El Colegio de la Frontera Sur

Historia ambiental del tiburón toro (*Carcharhinus leucas*) en la planicie de inundación del río Usumacinta y zona costera de influencia

TESIS

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PD. Si olvide mencionar tu nombre recibe una humilde disculpa 😊

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Resumen

Carcharhinus leucas es una especie de tiburón cosmopolita con distribución en mares tropicales y subtropicales del mundo, y es de las pocas especies de tiburones capaz de penetrar a los ríos para completar parte de su ciclo biológico. Conocer la abundancia histórica de las poblaciones marinas permite realizar evaluaciones precisas de su estado actual de conservación. Sin embargo, los datos pesqueros no son suficientes ya que se remontan después de que las especies comenzaron a explotarse y reportan las capturas en grandes grupos taxonómicos. La presente investigación se desarrolló con metodología de historia ambiental a través del uso de la historia oral y síntesis de publicaciones históricas y tuvo como objetivo principal describir los cambios históricos en la abundancia de la población de tiburón toro en la planicie de inundación del Río Usumacinta. Mis resultados indican que el tiburón toro ingresaba río arriba hasta Tenosique en Tabasco, a más de 300 km de la costa del Golfo de México. Las entrevistas con los habitantes de esta zona indican que fue una especie muy abundante y explotada localmente hasta la década de los 1990s. Mediante la revisión de literatura histórica e historia oral documenté que en el Río Usumacinta la captura del tiburón toro mantenía una pesquería de subsistencia que se presentó de 1950s a 1990s. Nuestro trabajo es un ejemplo de lo que podría pasar con otras poblaciones de *C. leucas* en otros ríos del mundo. Por lo tanto, considerando la biología de la especie, su vulnerabilidad y los datos obtenidos de la narrativa histórica y oral de pescadores locales se propone que este trabajo sea considerado como un antecedente regional para hacer un trabajo futuro que permita recopilar los datos para evaluar si la especie está en la categoría correcta o debiera ser incluida a la norma oficial mexicana de especies en riesgo NOM-059-SEMARNAT-2010.

Palabras clave:

Historia oral, cambio de línea base, migraciones de tiburón toro, ambientes dulceacuícolas, ecología histórica

Capítulo 1. Introducción

Históricamente los ecosistemas costeros han sufrido afectaciones a causa de las actividades humanas (Lotze et al. 2006). En este sentido, la merma/declinación de los grandes depredadores marinos como los tiburones que utilizan estos sistemas dentro de su ciclo de vida se ha incrementado en todo el mundo (Elvira y Almódovar 2007; Ferretti et al. 2008). A nivel global, para el año 2000 por ejemplo, se calcula que la biomasa de los grandes depredadores marinos representa el 10 % de la que hubo antes del comienzo de la pesca industrial (Myers y Worn 2003). En ese sentido, los tiburones son uno de los grupos más afectados, debido al esfuerzo pesquero y a la captura incidental a la que han sido sometidos (Fowler 2014).

Derivado de lo anterior es imperativo contar con información histórica que nos permita evaluar el estatus actual de las especies marinas, sobre todo de aquellas poblaciones sometidas a fuerte presión pesquera (Taylor et al. 2018). Sin embargo, muchos ecosistemas marinos son evaluados una vez que la abundancia de determinados componentes (poblaciones) ha disminuido (Lotze y Worn 2009); o bien, la información disponible sobre el estado actual de poblaciones se refiere a estudios muy recientes, justo cuando las poblaciones presumiblemente ya se encontraban en un nivel sobreexplotado. En consecuencia, se aplica “de facto” un cambio de línea base; es decir nuestra percepción de lo que es natural es construida con la referencia de ecosistemas ya degradados, obteniendo puntos de referencia inadecuados (Pauly 1995; Sáenz-Arroyo et al. 2005a; Lotze y Worn 2009).

Por otro lado, cuando se requiere efectuar una evaluación poblacional haciendo uso de los datos pesqueros, a menudo estos son insuficientes, pues no presentan una descripción detallada por especie, sino más bien se reportan agregados en grandes grupos taxonómicos como tiburones, rayas o cazones, categorías que incluyen a múltiples especies de tiburones (Fowler 2014; Pérez-Jiménez et al. 2012). En consecuencia, se considera que el 99 % de pesquerías en todo el mundo no han sido evaluadas correctamente y en particular en países tropicales dónde escasamente se

cuentan con datos pesqueros específicos e históricamente correctamente contextualizados (Johannes et al 2000).

En las últimas dos décadas, los científicos marinos se han dedicado a usar herramientas históricas para conocer mejor la trayectoria poblacional (Sáenz-Arroyo et al. 2005a, 2006; McClenachan et al. 2012), donde la ciencia pesquera no ha podido llegar. En ese sentido la historia ambiental es una ciencia que se enfoca en investigar la relación entre la sociedad y su entorno natural en el tiempo y el espacio (Martínez-Castillo 2001), utilizando diversas herramientas, entre las cuales la historia oral, en particular en ambientes marinos, representa una aproximación poderosa ya que la mayor parte de los impactos producidos por la pesca han ocurrido a partir de la segunda mitad del siglo pasado (Szabó 2014; McClenachan et al. 2015).

La historia oral es una herramienta historiográfica que permite reconstruir procesos sociohistóricos desde la interacción sujeto-investigador, utiliza como fuente principal para la reconstrucción del pasado los testimonios orales a partir de la percepción de los protagonistas (Iturmendi 2008; Lara y Antúnez 2014). Asimismo, es una ciencia que no se aísla de las fuentes escritas y busca que éstas sean complementadas basándose en el análisis y compresión de otras fuentes pertinentes, lo que le permite analizar el pasado desde diversos enfoques y puntos de vista (Moss y Mazikana 1997; Iturmendi 2008). En ese sentido, algunos investigadores han involucrado más de un recurso para dimensionar los cambios en el tiempo y el espacio de algunas poblaciones marinas como fotografías antiguas (McClenachan et al. 2015; Mendoza-Carranza y Espinoza-Tenorio 2015), documentos antiguos, literatura gris (Sáenz-Arroyo et al. 2005a, 2005b), restos arqueoictiológicos (Jiménez-Cano y Sierra-Sosa 2018), registros ictiológicos en colecciones (Pérez-Jiménez 2014), restos zooarqueológicos combinados con conocimiento tradicional de pescadores (Rubio-Cisneros et al. 2019) y combinado con teoría sobre vulnerabilidad (Martínez-Candelas et al. 2020).

El uso de recursos históricos resulta esencial para la conservación de la biodiversidad y ecología, además su utilización es útil sobre todo en lugares donde no

existe un monitoreo continuo y confiable de recolección y análisis de información pesquera (Cuello y Duarte 2010). Tal cual sucede con las pesquerías del Usumacinta y con la mayoría de las pesquerías de aguas continentales de México (Mendoza-Carranza et al. 2018).

Así como las pesquerías continentales son poco estudiadas, de igual forma poco se conoce sobre el papel de los tiburones en los ríos; en particular los géneros *Carcharhinus* y *Glyphis* de la familia Carcharhinidae incluyen a varias especies de tiburones que incursionan en los ríos (Compagno 1984). Particularmente *C. leucas* es una especie cosmopolita con distribución en mares tropicales y subtropicales del mundo, incluyendo el Mar Caribe y Golfo Pérsico (Castro-Aguirre et al. 1999), y penetra a los ríos tropicales y subtropicales del mundo para completar parte de sus ciclos biológicos (Compagno 1984). Lo cual lo convierte en un tiburón eurihalino altamente migratorio, además, de ser la única especie de tiburón eurihalino reportada en México (Castro-Aguirre et al. 1999; Fowler 2014).

Desde hace tiempo se sabe que la especie habita durante largas temporadas en cuerpos de agua dulce, como el lago Izabal de Guatemala (Thorson et al. 1966a); asimismo en el lago Nicaragua y en el río San Juan en donde se registra la presencia de varias poblaciones que permanecen largas temporadas como parte de su ciclo de vida (Thorson et al. 1966b). Por otro lado, en América del Sur Thorson (1972) menciona la ocurrencia de *C. leucas* en el río Amazonas. Además, Myers (1952) reportó su presencia en el río Iquitos, Perú, a una distancia de 4000 Km del Océano Atlántico.

En México, Bonfil (1997) reportó su presencia en las lagunas costeras al sur del Golfo de México y el Caribe. Además, se ha detectado a varios individuos que efectúan movimientos de gran consideración entre los ríos que desembocan al Caribe, principalmente por el rio San Juan (Castro-Aguirre et al. 1999), el cual nace en Nicaragua. Para el Golfo de México ha sido reportado en localidades continentales, tal es el caso de Tampico en Tamaulipas y Tuxpan en Veracruz (Castro-Aguirre 1978); asimismo, en Laguna de Términos; al igual que en las localidades de Frontera, Chiltepec y Emiliano Zapata en Tabasco (Castro-Aguirre 1978; Castro-Aguirre et al.

1999), así como en la Laguna las Ilusiones (Castro-Aguirre 1978), actualmente un sitio urbanizado en el centro de la ciudad de Villahermosa, Tabasco. Sosa-Nishizaki et al. (1998) reportaron la captura de un macho adulto de 14 años de edad en la Laguna San Pedrito en Centla, Tabasco; y la captura de individuos en el Río Usumacinta aun con presencia de cicatriz umbilical, los cuales tenían una talla de 0.78-0.83 m de longitud total.

La especie es clave para ilustrar la conectividad que existe en los sistemas dulceacuícolas y costeros. Sin embargo, poco se sabe de la abundancia de *C. leucas* en el pasado y de cuan abundante fue en el Río Usumacinta y de lo lejos que podía incursionar río arriba. Dado que en el pasado muchas especies eran de escaso valor comercial, sus datos de captura no se registraron en las estadísticas de pesca (Ferreti et al. 2010), o bien como es el caso de México, aunque las estadísticas comenzaron a tomarse a finales de la década de los 1930s (Pérez-Jiménez, Méndez-Loeza et al. 2012), su colecta no fue desagregada por especie. En ese sentido, el presente estudio hace una reconstrucción histórica de la explotación pesquera de *C. leucas* en el Río Usumacinta y zona costera de influencia, por medio de la historia oral con pescadores artesanales y la revisión de fuentes escritas. El presente documento está conformado por una introducción, el artículo científico, conclusiones y literatura citada.

Planteamiento del problema

Aunque existen algunas anécdotas dispersas de que el tiburón toro, solía entrar en los grandes ríos de México, esta pesquería nunca fue documentada, ni tampoco fueron tomados datos pesqueros que nos permitan evaluar el estado actual de las poblaciones de esta especie en los ríos. La historia ambiental, en particular la historia oral, contrastada con documentos históricos, permite describir si esta pesquería fue importante en una región, así como sugerir algunos cambios aproximados en la abundancia histórica de esta especie en la región.

Objetivos

- Documentar la pesquería del Tiburón Toro en la planicie de inundación del Usumacinta y zona costera de influencia, describir su importancia social, y evaluar la diferencia de la percepción de la abundancia entre las diferentes generaciones de pescadores de la zona ribereña.

Capítulo 2. Articulo científico sometido a la revista Endagered Species Research

Historical fishery of the bull shark (*Carcharhinus leucas*) in the Usumacinta River and coastal zone, in the southern Gulf of Mexico

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Running head: Bull shark from the Usumacinta river

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Abstract

The study of fisheries of highly migratory organisms such as sharks is a challenge in tropical and subtropical zones of the world. Much of the fishery information is collected once the population abundance of these species has already diminished. This phenomenon is particularly dangerous for species that are highly vulnerable as a result of their particular life cycles, such as the bull shark (*Carcharhinus leucas*). Through the revision of the historical literature and oral history, this study describes the subsistence fishery of the bull shark presented from the 1950s to the 1990s in the Usumacinta River in Mexico and its coastal zones of influence. Our data indicate that the species was abundant and exploited locally up to the 1990s and data from the catches that took place in the river where never taken inside the rivers; likewise, individuals captured used to swim at a distance of more than 300 km upstream the Usumacinta River. The contrast between fishery studies conducted at the end of the 20th century and modern data, the philopatry that characterizes this species in other rivers of the world and the narrative of the fishers in terms of the historical abundance, leads us to suggest that deep studies should take place to understand the status of this species in tropical and subtropical rivers. Our study provides an example of what could be done in other tropical and subtropical rivers of the world to document historical fisheries where populations of bull sharks used to present wide distribution.

Key words: Oral history, shifting baseline syndrome, ecological extirpation, euryhaline sharks, philopatry.

Introduction

Sharks, rays and chimaeras form a group of species that are among the most threatened in the world, and their conservation and management present enormous challenges (Dulvy, Simpfendorfer et al. 2017). These species are of slow growth and low reproductive capacity, and reach sexual maturity late (Musick 1999). They are highly migratory: their home range generally includes various countries and almost all of the species present ontogenetic migration (Andrews, Williams et al. 2010), in which neonates, juveniles and sub-adults have adapted to utilize specific habitats that allow them to complete their life cycles.

The family Carcharhinidae comprises 12 genera and 60 species of sharks, with a wide distribution globally (Fricke, Eschmeyer et al. 2020). Within this family, the genera *Carcharhinus* and *Glyphis* include species that enter the tropical and subtropical rivers of the world to complete part of their biological cycles, for which reason they have been called “river sharks”, a vernacular term proposed by Compagno (1984). This is the case of the bull shark *Carcharhinus leucas* (Valenciennes 1839), which is a highly migratory species of marine euryhaline species, with a global distribution in tropical and subtropical regions, including the Caribbean sea and Gulf of Mexico (Castro-Aguirre, Espinosa-Peréz et al. 1999, Fowler 2014). The species has coastal habits, and is capable of venturing into brackish, marine and freshwater environments (Compagno, Dando et al. 2006, Brunnschweiller, Queiroz et al. 2010). It has been known for some time that the species can spend long periods inhabiting bodies of fresh water, such as Lake Izabal in Guatemala (Thorson, Cowan et al. 1966) and Lake Nicaragua (Thorson, Watson et al. 1966) and its tributaries, and can travel long distances in rivers. In South America, for example, it has been reported in the Iquitos River in Peru at a distance of 4000 km from the Atlantic Ocean (Myers 1952).

Although there are ancient records of the use and presence of the bull shark in the continental waters of Mesoamerica during pre-Hispanic times (Newman 2016), little is known about the abundance of the species in the rivers and how far they can penetrate into these bodies of fresh water. During the period 1976-1992, *C. leucas* was

reported as common in the coastal fisheries of the Gulf of Mexico in the states of Tamaulipas, Veracruz, Campeche and Yucatán (Bonfil 1997). Other studies describe the presence of this species in continental localities such as Términos lagoon in Campeche and Chiltepec in Tabasco; likewise in other continental localities of the Usumacinta River basin, such as Frontera and Emiliano Zapata in Tabasco (Castro-Aguirre 1978, Castro-Aguirre, Espinosa-Peréz et al. 1999), being the latter the most distant locality from the Gulf of Mexico in which the presence of the species has been reported (Fig. 1). At the end of the 20th century, Sosa-Nishizaki et al (1998) reported the presence of *C. leucas* in San Pedrito lagoon and the Usumacinta River, very close to Tres Brazos, and at the end of the 1970s, its presence was reported in Las Ilusiones lagoon, today found in a park in the center of the city of Villahermosa in Tabasco (Castro-Aguirre 1978).

Derived from its use of estuarine habitats subject to degradation through anthropogenic activities such as pollution, sedimentation and habitat fragmentation (Moore 2018), as well as its own biological characteristics (Clark and Von Schmidt 1965, Branstetter and Stiles 1987, Cruz-Martínez, Chiappa-Carrara et al. 2005, Yeiser, Heupel et al. 2008, Carlson, Ribera et al. 2010), *C. leucas* presents the attributes of a species that is highly vulnerable to overfishing and prone to a high risk of extinction (Dulvy, Simpfendorfer et al. 2017). However, due to the lack of information with which to reconstruct the trajectories of its abundance, the most recent global evaluation of its population status categorizes it as “near threatened” in the IUCN Red List (Simpfendorfer and Burgess 2009, IUCN. 2020).

Recent studies in the coastal area where the largest river system of Mesoamerica (Usumacinta-Grijalva and Mezcalapa) drains, consider that the local bull shark population is highly vulnerable precisely due to its biological characteristics and trajectory of historical impact (Martinez-Candelas, Perez-Jimenez et al. 2020). The contrast between recent scientific studies and those conducted more than twenty years ago suggests that this species could indeed be at risk of extirpation. For example, a study published at the end of the 1990s reported *C. leucas* as a very common species in

coastal catches made in the Gulf of Mexico (Bonfil 1997) and present in the municipal market of Frontera, Tabasco (Sosa-Nishizaki, Taniuchi et al. 1998), while a study published almost two decades later indicated that, in the different ports of the Yucatán Peninsula, the low proportion of this species in the total catch of sharks means that it can be considered rare (Perez-Jimenez and Mendez-Loeza 2015).

Understanding the population dynamics of a species with a relatively long history of exploitation requires an accurate baseline (Sáenz-Arroyo, Roberts et al. 2005). However, marine ecosystems are often evaluated after the abundance of its given components has undergone historic reductions. As a consequence, our perception of what is natural is formed in the context of ecosystems that are already downgraded and thus provide misleading points of reference (Sáenz-Arroyo, Roberts et al. 2005). This condition is known as “shifting baseline syndrome” (Pauly 1995) and refers to the gap in the information regarding changes in the historical abundance of the population of the target species prior to ecological population monitoring.

The goal of the present study was to describe the historical importance of the bull shark *C. leucas* in fresh water environments of the Usumacinta River flood plain in order to contribute to the understanding of how the population of this shark has changed. Even this study will not provide population trends similar to the ones produced by ecological and fisheries methods, it will create a history that could help to sustain that this species might be at greater risk of what conventional methods could state. This study provides a methodological tool that allows evaluation of the risk of local extirpations of the bull shark at global level. A historical ecological reconstruction was carried out aimed at developing a quantitative approach that would allow description of the historical importance of the bull shark fishery in the Usumacinta River flood plain and marine zone of influence, and thus to determine its current state of vulnerability in the region.

Methodology

The methodology proposed by Sáenz-Arroyo et al. (2005, 2005, 2006) was used to reconstruct the past catches of the bull shark in the study area. This method combines grey literature, archives, review of official fishery statistics and interviews with fishermen (oral history), and then crossing this information in order to reconstruct a trajectory of historical impact. The summaries of these information sources were contrasted in order to describe the historical fishery and propose the conservation status of this subpopulation, in this region using the qualitative approach IUCN suggests should be considered in case of data less regions (UICN 2020).

For this, we visited public libraries and historical archives of the region in search of old literature about fisheries. In Tabasco, we visited the Archivo Histórico y Fotográfico de Tabasco, Archivo General del Estado de Campeche, Archivo Municipal de Campeche, the José María Pino Suárez public library and the José Martí library of Universidad Juárez Autónoma de Tabasco. Likewise, we consulted the fishery records available in the series of statistical yearbooks 1970-2018 of the Comisión Nacional de Pesca y Acuacultura (CONAPESCA), a department of SADER.

Fishermen were interviewed in localities selected based on the scientific reports of bull shark presence of Castro-Aguirre (1978), Castro-Aguirre et al. (1999) and Sosa-Nishizaki et al. (1998) (Figure 1), as well as other localities that form part of the Usumacinta river and tributaries (the Palizada and San Pedro-San Pablo Rivers) flood plain and influencing coastal zones (Figure 1). The bull shark is caught frequently in the coastal area, in Torno largo, near Chiltepec (Perez-Jimenez and Mendez-Loeza 2015).

Information was collected from the fishermen through a semi-structured interview (see Annex I), designed to detect possible changes in the historical catches. The interviewees were asked specifically about the bull shark fishery, their best catch day and the biggest bull shark they had caught, as well as the years in which these events took place (Sáenz-Arroyo, Roberts et al. 2005). To calculate the largest shark ever remember was caught, we asked fishers to put the size remembered in the wall or in the floor and record the measure this memory with a tape measure (Saenz-Arroyo et al.

2005). Relation of anecdotes was encouraged among people considered fishing experts, or veterans (of greater age) (Early-Capistran 2014), which provided us with qualitative dimensions on the magnitude of the fishery activity. Considering that the fishermen use common names to describe the different species and that some of these names differ among communities, or that the same common name may refer to more than one species, pictures were used as a guide with which to identify the target species during the interview.

Interviews were conducted in 2019, from the 28th of February to the 22nd of March and from the 24th to the 27th of June. As a first approach in the search for interviewees, we went to fishery cooperatives and warehouses that receive fishing products. We interviewed a total of 52 fishermen belonging to 13 fishing communities located in six municipalities of the states of Tabasco, Chiapas and Campeche (figure 1). The interviewees presented an age range of 26 to 84 years (greater than 60 years of age, n= 31; between 40-60 years, n= 19; less than 40 years, n= 2). It should be noted that, although we tried to include a greater number of younger fishermen in order to have appropriate representation of this generation in the oral history, we found almost no fishermen under the age of forty years in the sites we visited. With the prior permission of the interviewee, the interviews were recorded and transcribed for use in the construction of the oral history.

Results

Historical literature and fishery review

Zooarchaeological studies of the fishery exploitation and diet of the postclassical Maya population (Götz and Sierra-Sosa 2011, Newman 2016) indicate that the consumption of fish was a daily practice among the inhabitants of the Usumacinta River flood plain (Ruz 1993). The archaeological evidence indicates that the exploitation was directed mainly at the marine fauna of shallow waters and the capture of rocky and muddy bottom species (Götz and Sierra-Sosa 2011). It is possible that the sedentary life began at the edge of the sea, lakes and rivers, where the food resources are abundant

and its capture is possible even with fishing methods of low technological level (Ruz 1993).

The written chronicles in the first years of the Spanish conquest provide evidence of the abundance of marine fauna (fish, octopuses, rays) and of the great abundance of sharks along the entire coast of Campeche (De Landa 1566 (2007)). Likewise, the exploitation of natural riches such as the logwood tree at the hands of buccaneers who were also naturalists, such as William Dampier, leaves a testimony of the biological diversity that was found in this region and a description of the presence of species, now extinct, such as the Caribbean monk seal (Dampier 1699 (2014)). The exploitation of marine and aquatic resources, however, seems not to have gained interest in the region until the mid 19th century, when multiple vessels were reported dedicated to fishing (Barbachano and Carbó 1861), as well as the initiation of fisheries of local importance, such as that of the cazón (a general term mostly used in the past for juveniles of several species of sharks) of Campeche (Morelet 1871) and the trade of other marine products in the local market of the city (Romero 1887).

From the mid 19th century, sharks were considered the main fishery due to their abundance and accessible price (Alcalá-Ferráez 2010). They constituted a basic element in the diet of the inhabitants of Campeche (Morelet 1871, Alcalá-Ferráez 2010). It should be noted that, in the language of the local inhabitants of this region in this era, there was no differentiation between shark and cazón according to specimen size, indeed all juvenile and adult sharks were referred to as “cazónes” (Morelet 1871). However, fisheries scientist currently name cazon, small sharks and juveniles of large shark species that never exceed the 1.5 m of maximum length (Pérez-Jiménez, Méndez-Loeza et al. 2012).

For the first half of the 20th century, the economy of Campeche depended mainly on agriculture and forestry resources, mainly latex and precious timbers (De La Peña 1942). However, by the middle of that century, the great abundance of marine species for the Gulf of Mexico and the Bay of Campeche was being described as a potential resource for the development of a prosperous industry (De La Peña 1942).

Commercial trade in shark meat in the region of Campeche is first mentioned by Morelet (1871), who describes different techniques of preservation for its consumption, which are still in use today. Sharks were consumed fresh, salted, grilled, fried and stewed. In the 20th century, sharks and cazón were preserved in salt and sun-dried for transport over long distances, and also grilled for preservation for several days, which allowed the meat to be transported to settlements and ranches inland. For its sale, and once cut into pieces (*tasajo*), sun-dried and preserved in salt (Figure 2), the meat was packed into sacks and sent to the interior of the country for distribution (De La Peña 1942).

In 1952, the fishing industry reached its peak in the region, as in the rest of the country, through the application of official programs to encourage the development of the fishing industry in Mexico such as “La marcha al Mar” (Alcalá 2003), that had the goal of decentralize the population of the Mexican high central plateau and promote the use of the marine resources of the country (Martínez-Martínez and González-Laxe 2016).

Between the 1970s and 1980s, the importance of the shark fishery increased through governmental support, including the provision of boats, engines and fishing subsidies (Alcalá 2003). This is clearly reflected in the fishery statistics (Figure 3). In the second half of the 20th century, *C. leucas* was listed as a marine and freshwater species that is commercially exploited or incidentally captured in the region (Smith 1988). Although bull shark was still considered an abundant resource in the catches made in the zone at the end of the 1990s (Bonfil 1997), only two decades later it represented a minimal percentage in the catches made in the coastal zone (Perez-Jimenez and Mendez-Loeza 2015). This agrees with reports from in the statistical yearbooks of CONAPESCA in which, from 1979-1999, the annual catch of shark and cazón in the coast of Tabasco y Campeche ranged around 3,912 tons, while during the period 2000-2017 the annual catch was 1,482 tons, revealing a decrease of 62.11 % relative to 1979-1999.

Oral History

Fishing in the river mouths

Of the 52 interviewees, 86.5 % (n= 45) corresponded to fishermen in continental zones and 13.4 % (n=7) to fishermen in the river mouths (Boca barra). Of the total number of interviewees, 53.8 % (n=28) reported having caught bull sharks while 46.1 % (n= 24) had never caught the species. However, of the 46.1 % who did not catch bull shark, 21.1 % (n=11) had observed the past abundance of the species, while 25 % (n=13) did not report the past abundance of the bull shark.

The interviews conducted with fishermen of the mouth of the San Pedro-San Pablo River, the sandbar and the port of Frontera indicate that the fishermen recognize this species that “enters to have its young” in the rivers. On the coast, all species of shark are known as “cazónes” in their juvenile stage and as “sharks” when they are adults, which agrees with the findings of recent studies that describe the shark fishing on the coast (Perez-Jimenez and Mendez-Loeza 2015). However, each species is known by the different names conferred by the local inhabitants. In particular, the bull shark is referred to as “blanco”, “chato” and “jaquetón”, and when it is captured in the river or in coastal lagoons it is known as “xmoa”.

The first report we documented of the biggest shark ever captured was in 1956 and corresponds to a fisherman of 84 years of age in Frontera (Fig.1). The last report, from 2014, corresponds to a fisherman of 59 years of age at the mouth of the San Pedro-San Pablo River (Figure 4a). According to the fishermen, the average size of the specimens caught was 2.2 m in length; however, the capture of the biggest sharks of up to 3.3 m in length was also reported (Figure 4a). While the data gathered from the interviewees of the mouth of the Usumacinta river and its tributaries seems to indicate a negative trend over time with regard to the largest sharks ever captured, according to the interviewees, the species was still present until relatively recent times (2014).

According to the oral history, sharks were very abundant in the 1950s; interviewees recognize that the bull shark was much more abundant in the past that nowadays. With regard to the best day of fishing (Figure 4b), the data show that an

average of 10 sharks were caught daily in the coastal localities, and the data seem to indicate a slightly positive trend in this regard on the coast from 1950 to 1990. This could be related to technological changes in the fishing methods that occurred from 1960, as well as the support given to fishermen and the creation of cooperatives that drove the capture of sharks from 1971 (Tello-Domínguez 1988), and concurs with the commercial peak of the fishing activity reported for the zone (Figure 3).

In these sites (the Frontera estuarine-bar and San Pedro-San Pablo river mouth), the sharks fishery was much more intense than in the continental sites, given the existing demand and the presence of routes of communication for its trade. At the mid 20th century, all shark species were valued for their large size. The interviewees state that, due to their abundance, they only captured sharks greater than 100 kg in weight and avoided catching smaller animals, a situation that apparently changed over time. In this sense, it is considered that the abundance of sharks began to decrease after 1990 (Figure 4a), for which reason the fishermen resorted to catching other species basically comprising teleost of different families but predominantly groupers and snappers. According to the interviewees, this decline in the abundance of sharks was related to the modernization of fishing technology, and to the introduction of longline fishing in the 1990s, which caused overexploitation.

The oral history reveals that the shark trade was lucrative between the 1940s and 1960s. For example, veteran fishermen remember that in the 1950s, the fins, skin, meat, liver, jaws and the entire shark were sold. The fins had a price per kilogram of $20.00 MN, jaws sold for ¢20.00 MN each and a whole shark sold for $6.00 a $7.00 MN. The prices increased over time; by the 1960s, the price of a whole shark was between $50 and $100 pesos. The fishermen remember that, in order to utilize the skin, it was necessary to catch sharks of a minimum length of 1.80 m or weight of 100 a 260 kg. This was the time during which strong medicinal properties were being discovered worldwide in shark liver oil, which is a source of vitamins A, D and E, and saturated and unsaturated fatty acids (García, Fernández et al. 2015). Such properties made the shark

trade become more lucrative. The fishermen of the region even remember that a mixture of chalk and shark liver oil was used to repair the wooden boats in the docks.

Given the poor infrastructure for preservation, the meat was sun-dried and preserved in salt, a method that is still in use and appears to have been practiced since pre-Hispanic times. The fishermen state that shark was consumed in its juvenile, adult and even unborn stages. It was fished with various types of nets, such as "caliche"‡, "chinchorro" (A net with large mesh) and "paño" (A net with small mesh), as well as hooks, frames and harpoon. Subsequently, the use of longlines began in the 1990s. Older fishermen remember that, in the harpoon fishery of the mid 20th century, the liver of the giant manta ray (*Manta birostris*) was used as bait through a procedure known as "engodo", which attracted a great variety of shark species that could then be caught with a spear or harpoon.

The ecological observations of the fishermen interviewed reveal that in March there was a greater possibility of catching pregnant females, each carrying 10 to 15 young; likewise, by June or July, the bull shark juveniles weighed around 4 kg and came down the Usumacinta River where they could be caught with nets.

Upstream fishing

The continental sites in which the interviews were conducted correspond to the municipalities of Tenosique, Balancán, Emiliano Zapata and Centla in Tabasco; Jonuta in Campeche and Catazajá in Chiapas (Figure 1). At the time of conducting this study, Emiliano Zapata was the locality most distant from the ocean with a report of bull shark presence (Castro-Aguirre, Espinosa-Peréz et al. 1999). It is found at an approximate distance of 218 km following the course of the river or 109 km in a straight line from the coast. However, our findings indicate that this species came inland via the Usumacinta River at least as far as Tenosique, an approximate distance of 389 km from the Usumacinta River mouth at the port of Frontera, following the course of the river (or 145

‡ Local variety of mesh net. In the region, caliches were originally made with fiber of sisal and other local materials and traditionally used to trap juvenile sharks.

km in a straight line from the coast). On the banks of the Usumacinta River and its tributaries, the bull shark is known as cazón in both juvenile and adult stages, and there is no differentiation in name according to size as is the habit in the coastal zones (Table I).

The interviews with older fishermen indicate that this was a very abundant species in the zone up to the beginning of the 1990s, but that it can now be considered rare. Information relating to the past abundance and exploitation to which the bull shark was subjected was provided by interviewees of older age, but to a lower extent by those of middle age and the younger subjects. The latter are, in fact, a poorly represented group in our sample due to the fact that most do not practice fishing anymore, and in some cases do not even know that this shark species was found along the length of the river. The veteran fishermen remember passing shoals of 10 or 15 animals, which could be observed from the tops of the mountains that surround the Tenosique canyon (Table I). They remember that many more than one shark could be caught daily but that there was little market since it was generally only destined for sale in the local market of Emiliano Zapata.

The earliest report of a captured bull shark corresponds to a fisherman of 74 years of age in 1957 for the locality of Boca del Cerro in Tenosique with the capture of a 2 m bull shark (Figure 4a), while the most recent catch was in 2014, with two “cazónes” caught in a locality of Tres Brazos, reported by a fisherman of 48 years of age (Figure 4b). The average length of the largest bull sharks reported as caught by the fishermen interviewed was 2.1 m in length. However, animals of up to 3.5 m in length were caught according to the interviews (Table I).

Older fishermen remember that the bull shark was very abundant and that its capture was part of traditional fishery activities between the 1950s and the 1970s. During the 1980s, however, a decrease of reports of the presence of the species in riverine habitats is perceptible, along with its size and abundance (Figure 4a). Moreover, according to the report of a 51 year old fisherman in Emiliano Zapata, by the 1990s bull shark was caught just by older fishermen, considering that by then its capture was

already very rare, considered as “an extraordinary”. Moreover, there was by then no local market, as described by the older fishermen from the 1950s to the 1970s, in Tenosique and Emiliano Zapata. For this reason, by the 1990s, captured bull sharks were destined for self-consumption. As a consequence, it is estimated that, by the 1990s, the abundance of the species in riverine habitats had declined considerably.

When the interviewees were asked about their best day of fishing, the average catch was three sharks per days; likewise, the fishermen reported the most frequent catch of one to two adult sharks daily between the years 1957 and 1985 as well as the capture of four to seven juveniles. By 1995, the capture of five juvenile sharks and two juvenile sharks in 2014 was mentioned by fishermen of 62 and 48 years of age in Tres Brazos. It should be noted that these latter two events were considered very rare by the interviewees (Figure 4b).

The fishermen indicated that bull shark catches were not recurrent given the absence of routes of communication (highways and transport) and the deficient infrastructure for their preservation, which acted to limit the trade in these zones. It was common to hear stories in which, due to the fact that some of the fish was unsold, the product decomposed and various species of fish were thrown into the river or buried to avoid the bad smell.

The accounts of the fishermen who remember the bull shark fishery in the interior reaches of the Usumacinta River indicated that this and other species were destined mainly for self-consumption or local sale. Their capture was either directed or incidental, with the use of nets, large hooks and trotlines. With the hooks, they caught adult bull sharks and with the trotlines, a fishing method similar to the longline technique, they caught juveniles of between 50 and 100 cm in length. Their sale was representative in Emiliano Zapata and, to a lesser extent, in Tenosique. The interviewees report that only the meat was consumed, with no other part of the body, such as fins, jaws, liver or skin, used. The meat was sold in pieces of 3 to 5 kg in weight (Table 1). In Tenosique in 1957 each piece of meat was sold at $5.00 MN, in Emiliano Zapata by 1956 at a price of ¢60.00 [centavos] MN, and at the start of the 1980s, it had a price of $2.50 MN. All of

this information demonstrates the abundance of the bull shark at that time and its importance in the diet of the local inhabitants and in the local market.

Finally, it was possible to collect data of ecological observations. The fishermen state that the bull shark entered the river in order to feed on other fish species such as catfish (e.g. *Ictalurus meridionalis*) and snook (*Centropomus spp.*). They also report that the bull shark entered the Usumacinta River to give birth to its young. The inhabitants of the locality report that the bull shark came upstream between the months of June and August when the strength of the current was high because of the rains, supporting what described by Clark and Schmidt (1965) for the Gulf of Mexico and Jensen in Lake Nicaragua (1976).

Discussion

The interviews with the fishermen indicate that during the first half of the 20th century, the bull shark *C. leucas* was abundant in the Usumacinta River for up to 300 km upstream in places as far from the coast as Tenosique in Tabasco and Catazajá in Chiapas (Figure 1), and that it formed part of a subsistence fishery and was sold in the local markets along the length of the river. On the coast, the species appears to still be present, although its capture appears to have decreased notably., the species appears to still be present.

Although the interviews did not reveal a clear population trend up to the present (Figure 4), the tendency of the best day of fishing according to the memories of the fishermen suggests that the number of bull sharks that entered the Usumacinta River flood plain and its tributaries declined notably after the 1990s.

While there is no official record of the *C. leucas* catch on the Usumacinta river, the capture and abundance information held in the oral memory of the fishermen indicates that the population of the species was important, since it used, and perhaps continues to use, these hydrological systems as an important part of its life cycle (feeding, rearing or reproduction), as is reported in other parts of the world (Springer 1963, Bonfil 1997, Sosa-Nishizaki, Taniuchi et al. 1998, Yeiser, Heupel et al. 2008, Heupel and Simpfendorfer 2011).

The characteristics in the life history of *C. leucas* (Clark and Von Schmidt 1965, Branstetter and Stiles 1987, Cruz-Martínez, Chiappa-Carrara et al. 2005), such as low fecundity, slow growth and late sexual maturity, are compounded by the environmental variations that affect the estuarine systems and freshwater wetlands of the world (Lotze, Lenihan et al. 2006), causing a drastic increase in the vulnerability of this species to human activity (Martin 2005). In Mexico, as in other parts of the world, which challenge is increased since the fishery catches are frequently grouped into large taxonomic categories such as “shark” or “cazón” (Bonfil 1997), which complicates the identification of population trends per species (Mendoza-Carranza, Arévalos-Frías et al. 2018), and the records in continental waters are even more precarious, or even absent.

This is the first report of the historical fishery of a euryhaline elasmobranch in freshwater ecosystems and one that formed part of the local fisheries in the delta of the Usumacinta River, the largest river in Mesoamerica. Evidence from around the world indicates that the bull shark is a philopatric species, i.e., the sharks, in this case the females, tend to return to the same estuarine system and rivers in which they were born (Tillett, Meekan et al. 2012, Feldheim, Gruber et al. 2014). This suggests that the bull shark was probably an abundant species in all of the large rivers of Mexico, playing an as yet little understood role in the trophic ecology of these systems. *Carcharhinus leucas* also presents an ontogenetic migration of hundreds to thousands of kilometers, not only connecting terrestrial and marine ecological processes, but also tropical and temperate systems, as has been documented in other parts of the world (Daly, Smale et al. 2014, Heupel, Simpfendorfer et al. 2015).

This, added to the reports of extirpation of populations due to habitat loss, such as in California (Swiff, Haglund et al. 1993) or the near extirpation of the population of Lake Nicaragua in the 1970s as a result of overexploitation in order to supply the market for fins (Martínez-Sánchez, Maes et al. 2001), allows us to suggest that *C. leucas* in this river basin is an endangered species at least should be recategorized as a species with the status of “near threatened” (Simpfendorfer and Burgess 2009), as an endangered species, which would highlight the urgent attention required in terms of understanding

the continental and oceanic migratory patterns of this species, as well as its population trajectory, as well as assessing what is happening with this species in other river basins. At global level, it is likely that *C. leucas* has a risk status similar to that of other species linked to habitats of reduced salinity, such as *Glyphis gangeticus*, which is cataloged as being “in critical danger”, and *Glyphis glyphis*, cataloged as “endangered” by the IUCN (Compagno 2007, Compagno, Pogonoski et al. 2009) or species of the family Pristidae, also considered as endangered or in critical danger around the world, as well as in various estuarine systems of Mexico (Bonfil, Mendoza-Vargas et al. 2017, Bonfil, Ricano-Soriano et al. 2018). However, studies as the one we presented should be done in different parts of the world, where this species might have had an historical distribution.

Currently, there is no legislation in force in Mexico to specifically protect the bull shark, other than a general for shark species NOM-029-PESC-2006 that established the closing seasons for all species of shark during their breeding season (DOF 2007) however, the anecdotal information suggests that the species is at risk in the study area and possibly in other rivers of the region. It is therefore necessary to consider these results as a basis for an inclusion of *C. leucas* into the Official Mexican Norm concerning species at risk NOM-059-semarnat-2010 (DOF 2010).

The methodology employed in this study presents a very useful alternative for estimating the historical importance of populations of *C. leucas* in the different estuarine systems and tropical rivers of Mexico and the rest of the world, where this species is very likely to have occupied the niche to exploit the richness of nutrients that come down the river from the mountains, as has been identified in other regions of the world. Environmental history, particularly oral history, represents a very powerful tool that allows consideration of species that are highly vulnerable to fishing or to environmental deterioration in the priorities of conservation (Sáenz-Arroyo, Roberts et al. 2005), which otherwise could be overlooked due to the lack of conventional data. However, this perspective does not discount the need for biological and ecological studies that would allow us to better understand the current range of distribution of these species, as well

as their role in the trophic ecology of the continental and oceanic systems they inhabit. Likewise, it is crucial to understand the current and past role of these species in the food security of the human populations that live in the riverine areas that either used to catch them, or still do. Our study is just the beginning of a line of research that should be considered priority in terms of understanding the ecological and social role of highly migratory species such as the bull shark in the estuarine systems and rivers of the tropical and subtropical countries of the world.

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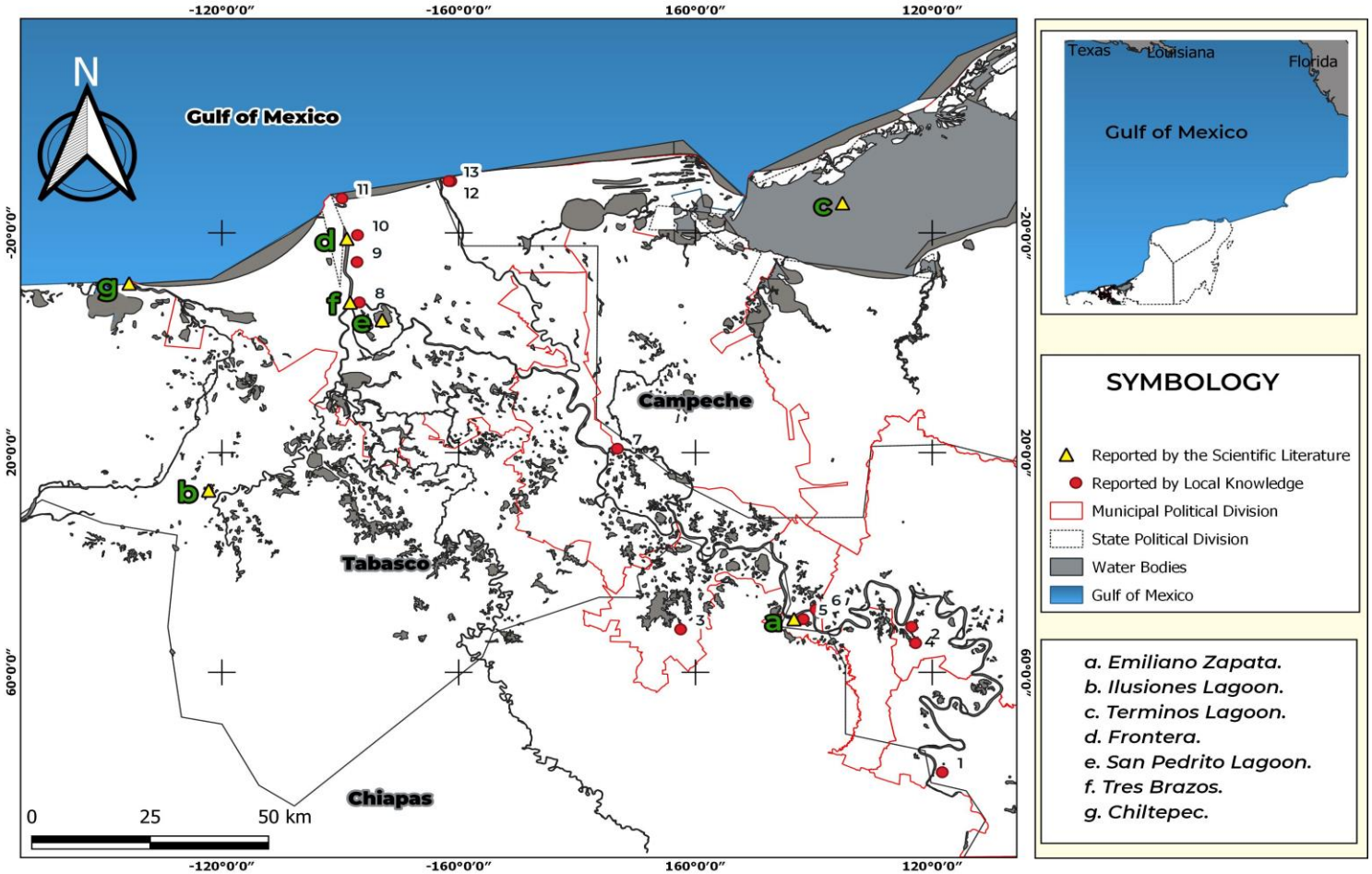


Figure 1 Study area. ***Sites in which interviews were conducted:*** *1) Tenosique, 2) San José del Río, Localidad. de Balancán, 3) Catazajá, 4) Ejido Leona Vicario; Localidad de Balancán 5) Emiliano zapata, 6) Sección Pochote; Localidad de Emiliano Zapata 7) Sacrificio Localidad de Jonuta, 8) Tres brazos Localidad de Centla, 9) Ejido Polo Localidad de Centla, 10) Frontera, 11) La Barra de Frontera and 12) San Pedro-San Pablo; 13) Nuevo Campechito.Localidad del Carmen* ***Reported in the literature:*** *Castro-Aguirre, 1978 and Castro-Aguirre et al. 1999: g) Chiltepec, d) Frontera, c) Términos lagoon and a) Emiliano zapata. Castro-Aguirre, 1978; Sosa-Nishizaki et al. 1998 and Castro-Aguirre et al, 1999; b) Las Ilusiones lagoon. Sosa-Nishizaki et al. 1998: e) San Pedrito lagoon, and f) Tres brazos (Produced by G.Y. Oliva-Macías).*

Figure 2 Drying nurse shark (Ginglymostoma cirratum) meat of the cooperative of fishermen of Ciudad del Carmen. Taken from Campeche Económico: Tomo II (De La Peña 1942).

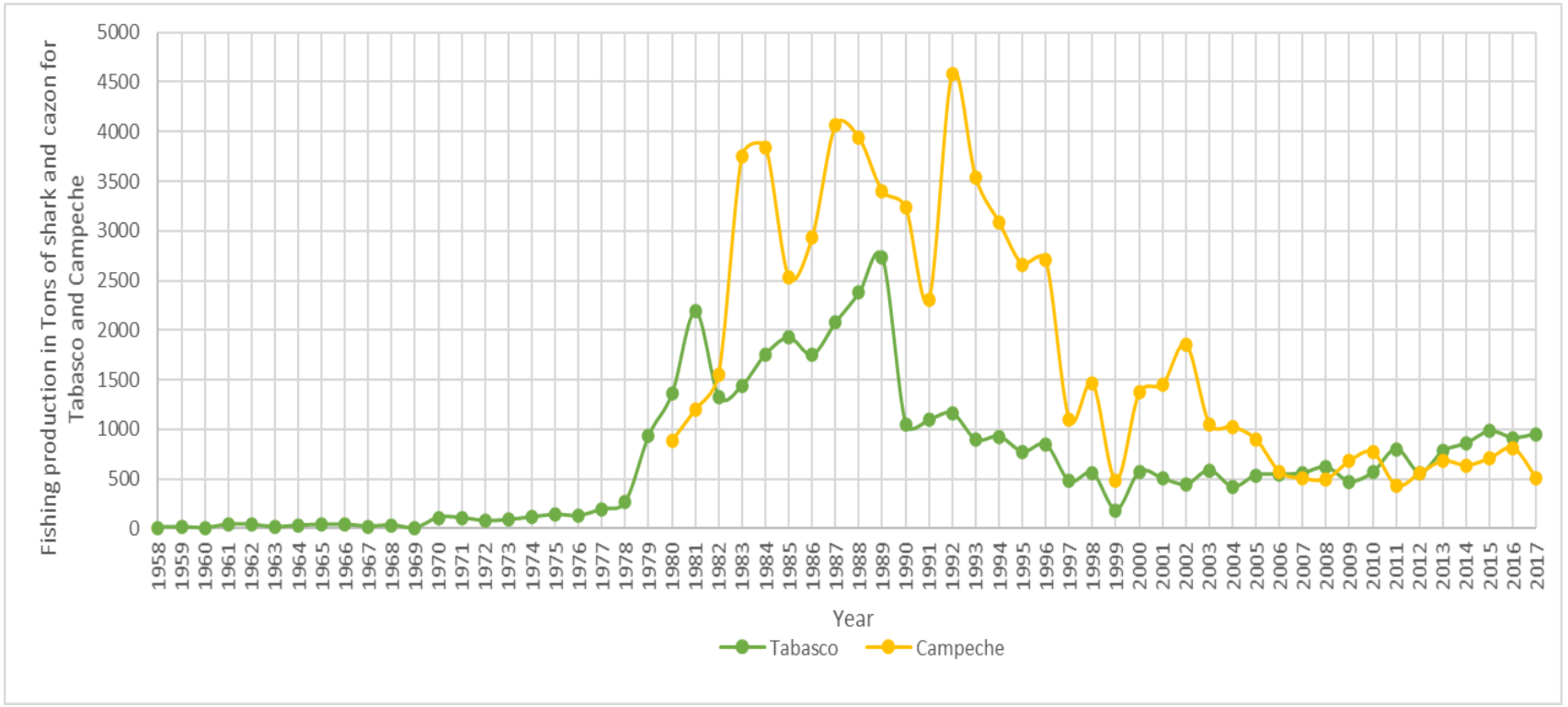
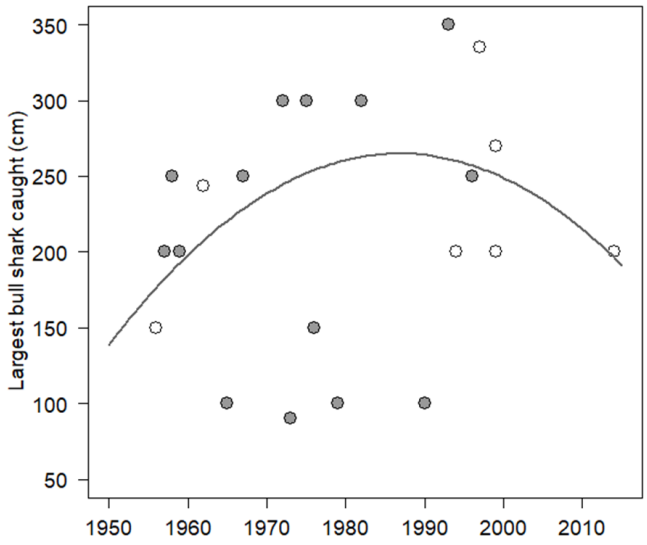


Figure 3 Production of shark and cazón in the states of Tabasco (1958-2017) and Campeche (1980-2017). Fishery production data from Tello-Domínguez, 1988 and the fishing statistical yearbooks from 1979 to 2017.

a)



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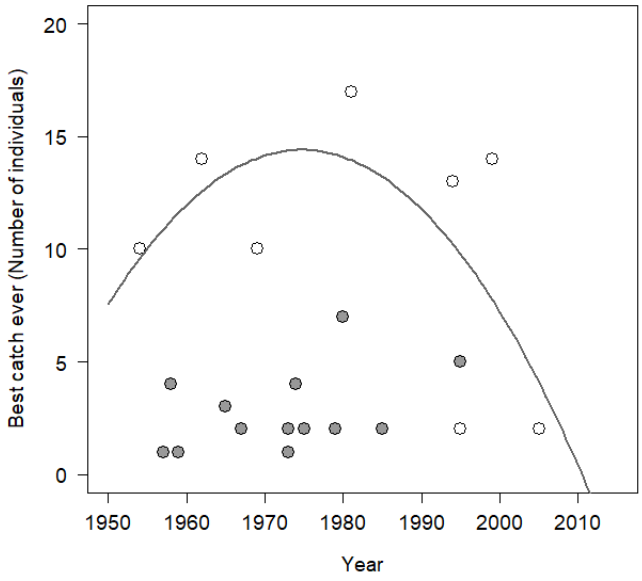

Figure 4a) largest bull shark caught (cm) and year of capture (Y= -0.093X^2 + 369.46X – 366760). P=0.4663, r^2= 0.31 b) best day´s fishing in number of specimens caught (n) and year of capture (Y= -0.0112X^2 + 44.40X – 43828). P=0.3269, r^2= 0.36 Empty circles denote the coast and full circles denote the Usumacinta river. The curves fitted to data from the coast do not have statistical support; it is only used to outline the trend.

Table. 1. Most relevant comments concerning the local ecological knowledge of the fishermen regarding the past abundance and exploitation of the bull shark

Source	Year and site	Quotes
Interviewee of 68 years of age from Tenosique, Tabasco	1966. Close to the bridge of Boca del cerro in Tenosique, Tabasco.	(Passing) shoals of 10 (to) 8 (bull sharks) could be seen, shoals of up to 15 animals passed.
Interviewee of 74 years of age from Tenosique, Tabasco	1957. Close to the bridge of Boca del cerro in Tenosique, Tabasco	“There were small (bull shark individuals), of less than two meters (in length); but (there were) several, a shoal you could say; but they were not very big’. Interviewer: What size were they?’ ‘About a meter and a half or close to two meters, they could be seen from above (on the mountain)’.
Interviewee of 80 years of age from Balancán, Tabasco	1960. On the Usumacinta River, close to the ejido Leona vicario	'They looked about three to four meters (in length), this shark does not attack you like the one in the sea '. Interviewer: ‘Did you see small ones (bull sharks)?' 'Yes, those called “cazón de vientre”; they grabbed these (small specimens) to eat them’.
Interviewee of 57 years of age from Emiliano Zapata	1969. Close to Emiliano Zapata, in Sección Pochote	You could fish what (the quantity) you wanted, but my father fished (no more than) one per day in order to sell it. There were all sizes, adult and young; my father set the trotline[§] weighted with a stone, when the line was tense, the (bull) shark had been caught. All year these animals were present, and 50 years ago, the last shark (was caught).
Interviewee of 72 years of age from Emiliano Zapata	1966. Close to Emiliano zapata, in Sección Pochote	At eight or nine at night we went down to see if the hook was already tight, and if you only caught one large (bull shark), we didn’t fish anymore. We could not catch five or six cazones, because we could not sell them; when they were small we put them back (on

[§] Trotlining is a fishing method similar to the longline, with various hooks on a line suspended across a river, perpindicular to the flow.

		the hook) to see if we could catch another one.
Interviewee of 68 years of age from Emiliano Zapata	1970s. Close to Emiliano zapata, in Sección Pochote	'There we saw them pass, suddenly they go swimming (in the river cazón and afterwards) changed direction, then you saw passing another. Interviewer: 'How many bull sharks did you see in a day? ' Interviewee: 'I saw (passing) about 10 (bull) sharks; they were big (sharks) because you see the big fins, when they are small you see a small fin, and these sharks were adults'.
Interviewee of 62 years of age from Emiliano Zapata	1970. Close to Emiliano zapata, in Sección Pochote	'They fished cazones of 3 to 4 meters (in length). These were sold here in Emiliano Zapata, they were sold per piece, or “por trucha” as they said. I was a young boy, but I remember that my father, my uncles and my grandfathers cut it up into pieces and in these pieces they took it to (Emiliano) Zapata to sell it; the people liked cazón very much'. Interviewer: 'How much did each piece weigh? 'About 4 or 5 kilos, but they were big pieces'.
Interviewee of 62 years of age from Emiliano Zapata	1972. Close to Emiliano zapata, in Sección Pochote	No one fishes now, before, the people did not bathe in the river for fear of serious injury. The water was clear and in the afternoon close to the bank of the river, the cazón could be seen passing; you saw them passing where they had been hunting snook or some other fish to eat.
Interviewee of 70 years of age from Jonuta, Tabasco	1967. In the Usumacinta River of Jonuta, Tabasco	Here, there were (bull) sharks; they entered the rivers because the rivers are deep. There are large and small (bull sharks), the largest measured from two to two and a half meters. You could see it when it showed a fin, (its fin) is like (the fin of) an airplane; as it moves forward it cuts the water very fast.
Interviewee of 84 years of age from Frontera, Tabasco	1950s. In Frontera bar, Tabasco	The bull shark was caught in the nets, before it had given birth to its young, it had about 10 or 15 unborn cazones; the young of the shark were also eaten.
Interviewee of 82 years of age from	1950s. In Frontera bar, Tabasco	The shark fins had value; I worked the shark fishing sold the meat and skin. (Before) the oil of the shark was extracted and taken to laboratories, where they made other products.

Frontera		
Interviewee of 60 years of age from Frontera, Tabasco	1980s. In Frontera	They call the young of the shark “cazón”. In June-July, the cazón (of bull shark) weigh around 3 to 4 kilograms, and when it comes down (the river) we fish it with nets; we caught up to 400-300 kilograms of cazón, which is equivalent to 100 or 200 small sharks. When we caught 15 or 20 adult sharks, they were fished with the caliche net[**]; (to catch them) we brought harpoon and caliche. If we did not catch them during the day with the harpoon, at night we left the caliche net set and hauled it the next day, you got 15 to 20 (sharks). You took what would fit in the canoe; sometimes we had to leave (the net), because there was no room on the boat.
Interviewee of 50 years of age from Ciudad del Carmen	1991. In Ciudad del Carmen	The shark (currently) is very rare, before there was an abundance of shark. All of the boats fished more shark (because) they earned more money, now there is no abundance of shark, we fish for bony fish. After the oil platforms arrived they (the sharks) went away.
Interviewee of 65 years of age from Atasta	1969. Atasta	There was cazón, (to catch it) we threw the caliche net and caught about 8 or 10 cazones of good size per night, sometimes 15 or 18 cazones.
Interviewee of 55 years of age from Isla aguada	1979. Isla aguada	With my grandfather, we fished 4 or 5 (sharks), we could not fish more because we did not use ice (to preserve them) they were salted and afterwards transported to Campeche, where they were sold'.
Interviewee of 48 years of age from Nuevo Campechito	1985. Close to Nuevo Campechito, in the Usumacinta River	The bull shark is the one that enters the rivers to have its young. An aunt commented that there were many sharks in the river, and the older people fished them. I was 14 years old, I fished and we went close to here (upstream), and had caught 15 to 20 sharks by the following day. Now there are none.

Annex I. Semi-structured interview to document the capture of the bull shark

Have you ever caught a Bull shark (*Charcharinus leucas*)?

Yes ( ) No ( )

If the response was yes;

What size was the largest bull shark you have caught? _____ cm ____ kg

In which year was it caught?

What type of fishing equipment was used?

Where was it caught? *NOTE LOCATION AND FILL MAP*

How many sharks have you caught in your best day of fishing?

_____

Were these sharks adults or cazón? _____

In what month was this?

In what year was this?

Where was this? *NOTE LOCATION AND FILL MAP*

Bull shark sightings

Have you seen a bull shark?

Yes ( ) No ( )

What size was the largest bull shark you have seen? _____ cm ____ kg

In what year was this?

Where was it? (in the water, on the pier) *NOTE LOCATION AND FILL MAP*

What is the highest number of bull sharks you have seen in one day? _____

Were they adult bull sharks or cazón? _____

In what month was this?

In what year was this?

Where was this? *NOTE LOCATION AND FILL MAP*

Do you know if bull shark females enter this place to give birth to their young?

Detail the places in which you have seen pregnant females and where their young are found.

Capítulo 3. Conclusiones

Las pesquerías en todo el mundo han sido afectadas por la combinación de elevada presión de pesca y degradación ambiental, por lo que se encuentran ya degradadas. Las pesquerías del Golfo de México no son la excepción. El presente estudio indica una notable disminución y posible extirpación de las poblaciones de *Carcharhinus leucas* en el Río Usumacinta. Si bien la narrativa histórica parece indicar que la población de este Río se encuentra funcionalmente extinta en lugares más alejados de la costa como Tenosique, o Emiliano Zapata en Tabasco donde se tiene reporte de la especie. No es posible descartar que algunos individuos ingresen a sitios continentales cercanos a la costa de manera extraordinaria, y en cantidades tan reducidas numéricamente que ya no son percibidas por los pescadores. En ese sentido sería conveniente realizar a futuro un estudio ecológico, con tecnología apropiada en busca de *C. leucas* en el Río Usumacinta.

Es importante mencionar que los tiburones son especies naturalmente vulnerables dada sus características de historia de vida. *C. leucas* es una especie migratoria que incursiona recurrentemente a los ríos, situación que lo convierte en una especie aún más vulnerable a las pesquerías durante toda su distribución y cambios de hábitat; así como por la propia destrucción de los cuerpos de agua. Se ha demostrado que es una especie filopátrica (Karl et al 2011; Tillett et al 2012), de acuerdo con Sandoval-Laurrabaquio-A et al (2020) bien podría tratarse de varias poblaciones las que ingresaban en el Usumacinta. Por otro lado, *C. leucas* es una especie carnívora con hábitos alimenticios del tipo generalista como otras especies de tiburones; es decir, se alimentan de una gran variedad de presas (Bascompte et al 2005). Es una especie clave en el mantenimiento y regulación de los sistemas marinos (Baum y Worm 2009). Sin embargo, se desconoce el papel que este gran depredador juega en los ríos.

Mi tesis puede ser usada como antecedente para el estudio de otras poblaciones de la especie *C. leucas* en otros ríos tropicales y subtropicales. El uso de la

historia oral de pescadores es una excelente herramienta de investigación para conocer la situación histórica y actual de las poblaciones de elasmobranquios y otros grandes depredadores en los ríos y costas donde prevalece una escasez de datos pesqueros históricos y recientes sobre capturas. La entrevista usada en la presente investigación fue diseñada para documentar la historia oral de los pescadores de manera precisa y demostrar así la presencia y abundancia pasada de *C. leucas* en la planicie de inundación del río Usumacinta y la zona costera de influencia.

De acuerdo a nuestros resultados de capturas en el mejor día de pesca se estima que la abundancia poblacional de la especie en el Río Usumacinta disminuyó. De reportar escuelas de hasta 15 tiburones (Tabla 1), la captura promedio de tres tiburones toro en un día y una captura recurrente de uno a dos tiburones de 1957 a 1985 en las localidades río arriba, para la década de 1990 la captura de *C. leucas* ya era considerada como rara. Si bien la especie fue parte fundamental del aprovisionamiento de proteínas en comunidades ribereñas, y también fuente de temor para los pobladores ribereños al grado de evitar meterse al río por temor a ser heridos de gravedad ahora ya no lo es. A su vez esta tendencia decreciente respecto al mejor día de pesca y el tiburón más grande capturado coincide con las cifras oficiales obtenidas de los anuarios estadísticos de CONAPESCA, quienes desde 1990 para los estados de Tabasco y Campeche se observa un comportamiento decreciente (figura 4a y b). En donde la captura anual de tiburón y cazón para el estado de Tabasco y Campeche de 1979-1999 se mantuvo a un promedio de 3,912 toneladas con una producción total de 82,146 toneladas. Siendo para 2000-2017 un promedio de 1,482 toneladas con una producción total de 26,686 toneladas para ambos estados, lo que arroja un decremento de la captura anual de 62.11 % respecto al periodo de 1979-1999.

Por lo anterior se recomienda que la especie *C. leucas* sea incluida dentro de la norma oficial mexicana sobre especies en riesgo NOM-059-semarnat-2010. Aunque los datos históricos recogidos de la memoria de los pescadores nunca van

a tener la solidez matemática que ofrecen los datos de captura por unidad de esfuerzo tomados sistemáticamente, la historia que he reconstruido en este trabajo permite inferir, o sospechar, como lo plantean los criterios de IUCN, que esta especie está a punto de ser extirpada en la zona ribereña del rio Usumacinta (IUCN, 2020).

Por lo tanto, Este trabajo aporta una línea respecto al estado actual de la población de tiburón toro en el Río Usumacinta. Además de proponer nuevas metodologías cuando a la reconstrucción de poblaciones históricas se refiere.

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