Shark detectives

Text by Thomas P. Peschak & Michael C. Scholl
Photographs by Thomas P. Peschak

Surprisingly little is known about great white sharks, considering that in some quarters they are regarded as a public enemy and extremely dangerous to humans. But think about it – they don't survive in captivity and they are not easy to see, let alone track, in their ocean environment. When researchers do see them they are, understandably, reluctant to get too close. To this day, the sharks' migration patterns and mating habits, even their population status, remain a mystery. Down in south-western South Africa, though, biologists Michael C. Scholl and Thomas P. Peschak are going to great – and increasingly ingenious – lengths to learn more about one of the ocean's greatest predators. ▸

Too close for comfort? On a fine summer's day, a great white shark patrols the shoreline at Shark Bay.

The scene unfolding before us is so clichéd it could have been spliced straight from *Jaws*. A dark shadow glides beneath the ocean's surface just 50 metres from a postcard-perfect beach that is packed with playing children, fussing mothers and bouncing beach balls. It is October 2003 and we are following a pod of dolphins in our research boat. We cruise slowly inshore to investigate a dark shape that is too small for a whale, too large for a Cape fur seal and too slow for a dolphin. Then, as it passes over a sand bar, an unmistakable steel-grey, triangular dorsal fin punctures the glassy surface. We watch the great white shark swim towards the beach in water less than two metres deep, its belly scraping the bottom and creating whirls of sand. Without the benefit of 15 years of marine research experience between us, we might have assumed that the shark is looking to the beach for a meal. But as we watch, it turns and swims straight past the bathers splashing in the surf. It's focused on something, but not on humans.

We returned the following day, expecting to establish that the encounter had been a fluke. Instead, we found three more great whites swimming within 50 metres of Shark Bay's beach, and then another five as we cruised eastward. For some years we had known that large numbers of great whites frequent the bay's deeper reaches between September and mid-January, but not that they travel this close inshore and in such numbers. Aware that an inshore aggregation like this was unlikely to be a random event, we began daily surveys of a fixed six-nautical-mile transect running parallel to the beach.

It is easy to spot a great white from the raised tower of our research boat, as its dark dorsal side contrasts so clearly with the light-drenched sandy bottom. Over the next four months that summer we saw them almost every day. Many surveys recorded more than 20 – an astonishing statistic of over three sharks per nautical mile. Every dawn delivered new surprises – until one day in January the shark encounters suddenly stopped. For weeks we continued with the surveys, but the sharks had gone. Convinced that these inshore aggregations were a seasonal event, we vowed to return to the shallows the following spring. Soon the great whites disappeared from the deeper reaches of Shark Bay too, and we moved our survey five nautical miles offshore to Dyer Island, a research site well known to us. Here, we were sure, we would find great whites – and lots of them.

In the autumn and winter months the seas around Dyer Island host what is perhaps the world's highest concentration of transient great white sharks, and this is where many of them were fitted with number- or colour-coded tags during the early days of shark research in South Africa. Tagging, however, proved to be largely unsuccessful as a means of identifying ▶

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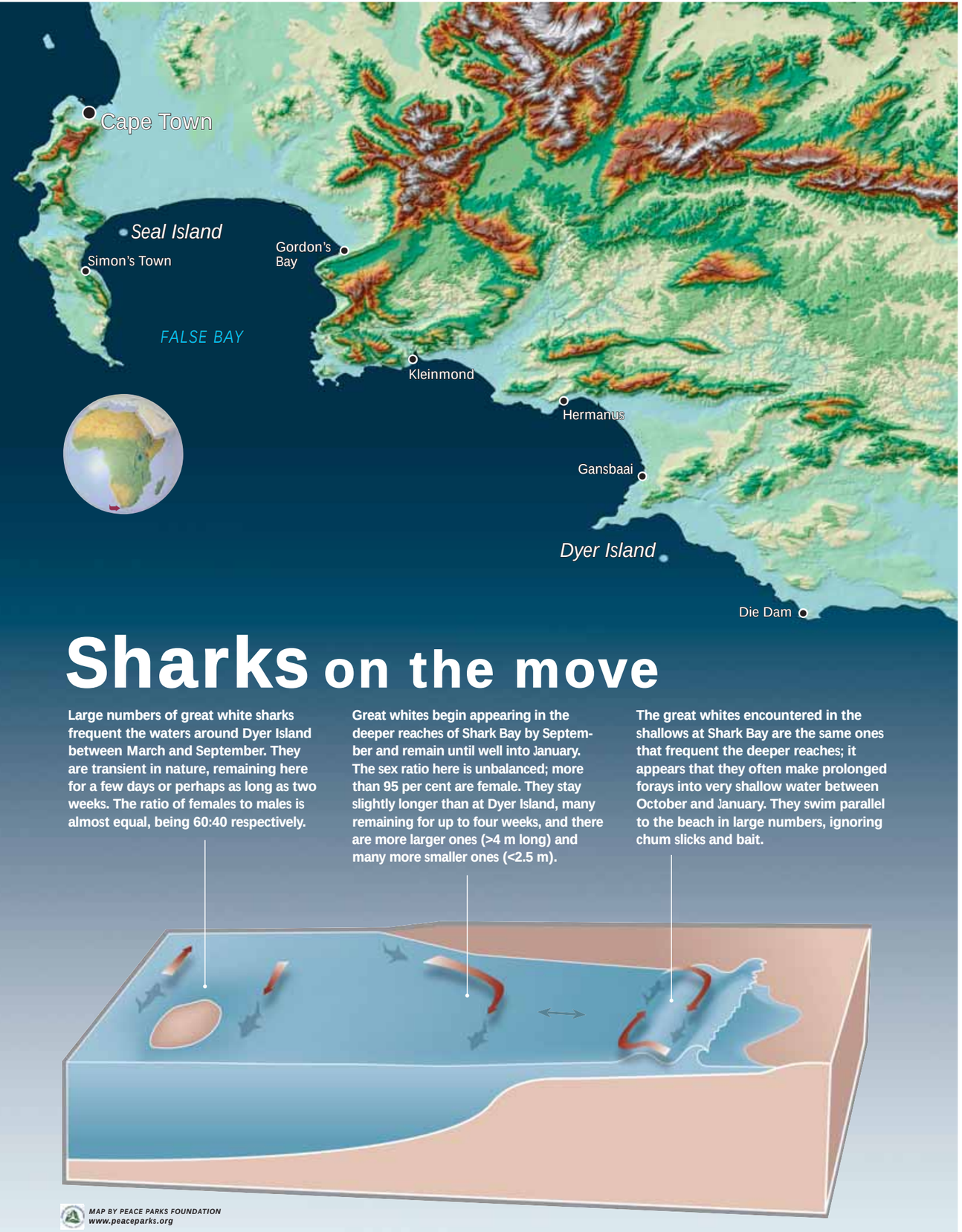
ABOVE Most people believe a great white shark's eye is cold, black and devoid of expression, but a close-up view shows it to be full of life.

OPPOSITE The great white's dorsal fin is better than any identification tag. The notches in its trailing edge, the shape of its tip and the pigmentation pattern on the fin itself enable us to recognise individual sharks over long periods.



Sharks on the move

Large numbers of great white sharks frequent the waters around Dyer Island between March and September. They are transient in nature, remaining here for a few days or perhaps as long as two weeks. The ratio of females to males is almost equal, being 60:40 respectively.

Great whites begin appearing in the deeper reaches of Shark Bay by September and remain until well into January. The sex ratio here is unbalanced; more than 95 per cent are female. They stay slightly longer than at Dyer Island, many remaining for up to four weeks, and there are more larger ones (>4 m long) and many more smaller ones (<2.5 m).

The great whites encountered in the shallows at Shark Bay are the same ones that frequent the deeper reaches; it appears that they often make prolonged forays into very shallow water between October and January. They swim parallel to the beach in large numbers, ignoring chum slicks and bait.

MAP BY PEACE PARKS FOUNDATION
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individual sharks, as algae growing on the tags rendered them unreadable and the tags themselves were inclined to fall off. Then, in the late 1990s, we realised that a great white's dorsal fin, like that of dolphins and some whales, bears very obvious markings that make it possible to identify individuals by non-invasive means and from a distance. It took us another five years to demonstrate to our satisfaction that we could indeed reliably identify individuals – by the notch pattern of the dorsal fin's trailing edge, by the shape of the fin's tip and, sometimes, by pigmentation patches present on it.

More than a thousand individual great whites have been identified to date in the waters surrounding Dyer Island, and from this and other data we have established that most of them only remain around the island for a few days to two weeks. The majority are never re-sighted, but a small percentage return consistently and with uncanny accuracy, reappearing within the same week year after year. By late August, Dyer Island seems to lose favour with the sharks and they leave, turning up again in the deeper reaches of Shark Bay in September.

When we analysed the data regarding the size and sex of the great whites seen at Shark Bay and Dyer Island over five seasons, it became clear that the populations at these two locations differ markedly in their composition. At Shark Bay, more than 95 per cent of the sharks are female, whereas the population around Dyer Island has a more balanced sex ratio: 60 (female) to 40 (male). The females at Shark Bay exhibit a high incidence of fresh bite wounds, mostly around the pectoral fins and gills, and the population comprises large sharks (longer than four metres) and much smaller ones (less than 2.5 metres), with very small sharks being especially abundant. The great whites surveyed in the extreme shallows of Shark Bay are very similar to those in the bay's deeper reaches, but quite different to those at Dyer Island. In many cases at Shark Bay we even found that the same sharks were frequenting both the deeper and the inshore reaches, but never on the same day.

Having combined these observations with everything else we know, we came up with three possible explanations for the presence of so many great whites so close to the beach during the summer months: they could be there to hunt, to mate or to give birth.

More than a thousand great whites have been identified in the waters surrounding Dyer Island

Soon after the great whites reappeared in the deeper reaches of Shark Bay in September, we encountered the first one in the shallows. Now was the time to test our hunting theory. Our systematic search for signs of potential prey species turned up abundant runs of game fish and plenty of seals in the deeper reaches of the bay, but much of the immediate inshore area resembled an undersea desert. We then took a closer look at how the sharks behaved when onshore winds pushed the chum slicks from cage diving boats into the shallows. All the sharks we tracked swam straight through the slicks without investigating or responding to them – in stark contrast to sharks in the deeper reaches, which were readily attracted to the scents generated by chum and which fed on the cage divers' bait. It appeared, therefore, that in the shallows the sharks' hunting or feeding was inhibited. In species such as lemon and ragged-tooth sharks, feeding inhibition occurs during pregnancy and immediately after giving birth, so that newborns do not fall prey to their own mothers.

A great white's snout is equipped with an arsenal of sophisticated sensors that put any human-created device to shame. This inquisitive shark is about to lightly bump the glass dome of the camera to learn more about the strange object that has invaded its realm.

Sitting in a 3.8-metre sea kayak and watching a four-metre great white approach you is a fairly tense experience

Great white sharks are usually attracted by the electromagnetic field discharged by a boat engine. This one has swooped in for a closer inspection.

Could Shark Bay be a pupping and nursery ground? Many shark species make use of shallow and protected areas to give birth. No one has ever seen a great white being born, but other researchers estimate the length at birth to be between 1.2 and 1.5 metres; the smallest great white that we've seen at Shark Bay was about 1.5 metres long. The high proportion of very small sharks here, together with the fact that the shallow waters would protect juveniles from predators (primarily other great whites), suggests that the bay is indeed a nursery ground. Why, though, were there large, mature sharks amongst the juveniles?

We don't yet have the proof, but we believe that feeding could also be

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inhibited because the great whites we saw inshore were mating. Sex between great white sharks has never been observed and no mating ground for the species has been identified anywhere in the world. Could we have been lucky enough to stumble across one right under our noses? If great whites mate like other sharks, the male would bite and grasp the female around the pectoral and dorsal fins, then insert his two claspers into her. It's a violent process and would account for the high number of females with fresh scars that we saw in the bay. Feeding inhibition, especially in males, would prevent potentially fatal injuries.

The sharks probably stop swimming during mating and, as water would no longer be pumping over their gills, their oxygen-starved bodies would sink. By mating this close to shore, they would avoid sinking deep and hitting the bottom hard. Moreover, they would be immersed in or near the turbulent and oxygen-rich surf zone and would thus be able to recover from oxygen starvation more quickly. But if they do come here to mate, why do we not see significant numbers of males in the shallows?

By now we had more questions than answers, but at least the hunting theory was out of the running. Testing whether our mating/pupping ground theories were correct would be like looking for a needle in a haystack – we would have to observe either activity in situ, as the great white's protected status precludes any kind of invasive research. We would also have to abandon our motorised research boat, since it could not take us into very shallow or treacherous waters and the engine's noise and vibrations seem to disrupt the sharks' natural behaviour, either repeatedly attracting them to or repelling them from the vessel. We needed a mode of transport that is quiet, non-motorised, manoeuvrable and capable of handling rough seas. In late December we took to the sea in kayaks.

Large numbers of great whites congregate in the shallow waters of Shark Bay and we observed frequent encounters between two or more. The sharks circled one another repeatedly when they met or swam parallel, and showed no signs of aggression.

Sitting in a 3.8-metre sea kayak and watching a four-metre great white approach you is a fairly tense experience. Although we had extensively tested the sharks' reactions to an empty kayak and had observed no signs of aggression, this gave us little comfort as we eyed a great white heading straight for us, albeit slowly. Just a metre or so from the craft it veered off, circled and slowly approached from behind. It did this several times, occasionally lifting its head out of the water to get a better look. Then it lost interest, and as it continued on its way we were able to follow a short distance behind. Once we'd come to terms with having nothing between ourselves and a four-metre shark except a thin layer of plastic, our kayak made an ideal research platform for observing great white behaviour in shallow water. Its advantages are twofold: it is inconspicuous and appears not to cause the sharks to alter their behaviour for long, and it allows us to watch them in a natural situation, as it is not necessary to attract them to us with food.

We saw no signs of mating or pupping on our first outings, but we did witness some curious behaviour. The sharks mostly swam up and down in shallow water parallel to the beach and often crossed paths. It was unclear whether they did so by accident or design – their acute senses and even pheromones could enable them to detect other great whites nearby – but when these encounters occurred, the sharks seemed to circle one another slowly a few times before parting. On other occasions, one followed another parallel to the beach. All the interactions observed thus far were slow and relaxed, with no indications of aggression.

We will continue to patrol the shallows in kayaks, but working from water level gives us detailed information about the behaviour of only a few sharks. To view the maximum number of sharks for the maximum amount of time – and thus increase our chances of witnessing mating or pupping – the only way to go was up. We took to the skies in a variety of small aircraft and were tossed about by strong winds battering the coast of Shark Bay and beyond. Although these flights yielded valuable distribution data, lack of funds prevented us from being airborne long enough to collect behavioural observations. We were ▶

Finding out what great whites are doing so close to shore will be the first step in understanding and preventing shark attacks

about to give up on our aerial exploits when the answer drifted into view during a televised sports match. A blimp. Tethered to a boat anchored in the shallows or to a vehicle on the shore, a specially designed blimp, equipped with a remote-controlled digital video camera, would beam down live images of a large section of Shark Bay for 10 hours every day in spring and summer. If anything sexy happens down there, we will see it – it's only a matter of time.

Shark Bay is not the only great white hotspot along southern Africa's coastline. Both False Bay and the western shores of the Cape Peninsula have recently been hitting the headlines as sites of human–shark encounters, with a spate of them over the past four years. In the wake of one fatal encounter, off Fish Hoek in November 2004, journalists took to the air in the hope of photographing the 'rogue' killer shark. They found many sharks, none of them rogues, and their front-page pictures of large numbers of great whites in shallow water close to Cape Peninsula beaches served to confirm that what we were observing in Shark Bay was not a localised phenomenon.

Unlike Shark Bay, which is remote and where only a few hundred metres of beach out of seven kilometres is used for bathing, False Bay has dozens of popular bathing and surfing beaches. Following the attacks, the public by and large wanted the 'shark problem' dealt with. Suggestions ranged from subsidised shark hunting and swelling tourism coffers by offering shark-fishing holidays to wealthy overseas visitors, to installing shark nets. But if the inshore great white aggregations are related to mating or pupping, then such persecution will have dire consequences for the species.

Some lobbyists maintain that the high inshore aggregations, and attacks, result not from natural causes but from the presence of chum used by shark diving boats. There is, however, no scientific evidence to support this, and local fishermen, who have been working in the bay far longer than the shark diving operators, say that they have always seen great whites so close to shore. Moreover, as our observations of great whites inshore at Shark Bay indicate that not only do they not respond to chum, but they are not even interested in feeding, there seems to be no foundation for blaming shark tourism for the perceived rise in attacks.

Finding out what great whites are doing so close to shore will be the first step in understanding and preventing shark attacks. In addition to our work at Shark Bay, there is a large-scale project in False Bay led by University of Cape Town PhD student Alison Kock, and another in Mossel Bay led by University of Pretoria PhD student Ryan Johnson. For the second consecutive season, acoustic monitoring equipment has been deployed in key areas, especially off False Bay's popular beaches, to examine the inshore movements of great whites. Whenever a tagged shark swims past one of the monitors, it is scanned, just like an item at a supermarket checkout. The downloaded information enables scientists to establish which tagged great white was where in False Bay, and when.

Our field work at Shark Bay and the research carried out by colleagues in False Bay and Mossel Bay have yielded some surprising insights into great white behaviour, but many questions remain unanswered. From this month we will again squeeze ourselves into kayaks and small aircraft, and throw a research arsenal of blimps and acoustic tracking equipment at the great white sharks off this coast. It's not just about learning more about their behaviour and ecology, it's about trying to make the ocean a safer place – for humans and for sharks. ■

*Since 1997, Michael Scholl (*www.White-SharkTrust.org*) has been carrying out research at Dyer Island and in the deeper reaches of Shark Bay; research in the shallows using kayaks, aircraft and blimps is part of an ongoing collaborative project between Scholl and Thomas P. Peschak. Peschak is the principal author of this article, but he has drawn substantially from Scholl's notes and experiences. The term 'we' has been used throughout to enhance readability.*

At the end of another day's research – and as if in farewell – the dorsal fin of the season's last great white punctures the surface, gliding effortlessly through the water past the stern of our boat.

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See stunning photographs of great whites on the hunt in False Bay in Vol.8 No.10, and read about the shark cage diving debate in Vol.12 No.9.

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