



What is the Great White Shark?

The great white shark, *Carcharodon carcharias*, is a very large, fast-swimming predatory fish mostly of cool, coastal waters. It is found worldwide and has been known and feared since ancient times as a man-eater. The first scientific treatment of this shark is apparently that of the Renaissance investigator Guillaume Rondelet, whose 1554 book contained a description and woodcut illustration. The species were given a scientific name by the classifier Carolus Linnaeus in his 1785 catalogue, *Systema Naturae*, and he called it *Squalus carcharias*. For centuries this misunderstood fish like the predatory cats of the African veld, has been the object of horror as fearsome killer, aided in part by the popular media and some misguided people. But here we shall explore the world of this shark and try to understand its rightful role in the marine environment

Names and Classification

Linnaeus's system was worked out to provide all species with two names, the generic and specific. This was so that closely related species could be recognized in a named grouping: the genus. The tenth edition of Linnaeus' book was chosen as the earliest publication available for scientific names, so his *Squalus carcharias* the oldest acceptable name for the great white shark. A different generic name has to hold the great white because scientists after Linnaeus realized that this his *Squalus* included many very different kinds of sharks. *Squalus* therefore needed to be restricted, so several new names had to be created to sort out the other species placed there. In 1833 Sir Andrew Smith proposed the generic name *Carcharodon*, but it wasn't until 40 years later that Sir Andrew's generic name was identified with Linnaeus's specific name. The generic name stems from the Greek words "karcharos" (sharp or jagged) and "odous" (tooth).

The great white is classified in the mackerel shark family, the Lamnidae. There are four other species in this family, two mako and two porbeagle sharks. Only one of these, the shortfin mako, is common off South Africa.

Local names for the great white vary across all the linguistic groups where coastal people live, but in English-speaking countries the name "white shark" is often used, and less often, the more archaic "man-eater". In Australia "white pointer" is common, less so is "white death". In South Africa these terms are also used, but so is "blue pointer" (the backs of the some great whites have a bluish sheen) or "tommy", perhaps a reference to the old nickname for the British Army soldiers. The Afrikaans name "(Witdoodshaai)" stems from one of the lesser-used English names.

Recognition

The most familiar sharks (e.g. a blacktip shark) have torpedo-like bodies, as does the great white, but it is also rather stout when compared to other sharks. The snout of the great white is short and conical. The eye is circular and solid black. The jaw teeth, especially the uppers, are broadly triangular, with fine serrations on the edges with small lateral cusps. Juveniles fewer than two meters may have some smooth-edge teeth. The five gill slit are long, and all in front of the pectoral fin. The anal and second dorsal fins are nearly rectangular in adults and very small. The tail fin support area (caudal peduncle) has a wide lateral keel that strengthens the fin's movement. The caudal fin is crescentic (both upper and lower lobes are about the same size). The upper part of the body, roughly on a line through the eye to the pelvic fin, is dark to light grey. Below this, the body is white. Freshly caught fish often exhibit a brassy sheen that fades in air. The pectoral fin axil usually has a large black spot.

The shortfin mako shark is similar in appearance to the great white. It differs in being brilliant blue above and on the sides of the body. It has a larger eye than the great white, and the teeth are narrow and without serrations. It grows to 4 metres.

An Albino Great White

On 25 March 1996, an albino great white was caught by Mr. Gerhard Els off Boknes, Eastern Cape, in 50 m of water. Mr. Els hooked the shark on a pilchard and squid-baited rig. It was donated to the JLB Smith Institute of Ichthyology and, after some research, was determined to be the first albino of the species known to science. This individual, a juvenile female less than a year old and measuring 145 cm to the fork of the tail, was solid white with reddish eyes, as are albinos of other animals. Much media attention was given to the specimen and it formed part of the public display at the Institute. Notice to the scientific community of this extremely rare discovery was made by Drs Malcolm Smale and Phil Heemstra, who gave a detailed physical description of the specimen with an emphasis on the conditions of its eyes.

Habitat

The great white is chiefly a continental, near-shore fish of the world's temperate seas. It does not avoid the tropics (especially large individuals), but may make only sporadic appearances in some regions, especially Central America, tropical South America and the central Pacific islands. Many records from isolated areas

show that it is capable of ranging widely and even crossing ocean basins. Great whites stay mainly in near-surface waters, especially when hunting, but one has been caught on the bottom hook and line rig at a depth of 1280 metres.

Known areas of abundance for the great white perhaps reflect its interaction with man (sport fisherman, beach bathers, scuba divers and surfers). These areas include California, the Mid-Atlantic States of the USA, southern Africa and eastern Australia, New Zealand and some Pacific islands.

Relatives, Living and Fossil

The living great white is one of five species classified in the genus *Carcharodon*, but four are extinct. Researchers now believe an ancestral species, *Carcharodon landanensis*, arose in the Paleocene age (65-57 million years ago) and gave rise to the two lineages at about the same time. The first, including the living great white, has intermediate fossil species that connect it to a relatively smaller *C. landanensis* (2-3 metres in length). A second line, recognized as a separate genus, *Carcharocles*, by some researchers, include gigantic relations that can be traced back about 50 million years. The evolution of these huge sharks is characterized by increasing body size, and one may have lived up to fairly recent times.

The modern great white evolved in Miocene times, about 20 million years ago. At the same times, two other much larger sister species that evolved from the second parallel lineage, called *Carcharodon megalodon* and *C. angustidens*, were present in the world's sea. Teeth of the *C. megalodon* measuring 17 cm in length were found in Peru, and this indicates that it reached 13 metres or more, and weighed around 20 tons. This huge predator, at least at its largest sizes, probably fed mostly on large baleen whales. Some researchers postulate that it became extinct when the whales evolved a migratory behaviour into polar seas to feed on the abundant plankton there. This would have cut off the huge shark's main food source for much of the year because they were not temperature adapted to follow the whales into icy seas.

Fossilized teeth of the three species of *Carcharodon* have been found in southern Africa. Those of the modern great white, *C. angustidens* are known from KwaZulu-Natal near Uloa in a Lower Miocene deposit, about 15 million years old. Teeth of the larger *C. angustidens*, measuring up to 15 cm, have been collected from the KwaZulu-Natal locality as well as the Eocene beds in the Eastern Cape and in Namibia. Another close lineage of Paleocene giant sharks without serrated teeth (Family Otodontidae) evolved alongside the *Carcharodon* species and gave rise to the living porbeagle sharks (genus *Lamna*).

Size and Age

Ageing sharks is not as easy task. This is mainly due to the fact that growth is related to nutrition (which may vary), geographical area, and that in some species males and females grow at different rates, which slows with age. Researchers have shown that calcified bands in the great white's vertebrae may reflect age, something like tree rings. On this basis, eastern Pacific great whites were aged at 13-14 years at a length of 16 ft (4,75 m), while sharks from the North Atlantic were thought to be 20 years old at the same length.

Great whites measure 109-129 cm at birth. Size and sexual maturity varies individually. Males mature at 3,5 to 4,5 m and are about 9 years old. Females around 4,5 to 5 m and 12-14 years old. Presently it is unknown if males grow to a larger maximum size than females, though most of the largest (over 5 m) seen are females. Many incorrect maximum sizes have been reported over the past years; one at 36 feet (11 m) that persisted for decades was apparently a typographical error for 16 feet. The largest great white caught in recent years were not measured, but researchers have little doubt that one from Malta and another from South Australia were over 7 m total length. These sharks would be approaching 30 years of age. A 6 m female recently caught in Gans Bay and examined by the Shark Research Centre, Cape Town, would have been about 22 years old, if one vertebral band equals to one year.

Reproduction and Development

Fertilization is internal in the great white and females give birth to live young (they are ovoviviparous). Courtship behaviour is unknown, but scientists think that scarred individuals suggest male-male aggression or that a male's gentle biting of females may precede mating. After absorbing all their yolk the embryos begin to feed on eggs or even on other embryos, inside the mother. This is called intrauterine cannibalism and occurs in the great white's relatives as well. Females with young are not documented, but larger females may bear more young ("pups") than smaller ones, as in other sharks. One Australian female was found with 11 pups. The gestation period is unknown, but with the large size at birth (above), it is likely to be around a year or longer. Dr Leonard Compago of the Shark Research Centre, Cape Town, has deduced an "average" female reproductive potential, bearing in mind number of variables and unknowns. With maturation at 5 m at the age of 15, with maximum size of 7.2 m at the age 30-31, and an average of nine pups every three years with a lag time of a year after giving birth before the next pregnancy, such as an "average" female would produce 45 young up to a year before her death. However, owing to natural mortality, relative health and mate availability, most female great whites probably produce fewer young, especially in areas of heavy human impact.

Some researchers believe that great whites are born to non-feeding, self-isolated females in coastal, warm-temperate seas and become adapted to wider temperature ranges as they grow. This would allow larger sharks to venture into open ocean areas, explaining their occurrence among the tropical mid-ocean islands. Scientists note that the known distribution of small great whites (two years old or less) and growth estimates suggest the young may be geographically restricted to areas of narrow temperature fluctuations until the supposed water temperature tolerance develops.

Food and Feeding Habits

It is known, even among land-locked people the world over, the great white shark is a top predator. The sheer size, power and fearsome jaws of this creature demand such an observation. But surprisingly, great whites also scavenge carrion and garbage. Researchers have recorded prey items based on stomach contents as follows: bony fishes of many varieties and sizes of pilchards to sturgeons; Cartilaginous fishes, including other larger sharks and rays; sea turtles; birds; including gannets; gulls and penguins; marine mammals like dolphins, porpoise, seals and dead whales; invertebrates including abalone, other marine snails, squid, cuttlefish, starfish and crabs.

Off seal colonies, great whites larger than 3 m evidently shift their diet from mostly fishes to seals. Jackass penguins are occasionally bitten by great white but these birds are seldom seen in their stomachs. Especially important feeding areas include Bird Island, Eastern Cape, and Dyer and Robben Islands, Western Cape. However, in tropical areas where the seals are rare or absent, great whites are perfectly capable of surviving on bony fishes, other sharks and marine mammals. It is important to note that whatever specialized predatory preference develops in one may not occur in other areas, as these large sharks are capable of ambushing, or otherwise catching, just about anything that swims in the sea.

Large live seals must be among the great white's most difficult prey. They are usually killed by a sudden burst of high speed that may throw the seal completely out of the water, with "bite" and "spit" behaviour. This action is viewed by scientists as a defensive kill; in other words, sharks are protecting themselves from the claws and teeth of an agitated, wounded animal. Penguins have been seen to be repeatedly tossed about like this off South Africa. This behaviour may not be part of an actual feeding repertoire, but may be more "playful" (except to the penguin!), or "testing", in the case of young sharks. Wounded, dying prey will then be circled by the shark until it is sufficiently weak, then consumed. In the context of the next section it is important to understand the great white's marine mammal feeding strategy as outlined here.

Attacks on Humans

One of man's deepest primal fears is that of being beaten alive by a wild animal. Perhaps the greatest part of the mystique of the great white concerns its long history of attacking people for just such a purpose.

More attacks by great whites have been reported than any other shark. But, of all the shark attacks ever reported, 80 % have occurred in the tropics where great whites are rear. There, large hammerheads or requiem sharks are usually to blame. Indeed, Dr. Davies, former Director of the Oceanographic Research Institute, Durban, as long ago as 1964 (see References), credited seven species as dangerous in South Africa. Still, more people drown or are injured or killed by bee stings, lightning, or snakebites every year than are attacked by sharks. Nevertheless, great whites are dangerous to human in the water, and some regions have reported more captures or attacks than others (see "Habitat").

American researchers documented 115 attacks by great whites worldwide from the 1926 to 1991. Off South Africa there were 29 attacks, six of them fatal. But a total of 89 shark attacks with 28 fatalities have been reported in S.A since 1940, so some of these are attributable to other species.

Why are great whites dangerous? Contrary to some popular counts, they are dangerous simply because we, as land dwellers, do not naturally fit into the ocean environment where these large, fast predators view humans as potential prey. They may also react to people in the water as territory invaders that need to be chased off, possibly explaining the may single-bite attacks attributed to great whites where victims have survived. Some sensational portrayals of sharks, particularly certain films and books of a by-gone era, have warped their natural predatory behaviour to instill horror in us by depicting hate-filled monsters bent on mindless destruction or revenge. Nothing could be further from the truth.

Advice to Bathers, Surfers and Divers

Even if great whites are simply part of the natural world and are not malicious, precautions need to be taken while in their world, just as wildlife tourists in our game parks take precautions against attack by predators such as lions. Below are some helpful guidelines we hope may serve to avoid a shark attack.

1. Never swim alone, or wander far from a group of others in the water, thereby isolating yourself as a target. Many of our beaches have lifeguards or are protected by anti-shark nets and these areas should be favoured by bathers.
2. Leave the water immediately if surfing or bathing and a large shark is seen. To scuba divers, many sharks will not recognize humans as prey, but may feel threatened by their presence. Leave the water if circled, bumped, or if a shark arches its back and twists from side to side in an exaggerated fashion. This is a pre-attack warning behavior. Do not, however, count on a shark to circle, pass close or threaten before it makes a direct charge.
3. Blood is an attractant to sharks, whether from the fish, birds or mammals. Do not tow speared fish; remove them immediately and do not hang them in the water over the side of boats. Women should avoid the sea during their menstrual period. People have been attacked by sharks in knee-deep water.
4. Avoid swimming or surfing in murky waters, such as off estuaries. Keep a watch out for shadows and movement around you while diving in reduced visibility. Leave the water if shoals of fish around you behave in an erratic manner, particularly near drop-offs or in channels.
5. If diving from a boat, take care to observe the sea for a few minutes before entering the water. Sharks may surface and submerge repeatedly over the short intervals. Exit the water upon reaching the surface quickly, with minimal fanfare.

6. Avoid swimming far offshore at dusk or at night. Many sharks search for prey at these times. Night divers need to be particularly wary when diving in known shark-inhabited areas. Move slowly about and avoid flashing your touch around the water column needlessly.
7. A popular myth is that if dolphins are around it is safe, since dolphins chase sharks away. Dolphins will not chase sharks unless protecting new-borns or if they feel threatened in some other way.
8. Never molest or provoke a shark in any way, no matter how small or harmless it may appear. It is disrespectful of nature to do so; it may get you a nasty bite that could lead to greater trouble later.

Treatment for Victims of Shark Attack

Despite all precautions, in the eventuality of an attack there are several important things to know:

1. It is most important to staunch the flow of blood as quickly as possible. A tourniquet to limbs may be needed between the wound and heart, taking care it is not too tight. Place compress bandages of anything soft and pliable at hand directly on wounds. Keep the victim immobile and as warm as possible. Summon medical emergency aid immediately, even for what may appear to be minor wound.
2. For major injuries to surfers or bathers, lie the victim parallel to the sea on dry sand and raise the legs to promote blood flow to the head. Do not place a victim head down to the water's edge. Help the victim to breathe if necessary.
3. While awaiting medical aid, keep the victim conscious and calm by speaking reassuringly. Do not attempt to carry the victim off the beach or boat to a private vehicle to dash to hospital, as this may promote the onset of shock.
4. Do not give any drink, especially of alcohol, as this may help lower the body's core temperature and aid the onset of shock. Water may be used to wet the victim's lips.

Fishing for Great White Sharks

Trophy fishing for large sharks is in vogue for decades, seriously so since the 1920s. In former years, avid fishermen caught sharks not only for perceived personal glory (setting records), but also to combat the shark "menace", particularly off the USA, Australia and South Africa.

In Australia after the second World War, catching great whites became an obsession to some, with Alf Dean setting the International Game Fish Association for the largest fish ever caught on rod and reel with a 1211 kg great white. Australian fishermen set chum slicks from boats using fish oil, blood or offal and often wait at the sea for days before a great white picks up the trails and rises to the occasion. Once a shark comes around the boat guided in by the slick, it is in an excited state and hooking it is little more effort than leading lambs to slaughter.

In South Africa, trolling off the seal or penguin colonies was a more common practice until this became unlawful in 1991. On Durban's South Pier, during the heyday of the Union Whaling Company in the 1950s and 60s, large sharks were attracted into Durban harbor by blood. Shore fishermen devised a long pole and ladder-line rig to get large chunks of whale meat far into the harbor entrance and, after hooking a shark and playing it for hours, usually roped it up to the pier by its head. Most of these fish were Zambezi or tiger sharks, but many great whites were taken too.

In 1947, Mr. L.M. Bowman, a Port Elizabeth businessman, initiated the annual Bowman trophy for the largest South African shark caught from land. From 1948 to 1966 every winner was a great white except for one. The record during this time was a great white weighing 755 kg landed in 1953.

In the early days of the great white fishing very few, if any, were used for food. Their jaws were seldom cut out and prepared as trophies then, unlike after the release of the film, Jaws when large, well preserved great white jaws fetched large sums. As trophy hunting for great white is illegal now in South Africa, what is the point of fishing for them? For the expense involved there are cheaper ways to stock the freezer, so if not for trophies or food there seems to be no real reason to fish for these magnificent creatures anywhere in the world. In fact, conservation efforts are in place in South Africa to fully protect our great white populations.

Marine Conservation: Sympathy for the Devil

In a balanced ecological community (ecosystem), whether on land, sea or air, top predators are numerically rare compared to their prey species. This applies to great whites, lions, polar bears, fish eagles and many other species near the top of food chains everywhere. Great whites are nowhere abundant, even relative to most other large sharks.

Adding fishing pressure to a species whose population numbers are already low is worrisome. Sharks are especially susceptible to population crashes because their reproductive rate is low and it takes years to reach maturity (see Reproduction and Development above). Indeed, today South Australia, in areas made famous by filmmakers and scuba tour operators, such as Dangerous Reef, great whites have all but disappeared due to overfishing. Still, a network was recently set up there to report all great white occurrences to scientists in order to make management plans for the conservation of the species. South Australian conservation groups mounted a campaign to ban the targeting of great white for sport fishing, and chumming was outlawed. By the end of 1996 New South Wales' and Tasmania's Fisheries Regulations protected great whites.

In South Africa, protection for the great white was a world first, thanks in large part to a long-term research programme organized by the Shark Research Centre, Cape Town. Researchers, conservation groups, sport

and commercial fishing interests and private citizens joined a debate that resulted in the 1991 Act that include a total ban on intentionally catching, molesting and commercially utilizing great whites (or parts like jaws), with heavy penalties for violators. Objectives to the Act came primarily from sport and commercial fishing interest that had profited from their capture (mainly the sale of meat and prepared jaws)

Trophy fishing is not the only cause of great white population decline in Australia and South Africa. Also important is mortality caused by the commercial fishing industry, which is difficult to assess because of reporting problems, and the Shark Board (SB) nets. The SB. is a major known cause of great white mortalities in South Africa today. Between 22 to 61 great whites per year were taken in the anti-shark nets of KwaZulu-Natal between 1974 to 1988, with declining numbers in recent years. Live great whites have been released from SB nets since the late 1980s, however most sharks seen by SB staff in the nets died before it was possible to help them.

Much emotional debate, as with that aimed at protecting the great white, has centered on the KwaZulu-Natal nets. Probably central to the debate is that the vast majority of sharks caught and killed have never been implicated in attacks on humans and most likely would not attack unless provoked. Reactions to the nets run gamut from keeping the nets up to protect the public (and foreign tourists!) at all costs from mindless killers, to a complete ban on the nets for all time, thus making people who venture into sharks territory take responsibility for their actions.

Recent technological studies made to address the carnage in anti-shark nets and protect swimmers and divers may soon be put into place. Sharks Board director Dr. Graeme Charter and researcher Mr. Norman Starkey developed a device called the "POD" (Protective Oceanic Device), the first successful electronic shark repellent known. The device produces an electromagnetic field that irritates sensitive organs set in head pores that sharks use to detect prey, called the Ampullae of Lorenzini. PODs worn by scuba divers are powered by a 90 volt power pack and work for up to 75 minutes. Devices for life jackets, paddle skis and surfboards will soon be planned. Until then, humans in the sea must remain wary so as not to be confused with the natural prey of such magnificent animals as the great white shark.

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