

# First Recorded Account of a White Shark Agonistic Pectoral Fin Depression Behavior at Guadalupe Island, Mexico

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## Abstract

An agonistic display by a white shark was observed and photographed during a cage dive at Guadalupe Island in November 2015. Exhibiting exaggerated pectoral fin depression, agonistic behaviors have been previously observed and described in several shark species. This account may be the first record of a white shark in close proximity to a caged diver, exhibiting strong pectoral fin depression significantly dipped, in the mid-agonistic display. Such displays should be considered as aggressive and potentially life-threatening by those using the ocean for recreational or professional purposes.

## Keywords

White Shark, Ocean, Agonistic Behavior, Pectoral Fin Depression, Cage Diving, Guadalupe Island

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## 1. Introduction

The shark cage diving industry has historically been a topic of controversy. While it offers an opportunity to view sharks in their natural environment, it has been frowned upon in some communities as a means of conditioning and habituating sharks to boats and people. A flurry of shark bite incidents off South Africa in the late 1990s (for example) spawned a high-profile media-hyped controversy on the assumption that exposure of white sharks *Carcharodon carcharias* (Linnaeus 1758) to cage diving in the Western Cape somehow caused them to bite people elsewhere [1] (Compagno, 2001).

A recent study, however, suggests that current ecotourism has no effect on the conditioning of white sharks [2] (Becerril-García *et al.*, 2020). Combined with

potential educational opportunities for tourists, shark cage diving ecotourism has been credited with financial gain and employment for local communities. The combined undesirable effect of what a boat, cage, and human may have on the shark, however, can be overlooked. While the whole cage diving experience is generally a positive one for the human, the negative effect of a cage in the water, intruding into the sharks' environment, needs to be considered along with the possible short-term impact and energy cost this has on the animal.

When observing sharks from the safety of an underwater cage, trying to determine what effect the presence of a foreign object has on the animal, can prove to be extremely challenging and problematic.

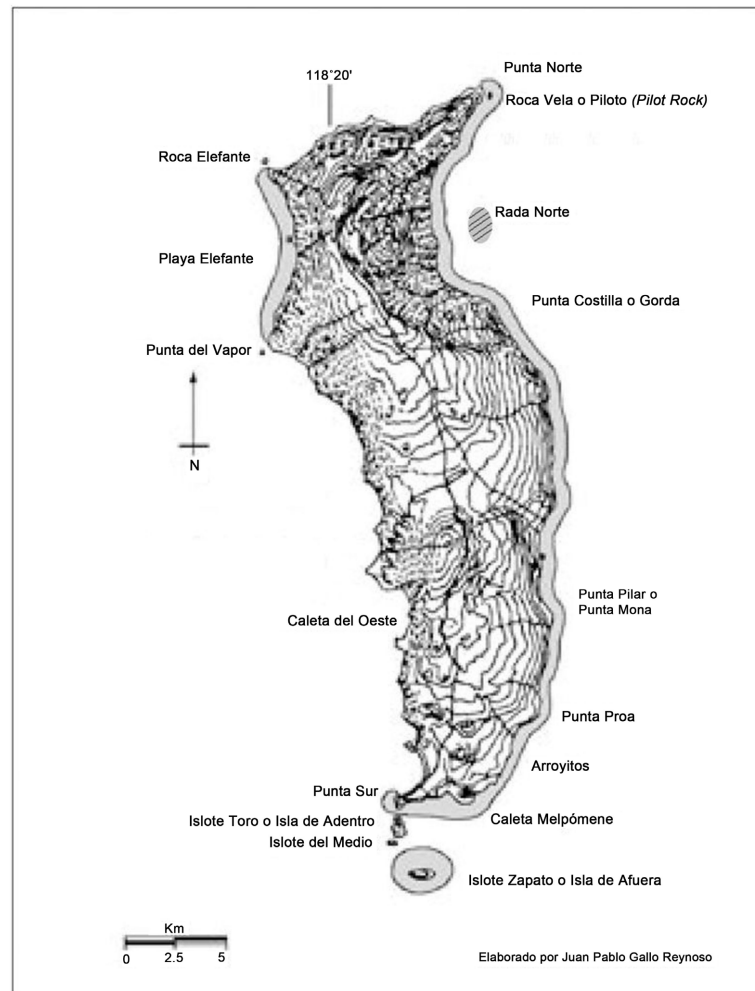
For the vast majority of shark species, very little is known about their social behavior under natural conditions. Although there are always exceptions, if a shark happens to cross paths with a diver, the shark's typical response is to move out of sight of the diver and not return [3] (Nelson, 1977). In a baited scenario, as soon as a cage is put into the water for observation purposes, an unnatural environment is immediately created which may trigger behaviors that could be energetically costly to the shark.

The agonistic displays of various species of sharks have been well-documented in numerous publications. Several carcharhinid sharks have been observed displaying such as the silvertip shark *Carcharhinus albimarginatus*, Galapagos shark *C. galapagensis*, oceanic white tip shark *C. longimanus*, and the grey reef shark *C. amblyrhynchos* [4] (Martin, 2007). The carcharhinids are perhaps the most widely documented species of shark known for this behavior, the earliest authoritative documentation recorded off Wake Island in the Pacific Ocean in 1961 resulted in an injurious attack [5] (Church, 1961).

The agonistic displays of sharks are not limited to members of the Carcharhinidae family, however, Martin (2007) [4] describes such displays in 23 different species of sharks from five other families: Odontaspidae, Cetorhinidae, Triakidae, Sphyrinidae, and Lamnidae. The *Tail Slap* and *Breach* behavior of white sharks has been described as an agonistic display [6] (Klimley *et al.*, 1996) primarily from boat observations at the South Farallon Islands, central California. This account may be the first record of a white shark performing an agonistic display at Guadalupe Island.

## 2. Materials and Methods

Guadalupe Island, Mexico (29.12°N, 118.27°W) is 407 km south-southwest of San Diego, California and 260 km offshore of Baja California. The largest of three known white shark aggregation sites used specifically for cage diving [2] (Beceril-García *et al.*, 2020), this Mexican nature reserve is a pinniped sanctuary that measures approximately 35 km north to south and 10 km east to west. Shark cage diving is conducted along the 7 km × 2 km Rada Norte area in the northeast bay of the island at a distance of 200 - 300 m from the coast (Figure 1).



**Figure 1.** Guadalupe Island, area of cage diving (horizontal shaded grey) in the northeast bay, Rada Norte.

Several species of pinniped may be encountered at the Island including the Northern elephant seal *Mirounga angustirostris*, Guadalupe fur seal *Arctocephalus townsendi* and the California sea lion *Zalophus californianus*.

Both male and female white sharks were encountered during the 24 h period spent at the island. The sex of each animal was determined by the presence or absence of claspers. Eight white sharks were recorded in total (4× males and 4× females), four of which (2× males 1× female 1× unknown) had tags on them.

Sharks were attracted to the research vessel M/V *Islander's* cages in compliance with local regulations by means of mackerel, *Scomber japonicus*, bait bag lures and 2 - 3 bait lines of fresh yellowfin tuna, *Thunnus albacares* [7] (Torres-Aguilar *et al.*, 2005). Water temperature was 18° - 23° Celsius. Water visibility was approximately 30 m. Anchor site water depth at Rada Norte is in the region of 45 - 76 m deep.

Two surface viewing cages, 300 cm × 244 cm × 91 cm made of welded aluminum were tethered to the stern of the boat and lowered to a depth of approximately 243 cm. These known dimensions aided in estimation of shark size when

the animal was horizontal, parallel and close to the cage. Compressed air was delivered by means of a “hookah” system. No other vessels were in the vicinity.

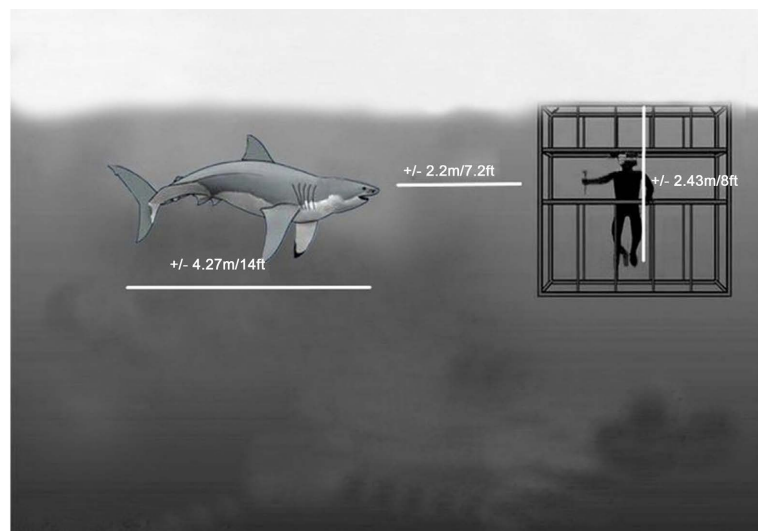
The agonistic display was photographed using an Olympus Stylus 710, 7.1 MP digital camera with a PT-036 underwater housing. Observational distance from the cage to the shark was approximately 220 cm (**Figure 2**). The term “agonistic shark” is used for clarity purposes when referring to the white shark observed at Guadalupe Island.

### 3. Results

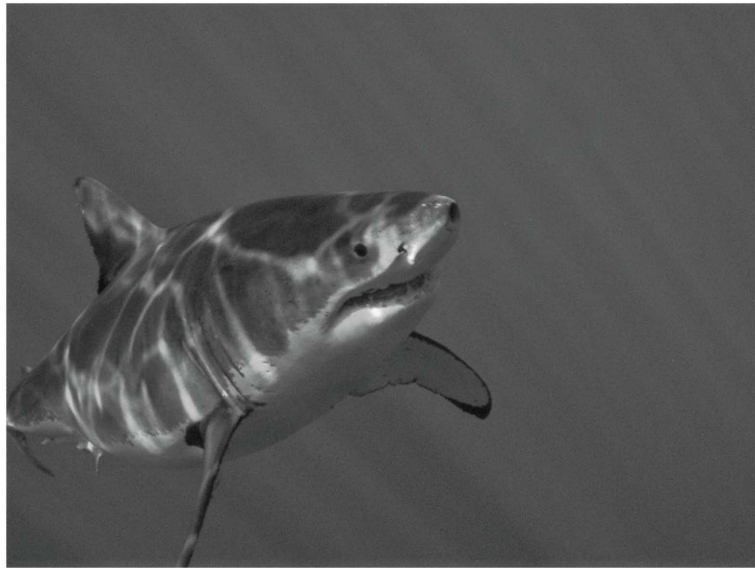
On Monday, 23<sup>rd</sup> November 2015 at 11.45 a.m. a white shark slowly ascended toward the lower left of a starboard positioned dive cage to a depth equal to the level of the diver, approximately 243 cm below the surface. The shark was identified as a male by the presence of claspers (**Figure 3**). The animal, estimated by the observer to be 400 - 430 cm total length (TL), turned towards the cage, raised its head and snout slightly adopting a visible hunched back profile.

Simultaneously, the animal significantly depressed its pectoral fins for a duration of < 5 seconds (**Figure 4**). Then, it slowly turned in front of the cage (**Figure 5**), turned back towards the direction from which it had come and rapidly swam away at an increased speed, noticeably quicker than when it initially approached.

The shark stayed within sight for several minutes making two or three more swim by's. No further agonistic behavior was seen. The observer who recorded the incident was the sole occupant of the cage at the time, there were no other occupants in the second cage on the port side, and the event went unnoticed by crew members on board the boat. No other sharks were visible from the cage at the time. Following the departure of the shark, there was a period of inactivity around the boat and cage for almost 2 hours until the arrival of a large female white shark estimated to be 533 - 548 cm TL.



**Figure 2.** Approximate observational distance from cage diver to agonistic shark.



**Figure 3.** The male white shark (pre agonistic display) approaching cage from depth (right clasper visible).



**Figure 4.** Agonistic shark display showing raised snout, hunched back and extreme pectoral fin depression.

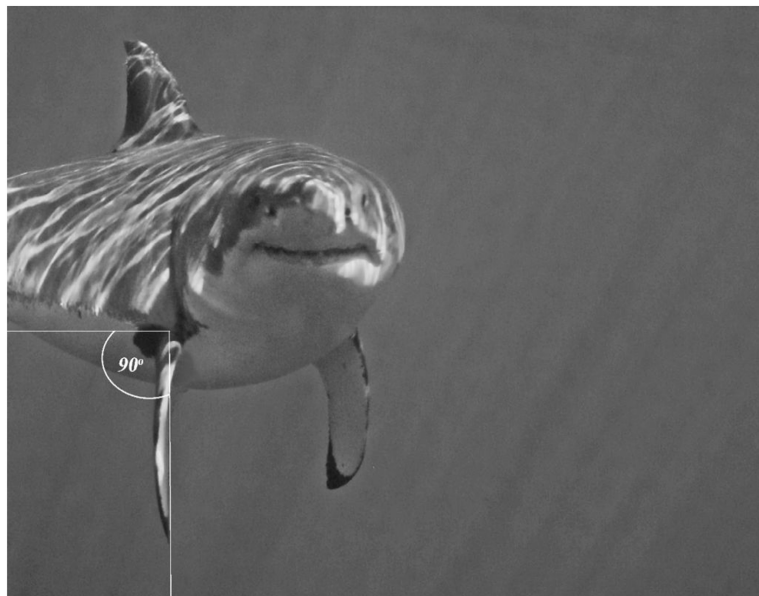
The degree of depression in the pectoral fins—the pectoral fin angle (PFA)—was estimated to be PFA  $90^\circ$  (Figure 6), calculated from a horizontal plane perpendicular to the body axis at the level of the chord formed by a straight line from pectoral fin origin to pectoral free rear tip [4] (Martin, 2007).

#### 4. Discussion

A shark often responds to confrontational situations by simultaneously lowering both pectoral fins to a comparable degree and holding them stiffly downward which helps distinguish this behavior from simple course correction, in which



**Figure 5.** Slow turn towards the direction of arrival, pectoral fins rising out of agonistic display position.



**Figure 6.** Pectoral Fin Angle (PFA) 90°.

one pectoral fin is fluidly and momentarily dipped lower than the other (**Figure 7**). Often the pectoral fins are flexed, which reveals their black tips, pale inner corner, or a dark spot at each axil. This is a graded response, ranging from mild to extreme, with the degree of pectoral fin depression apparently increasing with the perceived intensity of a threatening situation. This posture is often accompanied by a change in swimming style and may be combined with jaw gaping. Typically, a white shark displaying in this manner will suddenly flee, accelerating away while holding its pectoral fins stiffly downward [8] (Martin, 2003).



**Figure 7.** White shark showing natural position of pectoral fins whilst turning.

Based on this description, the frontal display of the agonistic shark may be perceived as being extreme. **Figure 6** clearly indicates the severe angle of the pectoral fin depression, significantly different from that used for normal maneuvering as depicted in **Figure 7**. Similarly, a white shark employing its pectoral fins as a “braking” mechanism will exert downward movement of both pectoral fins accompanied by exaggerated forward angling of the posterior margins (**Figure 8**).

The shark in **Figure 8** was observed heading horizontally towards the cage at speed before “braking” (personal communication with the photographer). The agonistic shark came into view slowly from depth, negating any need to employ the pectoral fins to suddenly “brake”. In **Figure 8**, it is noteworthy that during the “braking” action, the eye of this animal has rolled upwards and backward in a protective movement. The eyes of the agonistic shark in **Figure 6** are open.

What triggered the shark into an agonistic display at Guadalupe Island is impossible to say. It may have been in response to a combination of unnatural visual cues such as the boat, cages, diver, etc., or to the presence of another white shark. Although no conspecifics were visible at the time, this cannot be ruled out. Water visibility at this location is exceptionally clear, but still has its limits for the human observer. Although vision may not be a major factor in guiding sharks that swim in turbid waters [9] (Gilbert, 1962), the clear water that prevails at Guadalupe Island, may become an important factor to a white shark that comes within 15 m of any foreign object such as a cage, boat, bait bags or buoys, etc.



**Figure 8.** White shark using pectoral fins to “brake” (note the eye has rolled upwards and backwards in a protective movement).

Based on similar agonistic displays towards divers by other shark species, the behavior of this white shark may be considered as one of a threatening nature. Frontal and lateral agonistic displays occur as a result of motivational conflict between attacking and fleeing, with frontal displays indicative of a tendency toward attack and lateral displays of a tendency toward escape [10] (Fine *et al.*, 1977).

Although numerous incidents have been reported where sharks swim up to divers as close as a few feet and depart without biting or without displaying possible agonistic behaviors such as hunch [1] (Compagno, 2001), any such behavior should be regarded as a warning to any water users in the proximity of the displaying shark. This can be exemplified in Shark Attack File (SAF) Case #155. Graham Hitt, a 24-year-old spear fisherman, was fatally mauled at South Island New Zealand by a 426 cm white shark on 15 September 1968. A witness described the shark as “appearing to be moving in an agitated manner, balancing and pivoting on the tips of its pectoral fins which were about 6 to 8 feet apart” prior to striking the victim [11] (Baldrige, 1975).

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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