these efforts, and the tendency in the number of nestings indicates an important increase, as for example with *L. kempi* and some populations of *E. imbricata* and *C. mydas*. *Caretta caretta*, on the other hand, remains stable and *D. coriacea* presents an uncertain status. Therefore, better support and more reliable monitoring of the evolution of populations on the beaches and at sea are needed, through the development of essential actions for the precise understanding of the status of these populations and definition of the most adequate strategies for their recovery. However, current information obtained through some camp coordinators shows that poaching continues, and more drastic action and efficient measures are necessary to avoid the collapse of sea turtle populations.

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