

White Sharks

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Summary and Introduction

Each fall, white sharks (*Carcharodon carcharias*) (fig. 1) are observed around the Farallon Islands, preying on seals and sea lions (pinnipeds) (see chapter on Marine Mammals). The shark's dark back and light underbelly blend with the surrounding environment, hiding the shark from unsuspecting pinnipeds. White sharks spend a great deal of time searching for food; it may be weeks or a month between feeding opportunities.

The peak in predation, in the fall months, is related to the number of young (1- and 2-year-old) northern elephant seals arriving at the islands at this time. These immature seals are the preferred prey of the white shark at the Farallon Islands. Observations there indicate that the white sharks eat young elephant seals seven times more frequently than they eat other pinnipeds, such as California sea lions and harbor seals.

Immature elephant seals arrive at the Farallon Islands to come ashore beginning in September and continuing through November. The small pocket beaches and surge channels around the islands offer undisturbed "haul out" sites and resting areas. Unlike California sea lions, which are the most numerous pinnipeds on the islands, elephant seals cannot climb high up on the islands' rocky shores. Therefore, they are restricted to the pocket beaches and surge channels. The fall haul out of elephant seals is commonly their first visit to the islands. Many of these seals are from other colonies, such as those at the Channel Islands or Point Año Nuevo to the south, and they may be unaware of white sharks patrolling the waters around the Farallon Islands.

Studies of white sharks in the Gulf of the Farallones begun in 1987 have revealed the remarkable way in which these predators are able to locate and catch pinnipeds. Using photographs of dorsal and tail fins, and underwater videotapes of entire sharks, it has been possible to identify individual white sharks and follow their movements in the gulf over many years. Several of the larger sharks have been seen in the same areas for more than 5 years. When individual sharks are identified, they are always seen in the same area. However, some of the sharks are regular visitors, whereas others are only intermittently seen in the gulf.

By 1995, monitoring of individual white sharks around the Farallon Islands, using small transmitters swallowed by the animals, had documented their movement patterns and internal temperatures. The movement patterns indicate that each shark has an area that it covers by zigzagging back and forth. These sharks are not swimming aimlessly; they increase their odds of finding pinnipeds by looking in familiar areas where they have previously been successful. The largest sharks covered the smallest home ranges and the smallest shark tracked covered the largest home range. The larger, older sharks seem to be more experienced and therefore know where to search.

Monitoring found that white sharks in the Gulf of the Farallones maintain a constant body temperature of nearly 80°F in the cold (54 to 57°F) water of the gulf. This allows them to move quickly and to capture warm-blooded marine mammals, such as pinnipeds. Most of the world's predatory sharks cannot increase their body temperature above the ambient water temperature, and so their range is limited to warmer tropical waters.

High tides and large swells affect the rate of white shark predation on pinnipeds in the waters around the Farallon Islands. Such conditions force many of the seals to move from their

haul-out space. This displacement may explain why significantly more attacks on elephant seals—sometimes two or three in one day—are observed when large swells are combined with high tides.

Despite the white shark's fearsome reputation and Hollywood image, attacks on humans are relatively rare. In northern and central California, there is on average one or two white shark attacks on humans per year and about one fatality per decade (chances of drowning in the State's coastal waters are at least 100 times greater). In most of these instances, the shark has bitten only once and then released the person immediately. Those bitten usually survive if they can make it to shore, so swimming alone is not advised. Some evidence suggests that white sharks do not like the "taste" of people but sometimes mistake them for their favorite prey, pinnipeds. Therefore, it is not advisable to swim or surf near colonies of pinnipeds, where white sharks may be actively feeding. Areas where there has been a history of shark attacks should also be avoided. For these reasons, sport divers avoid the waters around the Farallon Islands.

The population of white sharks off California's coast is probably small, having perhaps a few hundred to a few thousand adults. White sharks are important predators in the State's marine ecosystems. In 1994, with the support of scientists, fishermen, surfers, divers, and others, the State of California placed the white shark on the list of species protected in its waters.

Seasonal Elephant Seals

Immature elephant seals arrive at the Farallon Islands to come ashore beginning in September and continuing through November. The small pocket beaches and surge channels around the islands offer undisturbed "haul out" sites and resting areas. Unlike California sea lions, which are the most numerous pinnipeds on the islands, elephant seals cannot climb high up on the islands' rocky shores, because they do not have the ability to move on land using their flippers. Therefore, they are restricted to the pocket beaches and surge channels. The fall haul out of elephant seals is commonly their first visit to the islands. Many of these seals are from other colonies, such as those at the Channel Islands or Point Año Nuevo to the south, and they may be unaware of white sharks patrolling the waters of the gulf.

White Sharks Searching For Prey

Studies of white sharks in the Gulf of the Farallones begun 1987 have revealed the remarkable way in which these predators are able to locate and catch pinnipeds. Using photographs of dorsal and tail fins and underwater video tapes of entire shark, it has been possible to identify individual white sharks in the gulf over many years. Several of the larger sharks have been seen in the same areas for more than 5 years. When individual sharks are identified, they are always seen in the same area. However, some of the sharks are regular visitors, whereas others are only intermittently seen in the gulf.

By 1995, acoustic telemetry had been used to successfully track five white sharks in the gulf and document their movements around the Farallon Islands. This was done by attaching a small transmitter, with a signal that can be detected nearly 1 km away (0.6 mi), to bait that was presented to the sharks. Once the transmitter was swallowed and in the animal's stomach, the shark could be tracked and information on its depth, location, and internal temperature of the could be recorded. In less than 27-m (90 ft) water depth, sharks orient to the ocean floor, staying 1 to 3 m (3 to 10 ft) off the bottom. In more than 27-m (90 ft) water depth, sharks orient to the ocean's surface and no longer follow the bottom contour (fig. 2). In both situa-

tions, the shark's dark back and light underbelly blend with the surrounding environment, hiding the sharks from unsuspecting pinnipeds.

The tracking also documented movement patterns of individual white sharks around the Farallon Islands (fig. 3). These movement patterns indicate that each shark has a home range that it covers by zigzagging back and forth. These sharks are not swimming aimlessly; they increase their odds of finding seals by looking in familiar areas where they have previously been successful. Sharks spend a great deal of time searching for food; it may be weeks or a month between feeding opportunities. The largest sharks covered the smallest home ranges, generally less than one square mile, and the smallest shark tracked covered the largest home range, several square miles. The larger, older sharks seem to be more experienced and therefore know where to search for pinnipeds.

High Tides and Large Swells

White sharks in the waters around the Farallon Islands do not appear to come and go with the tide but are present throughout daylight hours (no one yet knows what they do at night). However, high tides and large swells affect the rate of white shark predation on pinnipeds in the area. Significantly more attacks are observed when large swells are combined with high tides. Therefore, it appears that seals must migrate to and from the island during periods of high tide or are forced to move at these times. The lack of haulout space is a real problem for elephant seals on the islands. As a result, after their hunting was stopped, this colony was the first to reach stable numbers, peaking in 1984 at 400 pups and now averaging about 350 pups per year. During periods of high tides and large swells, many elephant seals are forced to move from their haul out space. For example, during the fall, a surge channel called Breaker Cove can have 20 to 30 seals lounging in the water at one time. Large swells, combined with a high tide, force the seals to move out of the channel and into deeper water or, possibly, to leave the gulf. The force of the waves makes it impossible for the seals to stay in Breaker Cove. This displacement of seals may explain why two or three attacks sometimes occur in one day when high tide and large swell conditions exist.

Cold Water, Warm-Blooded Sharks

The water in the Gulf of the Farallones is part of a cold temperate marine system; water temperatures average 12 to 14°C (54 to 57°F). Most of the world's predatory sharks cannot increase their body temperature above the ambient water temperature, and so their range is limited to the warmer tropical oceans. White sharks, however, are capable of regulating their body temperature, making them one of the few predators that can exploit the abundant seal and sea lion populations in the cold waters of the north Pacific. Studies of white sharks in the gulf found that they maintain a constant body temperature of about 26.5°C (almost 80°F). This adaptation allows them to move quickly in cold water and to capture warm-blooded marine mammals, such as seals and sea lions (figs. 4–6).

White Sharks and Humans

The white shark is a unique apex predator that uses stealth and takes advantage of locally abundant prey. Despite their fearsome reputation and Hollywood image, attacks on humans are relatively rare. In northern and central California, there is on average one or two white shark

attacks on humans per year and one fatality per decade (chances of drowning in the State's coastal waters are at least 100 times greater). In most of these instances, the shark has bitten the person once and then released or spit them out immediately. Those bitten usually survive if they can make it to shore, so swimming alone is not advised. It is thought that white sharks do not like the "taste" of people but sometimes mistake them for their favorite prey, pinnipeds. In particular, a surfer paddling on their board may appear to be a seal when seen from below. Therefore, it is not advisable to swim or surf near colonies of pinnipeds, where white sharks may be actively feeding. Areas where there has been a history of shark attacks should also be avoided. For these reasons, sport divers avoid the waters around the Farallon Islands.

The population of white sharks off California's coast is probably small, having perhaps fewer than 100 adults. White sharks are important predators in the State's marine ecosystems. In 1992, with the support of scientists, fishermen, surfers, divers, and others, the State of California placed the white shark on the list of species protected in the State's waters. The white shark is an evolutionary success because of its specialized behaviors and adaptations. It is far from a primitive cold-blooded fish but is actually a highly evolved warm-blooded animal.

Further Reading

Klimley, A.P., and Ainley, D.G., eds., 1996, *Great white sharks*: New York, Academic Press, 517 p.



Figure 1. The white shark is a fearsome predator, well adapted to live in cold water, where food is more abundant. It is far from a “primitive” cold-blooded fish but is actually a highly evolved warm-blooded animal.

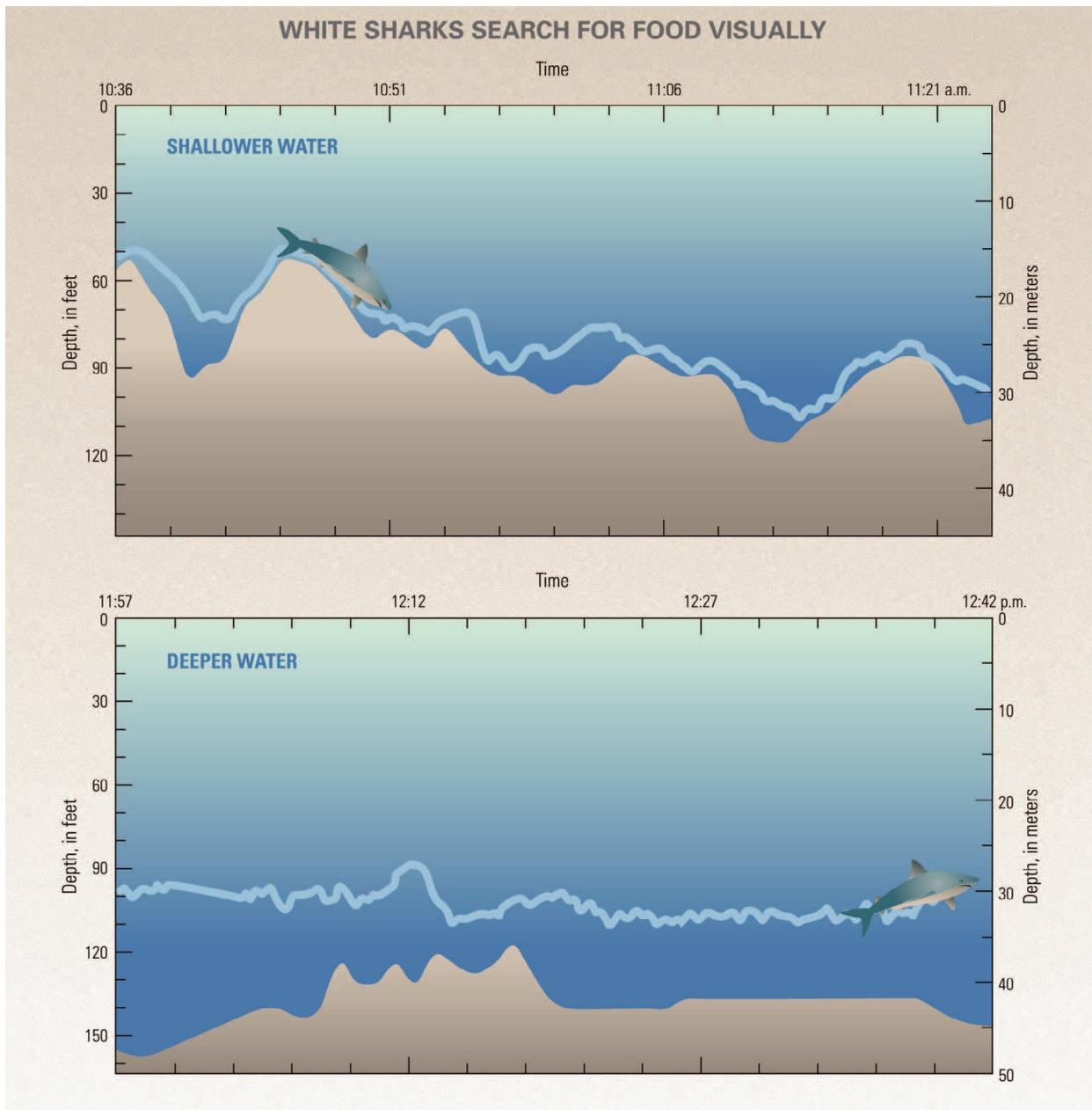


Figure 2. The white shark searches for food visually, staying near the sea bottom in water less than 27 m (90 ft) deep (top) and paralleling the ocean's surface in deeper water (bottom). In both situations, the shark's dark back and light underbelly blend with the surrounding environment, hiding the shark from seals and sea lions, its usual prey.

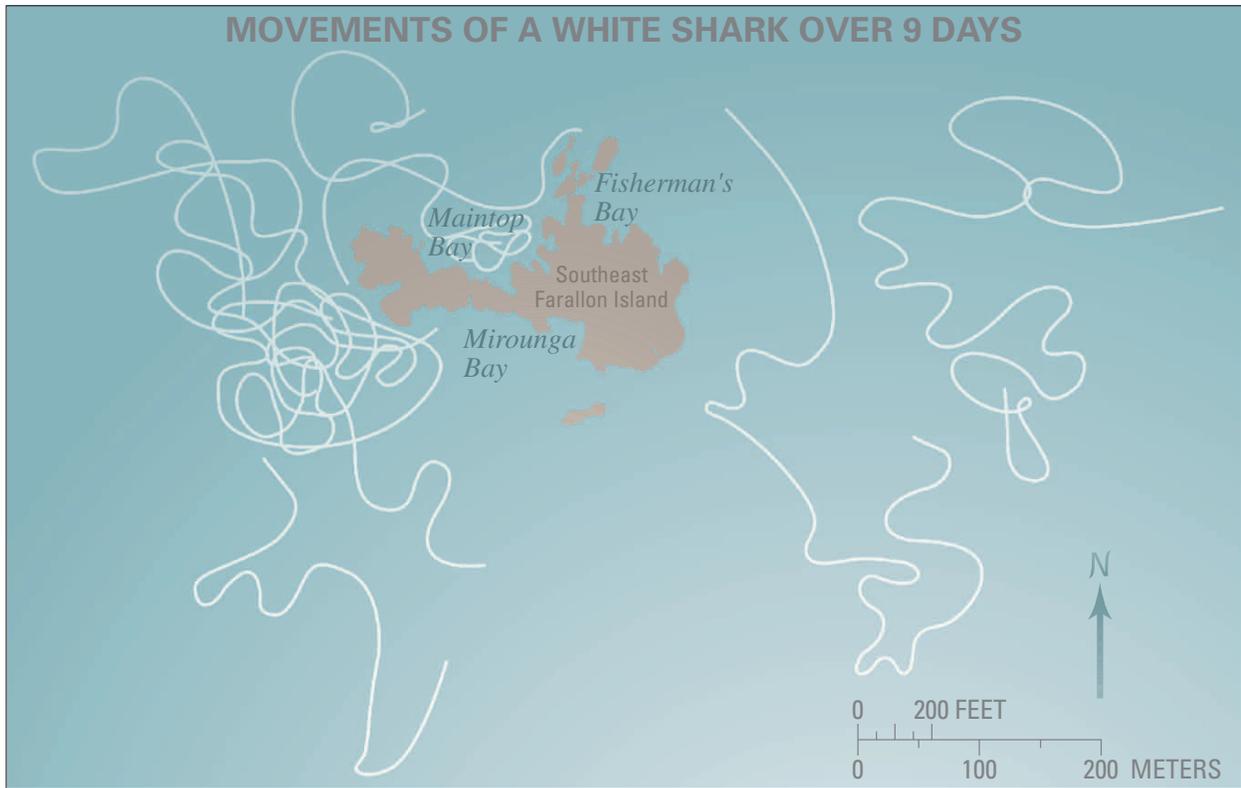


Figure 3. White sharks do not swim aimlessly; they increase their odds of finding seals by looking in familiar areas where they have previously been successful. The map shows the movements of a white shark tracked during October 21–29, 1993, around Southeast Farallon Island, using a transmitter swallowed by the animal.



Figure 4. Gulls hover over a predatory attack by a white shark on a northern elephant seal. Southeast Farallon Island is in the background.



Figure 5. Attack by white sharks is violent and quick; the sharks can strike quickly because they are warm blooded.



Figure 6. A decoy is struck during a study to determine how the white shark attacks its prey.