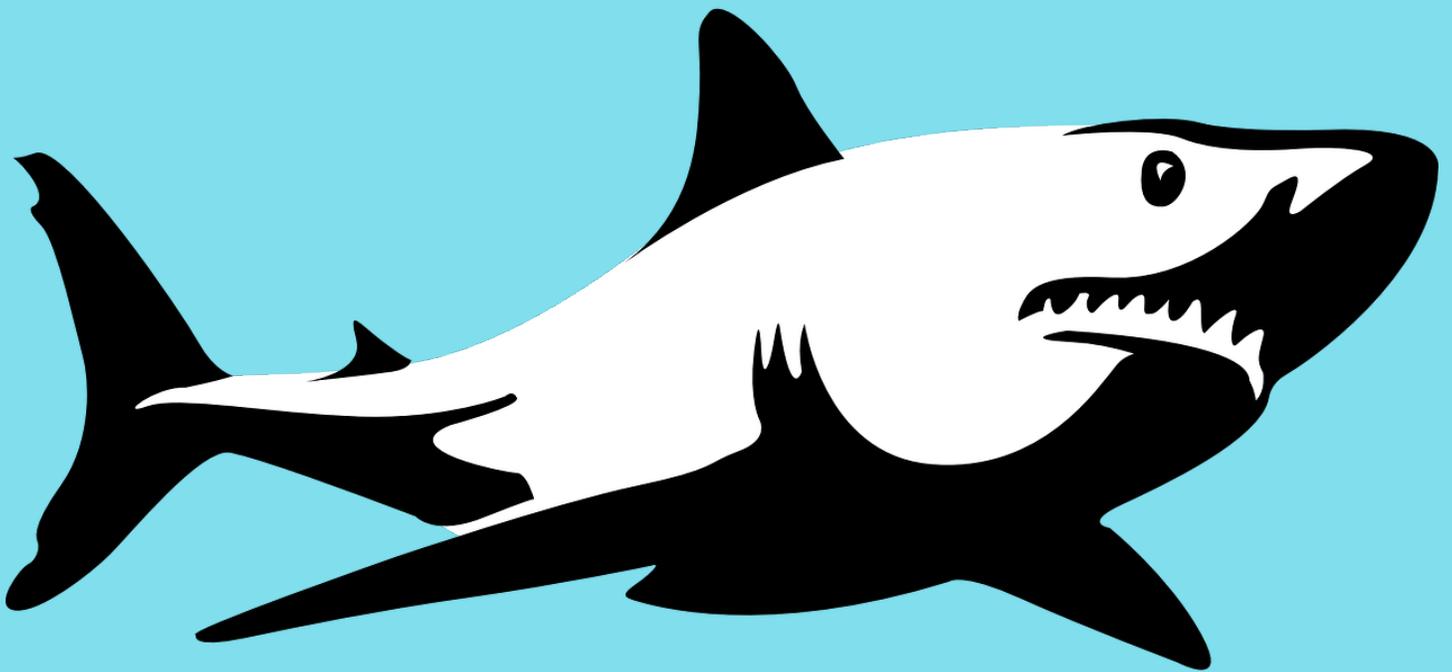


The Great White Shark

By Julia Hale





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The great white shark (*Carcharodon carcharias*), also known as the great white, white shark or white pointer, is a species of large mackerel shark which can be found in the coastal surface waters of all the major oceans. The great white shark is notable for its size, with larger female individuals growing to 6.1 m (20 ft) in length and 1,905 kg (4,200 lb) in weight at maturity. However, most are smaller; males measure 3.4 to 4.0 m (11 to 13 ft), and females measure 4.6 to 4.9 m (15 to 16 ft) on average. According

to a 2014 study, the lifespan of great white sharks is estimated to be as long as 70 years or more, well above previous estimates, making it one of the longest-lived cartilaginous fish currently known. According to the same study, male great white sharks take 26 years to reach sexual maturity, while the females take 33 years to be ready to produce offspring. Great white sharks can swim at speeds of over 56 km/h (35 mph) and can swim to depths of 1,200 m (3,900 ft).

The great white shark has no known natural predators other than, on very rare occasions, the killer whale. The great white shark is

arguably the world's largest known extant macropredatory fish and is one of the primary predators of marine mammals. It is also known to prey upon a variety of other marine animals, including fish and seabirds. It is the only known surviving species of its genus *Carcharodon* and is responsible for more recorded human bite incidents than any other shark.

The species faces numerous ecological challenges which has resulted in international protection. The IUCN lists the great white shark as a vulnerable species, and it is included in Appendix II of

CITES. It is also protected by several national governments such as Australia (as of 2018).

The novel *Jaws* by Peter Benchley and its subsequent film adaptation by Steven Spielberg depicted the great white shark as a “ferocious man eater”. Humans are not the preferred prey of the great white shark, but the great white is nevertheless responsible for the largest number of reported and identified fatal unprovoked shark attacks on humans.

Distribution and Habitat

Great white sharks live in almost all coastal and offshore waters which have water temperature between 12 and 24 °C (54 and 75 °F), with greater concentrations in the United States (Northeast and California), South Africa, Japan, Oceania, Chile, and the Mediterranean including Sea of Marmara and Bosphorus. One of the densest known populations is found around Dyer Island, South Africa.

The great white is an epipelagic fish, observed mostly in the presence of rich game, such as fur seals (*Arctocephalus* spp.), sea lions, cetaceans, other sharks, and large bony fish species. In the open ocean, it has been recorded at depths as great as 1,200 m (3,900 ft). These findings challenge the traditional notion that the great white is a coastal species.

According to a recent study, California great whites have migrated to an area between Baja California Peninsula and Hawaii known as the White Shark Café to spend at least 100 days before migrating back to Baja. On the journey out, they swim slowly and dive down to around 900 m (3,000 ft). After they arrive, they change behavior and do short dives to about 300 m (980 ft) for up to ten minutes.

Another white shark that was tagged off the South African coast swam to the southern coast of Australia and back within the year. A similar study tracked a different great white shark from South Africa swimming to Australia's northwestern coast and back, a journey of 20,000 km (12,000 mi; 11,000 nmi) in under nine months. These observations argue against traditional theories that white sharks are coastal territorial predators and open up the possibility of interaction between shark populations that were previously thought to have been discrete. The reasons for their migration and what they do at their destination is still unknown. Possibilities include seasonal feeding or mating.

In the Northwest Atlantic the white shark populations off the New England coast were nearly eradicated due to over-fishing. However, in recent years the populations have begun to grow greatly, largely due to the increase in seal populations on Cape Cod, Massachusetts since the enactment of the Marine Mammal Protection Act in 1972. Currently very little is known about the hunting and movement patterns of great whites off Cape Cod, but ongoing studies hope to offer insight into this growing shark population.

A 2018 study indicated that white sharks prefer to congregate deep in anticyclonic eddies in the North Atlantic Ocean. The sharks studied tended to favor the warm water eddies, spending the daytime hours at 450 meters and coming to the surface at night.

Anatomy and Appearance

The great white shark has a robust, large, conical snout. The upper and lower lobes on the tail fin are approximately the same size which is similar to some mackerel sharks. A great white displays countershading, by having a white underside and a grey dorsal area (sometimes in a brown or blue shade) that gives an overall mottled appearance. The coloration makes it difficult for prey to spot the shark because it breaks up the shark's outline when seen from the side. From above, the darker shade blends with the sea and from below it exposes a minimal silhouette against the sunlight. Leucism is

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extremely rare in this species but has been documented in one great white shark (a pup that washed ashore in Australia and died).

Great white sharks, like many other sharks, have rows of serrated teeth behind the main ones, ready to replace any that break off. When the shark bites, it shakes its head side-to-side, helping the teeth saw off large chunks of flesh. Great white sharks, like other mackerel sharks, have larger eyes than other shark species in proportion to their body size. The iris of the eye is a deep blue instead of black.

Size

In great white sharks, sexual dimorphism is present, and females are generally larger than males. Male great whites on average measure 3.4 to 4.0 m (11 to 13 ft) long, while females at 4.6 to 4.9 m (15 to 16 ft). Adults of this species weigh 522–771 kg (1,151–1,700 lb) on average, however mature females can have an average mass of

680–1,110 kg (1,500–2,450 lb). The largest females have been verified up to 6.1 m (20 ft) in length and an estimated 1,905 kg (4,200 lb) in weight, perhaps up to 2,268 kg (5,000 lb). The maximum size is subject to debate because some reports are rough estimations or speculations performed under questionable circumstances. Among living cartilaginous fish, only the whale shark (*Rhincodon typus*), the basking shark (*Cetorhinus maximus*) and the giant manta ray (*Manta birostris*), in that order, are on average larger and heavier. These three species are generally quite docile in disposition and given to passively filter-feeding on very small organisms. This makes the great white shark the largest extant macropredatory fish. Great white sharks are at around 1.2 m (3.9 ft) when born, and grow about 25 cm (9.8 in) each year.

According to J. E. Randall, the largest white shark reliably measured was a 6.0 m (19.7 ft) individual reported from Ledge Point,

Western Australia in 1987. Another great white specimen of similar size has been verified by the Canadian Shark Research Center: A female caught by David McKendrick of Alberton, Prince Edward Island, in August 1988 in the Gulf of St. Lawrence off Prince Edward Island. This female great white was 6.1 m (20 ft) long. However, there was a report considered reliable by some experts in the past, of a larger great white shark specimen from Cuba in 1945. This specimen was reportedly 6.4 m (21 ft) long and had a body mass estimated at 3,324 kg (7,328 lb). However, later studies also revealed that this particular specimen was actually around 4.9 m (16 ft) in length, a specimen in the average maximum size range.

The largest great white recognized by the International Game Fish Association (IGFA) is one caught by Alf Dean in south Australian waters in 1959, weighing 1,208 kg (2,663 lb). Several larger great whites caught by anglers have since been verified but were

later disallowed from formal recognition by IGFA monitors for rules violations.

Adaptations

Great white sharks, like all other sharks, have an extra sense given by the ampullae of Lorenzini which enables them to detect the electromagnetic field emitted by the movement of living animals. Great whites are so sensitive they can detect variations of half a billionth of a volt. At close range, this allows the shark to locate even immobile animals by detecting their heartbeat. Most fish have a less-developed but similar sense using their body's lateral line.

To more successfully hunt fast and agile prey such as sea lions, the great white has adapted to maintain a body temperature warmer than the surrounding water. One of these adaptations is a “rete mirabile” (Latin for “wonderful net”). This close web-like structure of veins and arteries, located along each lateral side of the shark, conserves heat by warming the cooler arterial blood with the venous blood that has been warmed by the working muscles. This keeps certain parts of the body (particularly the stomach) at temperatures up to 14 °C (25 °F) above that of the surrounding water, while the heart and gills remain at sea temperature. When conserving energy, the core body temperature can drop to match the surroundings. A great white shark's success in raising its core temperature is an example of gigantothermy. Therefore, the great white shark can be considered an endothermic poikilotherm or mesotherm because its body temperature is not constant but is internally regulated. Great whites also rely on the fat and oils stored within their livers for long-distance migrations across nutrient-poor areas of the oceans. Studies by Stanford University and the Monterey Bay Aquarium published on 17 July 2013 revealed that in addition to controlling the sharks' buoyancy, the liver of great whites is essential in migration patterns. Sharks that sink faster during drift dives were revealed to use up their internal stores of energy quicker than those which sink in a dive at more leisurely rates.

Toxicity from heavy metals seems to have little negative effects on great white sharks. Blood samples taken from forty-three individuals of varying size, age and sex off the South African coast led by biologists from the University of Miami in 2012 indicates that

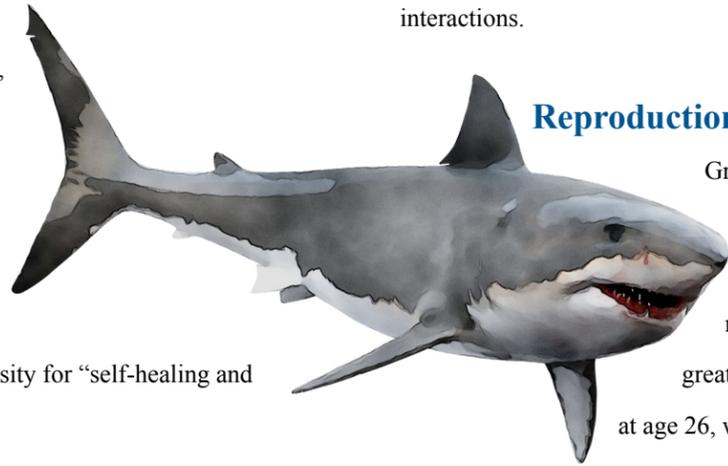
despite high levels of mercury, lead, and arsenic, there was no sign of raised white blood cell count and granulate to lymphocyte ratios, indicating the sharks had healthy immune systems. This discovery suggests a previously unknown physiological defense against heavy metal poisoning. Great whites are known to have a propensity for “self-healing and avoiding age-related ailments”.

Ecology and Behavior

This shark’s behavior and social structure is not well understood. In South Africa, white sharks have a dominance hierarchy depending on the size, sex and squatter’s rights: Females dominate males, larger sharks dominate smaller sharks, and residents dominate newcomers. When hunting, great whites tend to separate and resolve conflicts with rituals and displays. White sharks rarely resort to combat although some individuals have been found with bite marks that match those of other white sharks. This suggests that when a great white shark approaches too closely to another, they react with a warning bite. Another possibility is that white sharks bite to show their dominance.

The great white shark is one of only a few sharks known to regularly lift its head above the sea surface to gaze at other objects such as prey. This is known as spy-hopping. This behavior has also been seen in at least one group of blacktip reef sharks, but this might be learned from interaction with humans (it is theorized that the shark may also be able to smell better this way because smell travels through air faster than through water). White sharks are generally very curious animals, display intelligence and may also turn to socializing if the situation demands it. At Seal Island, white sharks have been observed arriving and departing in stable “clans” of two to six individuals on a yearly basis. Whether clan members are related is unknown, but they get along peacefully enough. In fact, the social structure of a clan is probably most aptly compared to that of a wolf pack; in that each member has a clearly established rank and each clan has an alpha leader. When members of different clans meet,

they establish social rank nonviolently through any of a variety of interactions.



Reproduction

Great white sharks were previously thought to reach sexual maturity at around 15 years of age but are now believed to take far longer; male great white sharks reach sexual maturity at age 26, while females take 33 years to reach sexual maturity. Maximum life span was originally believed to be more than 30 years, but a study by the Woods Hole Oceanographic Institution placed it at upwards of 70 years. Examinations of vertebral growth ring count gave a maximum male age of 73 years and a maximum female age of 40 years for the specimens studied. The shark’s late sexual maturity, low reproductive rate, long gestation period of 11 months and slow growth make it vulnerable to pressures such as overfishing and environmental change.

Little is known about the great white shark’s mating habits, and mating behavior has not yet been observed in this species. It is possible that whale carcasses are an important location for sexually

mature sharks to meet for mating. Birth has never been observed, but pregnant females have been examined. Great white sharks are ovoviviparous, which means eggs develop and hatch in the uterus and continue to develop until birth. The great white has an 11-month gestation period. The shark pup’s powerful jaws begin to develop in the first month. The unborn sharks participate in oophagy, in which they feed on ova produced by the mother. Delivery is in spring and summer. The largest number of pups recorded for this species is 14 pups from a single mother measuring 4.5 m (15 ft) that was killed incidentally off Taiwan in 2019. The Northern Pacific population of great whites is suspected to breed off the Sea of Cortez, as evidenced by local fisherman who have said to have caught them and evidenced by teeth found at dump sites for discarded parts from their catches.

Relationship with Humans

Of all shark species, the great white shark is responsible for by far the largest number of recorded shark bite incidents on humans, with 272 documented unprovoked bite incidents on humans as of 2012.

More than any documented bite incident, Peter Benchley’s best-selling novel *Jaws* and the subsequent 1975 film adaptation

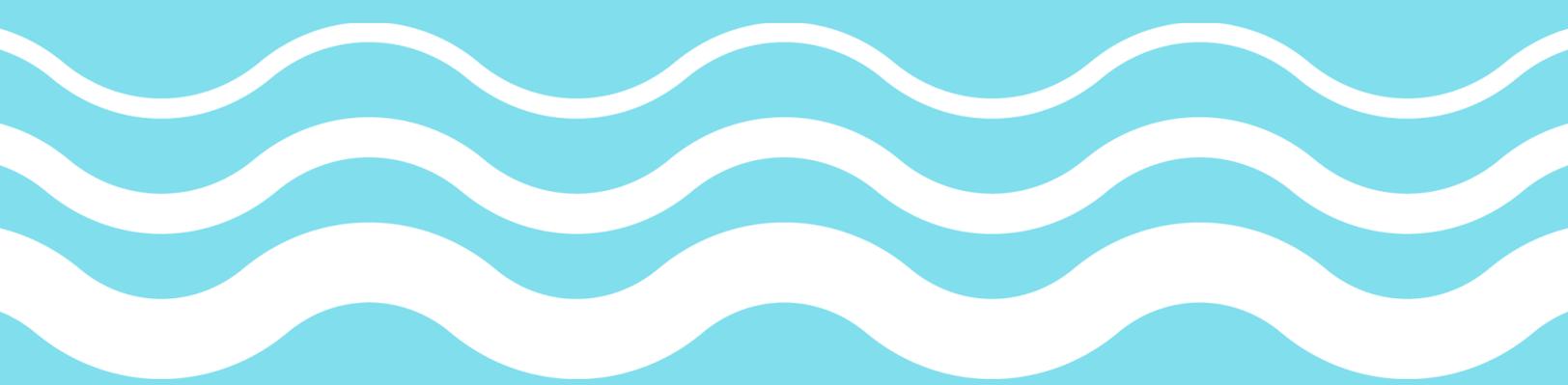
directed by Steven Spielberg provided the great white shark with the image of being a “man eater” in the public mind. While great white sharks have killed humans in at least 74 documented unprovoked bite incidents, they typically do not target them: for example, in the Mediterranean Sea there have been 31 confirmed bite incidents against humans in the last two centuries, most of which were non-fatal. Many of the incidents seemed to be “test-bites”. Great white sharks also test-bite buoys, flotsam, and other unfamiliar objects, and they might grab a human or a surfboard to identify what it is.

Contrary to popular belief, great white sharks do not mistake humans for seals. Many bite incidents occur in waters with low visibility or other situations which impair the shark’s senses. The species appears to not like the taste of humans, or at least finds the taste unfamiliar. Further research shows that they can tell in one bite whether or not the object is worth preying upon. Humans, for the most part, are too bony for their liking. They much prefer seals, which are fat and rich in protein.

Humans are not appropriate prey because the shark’s digestion is too slow to cope with a human’s high ratio of bone to muscle and fat. Accordingly, in most recorded shark bite incidents, great whites broke off contact after the first bite. Fatalities are usually caused by blood loss from the initial bite rather than from critical organ loss or from whole consumption. From 1990 to 2011 there have been a total of 139 unprovoked great white shark bite incidents, 29 of which were fatal.

However, some researchers have hypothesized that the reason the proportion of fatalities is low is not because sharks do not like human flesh, but because humans are often able to escape after the first bite. In the 1980s, John McCosker, Chair of Aquatic Biology at the California Academy of Sciences, noted that divers who dove solo and were bitten by great whites were generally at least partially consumed, while divers who followed the buddy system were generally rescued by their companion. McCosker and Timothy C. Tricas, an author and professor at the University of Hawaii, suggest that a standard pattern for great whites is to make an initial devastating attack and then wait for the prey to weaken before consuming the wounded animal. Humans’ ability to move out of reach with the help of others, thus foiling the attack, is unusual for a great white’s prey.





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Image 1: Pixabay.com
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