



APEX PREDATOR INTERACTION

Behavioral Observations of In-Situ Great White Shark (*Carcharodon carcharias*) and Human Contact as Isla Guadalupe, Mexico

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Introduction

Few animals on Earth have the power to elicit a visceral phobic response in man with the mere mention of their name or the slightest glimpse of their presence. Of those few, the great white shark (*Carcharodon carcharias*) is perhaps the most feared apex predator in existence, even if its malevolent reputation is largely undeserved. In 2009, two expeditions to Isla Guadalupe, 150 miles off the west coast of Mexico's Baja California peninsula, revealed many myth-dispelling behavioral discoveries.

Sponsored by National Geographic and produced by Emmy Award winning cinematographer, Michael Hoover, the crew assembled for these expeditions were comprised of world-class, record-holding spear-fishermen, free-divers, renowned underwater cinematographers, mechanics, and animal behaviorists.

Although we were working with sharks around Isla Guadalupe, we were not allowed to stay on the island. We had to live aboard the Captain Jack, a converted commercial fishing vessel, for the duration of the expeditions. The number of individuals aboard the Captain Jack ranged from ten to twenty at any given time.

Media-Driven Preconceptions

Everyone lives with preconceived ideas. Few preconceptions, however, are stronger than the media-driven fear of sharks in general and great white sharks in particular. One need only watch a few episodes during the Discovery Channel's popular Shark Week or listen to a few notes of that popular "JAWS" theme, then try to swim in the ocean immediately afterwards to realize how deeply rooted those shocking images have taken hold.

We received the call one afternoon requesting that we join the expeditions by Mike Hoover. His goal was for us to bring an understanding of animal behavior to the project, to make sense of the animal's movements and interactions, to see if we agreed with their interpretation of what was taking place at the island. It appeared to Mike that the sharks were remaining around the boat, not for the food source, but out of curiosity of the people, out of interest in the "monkeys in the water" as Mike put it.

White Shark Interactions

Seeing a great white shark, merely feet away from you, for the very first time, is mesmerizing. Frozen, you fumble for your camera, never taking your eye off the shark, no longer afraid, thinking to yourself, “I had no idea they’d be so beautiful.” And the preconception begins to crack.

When we boarded the Captain Jack for the first time in August, we climbed from a small panga that had just transported us for over two hours around the island in choppy seas to our temporary home. We threw our gear up to some of the crew aboard the Jack and hoisted ourselves on deck. We saw everyone’s focus at the back of the boat, and as our head’s turned to follow the action, there they were: three great whites swimming around the back of the boat with people in the water interacting with them.

Several levels of interactions occurred between the sharks and the crew aboard the Captain Jack during the course of the two expeditions. This wide span of interactions ranged from protected contact, meaning the person was on the boat and completely out of the water, to full contact, meaning the person made direct and full contact with the animal, on occasion riding the animal’s dorsal fin. Each level is described in detail below.

Protected indirect contact sessions occurred any time a crew member interacted with a shark from aboard the boat but never physically touched the shark themselves. This type of interaction often occurred when the crew was initially trying to lure the sharks to the boat with slabs of fresh tuna and buckets of chum. As one or two white sharks would appear behind the boat to investigate the smell, the crew would attempt to keep them interested by tossing them small pieces of fish (but trying to avoid letting them get the big tuna) and continuing a small trickle of blood into the water. The white sharks were unnervingly and unfailingly responsive to the smell of blood in the water during our first expedition. At that time, we were aware of ten white sharks in the water around our area, although approximately 150 different white sharks are known to reside at Isla Guadalupe at different times of the year. Without fail, we could have a white shark at the back of the boat within two minutes of starting a chum line.

The challenge for us was that the blood and fish did not serve well as a motivator for keeping them in the area. They rarely took the fish. They approached cautiously and slowly, for the most part, checked out the area, then left after a few minutes.

Dry direct contact sessions occurred any time a crew member interacted with a shark from aboard the boat and physically touched the shark. This was the least practiced of the contact sessions and only occurred a few times. In one instance, a large white shark swam slowly by the back platform of the boat, allowing Thad to rub his body from behind his eyes, along his back, across his dorsal fin, all the way to his tail with no evasive movement. The moment he touched the shark’s caudal fin (tail), however, the water exploded with movement and the shark was gone. He did not return for over an

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hour. We hypothesized at the time that perhaps the shark's didn't like their caudal fins touched because it is their propulsion and therefore must be protected. We have since learned, however, that some sharks in South African waters have allowed divers (one who was on our trip) to touch their tails, even to hold onto their tails while the shark slowly propelled itself through the water with no adverse reaction.

The challenge in this type of session was that the opportunities to engage were rare. The sharks were too cautious to swim right next to the platform or one of the dinghy boats most of the time, which is a requirement for this interaction. Therefore, the opportunities were diminished, even when we patiently waited and tried to bait them up to us.

There were safety considerations for each type of interaction. In this case, in order to make direct contact with the shark in the water, the person had to reach over the back or side of the boat and physically touch the shark. As we witnessed, these sharks can move explosively fast. If the person making contact is not cautious or makes a mistake, they risk being bitten or grabbed by the shark or even knocked into the water accidentally, increasing their risk due to their then vulnerable position in the water.

Semi-protected contact sessions occurred any time a crew member interacted with a shark from the underwater filming platform at the back of the boat in open ocean or the round shark cage placed on the sea floor, whether physical contact was made with the shark or not. By far, this was the most frequent interaction. It was highly effective on many levels. It allowed us to judge the shark's interest, relative disposition and was something the older sharks were likely accustomed to seeing given the rise in great white shark observation vacations. Most critical for our needs however, it gave us an intermediary step between the safety of being aboard the boat and the utter vulnerability of swimming freely in open ocean with an apex predator.

The veritable safety of the filming platform was likely more a state of mind than a reality however. Most shark cages used in commercial shark-diving operations are constructed of galvanized steel. For ease of movement around the Captain Jack, our's was specially constructed of aluminum. It was never intended to withstand an attack by a white shark. In fact, it was never referred to as an anti-shark cage or a shark-cage at all. It was referred to as the filming platform. The design was extremely open, allowing for cameras and people to easily slip through openings. One entire end of the cage was completely open with no bars whatsoever.

Regardless of the open nature and flimsy build of the cage's construction, the sharks never bit at, bumped, or touched the cage in any way while a member of our crew peered at the shark from inside. The sharks often swam in close proximity, eyeing the people in the cage, much as we were eyeing them, but they never made an aggressive move toward the cage while a person was inside.

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There was an incident with the cage one evening however, when the cage hung at the back of the boat empty. No person was in the water; everyone was aboard the Captain Jack. As it was described to us (it occurred a day before we arrived on the boat), suddenly there was a loud splashing sound at the back of the boat. When people ran back to see what was happening, they saw a white shark with its head stuck inside the cage, thrashing. The event lasted only seconds before the animal freed itself and disappeared into the water below. The aluminum cage survived, now a little more open to the ocean after the shark had successfully knocked out a couple of the vertical bars.

These sessions were highly successful at keeping the sharks' interest, In fact, this was often more effective than throwing a dead tuna in the water for them to feed on, which rarely held their interest. To get the sharks to approach the boat, we would chum the water, throwing chopped fish parts and blood into the water, creating a thin slick off the back of the boat. Within a couple of minutes a white shark would appear. Once a shark appeared however, the chum or large tuna slab would not hold their interest. To keep the shark in the area, we would often have one or more people jump into the filming platform to hold the shark's interest and keep them in the area while the rest of the crew assembled the needed camera equipment, got into their wetsuits and entered the water.

As described above, we never had an aggressive encounter while a person was inside the filming platform. The sharks appeared appeased to view the humans in their watery world.

Free contact sessions occurred any time crew members swam in open water with sharks. These sessions were extremely effective in holding the sharks' interest. The crew usually began these sessions from the relative safety of the filming platform and once the situation was assessed, including familiarity with the particular shark or sharks around the boat, number of sharks, size of sharks, and the sharks' behavior, if all elements were favorable, the free contact session began.

These sessions could be accomplished with crew members snorkeling, free diving, in traditional scuba gear or outfitted with quieter re-breather equipment. In working with the great white sharks of Isla Guadalupe for a couple of years before our expedition began, videographer Mike Hoover found that the noise created by the air bubbles escaping regular scuba equipment effectively kept the sharks at a distance and often scared them off entirely. Therefore, traditional scuba equipment was minimally used.

For obvious reasons, safety was a high concern and considered a significant risk for free contact sessions. To minimize the inherent hazard, although there was no possible way to alleviate it altogether, certain protocols were practiced throughout these particular interactions. Most importantly, no one was to swim freely with a great white alone. During all free contact session, a minimum of three people were supposed to be in the water. This allowed one person to interact, if needed with the shark while being protected by two safety divers. Interactions at this level did not involve touching the

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shark, but often involved swimming toward, behind or among the shark with camera equipment.

Full contact sessions occurred during free contact sessions when crew members made direct and full contact with a shark, physically touching the animal. These sessions occurred far more often than we believed possible when first entering into this project. These sessions included simply touching the shark as it swam by but a more prevalent interaction was a diver gently taking a hold onto the shark's dorsal fin and being pulled through the water. This interaction was referred to as a dorsal-tow based on dolphin and killer whale training of a similar result.

As we became familiar with certain individual sharks that would frequent the boat daily, one very large male stood out as the most trustworthy (a relative term to be sure). We called him "Bruce" and he was approximately 15 feet long. He moved slowly on most occasions and allowed the vast majority of dorsal-tows. During one session, he allowed eight dorsal-tows in a row.

Bruce swam slowly past the back of the boat, approximately ten feet away, watching everyone in the water, then allowed the free-diver to approach and place a hand on his dorsal fin. In each scenario, Bruce maintained his calm demeanor. He would propel himself and the diver a short distance in the water, 50 feet or so, the diver would release his hold on the dorsal and begin drifting up and away from Bruce then the shark would immediately begin making a slow wide turn to come back to the back of the boat to allow another ride.

In this particular type of session, Bruce did not feed on any fish. In fact, we had removed all fish from the water to assure that the rope and bait would not interfere with the shots being filmed. In other words, Bruce received no primary reinforcer for his behavior of allowing the dorsal tows to take place. Yet he returned again and again, allowing the same diver to interact with him. He allowed eight dorsal-tows in one 35-40 minute session. According to the laws of behavior modification, Bruce must have found the interaction reinforcing.

These sessions were the most dangerous of the interactions. We were aware that these sharks, although large and often slow in their movements around us, could explode into powerful bursts of speed and could turn on a dime. The same safety precautions were followed as during free-contact sessions for as long as possible. Once a diver committed to approaching a shark for a dorsal-tow however, he had to break free of the safety divers' protection and swim out on his own toward the shark. The dorsal-tow carried the diver even further away from the protection of the other divers and the boat. It was during this time that a diver was most vulnerable - swimming back to the boat alone. For this reason, the free-divers who obtained dorsal-tows from the sharks carried basic spear-fishing guns. The guns were never loaded. They were intended for tuna or grouper, not an adult great white shark. They were kept in hand primarily as a prod to

push the shark away should it turn and come in the divers' direction. They were never needed.

Contact Level	Sharks' Interest Level
Protected indirect contact	Low
Dry direct contact	Moderate
Semi-protected contact	Moderate/High
Free contact	High
Full contact	High+

The Expeditions

The two expeditions to Isla Guadalupe yielded vastly different experiences. During the first expedition, which took place August 23-29, 2009, we encountered sharks daily. According to Mauricio Hoyos, Ph.D., a biologist and shark researcher at Isla Guadalupe, there are up to 150 individual great white sharks that either migrate through the area on a semi-annual basis or reside permanently off the Isla Guadalupe coastline. Of those 150 animals, we interacted with ten during the August expedition. During this time of year, though there were Guadalupe fur seals (*Arctocephalus townsendi*), California sea lions (*Zalophus californianus*) and a small population of Northern elephant seals (*Mirounga angustirostris*), the white sharks were feeding almost exclusively on the large tuna, including yellowfin tuna, that were migrating through the area. All of the sharks that we interacted with were male. We were advised that the larger females would be arriving later in the season and would be in the area for our December expedition.

The second expedition took place December 4-12, 2009. To our great surprise, we did not encounter a single great white shark during the entire timeframe. We were certain there were sharks in the area based on the large fresh bite wounds inflicted on several of the elephant seals on the nearby beaches. At this time of year, the great whites' diet changes and their diet becomes primarily the elephant seals that gather on the beaches in great numbers to calve.

There were a couple of factors that may have influenced our ability to locate a white shark on the second journey. One factor was that the elephant seal pupping season had arrived earlier than in previous years and many of the adult seals had moved on from the island. Perhaps most of the white sharks left shortly after. Another factor was an invasive research initiative which took place with many of the sharks six weeks before our arrival. During this study, many of the white sharks were caught with a large fishing hook and hauled onto the deck of a boat for twenty minutes or more. Some of the sharks were initially caught miles away from the main research vessel and then had to be drug through the water to the main ship before being hauled aboard for dorsal-

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puncture tagging and other information gathering. According to the local shark biologist, it is highly likely that some of the sharks would not have survived this highly stressful collection method. In Dr. Hoyos' opinion, this may have driven many of the sharks from the area as well.

Still, we knew there were at least a few sharks left in the area due to the fresh bites on the elephant seals. We simply weren't able to attract them. The scent of fish blood in the water was ineffective. An entire tuna tethered behind the boat was ineffective. We even swam off the back of the boat interacting with a wild sea lion; nothing. We placed a round shark-cage on the sea floor where we knew there had been several predations the year before. There were seals on the beach who came and went. We had divers on the sea floor near the cage and swimmers at the surface. We never saw a shark.

Experience Matters

One of the most significant factors in interacting with the white sharks of Isla Guadalupe was the sharks apparent age. By this we don't insinuate a specific number of years, merely an experience level. By all observations aboard the Captain Jack, the larger (and therefore we assume more experienced) sharks were the better to interact with. These sharks ranged from 13-15 feet in length. Invariably, these were the animals that moved in cautious, methodical, slow paces. They seemed curious of their surroundings, yet displayed no aggression toward people in the water with one exception.

On one occasion, a female diver swam toward the shark we had named Bruce, trying to achieve a dorsal-tow. She was nervous and visibly less confident than the two free-divers who had interacted with the shark without incident countless times previously. To boost her confidence, the safety divers flanked her closely as she closed in on the shark. The shark turned sharply and puffed his gills out toward the divers, a behavior known as a gill-flare, then quickly swam away. We can't assume we know his reasons behind this clear warning, but we do know that the antecedents leading up to the dorsal-tow behavior were completely different for this diver than for the previous divers. Instead of one diver swimming out alone to take hold of his dorsal, there were three. Instead of the fluid assured approach Bruce had become accustomed to, this approach was hesitant.

Although there was virtually no aggression from the large sharks toward the humans in the water, there were occasions when there was visible aggression from the large sharks toward a smaller shark. On most occasions, there would be only one visible shark at the back of the boat to interact with at a time. We observed several instances where a smaller shark would approach the boat when there was already a larger shark present, only to have the larger shark chase him out of the area. We observed rapid, confrontational charges as well as jaw-popping under water. During a jaw-pop, one shark would open his mouth, extend his teeth, and snap at the shark he wished to threaten. We never witnessed actual physical contact between the white sharks; it was all effective bluff.

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The smaller sharks, 9-12 feet in length, were less predictable. Their movements were often explosive, suddenly appearing from the ocean depths, and erratic. They were quick to react to everything in their environment and changed direction rapidly when startled. We chose never to free dive with the younger sharks whenever possible.

Discriminating Feeders

The white sharks that we observed were discriminating feeders. During certain times of the year, when several species of tuna, particularly yellow fin, migrate along Isla Guadalupe, the sharks feed almost exclusively on tuna. They do so in spite of the fact that there are year-round residences of Guadalupe Island fur seals and California sea lions in the water. Once the elephant seals begin arriving in large numbers to calve however, their diet switches to an almost exclusive diet of elephant seal.

We learned that when elephant seals are available, white sharks almost never pursue California sea lions. Dr. Hoyos, relayed to us that his theory is that the sea lions are so much more agile, it is not worth the effort when the slower seals are available in such abundance. We were told it was not uncommon during these months for sea lions to even taunt the white sharks, nipping at their caudal fins.

It has been widely speculated that attacks on humans from great white sharks were cases of mistaken identity. This seems likely based on our observations of their selective palate. Most great white attacks consist of a bite, perhaps exploratory or mistaken identity, but not consumption of the person. Perhaps the reason we were never approached in this way by the sharks of Isla Guadalupe was due to the clarity of the water. We experienced excellent visibility in most locations, providing 100-150 feet of visibility in 200 plus feet deep water.

This may have assisted us in two ways. It allowed us to clearly see the sharks, although their countershading camouflage is startlingly effective, and allowed the sharks to clearly see us, minimizing the chance of mistaken identity. The clear visibility also hindered their strategy of ambush attack, the great white's specialty and preferred method of hunting. Either way, we clearly were not on the sharks' menu. An interesting note is that the island maintains a part-time residential population of lobster and abalone divers. In four decades of diving in the waters off of Guadalupe, they have never experienced a confirmed shark-related fatality (there was one fisherman who vanished, but was more likely a result of a diving accident), although they tell tales of inquisitive sharks that have come in close for inspection.

Help or Hinderance

Though there were no other boats present at Isla Guadalupe during our December expedition, during our August trip we were within view of three other boats operating shark-diving eco-tours. These boats were not interacting with the sharks in the same way we were. They were typical shark-dive operators that allowed their guests to view the sharks from the safety of their steel-reinforced cages.

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The operation of shark-viewing tourism has evoked a controversial debate. On one side of the argument, it is said that luring sharks to humans will train sharks to seek out people along beaches which will in turn lead to more shark attacks.

The opposing argument believes that having interactions with sharks is creating a new generation of individuals with a profound respect and admiration for these animals that cannot be obtained via a television production. What's more, the animals are clearly demonstrating that they know the difference between the humans in the water, the tuna, and the various species of pinnipeds. They are capable of selection.

Conclusion

The two expeditions to Isla Guadalupe in 2009, 150 miles off the west coast of Mexico's Baja California peninsula, revealed many myth-dispelling behavioral discoveries. Far from the mindless eating machines of "JAWS" fame, these animals demonstrated a wide array of calm direct interactions with people. By all observations and based on the laws of behavior modification, the white sharks found strategic human interactions with them reinforcing. Had they found the interactions aversive in any way, they could have simply swam away or expressed their displeasure in any number of overt gestures such as aggressing.

As we forge the future of animal management, we must begin thinking further outside the confines of the boxes in which most of us live and conduct our lives. We can no longer view captive animals as the individuals with which we interact and non-captive animals as separate from human environments that should be completely left alone to their own devices, to survive as best they can. We are beyond that narrow vision. Humans are a part of the environment; we are not separated from it. And we now live in a world so small that animal management for captive and non-captive animals is a reality. More than a mere reality, it is essential.

As we reflect on our in-situ interactions with this vulnerable species, as it is listed on the IUCN Red List of Endangered Species, we believe this much maligned highly evolved predator to be a trainable species that responds to reinforcers in his environment, primary or secondary. We observed that like many of the animals that we care for in our zoos and aquariums, the white sharks were motivated by curiosity and enrichment.

We learned through deployment of National Geographic Crittercams that were mounted onto the dorsal fins of several of the sharks, that these animals spend a great deal of time swimming in a sea of little visual stimulation. Much of the Crittercam footage revealed long periods of swimming to the surface, to the sea floor then to the surface again without encountering another animal other than small fish along the way. It seems no surprise then that the sharks were highly stimulated by people in the water in an area where swimmers are rare, to say the least. And we would hazard a guess that the sharks had never before had interactions that involved dorsal-tows.

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In the end, it seems these enriching interactions for the sharks are enlightening ones for the humans. To be clear, we are not advocating apex predator interactions for the general public. The crew of these expeditions were trained professionals. They worked around large dangerous animals on a regular basis and were comfortable in the water. More importantly, they understood the substantial risk involved in their undertaking. It is merely a step in the direction of understanding more about this elusive extraordinary animal. There is much to learn about this type of interaction as well, but without forward movement, without going where no one has gone before and doing what no one has done before, how can we say we are progressing?

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