Cage Diving with Great White Sharks

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<u>• What type of diving technology is be used to perform cage diving?</u>

Cage diving utilizes a blend of techniques gleaned from both recreational and working diving procedures. A surface supplied air system is utilized by the operations as the prime breathing source for divers. This is also called a hookah system. A high pressure air compressor fills a bank of high pressure 2500 (psi) storage cylinders. This air is then regulated to 140 psi of pressure over ambient water pressure and fed into a large capacity storage receiver. ½" ID Synflex™ style floating air hose is then connected from Quick disconnect deck fittings and down into the diving cage. At the end of the hose a US Diver's Aqualung second stage SCUBA regulator is adapted to the main air hose completing the set up.

Cage divers wear extreme amounts of lead in cave diving 40-50 lbs- even surpassing most commercial divers I have seen. The reason for this is to stay heavy on the bottom of the cage for good videography and to help the divers remain negative when the cage heaves up and down. I initially thought that the excess lead was overkill, but after the first dive, I was convinced.

The lead is worn using DUI harness- style weight-belts which distribute the load on the diver's shoulders versus the hips as is common in most recreational and some commercial modes of diving.

The operation experimented on one day with full face masks and acoustic communication units. They used a system called Ocean Reef, which is not quite as functional as the OTS acoustic units that we use in conjunction with AGA masks, EXO's and M-48 masks used by professional divers.

There was also a small topside video unit which was used to document cage activity quite successfully and transmit it topside for the non diving personnel to enjoy. Additionally this provides a means to record activity.

<u>• What types of equipment improvements can be made?</u>

There are numerous improvements that can be made to the equipment and diving operations based on my professional and academic diving experience:

The hookah diving rigs needs to be shackled into the diver's weight harness to reduce jaw fatigue and add a margin of safety for regulator recoveries. When I heard that the regulators were not attached, we decided to bring several snap shackles to use as we do in running commercial- tethered dives. Theses shackles should be either seized to the hose or a d-ring seized to the hose where the diver shackles into it. An attachment point at 34-38" from the second stage would be adequate. This will transmit any pulling force from the hose to the diver's harness shackle rather than the diver's mouth. This was the most evident improvement to be made upon my arrival. Many divers complained of jaw fatigue.

The quick disconnect fittings used are non-locking Parker-Hannifin™ style and not the locking Hansen™ brand used in professional diving. A popped QD connection on deck could result in an out-of air situation for the diver in the cage and cause un-necessary panic and free ascent. These same positive locking connections should also be used where the hookah hose attaches to the cage manifold.

A full face mask system with acoustic communications was used during the expedition by the operation called "the Ocean Reef™ system". It did not function very well and was quite uncomfortable as reported by the divers that dived with it. I have had much experience with full face masks and acoustic communications in my professional career. Ocean Technology Systems and Divelink™ systems make very good acoustic units that works well with standard AGA style full-face masks and the M-48 Supermask made by Kirby-Morgan Dive Systems™. I used a KMDSI M-48 mask on several dive during the trip without the communications.

Diver-to-Diver and diver to surface communications would add a new dimension to the experience. It is undetermined whether or not the higher frequency noises would affect the animals in the water however. All of the communication from diver to diver was done by tactile grabbing and signaling so that we could be aware of approaching animals. Many times during dives, the topside personnel could see sharks that we could not and vice-versa. Communications would increase the frequency of encounters if the acoustic noises do not impact the animals negatively.

The video camera used in the cage could be mounted onto a pan and tilt unit to move around and get more effective video footage and look at individual divers. This could also double as a backup means to communicate.

<u>• What are the safety precautions and diving protocols being used and are they effective?</u>

Cage diving requires unique diver discipline and respect of protocols. An effective list of “5 rules of cage diving” was explained several times during the briefing and on the trip:

- Never turn your back on a shark.
- Never enter or exit the water without permission of the divemaster.
- Don’t feed the sharks. Keep your arms, legs and head inside the cage.
- Don’t drink any alcohol during the day of diving.
- Never hold your breath after breathing compressed air.

Additional safety protocols focused on exiting and entering the cage. Weight belts were doffed in the cage prior to exit. Only one team at a time was loaded into the cage, one diver at a time. Each diver was assisted with the weight belt. The “red zone” around the swim step and ladder was created to keep people clear of the area. Efficiency was emphasized in moving on and off the swim step. A key concern was hand placement on the cage and swim step to be sure that crushing injuries did not occur. All cameras were passed into and out of the cage from diver to divemaster.

An emergency release from within the cage was explained, but not clearly demonstrated. This should be done, probably in the form of a video. A black release button could be pushed to eject a side panel of the cage in the unlikely event of a cage compromise where the divers (or shark could exit.) The latter actually happened on a prior cruise last year aboard another vessel. I was able to view video footage of the event. No divers were injured.

Some improvements to the safety of the operation include:

1. Record the video in the cages. This will give the operation a permanent record of the dives as well as permit other dive teams to observe and learn form watching others. It can also protect the operator in legal matters should an accident occur.

2. Make a supplemental videotape of the safety protocols and briefings. There is great potential liability exposure from omitting information or not having it explained clearly in a live briefing. This would enhance and backup the briefings and cage diving protocols so that everyone is clear. Some people may opt to review procedures and rules during the trip.

3. Consideration should be given to having an auxiliary underwater air source in the cage. Equipment does fail. These divers are wearing a lot of lead and are not agile underwater without fins. It is advisable to “stack the odds in your favor” and remember that “Murphy” comes aboard on many diving trips. It is only a matter of time before he is in the cage. If you approach the “what ifs” as we do in commercial diving, the margin of safety is increased.

• What influences these animals with respect to interaction with divers?

The single largest observable influence of the animals that the majority of divers on the trip confirmed was low frequency noise. During cage loading and unloading of divers, there would be a lot of sound generated in the water column. The white sharks would appear without failure during these times. In the cage that I was diving in, we would experiment with this by stomping on the bottom of the cage. It was observed that the animals would move in to investigate the sounds.

The animals would respond to movement and were quite curious, yet cautious. Any sudden movement when a shark was passing by the cages would often yield a change in the swimming pattern of the animal, whether to take a look, descend or veer in another direction. The larger animals appeared more bold and curious while the smaller animals (less than ten feet) appeared to swim quicker and were more skittish at times.

The seemed that the sharks would never approach from the same area. They would make several passes at food in the water before eventually nudging and smelling to confirm it as food. They would later return and if they felt the food was not a threat to them, they would bite at it. Onboard researchers confirmed that white sharks are unlikely to engage in a quest for food if it involved a fight. This explains their hunting strategy with pinnipeds, where they prefer to take one bite and wound the animal, wait for it to die or become incapacitated, then return to finish the meal.

Each animal had unique personalities that we had come to learn. Crew members had identified them by fin markings and size and had nicknamed them based upon their behavior. “Shredder” was certainly deemed the most aggressive- an animal around 13 feet in length. He was quite curious and often spent time rolling to the side to look up at the swim step on the boat. He was named due to his recent breaching on a prior trip where he actually bit the anchor line of the support ship, parting it. Researcher attributed this to his association with lines in the water and food at the end of it. Whilst seeing a line running to the surface and no tuna on the end of it, it is theorized that he breached to find the food.

• What are the habits, myths and realities associated with these animals?

It is clear that great white sharks are drawn to the area around Guadalupe Island. The challenge remains to determine why they have selected this spot. Perhaps they are taking advantage of the local seal colonies on the steep rocky shores. Guadalupe is also known for as a prime fishing spot for recreational anglers. The large tuna and yellowtail that are found here may also attract one of the oceans largest predators. Through our continued research we hope to answer these questions and others. (PIER Institute [PIER], 2003)

Some of the common myths associated with sharks were identified and discussed with marine personnel on the trip. The myths were also confirmed in the literature (Allen, 2003, 3):

1. Sharks are harmful to people.

   Of the 390 species of sharks, 80% cannot hurt people. 5-6 humans per year die from shark attacks out of six billion

2. Sharks eat continuously.

   Sharks eat periodically based upon food availability. Lemon sharks eat 2% of their body weight per day. Guadalupe Island sharks have been noticed to be most active in the hours of 10am-4pm based on reports from expedition crew members.

3. Sharks are attracted to and prefer human blood.

   Sharks prefer fish blood.

4. Sharks are not disseminating eaters, they are scavengers.

White sharks under nine feet in size eat mainly fish. Over nine feet or greater than 1000lbs, they feed on pinnipeds as confirmed by Peter Howorth, Director of Santa Barbara Marine Mammal center who was one of the divers on the expedition.

Sharks have been reported to have eaten tin cans and metal objects. This can be explained by the fact that metallic objects immersed in seawater generate an electric current, which is detected by dermal denticles along the skin of the shark. These aid in electro-inception by the animal in hunting for food.

5. Great White Sharks are common and abundant found off most beaches visited by humans.

   White sharks are relatively uncommon and prefer cooler waters. They are close to being an endangered species and are a protected animal in California waters. They follow their source of food.

6. Sharks have small brains which are not complex.

   White sharks have relatively large and complex brain by comparison to predators of their size. They can also be trained.

7. Sharks must swim continuously.

   Sharks have the ability to pump water over their gills by opening and closing their mouth while remaining stationary. One of the divers on the trip, Lynn Davies showed video footage of Galapagos sharks remaining stationary on bottom.

8. Sharks have poor vision.

   The shark's eye has a lens that is seven times more powerful than the human eye. The shark's hearing is its best sense. They can see up to 45 feet away. They can detect sounds from several hundred kilometers away and as far as 100,000 feet. Sharks have a sense of smell that can detect up to 3000' away. They can detect a pint of blood up to 1000 million parts of water. It is unlikely that sharks can be attracted from small bloody cut. A sense of vibration is can be detected via the lateral line which runs across the body, up to 100 meters away.

• What technologies are used in documenting white sharks in this mode?

A diverse range of technology was used in documenting the white sharks. Divers used both video and still photography to document. In the underwater realm, we have experienced a shift from analog to digital video several years ago. A similar shift is occurring now between 35mm film photography and digital cameras.

I used a 3 CCD hi 8 Sony Professional camera housed in an Amphibico™ aluminum housing for underwater video. I also used a Nikonos™ V 35 mm still camera with a 15mm and a 20mm lens for wide angle photography. All divers filmed and shot photos using natural ambient light, due to the shallow depths and availability of ambient light. By current technology standards, the equipment that I used was somewhat archaic. Seven years ago, it was state-of-the-art.

For surface documentation, I used a Nikon D-100 digital camera with 28-85 lenses and an 80-300 anti-vibration zoom lens. This provided me with the ability to get instant results and view or edit images immediately. For surface video I used a Sony Digital 8 camcorder which proved most useful in documenting. I also used a Sony ICD-P17 digital voice recorder to document interviews with expedition members.

The range of equipment used by others was extensive. We had personnel who could be considered high-end amateurs to full professionals in their skills and equipment. Most of the videographers used digital camcorders in an underwater housing.

One of the senior-most professionals on the trip was shooting Betacam SP™ video which is the standard for broadcast television. A unique aspect of this trip was that this unit was installed into a soft shallow water housing for underwater use. The results obtained by marine wildlife videographer Earl Richmond were very good. Videotape of white sharks using Betacam™ is quite rare if it exists at all in conditions this good. The underwater housings for Betacam™ can cost 40-60 thousand dollars.

A discussion was held on the advantages of Betacam™ versus digital cameras in this regard. According to Earl, television companies will prefer this footage for airing on television. Digital is good quality but has yet to become the standard for the broadcast industry. Digital footage submitted to Discovery or Explorer would have to be converted into another format. Most consumers do not have HD or digital TVs in their homes and cannot take advantage of digital format. While digital may be the standard for consumer camcorders and underwater use, it has yet to infiltrate the broadcast markets.

On the photography side, Dave Burroughs was shooting a Nikon D-100 in a Subal™ metal housing. He is a contributor to wetpixel.com digital photo website. He was able to download images daily for evening viewing and editing on his laptop. He was also able to view his results underwater and make adjustments in situ which is a concept foreign to 35 mm still photographers. Still digital allows for large numbers of photographs to be taken versus the standard 36 exposures on film for a single dive. He could also use his zoom/wide angle lens underwater at various focal lengths without having to exit the water and change lenses.

Dave and I had several discussions about 35mm still photography. We concluded that 35 mm Nikonos™ is destined to become an art-form as have known it. I shot over twelve rolls of film and was unsure what my results would be until I returned ashore and had film processed. On the first day, Dave was viewing his results and making adjustments based upon the conditions and subject matter. Clearly, underwater digital will surpass the 35 mm film systems.

Earl Richmond also used a “pole camera” in an underwater housing that fed into his Betacam™ input. He was able to lower this pole camera just below the surface and document the white sharks very closely with good success.

The cage that I was in utilized a small 400 line underwater camera that was fixed to the front corner of the cage. This was effective in transmitting topside footage to non-diving personnel with good resolution.

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