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The Mexican artisanal shark fishery in the Gulf of Mexico: towards a regulated fishery

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Abstract. Artisanal shark fisheries have been an important source of food and employment in Mexico for many years. In the Gulf of Mexico, this multispecific fishery is based on the seasonal abundance of several shark and teleost species. To obtain fishery and biological information needed to manage the fishery and conserve shark stocks, intensive monitoring of artisanal shark landings was undertaken from November 1993 to December 1994. The State of Campeche had the highest landings and effort. October 1994 had the highest monthly catch per unit effort for all species and areas combined (27.2 sharks per trip). *Rhizoprionodon terraenovae* (46%), *Sphyrna tiburo* (15%), and *Carcharhinus limbatus* (11%) accounted for most of the landings numerically, and the highest catch per unit effort for *C. limbatus* occurred late in the year as a result of increased landings attributable to an annual southward migration from USA to Mexican waters. The high proportion of neonate and juvenile sharks in gill-net catches from shallow coastal waters suggests that the main shark nursery areas are under heavy fishing pressure. In light of the heavy exploitation of shark resources, the Mexican National Fisheries Institute recommends a number of precautionary actions to avoid the collapse of this fishery.

Resumen. Las pesquerías artesanales de tiburones han sido una importante fuente de alimento y empleo en México durante muchos años. En el Golfo de México, esta pesquería multiespecífica está basada en la abundancia estacional de diversas especies de tiburones y peces. Para obtener la información biológico-pesquera necesaria para manejar la pesquería y conservar los stocks de tiburones, se realizó un monitoreo de las capturas artesanales de tiburón entre noviembre de 1993 y diciembre de 1994. Campeche presentó las mayores capturas y esfuerzo. En octubre de 1994 se registraron las mayores CPUE para todas las especies y áreas combinadas (27.2 tiburones por viaje). *Rhizoprionodon terraenovae* (46%), *Sphyrna tiburo* (15%) y *Carcharhinus limbatus* (11%) constituyeron la mayoría de las capturas numéricamente y las mayores CPUE para C. limbatus se produjeron hacia finales de año a consecuencia del aumento de las capturas atribuible a una migración anual norte-sur desde los E.U. hacia aguas mexicanas. La alta proporción de neonatos y juveniles capturados en redes agalleras en aguas costeras someras sugiere que las principales áreas de crianza están sometidas a una alta presión de pesca. En vista de los niveles de explotación el INP recomienda diversas medidas precautorias para evitar el colapso de la pesquería.

Extra keywords: shark biology, shark nursery areas, shark management and conservation.

Historic overview and production trends

Sharks have long been a traditional resource of important cultural and social significance in Mexico. Indeed, exploitation of shark resources can be traced back to the Aztecs and Olmecs—two of the most important prehispanic cultures in Mexico—who apparently were able to distinguish among different species of shark inhabiting the coastal waters of the Gulf of Mexico (Applegate *et al.* 1979).

The first shark fishery records in Mexico were collected in 1890–1900, when shark fins were first exported to the Asian market from La Paz, Baja California Sur, in the Mexican Pacific Ocean (Hernández 1971). With the growing international demand for vitamin A during World War II, especially from the USA, several shark liver processing plants were established in the north-west Pacific coast of Mexico, with catches reaching a peak of 4833 t in 1944 (Hernández 1971). Shark production steeply declined after vitamin A was synthesized in 1949, stabilizing at <1000 t year^{-1}. With human population levels steadily increasing during the 1960s, sharks quickly became an alternative source of animal protein,

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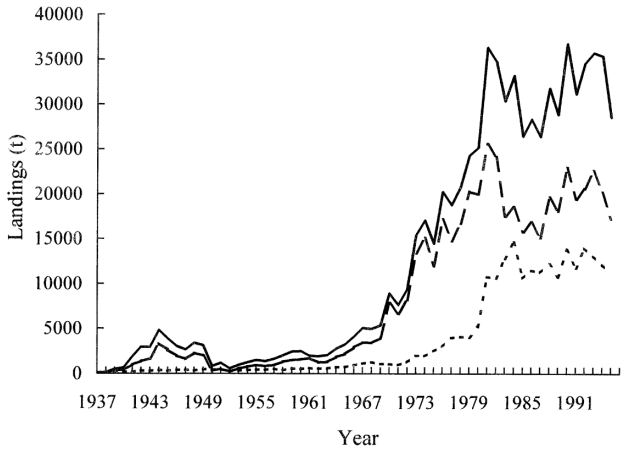

Fig. 1. Historical shark production in Mexico for (- - -)the Gulf of Mexico coast, (– – –) the Pacific coast and (—) the whole of Mexico, from 1937 to 1995: 'cazón' and 'tiburón' landings combined.

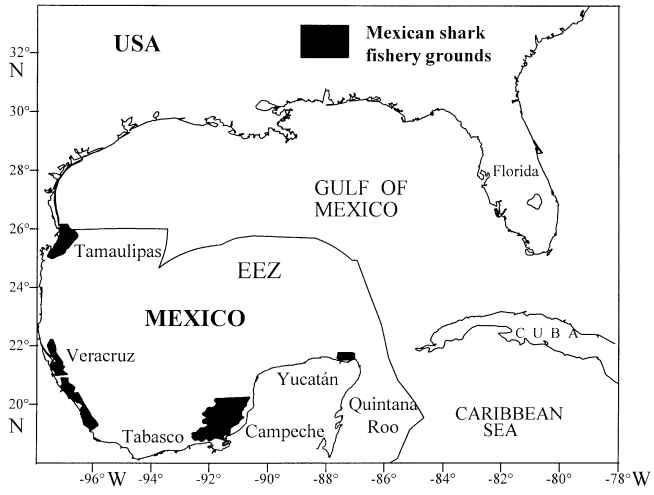

Fig. 2. Mexican shark fishery grounds in the Gulf of Mexico.

leading the Mexican government to promote shark fishing off both the Pacific and the Gulf of Mexico coasts. In the 1970s, shark production had reached almost 15000 t year^{-1} (Fig. 1), including 'cazón' (sharks approximately <150 cm total length, TL, comprising both small species and juveniles of larger species) and 'tiburón' (sharks >150 cm TL).

Shark fisheries currently represent an important source of food and employment on both coasts of Mexico. The shark fishery is the sixth largest fishery in the nation by tonnage and in 1995 alone amounted to 2.3% of the total fishery production of the country, representing 32576 t live weight (Anon. 1996; Fig. 1). Indeed, Mexico has become one of the leading nations in shark exploitation worldwide, with up to 90% of the Mexican shark production being consumed domestically. Of the three basic types of shark fisheries operating in Mexico (artisanal, offshore and pelagic), the artisanal coastal fishery represents almost 80% of the total production (Castillo 1992). Most of the artisanal landings from both coasts are sent to Mexico City and other major inland cities, where sharks are processed and commercialized in a variety of forms, including fresh, frozen, and dried and salted fillets.

Artisanal shark fisheries in the Gulf of Mexico operate in coastal waters, ranging from Matamoros, Tamaulipas, near the USA–Mexico border in the western Gulf of Mexico, to Quintana Roo in the southern Caribbean Sea (Fig. 2). During 1976–95, average annual shark catches reported in the Gulf of Mexico were 9289 t or one-third of the total national shark production. In 1995, total catches amounted to 11315 t (6630 t of 'tiburón' and 4685 t of 'cazón'; Fig. 1).

Description of the fishery and species composition of the landings

The Mexican artisanal shark fishery is part of a multispecific fishery that operates on the basis of the seasonal abundance of a number of shark and teleost species. A variety of fishing vessels and gears are used in the fishery. Depending on the region and time of year, fishing gears can include hook and line, small bottom longlines (referred to as 'cimbras' or 'palangres'), small drift gill-nets, and bottom-fixed gill-nets. Until this present report there has been no record of the type and number of, or number of trips by, vessels involved in this fishery (Bonfil 1997).

Intensive monitoring of the artisanal shark fisheries of the coastal waters of the Mexican Gulf of Mexico was carried out from November 1993 to December 1994, with some additional samples available from 1995 and 1996. Twelve of the most important fishing ports from the States of Tamaulipas, Veracruz, Tabasco and Campeche were sampled on a daily basis (Table 1). The shark fishing operations of 901 artisanal boats were monitored and boats classified into two categories. Type-A boats (commonly referred to as 'pangas') have hulls of fibreglass and wood, 7.5–10.0 m long and 1.0–2.5 m wide, with an outboard motor and an operational range of 1–3 days; they accounted for 97% of the total fishing effort. Type-B boats have hulls of wood and metal, > 10 m long and >2.6 m wide, with an inboard motor and an operational range of 4–15 days. The two types combined made 9964 trips. Campeche had the highest number of boats, fishing trips, and shark landings overall (Fig. 3).

Shark landings consisted of 34 species from 10 families and 6 orders (Table 2). Nine species accounted for 93.5% of all shark landings (n = 84 717) numerically, the most important being the Atlantic sharpnose shark, *Rhizoprionodon terraenovae* (46%), the bonnethead shark, *Sphyrna tiburo* (15%), the blacktip shark, *Carcharhinus limbatus* (11%), the blacknose shark, *C. acronotus* (9%), and the scalloped hammerhead, *S. lewini* (5%). The bull shark, *C. leucas*, the silky shark, *C. falciformis*, the smalltail shark, *C. porosus*, and the Cuban dogfish, *Squalus cubensis*, each made up 2% of the landings.

Table 1. Sampling localities and monitoring periods of the artisanal shark fishery in the Gulf of Mexico

State	Fishing locality	Monitoring period	
		Start	End
Tamaulipas	Matamoros, Playa Bagdad	April 1994	November 1994
Veracruz	Tamiahua	November 1993	December 1994
	Casitas	November 1993	December 1994
	Chachalacas	November 1993	December 1994
	Alvarado	November 1993	December 1994
Tabasco	San Pedro	January 1994	December 1994
Campeche	Campeche	November 1993	December 1994
	Ciudad del Carmen	January 1994	October 1994
	Isla Aguada	January 1994	October 1994
	Champotón	January 1994	October 1994
	Sabancuy	January 1994	October 1994
	Seyblaplaya	January 1994	October 1994
Yucatán	Progreso-Yucalpetén	January 1994	December 1994

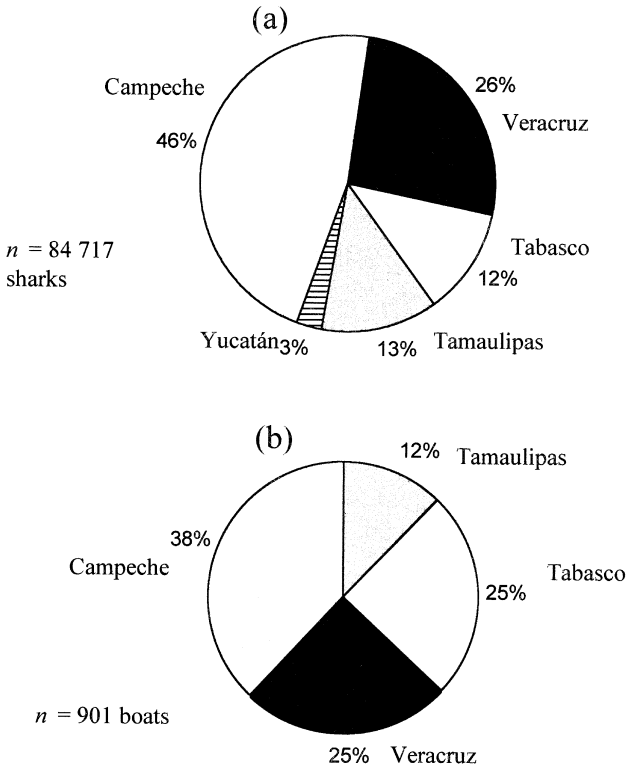

Fig. 3. Shark fisheries of the States on the Gulf of Mexico from November 1993 to December 1994: *(a)* landings, expressed as a percentage by number of all sharks landed, and *(b)* fishing effort, expressed as a percentage of the total number of fishing trips

The number of directed shark fishing trips per month was used as an index of effort, regardless of the fishing gear (nets or longlines) used. Mean catch per unit effort (CPUE), which was calculated as the number of sharks landed each month per number of trips per month, for all shark species landed in Tamaulipas, Veracruz, and Tabasco from November 1993 to December 1994 was 9.45 ± 1.92 (mean ± s.e.) sharks per trip. The highest CPUE for all species and areas combined was 27.20 sharks per trip in October 1994, and the lowest was 4.46 sharks per trip in April 1994 (Fig. 4). Veracruz had both the highest (33.50 sharks per trip) and lowest (0.78 sharks per trip) CPUE values of any states. Data from Campeche and Yucatán were not included in the calculation of CPUE because the total number of fishing trips may have been underestimated during field sampling.

Fishery and biology of the three most important species

Rhizoprionodon terraenovae

Fourty-six percent (n = 38 970) of the total number of sharks captured were *R. terraenovae*. The main landings of this species, by region, were in Campeche (46%) and Veracruz (26%), with landings in Tamaulipas (14%), Tabasco (11%), and Yucatan (3%) being less important. Main landings, by month, were in May and October 1994 (Fig. 5), with all specimens being caught mainly with bottom-fixed gill-nets. In Tamaulipas, there were year-round landings of *R. terraenovae*, with a peak during October–December 1994, and most of the sharks were adults (90–110 cm TL; Fig. 6). In Veracruz, mostly juvenile sharks ranging from 50–60 cm TL were captured in coastal waters from October to December 1994. In Tabasco, average size of sharks caught was 77.3 ± 0.21 cm TL (sexes combined). In Campeche, the 'cazón' fishery consisted solely of this species (n = 18 154) during the entire study period, with a mean size of 72.1 ± 0.62 cm TL and a range of 28–112 cm TL (sexes combined) for those specimens that were measured (n = 1865). This species was caught during all months, but a peak in landings occurred in late autumn and early winter of 1994. In Yucatán, landed individuals ranged from 40 to 114 cm TL, with two peaks corresponding to the 60- and 100-cm TL average size classes.

Table 2. The 34 shark species caught in the artisanal fisheries in the Gulf of Mexico from November 1993 to December 1994

Scientific name	Common name
Alopias superciliosus	Bigeye thresher shark
Alopias vulpinus	Thresher shark
Carcharhinus acronotus	Blacknose shark
Carcharhinus brevipinna	Spinner shark
Carcharhinus falciformis	Silky shark
Carcharhinus isodon	Finetooth shark
Carcharhinus leucas	Bull shark
Carcharhinus limbatus	Blacktip shark
Carcharhinus longimanus	Oceanic whitetip shark
Carcharhinus obscurus	Dusky shark
Carcharhinus perezi[A]	Reef shark
Carcharhinus plumbeus	Sandbar shark
Carcharhinus porosus	Smalltail shark
Carcharhinus signatus	Night shark
Centrophorus granulosus	Gulper shark
Galeocerdo cuvieri	Tiger shark
Ginglymostoma cirratum	Nurse shark
Heptranchias perlo	Sharpnose sevengill shark
Hexanchus griseus	Sixgill shark
Hexanchus vitulus	Bigeye sixgill shark
Isurus oxyrinchus	Shortfin mako shark
Isurus paucus	Longfin mako shark
Mustelus canis	Smooth dogfish
Mustelus norrisi	Florida dogfish
Negaprion brevirostris	Lemon shark
Rhizoprionodon terraenovae	Atlantic sharpnose shark
Scyliorhinus retifer	Chain catshark
Squatina dumerili	Atlantic angel shark
Squalus asper	Roughskin spiny dogfish
Squalus cubensis	Cuban dogfish
Sphyrna lewini	Scalloped hammerhead shark
Sphyrna mokarran	Great hammerhead shark
Sphyrna tiburo	Bonnethead shark
Sphyrna zygaena	Smooth hammerhead shark

[A]Identification not confirmed

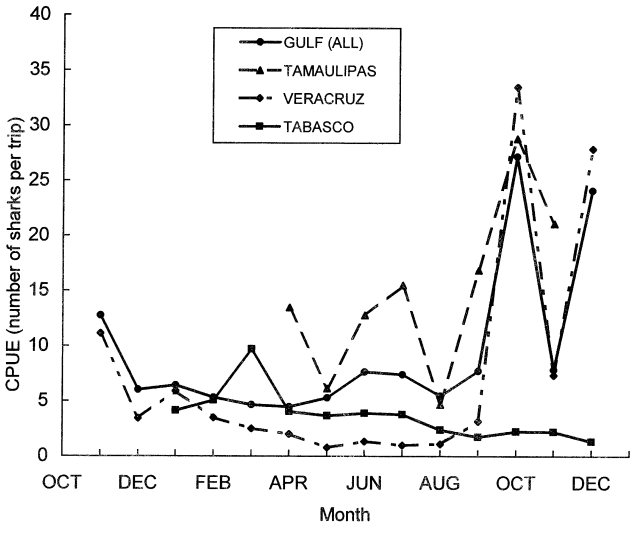

Fig. 4. Monthly CPUE for the artisanal fishery in the Gulf of Mexico from November 1993 to December 1994; all shark species combined.

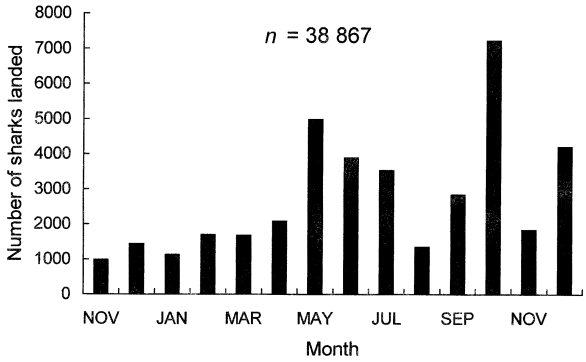

Fig. 5. Monthly landings of *Rhizoprionodon terraenovae* from the entire Mexican Gulf region from November 1993 to December 1994.

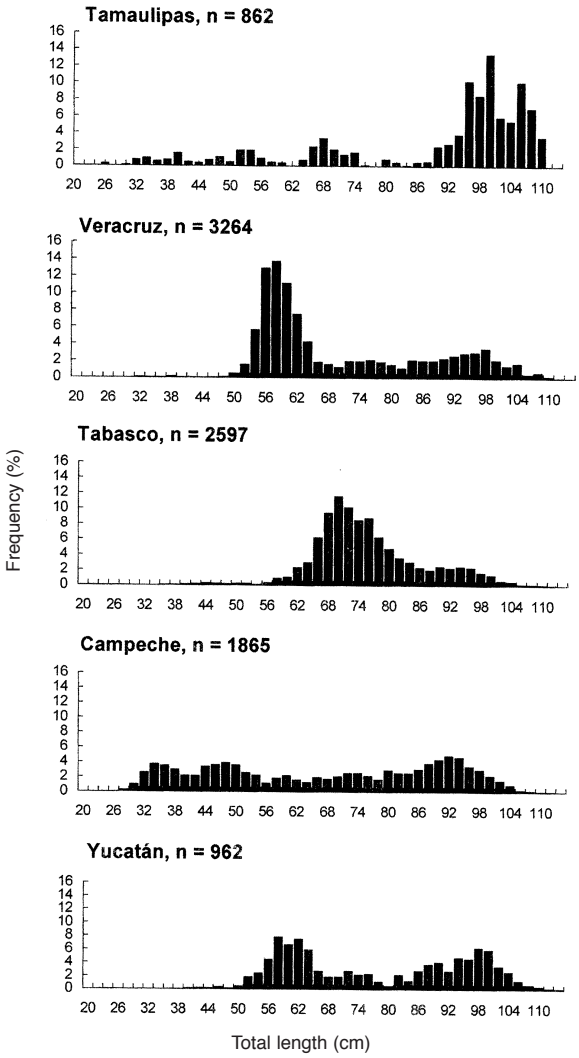

Fig. 6. Length–frequency distributions of *Rhizoprionodon terraenovae* by State in the Gulf of Mexico from November 1993 to December 1994.

Our observations of the seasonal abundance of *R. terraenovae* in Mexican waters of the Gulf of Mexico are in agreement with a description (Parsons 1983) of seasonal movements of this species between shallow coastal waters and deeper pelagic waters off the coasts of Mississippi and Louisiana, USA, late in the year. In late autmun, *R. terraenovae* appears to move in a southerly direction, penetrating the warmer coastal waters of Tamaulipas and Veracruz.

In the entire Mexican Gulf region, size ranged from 26 to 114 cm TL with a mean of 79.1 ± 0.22 cm TL (sexes combined). Sex ratio was 1:1.06 (females:males). Landings comprised juveniles and adults in similar proportions, and newborn individuals were observed in Campeche and Tamaulipas (Fig. 6), where gill-nets with a stretched mesh size of 7.6, 10.2, 11.4, 12.7 or 15.2 cm were used.

Mean CPUE in 1994 was 9.86 ± 2.43 sharks per trip, with two peaks corresponding to October and December 1994 (Fig. 7). By region, the highest CPUE corresponded to Veracruz in October 1994 (30.79 sharks per trip). Peaks in CPUE were also observed in Tamaulipas in August 1994 (23.50 sharks per trip) and Veracruz in December 1994 (23.06 sharks per trip).

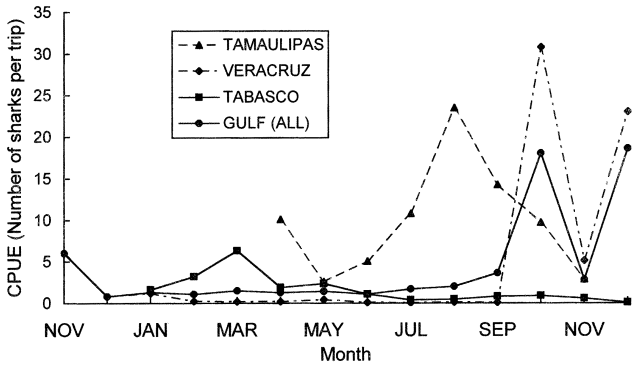

Fig. 7. Monthly CPUE for *Rhizoprionodon terraenovae* by State in the Gulf of Mexico from November 1993 to December 1994.

A plot of embryo length *v.* month of the year showed that embryonic development takes 11–12 months in *R. terraenovae* (Fig. 8). Embryonic development ends between May and July when the birth season starts. Embryos near 32 cm TL (size at birth) and mature eggs in the ovary occurred simultaneously in late May and early June. Most females had given birth by the last week of June. In early July a large proportion of females had mature eggs in the ovary, and some females had fertilized eggs just deposited in the uteri. Litter size ranged from 1 to 9 pups (5.3 ± 0.10) and sex ratio of embryos was 1:1. There was a weak yet highly significant correlation between female total length and total number of pups (r^2= 0.2, $P < 0.001$, n = 165). Pups were born at 28–32 cm TL. The smallest pregnant female in our samples was 91.5 cm TL. This information generally agrees with that on the species off the southeastern USA (Parsons 1983; Castro and Wourms 1993).

Sphyrna tiburo

S. tiburo accounted for 15% of the artisanal landings by number. This small sphyrnid shark is heavily fished in the southern Gulf of Mexico, particularly off the coast of Campeche, where 90% of all specimens were landed. *S. tiburo* was caught in coastal waters all year round, with the highest landings in August 1994 (Fig. 9). For the entire Gulf region, specimens caught included neonates, juveniles, adults and gravid females, ranging in size between 27 and 124 cm TL, with a mean size for sexes combined of 76.4 ± 0.35 cm TL (Fig. 10). Sex ratio of the catches was 1:1.16 (females:males). Gill-nets with a stretched mesh size of 7.6, 10.2, 11.4 or 12.7 cm were the main gear used.

Only data from Tabasco were used to calculate CPUE for this species, because data on landings and effort from the other States were incomplete. Mean annual CPUE was 0.27 ± 0.08 sharks per trip and maximum CPUE was 0.89 sharks per trip in December 1994 (Fig. 11).

We recorded 121 gravid females of *S. tiburo* in the artisanal landings, but could only collect data on number and size of embryos for 33 specimens. Most of these pregnant females were landed in Tabasco and Campeche in June and August 1994. Litter size ranged from 1 to 19 (10.4 ± 0.5) pups per female and sex ratio was 1:1. There was a weak but significant correlation between maternal size and litter size (r^2= 0.170, P= 0.05, n = 28). The smallest pregnant female was 91 cm TL. The smallest mature male was 70 cm TL, which is similar to the finding (Parsons 1993) for males of *S. tiburo* in Florida Bay, in the eastern Gulf of Mexico.

Carcharhinus limbatus

C. limbatus accounted for 11% of the artisanal landings by number. The highest landings were recorded in Veracruz and Tamaulipas, with 47% and 32% of the total, respectively, whereas Campeche and Tabasco made up 16% and 5%, respectively. In the entire Mexican Gulf region, the highest landings were observed in October 1994 (Fig. 12). In Tamaulipas, the highest landings occurred from October to December 1994, whereas in Veracruz the highest landings occurred from November 1993 to May 1994. These observations agree with the documented southward migration of this species from the USA to Mexico late in the year (Branstetter 1981, 1987). For the entire Mexican Gulf region, two main size classes were observed in the length–frequency distributions for this species: 70–90 cm TL juveniles, and 145–165 cm TL subadults and young adults (Fig. 13). Overall, size ranged from 46 to 200 cm TL (121.0 ± 0.70), and sex ratio was 1:2.62 (females:males).

This species was caught with gill-nets in Campeche and Tamaulipas, and with longlines in Veracruz and Tabasco. In Tamaulipas, juveniles were caught with gill-nets with a

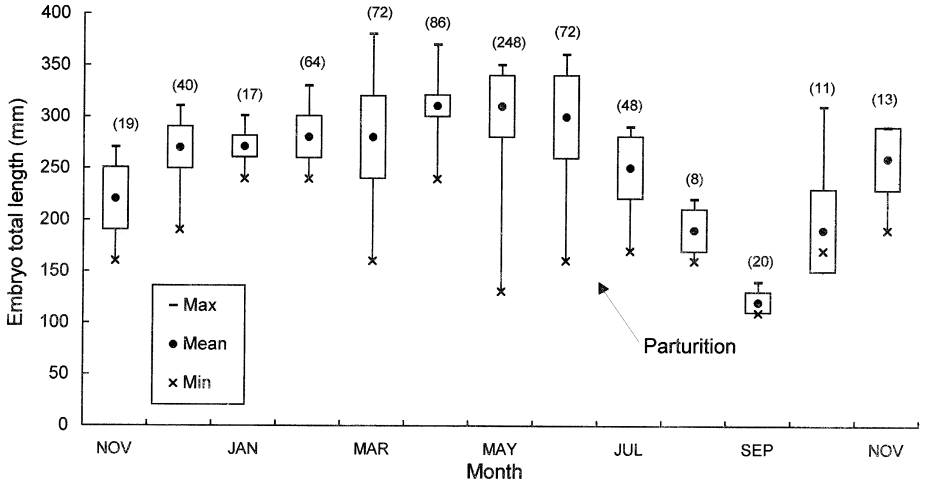

Fig. 8. Embryonic growth of *Rhizoprionodon terraenovae* in the Mexican Gulf region from November 1993 to December 1994. Boxes indicate mean ± 1 s.d.; numbers in parentheses are embryos examined.

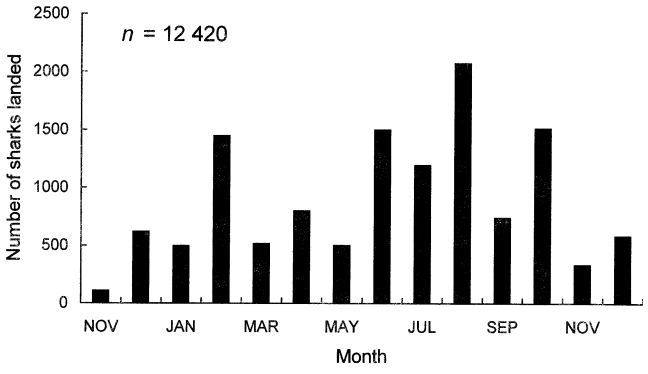

Fig. 9. Monthly landings of *Sphyrna tiburo* from the entire Mexican Gulf region from November 1993 to December 1994.

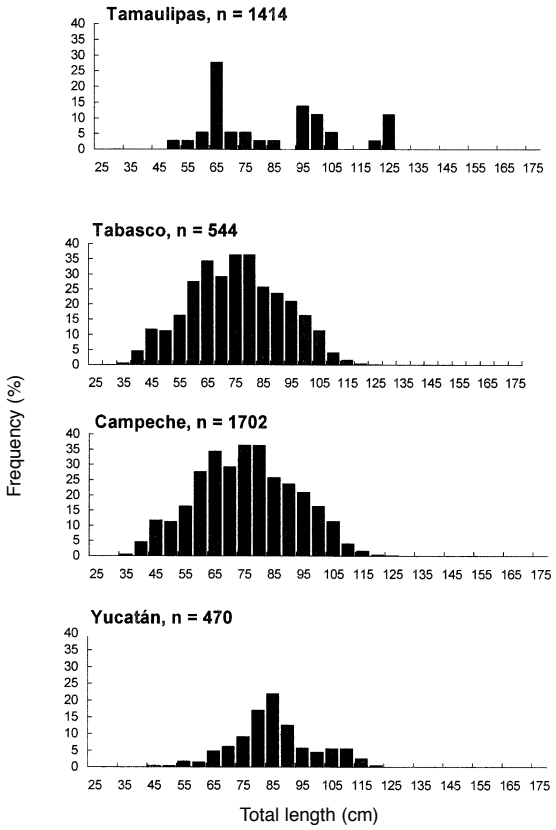

Fig. 10. Length–frequency distributions of *Sphyrna tiburo* by State in the Gulf of Mexico from November 1993 to December 1994.

stretched mesh size of 7.6, 10.2, 11.4, or 12.7 cm, whereas adults were caught with longlines in Veracruz. Mean CPUE for the entire Mexican Gulf region was 1.0 ± 0.27 sharks per trip, with the highest values corresponding to November 1993 (2.84 sharks per trip) and October 1994 (4.25 sharks per trip; Fig. 14). The highest monthly values by State corresponded to Tamaulipas with 17.48 and 15.70 sharks per trip in October and November 1994, respectively (Fig. 14). Thus, the highest CPUE values for *C. limbatus* in the Mexican Gulf region were observed late in the year (Fig. 14), when landings increased probably because of the annual southward migration from USA to Mexican waters.

Forty-four gravid *C. limbatus* females were examined, most of which were landed in April, May and September 1994, mainly from the northern waters of Matamoros in Tamaulipas. Litter size ranged from 2 to 7 (5.03 ± 0.18, n = 36) pups per female, and embryo size ranged from 11.5 to 57 cm TL (36.09 ± 1.38, n = 168). The intrauterine sex ratio was 1:1. Parturition in Veracruz, Tabasco, and Campeche appears to start in May and continue through June. For males, minimum size at maturity was estimated at 125 cm TL, on the basis of examination of clasper length and rigidity of 1439 specimens, whereas the smallest pregnant female observed was 145 cm TL.

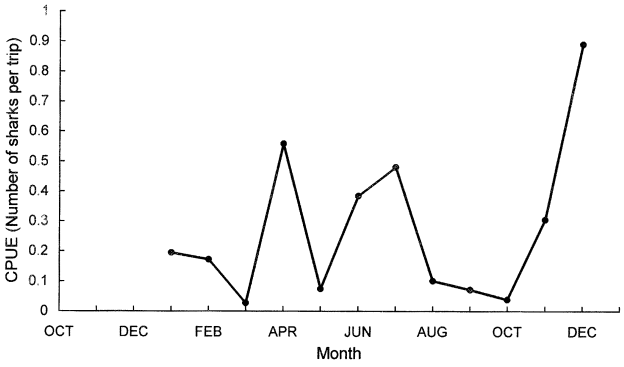

Fig. 11. Monthly CPUE for *Sphyrna tiburo* off the State of Tabasco, Gulf of Mexico, from November 1993 to December 1994.

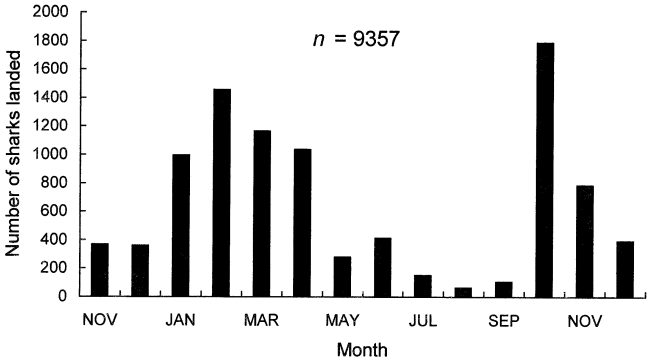

Fig. 12. Monthly landings of *Carcharhinus limbatus* from the entire Mexican Gulf region from November 1993 to December 1994.

Shark nursery areas

Several carcharhiniform species use inshore shallow waters, coastal lagoons, bays and estuaries as nursery areas in Mexico (Bonfil 1997), as reported for other temperate and tropical sharks off northern Australia (Simpfendorfer and Milward 1993) and the south-eastern USA (Castro 1993). The main criterion used to characterize these areas as nurseries in the present study was the simultaneous presence of gravid females and free-swimming neonates and small juveniles (Castro 1993). A further distinction was made between two types of nursery areas in coastal waters of the Mexican Gulf: protected areas and unprotected areas (Branstetter 1990). Of particular concern is that some of these areas coincide with traditional fishing grounds that have been used for decades by artisanal fishermen.

The shallow, open coastal waters off Matamoros, Tamaulipas, near the USA border, are part of an unprotected nursery area for *R. terraenovae*. During May 1994 we examined 29 gravid females with full-term embryos of 30–33 cm TL (31.8 ± 0.3 cm TL, n = 186) and 13 neonates of 32–39 cm TL (35.3 ± 0.1 cm TL). This area was classed as unprotected because of evidence of interspecific predation by large carcharhinid species on *R. terraenovae*. For example,

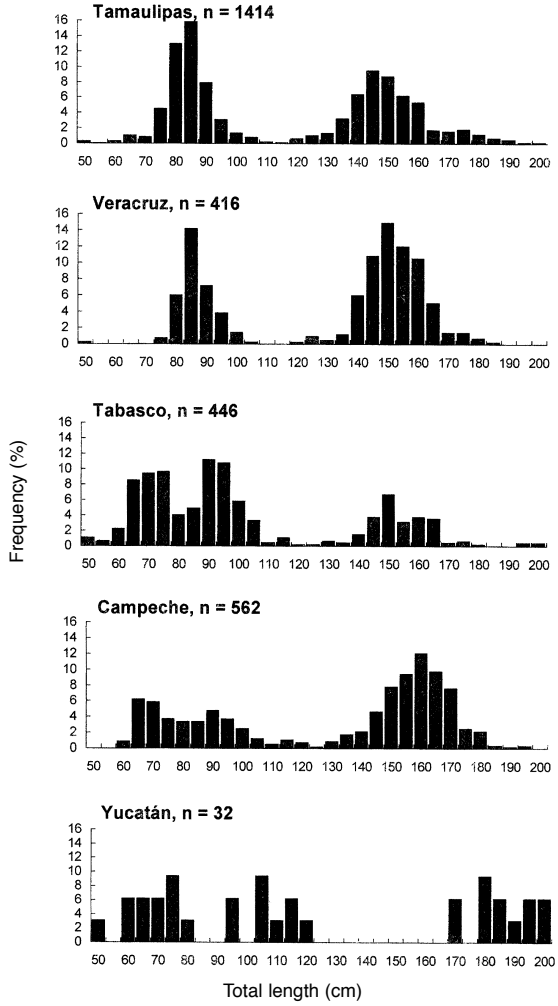

Fig. 13. Length–frequency distributions of *Carcharhinus limbatus* by State in the Gulf of Mexico from November 1993 to December 1994.

some *C. leucas* specimens landed in June 1994 contained one or two complete newborn *R. terraenovae* in the stomach. This area can be considered a primary unprotected nursery area (Bass 1978), because young-of-the-year *R. terraenovae* were absent from the landings after June, indicating that residence time does not exceed 30–40 days. On the basis of the 1994 landings, the coastal waters off Veracruz are probably another example of this type of nursery area for species such as *C. signatus* and *C. falciformis*. For example, in Tamiahua, Veracruz, we examined 17 neonate *C. falciformis* (69.9 ± 1.5 cm TL) during June–September, and 22 neonate *C. signatus* (77.1 ± 1.2 cm TL) during January–April. Bonfil (1997) also reported Tamaulipas and Veracruz as nursery areas for several species of shark.

Protected shark nurseries in waters of the Mexican Gulf are mainly coastal lagoons. In Campeche, Terminos Lagoon is an important nursery area, not only for sharks but also for several teleost species, including snook (Centropomidae), jacks (Carangidae), and drums (Sciaenidae). Uribe (1993)

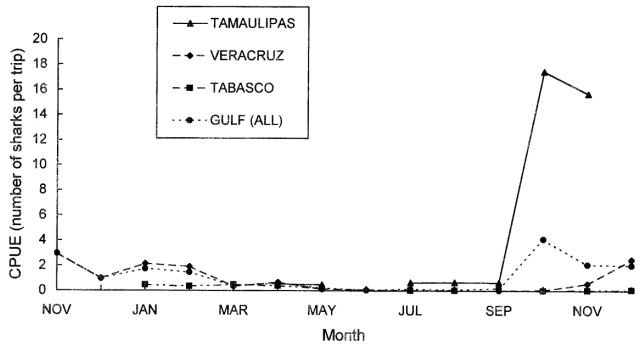

Fig. 14. Monthly CPUE for *Carcharhinus limbatus* by State in the Gulf of Mexico from November 1993 to December 1994.

documented the presence of neonate *C. leucas* in May 1992, *C. limbatus* in June 1981, and *S. tiburo* in July 1981, inside the lagoon. In the northern part of Quintana Roo, Yalahau Lagoon is also an important primary protected nursery area for *C. limbatus* and a variety of teleosts. Gravid females of this species appear to give birth at the mouth of the lagoon during May, and preliminary data from a joint tagging programme between the Mexican National Fisheries Institute (INP) and the Center for Shark Research at the Mote Marine Laboratory (Sarasota, FL) indicate that newborn sharks spend 1–3 months inside the lagoon before moving out.

Most of the tropical shark nursery areas identified in waters of the Mexican Gulf are also important fishing grounds for local communities. This study revealed a close relationship between the 'cazón' and finfish fisheries in coastal waters, owing to the non-specificity of the fishing gear used. Neonate sharks are caught mainly with gill-nets, which also capture several species of more profitable teleosts. In some localities, sharks represent a subsistence fishery between more profitable seasons of finfish fisheries. We thus agree with Applegate *et al.* (1993) and Bonfil (1997) in that shark nursery areas in Mexican waters should be considered of paramount importance for any management plan for sharks, because fishing mortality is extremely high in these areas and the stock–recruitment dynamics are undoubtedly affected.

Management and conservation

Despite their socio-economic importance, two major fisheries in Mexico, the artisanal finfish fishery and the shark fishery ('cazón' and 'tiburón' combined), do not have well defined management plans based on scientific information. In 1994, the combined production from these two fisheries was 356 251 t, amounting to 35% of the total fishery production of Mexico (Anon. 1995). These two fisheries represent the major source of food and employment for Mexico's fishing sector, yet they have traditionally received much less attention than other more profitable fisheries, such as the shrimp, tuna, sardine or lobster fisheries. Another reason for the lack of knowledge on the artisanal shark and finfish fisheries is that they are multispecific, involving over 240 species, and identification to species is often complicated by the use of different common names in different fishing areas. Furthermore, sharks are not identified by species, but classified according to size.

With the continued increase in human population, traditional sources of animal protein are becoming insufficient, hence the increasing importance of sharks and finfishes as food in Mexico. Finfishes and sharks are the cheapest seafood available for the lower economic strata of Mexican society, and they generate several thousand jobs. The annual 30 000 t of shark production (Castillo 1990, 1992) thus represents a matchless source of animal protein in Mexico.

Owing to this changing trend, management and conservation of shark stocks harvested in Mexican waters have become a priority in the past three years. Another important reason for this enhanced attention is the recent implementation of the US Fishery Management Plan for sharks of the Atlantic Ocean (Anon. 1993), which manages 39 species of shark in a single unit divided into three groups: small coastal sharks, large coastal sharks and pelagic sharks. Several species included in the management unit are highly migratory, even as juveniles in some cases, and are known to cross the waters between the USA and Mexico. This implies that successful conservation and sustainable use of this fishery resource requires multinational efforts and cooperation. In the Gulf of Mexico and adjacent regions, the sharks targeted by fishermen from the USA and Mexico may very well comprise common stocks. The logical approach to understanding and managing this heavily exploited resource, therefore, would be to involve researchers and managers from both nations in cooperative activities based in the Gulf of Mexico and Caribbean.

Although the interest in assessing the status of Mexican shark stocks is only recent, the INP initiated a number of research programmes in the southern waters of the Gulf of Mexico in 1982, with the main goal of characterizing the artisanal fishery off Campeche and Yucatán (Bonfil 1987; Bonfil *et al*. 1990, 1993; Uribe 1993). Results from those studies, combined with more recent work (Rodriguez de la Cruz *et al*. 1996), provided a reliable description of the status of the shark fishery in the entire Mexican Gulf region and allowed us to conclude that: *(1)* the main species in the coastal artisanal fishery have been heavily fished for the past ten years, *(2)* there is a high proportion of immature (neonate and juvenile) sharks in the overall artisanal shark landings, caught mostly with gill-nets, and *(3)* the few described shark nursery areas in the Mexican Gulf are under intense fishing pressure.

It is clear that the increasing domestic demand for shark fishing permits, coupled with the lack of regulatory actions,

poses a threat to the shark stocks harvested in Mexican waters. As a result, in 1991 the INP recommended to the Mexican Secretary of Fisheries that fishing effort in coastal waters not be increased until the status of the main exploited shark stocks were better known. In response to this recommendation, a moratorium on the issuance of shark fishing permits was imposed in March 1993 as a precautionary measure to prevent overfishing of shark resources. In addition, a Shark Working Group was established in January 1996 to prepare the first management plan for sharks of the Mexican Gulf region, with the goal of achieving the sustainability of shark fisheries in the region. The initial task of this working group, which includes representatives from the government, fishing industry, and academia, is to generate the first draft of the plan, which will determine the conditions for exploitation of the shark resources in Mexico. The plan will thus establish characteristics of the commercial vessels (artisanal and mechanized), number of boats or vessels, fishing areas, seasons, and type of gears permitted.

The INP suggests that the following actions be included in the management plan for sharks of Mexico: *(1)* continue the moratorium on new shark fishing permits indefinitely, *(2)* increase the collection of fishery statistics in the three shark fishery units identified (artisanal coastal fishery, offshore fishery, and pelagic fishery) and collect species-specific information on catches and landings, by number and weight, *(3)* conduct a census of the artisanal fishing boats and gears both in the Gulf of Mexico and in the Pacific coastal regions, *(4)* conduct socio-economic studies of the coastal artisanal fisheries and *(5)* assess the impact of fishing mortality on neonates, juveniles and gravid females in shark nursery areas.

The conservation and sustainable management of Mexico's diverse fish resources are essential for both the Mexican economy and as a food supply for the Mexican people. The actions proposed will help achieve the sustainability of shark fisheries and thus conserve the sources of food and employment that this activity generates in Mexico, as well as the shark stocks harvested in Mexican waters.

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