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Short Communication

**Occurrence of a juvenile white shark (*Carcharodon carcharias*)
in the southeastern Gulf of California, Mexico**

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ABSTRACT. Records of white sharks (*Carcharodon carcharias*) sightings or captures from the southern Gulf of California have been poorly documented and anecdotal evidence is limited. Even rarer is the event of a juvenile in subtropical waters. In the present paper, we report the capture of a juvenile female white shark taken in the lower Gulf of California, which represents an important contribution among the connectivity between individuals from California, United States and the Gulf of California, Mexico.

Keywords: *Carcharodon carcharias*, great white shark, incidental catch, Gulf of California.

The white shark (*Carcharodon carcharias*) is a member of Family Lamnidae. It is a widely distributed apex predator inhabiting coastal and pelagic zones from temperate and sub-tropical waters (Compagno, 2001; Weng *et al.*, 2007a). Juvenile white sharks occur in nearshore waters while adults are wide-ranging (Weng *et al.*, 2007b; Jorgensen *et al.*, 2012). Adults and subadults are known to perform long migrations, spending considerable time in oceanic waters (Boustany *et al.*, 2002; Bonfil *et al.*, 2010).

White sharks reproduce via aplacental viviparity and fecundity has been reported between 2 to 10 embryos per female (Fergusson, 1996; Uchida *et al.*, 1996). Although white shark sizes are frequently overestimated, recent examinations suggest maximum growth up to 6 m of total length (TL) (Castro, 2011). Diet varies according to maturity stages switching from bony fishes and invertebrates in juveniles to marine mammals for adults (Kerr *et al.*, 2006; Jaime-Rivera *et al.*, 2014). Recent age validation using bomb radiocarbon revealed that white shark can live up to 73 years old (Hamady *et al.*, 2014). This finding will change the corresponding age at maturity previously assumed for this species at California waters (*i.e.*, 10-12 years, Cailliet *et al.*, 1985) and also has implication for its conservation status where currently, the white shark is placed in the “Vulnerable” category in the IUCN Red List (Fergusson *et al.*, 2009).

The distribution of the white shark in the eastern Pacific Ocean ranges from the Gulf of Alaska to the

Gulf of California (GOC) and from Panama to Chile (Klimley & Ainley, 1996). In the GOC, white sharks have been reported in several localities (Galván-Magaña *et al.*, 2010), with the most sightings in the community “Golfo de Santa Clara” in the upper GOC. Records of white shark sightings and captures from the southern GOC have been scarcely documented. This paper reports the first capture of a juvenile female white shark in the southeastern Gulf of California, Mexico and represents the southernmost distribution of a juvenile in Mexican waters to date.

A female juvenile of white shark was caught near the shoreline in Mazatlán (22°51.050'N, 106°17.522'W) on the December 20th, 2013. The individual was incidentally caught by the fishermen using the long-line equipment typically employed in artisanal shark fishery (Fig. 1).

The bait used was jumbo squid (*Dosidicus gigas*) and skipjack tuna (*Katsuwonus pelamis*). Since commerce of any product, sub-product or by-product of the white shark is prohibited by Mexican fishing (NOM-029-PESC-2006) and environmental (NOM-059-SEMARNAT-2010) laws, the specimen was inaccessible making an examination of stomach content and gonad condition impossible. We estimated a fork length (FL) of 1.6 m (based on objects relative to the shark) and TL of 1.83 m estimated using the FL-TL relationship of Mollet & Cailliet (1996) (photo was taken with a digital camera, image was analyzed using the Image Pro Plus 7.0 software and calibrated with a

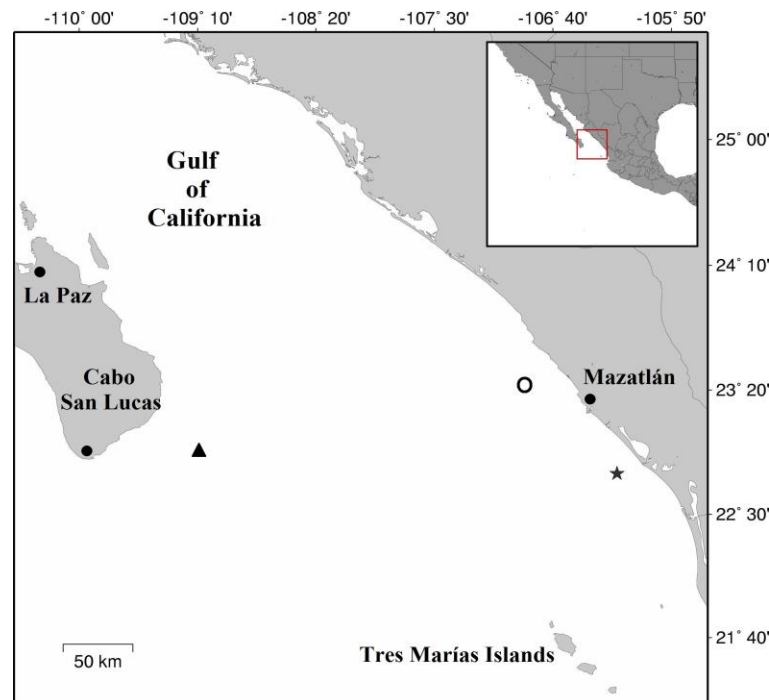


Figure 1. Position of the capture of the juvenile white shark by the artisanal fishery from Mazatlán (★) ($22^{\circ}51.050''\text{N}$, $106^{\circ}17.522''\text{W}$, 2013/12/20), Barras de Piaxtla (○) ($23^{\circ}35''\text{N}$, $106^{\circ}49''\text{W}$, 2002/04/04) by Corro-Espinosa (2005) and position of a juvenile white shark tagged by John O'Sullivan by Monterey Bay Aquarium (▲) ($22^{\circ}53'25''\text{N}$, $109^{\circ}09'28''\text{W}$, 2007/04/15).

known object) and total weight of 70 kg (reported by local fisherman) (Fig. 2). The jaw was obtained from the fisherman and kept to Facultad de Ciencias del Mar from Universidad Autónoma de Sinaloa at Mazatlán.

In Mexico, the white shark studies have been focused at Cedros, San Benito, Guadalupe, and the Revillagigedo Islands, also reported along the western coast of Baja California Peninsula, and its presence in GOC has been few documented (Galván-Magaña *et al.*, 2010; Domeier, 2012). Although spotty occurrences and governmental laws have limited the ability to gather knowledge on the biology of the white shark, satellite-based tagging technology has made important steps towards understanding patterns of movement and migration of large pelagics, including some sharks (Boustany *et al.*, 2002; Weng *et al.*, 2007a; Domeier & Nasby-Lucas 2008; Lyons *et al.*, 2013).

The long-distance migration of white sharks from Californian waters to Hawaii has shown that water temperature does not necessarily restrict the distribution of the species (Boustany *et al.*, 2002). A similar example of large-scale migrations of a female white shark from South Africa to Australia provides direct evidence of the capability white sharks to travel long distances that were not necessarily correlated to environmental factors (Bonfil *et al.*, 2005).

In the northeast Pacific, the connectivity between known populations of white sharks in California, Guadalupe Island, and the GOC has been poorly documented. However, recent evidence exists to re-elaborate the hypothesis not in the sense if connectivity exists but instead, why there would not be connected if we consider that in Isla Guadalupe takes place the highest concentration of subadult white sharks in northwestern Mexico (Galván-Magaña *et al.*, 2010; Domeier & Nasby-Lucas, 2013; Oñate-González *et al.*, 2015). On the west coast of Baja California Peninsula, Santana-Morales *et al.* (2012) reported the occurrence of white sharks in artisanal fisheries based on carcass remains. Notably, these records revealed that the incidental catch of white sharks is mostly composed of (79.8%) small juveniles (≤ 175 cm TL). These quantities are consistent to the proportions of juveniles reported in Californian waters (Lowe *et al.*, 2012; Lyons *et al.*, 2013). Historic reports of white sharks in the GOC show a distribution in throughout the area, juvenile and adults have been reported in upper, central and southwestern GOC but none in southeastern (Galván-Magaña *et al.*, 2010). Only one report has been documented in southeastern GOC by Corro-Espinosa (2005) who analyzed a juvenile female of 260 cm TL caught 65 km North of Mazatlán and near to the shark reported in this study (~97 km).



Figure 2. A female juvenile of white shark caught off the coast of Mazatlán (22°51.050'N, 106°17.522'W) on the December 20th, 2013 by artisanal fishermen.

Presence of juvenile individuals in GOC has been reported mostly in the upper Gulf, mainly in shallow waters during the cold season (December to May) (Galván-Magaña *et al.*, 2010; Oñate-González *et al.*, 2015), this is contrary to found in this study at southeastern GOC in cold season, in these productivity nearshore waters where most artisanal and industrial fishery operate, making them vulnerable to fishing mortality. Another report of presence was a white shark tagged with a pop-off satellite tag and released off the coast of California by the Monterey Bay Aquarium (J. O'Sullivan, *pers. comm.*) showed the movement of the shark southward. The satellite tag was recovered off the coast of Cabo San Lucas (southern tip of Baja California), revealing a trajectory of the juvenile white shark towards the GOC and this behavior is probably to feeding at this zone (Jaime-Rivera *et al.*, 2014). The Gulf is an area of high productivity, but also a zone with susceptibility for capture given the high fishing activity.

For decades, the white shark has been subject to considerable attention from the public and science, given its antagonistic and mysterious reputation. Although the state of knowledge about its natural history is still limited, this has gradually increased over the past decade with interesting findings. Recent age validation using bomb radiocarbon revealed that white shark can live up 73 years old (Hamady *et al.*, 2014). Although this finding has important implications for conservation, the validation, for now, is representative for specimens from Northwest Atlantic Ocean and care must be taken to assume same longevity to other oceans where habitat conditions may have different patterns or dynamics (L. Natanson, NEFSC-NOAA, *pers. comm.*).

Bycatch of white sharks in different fisheries from northwest of Mexico is not frequently reported and there is little or nothing opportunity to collect data from dead specimens. Although white sharks are considered in both fishing and environmental laws, until a combination of comprehensive educational programs and more rigorous enforcement of laws takes place, captures of the white shark in Mexico will continue to be considered a trophy of low price meat and very expensive jaws in the black markets.

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