

PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

Fourth Series

Volume 57, No. 17, pp. 479–501, 4 figs., 3 tables.

September 15, 2006

**White Shark Attacks Upon Humans in
California and Oregon, 1993–2003**

John E. McCosker¹ and Robert N. Lea²

¹*California Academy of Sciences, 875 Howard Street, San Francisco, California 94103;*
Email: jmccosker@calacademy.org

We report on 20 confirmed and five purported but unreliable incidents of unprovoked attacks by white sharks on humans in California and Oregon between 1993 and 2003. All attacks involved white sharks (*Carcharodon carcharias*). The discussion, map, and tables from McCosker and Lea's (1996) report are updated. The majority of attacks occurred at or near the surface, near shore, and often in the vicinity of pinniped colonies and/or river mouths and harbors. Attacks have now occurred during all months, and on surfers, breathhold and scuba divers, swimmers, hookah divers, kayakers, and, for the first time, on bodyboarders, a windsurfer, and a scuba diver using an electric propulsion device. Typical attack scenarios suggest that an adult *C. carcharias* mistakes its victim for a pinniped, its normal prey. Shark attacks were fewer during the extreme 1997–1998 ENSO (El Niño/Southern Oscillation) oceanographic warming event. The defensive activity of humans after being attacked and its effect are discussed. We also comment on recent legislation concerning white shark protection and disallowing the attraction of white sharks by chumming.

In 1996, we (McCosker and Lea, 1996) reviewed the history, human activity, and shark activity involved with unprovoked attacks by white sharks (*Carcharodon carcharias*) upon humans in the eastern North Pacific Ocean (ENP). The last attack that we reported upon was that involving Rosemary Johnson on 10 October 1993. We begin this study with an attack that occurred so late in 1993 that we were unable to include it in our earlier paper. In the subsequent decade 20 unprovoked attacks upon humans by white sharks have occurred in the ENP. We herein report upon those attacks and update our analysis and conclusions.

The following is a brief review of literature concerning attacks by white sharks in the ENP. A more extensive listing occurs in our 1996 report, and a nearly complete bibliography of *C. carcharias* can be found in the edited volume that included it (Klimley and Ainley 1996). In California, nearly all unprovoked shark attacks on humans involve white sharks, particularly north of Point Conception (34°27'N lat.) (Fig. 1). All known shark attacks in California between 1926 and 1979 were reviewed by Miller and Collier (1981). Subsequently, Lea and Miller (1985) added records for California and Oregon between 1980 and 1984, and Collier (1992) provided additional descriptions of attacks. More recently, Collier (2003) published a detailed account, with numerous photographs, of all known 20th Century shark attacks in the eastern North Pacific. Egaña and McCosker (1984) described white shark attacks in Chile, comparing the similarities and differences to those in the eastern North Pacific. Ellis and McCosker (1991) listed eastern Pacific white shark attacks between 1926–1991 and described several in detail. And, as stated above, McCosker and Lea (1996) reviewed all eastern Pacific attacks until the end of October, 1993. We have been advised by Mrs.

² Research Associate, California Academy of Sciences

W.C. Thompson (*in litt.*) of the following corrections that need be made to that report: the attack on Kenneth Gray (p. 423) occurred on 19 July 1971, not 1972; and the attack on Ken Kelton (p. 429) in 1992 occurred as he approached Steele (not Steel) Reef.

Several papers concerning white shark behavior that are relevant to this study have been published during the last decade; we will briefly describe those studies. Klimley et al. (2001) observed the pinniped-hunting strategy of white sharks at Año Nuevo Island in central California. They attached ultrasonic transmitters to seven adult white sharks during October and November and found: (a) the sharks spent a mean time of 39.5% of each day patrolling; (b) none moved far from a limited area; (c) the sharks spent equal amounts of activity in the same area during day and night; (d) the movements of the sharks relative to the island rookery were most often parallel to shore; and (e) some sharks preferentially patrolled but did not defend certain areas. In a study of white shark prey search behavior at Southeast Farallon Island (SFI) in north central California, Goldman and Anderson (1999) found that when searching for northern elephant seals (*Mirounga angustirostris*), the sharks combine alongshore and onshore/offshore movements while swimming close to the bottom until the depth reaches 30 m, thereby allowing them to remain hidden from their prey. They fed ultra-



FIGURE 1. Confirmed unprovoked attacks by *Carcharodon carcharias* in the eastern North Pacific, 1926–2003, adapted from McCosker and Lea (1996). Those attacks in which *Carcharodon* is implicated but not demonstrated are identified by “?”. Attacks during or after October, 1993, are identified by “◆”.

sonic transmitters to four individuals (3.7–4.9 m approximate total length) that were clearly large enough to have shifted from benthic prey to surface pinniped prey (Tricas and McCosker 1984), and of the size typical of encounters with humans. They also discovered that an inverse relationship exists between shark length and activity pattern, such that large sharks patrol within limited, particular areas, whereas smaller individuals did not restrict their movements. Martin et al. (2005) published a long-term study of 2088 observations of predatory events by white sharks in South Africa upon Cape fur seals (*Arctocephalus pusillus pusillus*) as well as shark attacks upon seal-shaped decoys. Kelly and Klimley (2003) briefly described a pilot study in which they observed *C. carcharias* at Point Reyes in north central California. Anderson and Goldman (1996), using photographs of white shark dorsal fins, were able to demonstrate the movement of two white sharks along the California coast. One was photographed at SFI in 1988 and not seen again until 1994, when it was photographed off Newport Beach, CA, >700 km to the south and 250 km south of Point Conception. The other shark was photographed at SFI in 1991 and resighted in 1994 at Tomales Point, >70 km to the north. Their work indicated that some sharks travel and that dorsal-fin appearance, like the caudal fin of some whales, is a useful character for identifying individuals. Martin (2005) described the distribution of white sharks in the northeastern Pacific, extended their known range to the central Bering Sea, and suggested that *C. carcharias* is more abundant off British Columbia and Alaska than previously suspected. He was unable to correlate their northerly distribution with El Niño or La Niña events between 1961–2004. A remarkable discovery of white shark movements was made in 1999 (Boustany et al. 2002) when four of six adult white sharks that had been tagged off the central California coast moved well offshore in a southwesterly direction; one of them travelled as far as Hawaii. Boustany et al.'s (2002) preliminary results suggested that at least some *C. carcharias* have a much wider range than had been assumed, and that they occupy an inshore continental shelf regime as well as an extensive pelagic phase. Pardini et al. (2001), using mitochondrial DNA of southern ocean white sharks, demonstrated that dispersal is sex-biased, with females probably being philopatric (non-roving) and males roving great, even transoceanic, distances. Their data and conclusions, however, contrast with those of Anderson and Pyle (2003), who found that in a 14-year study of 22 distinctively marked white sharks (239 observations made), individual males often occurred every year at SFI, whereas females were observed every other year at most. They concluded that in California, white sharks travel significant distances during a biennial reproductive and birthing cycle, whereas males travel shorter distances, if necessary, in order to copulate. Subsequently, Bonfil et al. (2005) demonstrated that Southern Ocean white sharks do make transoceanic migrations. Sharks that they tagged migrated between South Africa and Australia with remarkable speed and navigational abilities, dove to depths as great as 980 m, tolerated water as cold as 3.4°C, and confirmed that *C. carcharias* is philopatric. And finally, Estes et al. (2003) updated previous studies of white shark predation on southern sea otters (*Enhydra lutra nereis*) in California. They reported that the number of shark-bitten sea otter carcasses (expressed as a percentage of the otter population) has increased significantly between 1968–1999. They did not, however, attempt to relate this increase to any change in the California white shark population or any oceanographic parameter. The above-summarized references provide indirect but useful information in attempting to understand the normal behavior of *Carcharodon carcharias* and thereby interpret their interactions with humans.

METHODS

In this study, we have relied upon unpublished reports, newspaper articles, and interviews with victims, witnesses, and other experts; in most instances we sent a standardized, 4-page form devel-

oped by us, and in many, but not all, instances it was returned. We have been selective in our decision as to which unprovoked attacks to include: we do not doubt a number of anecdotal instances described to us during the last decade whereby the boards of surfers have been bumped or brushed by sharks, most probably *Carcharodon carcharias*. In such cases, however, we lack adequate evidence to demonstrate clearly that an “attack” did or might have occurred, and unless the shark attacked and bit the board and/or its rider causing mechanical and/or bodily harm, we have not included it in our analysis. In several instances, we have more extensively described those incidents that are particularly instructive or that have been misrepresented in media reports. Enumeration of incidents prior to 1984 follows that of Lea and Miller (1985) and that of our previous report (McCosker and Lea 1996). We continue with our numbering system such that the attack on R. Williams in California is assigned “California 70” and the attack on R. Mackenzie in Oregon is assigned “Oregon 11.” We herein define the short surfboards (generally shorter than 120 cm), variously known as “boogie-boards”, “belly-boards”, “spongers”, or “body-boards” as “bodyboard.” Although we give measurements in metric units, nearly all victims described their experience in terms of English foot/pounds. We have either not converted those measurements when quoting victims and witnesses or have done so and rounded them so as to avoid creating an incorrect impression of precision. And, we advise caution with regard to the accuracy of estimates of distance from shore and depth of water made by the victims and/or other respondents.

VERIFIED UNPROVOKED ATTACKS

In California

70. ROBERT WILLIAMS, surfer; 30 October 1993; Humboldt County, Bunkers, Eureka. This account is based largely on Collier (2003) and an article from the *Eureka Times Standard* (1 November 1993).

Williams, a 26-year-old male Caucasian, was wearing a full black wetsuit with gray markings on its arms and legs, and used a 2 m triple skeg white surfboard with a yellow and green design on the top rails. He entered the water at about 1530 and was attacked at about 1630. He was 200 m from shore, water depth ca. 7 m, at a surfing beach called “Bunkers,” located 0.8 km north of the Eureka breakwater jetty. The swell was ca. 1 m, the sea surface calm, water temperature ca. 10°C, air temperature ca. 16°C, and the water visibility 5–6 m. The victim recounted seeing several pinpineds in the surf very close to shore as he entered the water (Collier 2003).

Collier (2003:144) quoted Williams’ account of the event: “Five other surfers had gone out about 15 minutes before I got into the water and were waiting for a decent wave. They were talking when I pulled up to them. I paddled away from this group about 15 yards and waited several minutes before I saw a nice set [of waves] building. I began paddling out to catch the set when, all of a sudden, there was a surge of water that pushed me up into the air. I saw the shark at this moment for a fraction of a second. The shark grabbed my legs and board, pulling me underwater 3 to 4 feet. I hit the nose of the shark, which did nothing. Then I saw its eye, so I jammed my thumb in as far as I could.” The shark then released the surfer, swam seaward at a downward angle, shaking its head from side-to-side. The victim had resurfaced a few meters away from his board, climbed onto it, and realized the severity of the wounds to his left leg. He called to nearby surfers who then assisted him to shore. He was driven to St. Joseph Hospital in Eureka where he arrived in shock but alert. He was treated for a severe wound to the middle of his left thigh and lower leg which involved muscular, nerve, and vascular damage.

The attacking shark was estimated to have been 4–5 m in length and, based on the attack sce-

nario, location, and the injuries, was most probably *Carcharodon carcharias*. A subsequent attack occurred at precisely this location on a surfer on 4 November 2000 (see #82, C. Stewman).

71. JAMES ROBINSON, diver at or below the sea surface; 9 December 1994; San Miguel Island. Fatality. This account is based on wire service reports, RNL's discussions with the Santa Barbara County Coroner's Office, advice from Burr Henneman (*in litt.* 15 Mar. 2001) and Tom Kendrick, a commercial urchin diver and associate of the victim (pers. commun. April 2005), and Collier (2003).

Robinson, a 42-year-old male Caucasian, was a commercial sea urchin diver. He was aboard the *F/V Florentia Maria*, a 34' fishing vessel outfitted to support hookah diving. She arrived and anchored ca. 300–400 m off Castle Rock near Westcott Shoal, ca. 2.2 km off the northwest end of San Miguel Island, at about 0900. The sky was overcast and the sea was calm. Robinson entered the water (ca. 5–6 fms depth) using an electric scooter to check the boat's position on the reef, then returned to the surface to inform the crew to drop the anchor. He was clothed in a full black neoprene wet suit with gloves and booties. He then returned with the scooter to the bottom to collect urchins while his tenders were forward on the boat. They heard the diver call out "Hey, hey" from the stern and discovered that Robinson was attempting to pull himself onto the dive step and had been bitten by a shark. They pulled him onto the deck and observed a 3–4 m diameter blood stain in the water. Collier (2003: 148) reported that "the diver had been in the water about 15 minutes, but had been submerged only three to four minutes during his second dive before calling out." It was not clear whether his attack occurred at or beneath the surface. A tourniquet was applied and towels were placed over the wound. He began to lapse into unconsciousness after about 15 minutes and he was given CPR by the crew members. A 911 call was made and a US Coast Guard helicopter arrived ca. 30 minutes later and flew him to Goleta Valley Hospital in Goleta. Upon arrival he was given electroshock treatment by the emergency room physician, but he did not revive. Collier (2003: 148) described the wounds as follows: "he had received a single bite to the upper right leg, involving the hip and thigh. The crescent-shaped wound extended onto the anterior surface of the left thigh, terminating at the level of the right knee joint. This arc measured 45 cm at its widest dimension, from the thigh to the knee. Wound dimensions and interspace measurements were comparable with the dentition of a White Shark 5 to 5.5 m in length. Unfortunately, the wounds suffered during the attack — including massive loss of tissue, severing of vascular vessels, and the almost complete amputation of the right leg at the knee — were too severe to be treated effectively. . . ." A tooth, later confirmed to be that of a *Carcharodon carcharias*, was removed from the victim's femur.

This represents the third known attack upon a human by a white shark in the general vicinity of Castle Rock and Westcott Shoal, and the fourth occurred to the east at Harris Point, San Miguel Island. San Miguel harbors several large colonies of pinnipeds.

72. UNIDENTIFIED ADULT FEMALE, kayaker; 24 June 1995; San Diego County, La Jolla Cove. Sketchy reports of a young woman attacked while kayaking at La Jolla Cove indicate to us that an unprovoked white shark attack did occur, however we are unable to verify most of the purported details and thereby remain somewhat dubious about this incident. We base our report on discussions with R. H. Rosenblatt of the Scripps Institution of Oceanography and the newspaper articles published in the *San Diego Union Tribune* (7 July 1995 by Cheryl Clark and 8 July 1995 by Terry Rodgers and Mark Sauer).

The victim, a 19-year-old woman, was reported to have been kayaking along the kelpbeds off La Jolla Shores in the vicinity of La Jolla Cove. Four of her friends were boating in a dinghy nearby at the time. Clark reported after interviewing the treating physician, Joel Berger, that "Between 7:30 and 8:30 p.m., something went under the kayak and struck it, causing the woman to fall into

the water. She was bitten in the head before her companions pulled her into the dinghy, Berger said. The woman suffered lacerations to the head and face and was treated at an urgent care facility.” The doctor declined to release the woman’s name. Rodgers and Sauer reported that Berger, a face specialist, “found an unusual wound pattern — three separate cuts on one side of the head and a deeper cut on the upper cheek that penetrated a sinus. That indicates that the shark had most of the woman’s head inside its mouth, said Rosenblatt, who interviewed Berger. . .about the attack. . . . The surgeon. . .said . . .that he removed a one-inch tooth fragment from the woman’s sinus.” Although Rosenblatt did not see the fragment, on the basis of a drawing made by Berger, he proposed that the tooth was that of a “white shark that was at least 10 feet long.” Because the victim did not report the attack until two weeks had passed, and because he kept the tooth, we were unable to pursue this incident.

Unprovoked white shark attacks on humans are very rare south of Point Conception, California. The identity of the shark that attacked and killed Robert Pamperin (#8) in La Jolla Cove on 15 June 1959 remains disputed (McCosker and Lea 1996:427). Although it is presumed to have been either a white shark or a tiger shark (*Galeocerdo cuvier*), McCosker and Lea (p. 427) concluded that “Lacking additional evidence, we suspect that the identity of the attacker may never be determined.” In recent years, there have been occasional sightings of white sharks in the vicinity of Windansea Beach (ca. 1 km south of La Jolla Cove) and a white shark was observed consuming an adult pinniped about 1–2 km off the Children’s Pool at La Jolla Cove on 19 Nov. 2002 (reported by E. Zieralski in *The San Diego Union-Tribune*, 30 Nov. 2002). The dramatic increase in the pinniped population at La Jolla Cove during the last decade may well explain the current presence of white sharks at that location; however, white shark sightings hadn’t been reported during the 1959 and 1995 incidents.

73. MARCO FLAGG, scuba diver; 30 June 1995; Monterey County, Point Lobos State Reserve, Whaler’s Cove. This account is based primarily on the extensive and widely circulated report filed by Flagg over the internet on 2 July 1995, as well as a media report (Davis 1995) and JMc’s and RNL’s conversation with the victim and correspondence with T.C. Tricas (then of the Florida Institute of Technology), C. Lowe (then of the University of Hawaii), and H. Mollett and D. Powell (Monterey Bay Aquarium).

Marco Flagg, a 31-year-old male Caucasian and experienced scuba diver, was attacked in mid-water off Whaler’s Cove, a popular Central California diving site. He and two friends, Steve LeCompte and an unidentified woman, made two dives that day, the first commencing at 1445. They dove from a 12.5 ft Zodiac inflatable boat, anchored about 350–400 yds from shore in 90 ft. The bottom was characterized by rocky outcroppings interspersed by sand channels. There was kelp in the vicinity but not at the attack site. Pinnipeds were observed basking on large rocks within the cove. The sea was calm, with no swell and minimal wind. Surface light was reduced due to low clouds and the late afternoon time of the dives. Visibility was 10 ft at the surface and improved to 30 ft at the bottom. Flagg was wearing a 1/4” blue-striped black neoprene wetsuit, a black hood, booties and fins, and a yellow/orange 22 lb weight belt. Attached to his high pressure hose was a “DiveTracker DTX” instrument console housed in an 8” × 3.5” × 2.5” aluminum box with 1/4” aluminum wall strength, which rode at the level of his abdomen. His first dive, between 1445 and 1535, was to 98 ft and without incident. He buoyed the dive site, returned to shore for lunch, and returned to the buoy at 1720 to make a second dive. During this dive Flagg employed a white scooter (an electric diver propulsion vehicle). Propelled by the scooter, he descended at ca. 20°. After ca. two minutes and at a depth of ca. 50 ft, Flagg reported that he looked to his right “and saw the massive pectoral fin attached to the end of a torpedo shaped body of a large fish. The fish was at a distance of maybe 20 ft, at the edge of visibility. The sighting lasted for two to three seconds before

the animal disappeared from view in the cloudy water.” Flagg turned the scooter and propelled himself toward the boat. At 40 ft depth, 15–20 seconds after the shark sighting, Flagg reported that he looked to his “left and below and saw the massive, wide open, near circular, teeth-lined mouth of an animal coming at me. The mouth appeared to have a diameter of certainly more than two feet but most likely not more than three feet. . .and shortly (ca. one second) thereafter felt a severe but dull pressure on my body. I do not recall being shaken by the animal nor taking any significant evasive or defensive action. Instead, I appeared to be free from its hold after maybe two seconds.” He then used the scooter to return to the Zodiac at maximum speed, surfaced about 20 yds from it, and continued at the surface. Upon reaching the boat he dropped the scooter, attempted unsuccessfully two or three times to climb into the Zodiac while wearing his tank and weight belt. He then released the belt, removed his tank and buoyancy compensator, and climbed aboard, but fell in while attempting to retrieve his gear. He climbed back in and revved the outboard in short bursts to inform his partners. Although he had suffered cuts to his left arm, abdomen, and leg, he remained conscious and was aware that he had not suffered massive blood loss. His partners soon surfaced and they returned to shore where an ambulance transported him to the Community Hospital of the Monterey Peninsula. There he was treated by Dr. Blynn Shideler for a 1.75 inch diameter cut to his left forearm (requiring six stitches), a cut on his upper left leg (eight stitches), and a wound to his lower left abdomen (two stitches). Flagg noted that “the distance from the leg wound to the arm wound is 20 inch if my arm is down and 30 inch if my arm is extended at a 45 degree angle up (while standing). I do not specifically recall what position my arm was in when the animal bit. The fact that I was using the scooter at the time suggests that it should have been ‘up’.” He was given antibiotics at the hospital and, other than experiencing a slight fever, quickly recovered. Flagg hypothesized that he experienced only minor injuries either because “the shark . . . simply decided to not exert much force on my body . . . or that (he was) sandwiched between two layers of metal . . . the tank on (his) back and the Divetracker instrument on (his) front . . . (such that) the pressure on the tank and on the Divetracker spread the force of the bite over a large area. . .resulting in the bruise on my abdomen.”

Flagg’s incident is extraordinary for several reasons: a) he was attacked while scuba diving in midwater (an uncommon white shark attack scenario); b) he saw the shark prior to the attack. His female diving companion also saw the shark while she was underwater — “it was like a freight train going by underneath me” she said (Davis 1995); and c) he was using an electric diver propulsion vehicle. It is well known that sound (Myrberg 1978) and electric fields (Tricas and McCosker 1984) can be attractive to sharks and some have suggested that the scooter may have been responsible for the shark’s behavior. Discussions with shark behaviorists/physiologists T.C. Tricas and C.G. Lowe suggest that the sounds emitted by the electric propulsion device could have attracted the shark. Lowe reported that carcharhinid reef sharks in Hawaii that were attracted by operating propulsion scooters would move away when the devices were turned off. Tricas calculated that although the sound may have attracted a white shark, it was unlikely that the electric field created by such a device would be strong enough to project more than a few cm beyond the object’s surface.

74. Bryan Hillenburg, breathhold abalone diver; 3 Sept. 1995; Humboldt County, Shelter Cove. This account is based on conversations with Tobias Young, a reporter for the *Santa Rosa Press Democrat* who had considerable contact with the victim, and RNL’s examination of the shark tooth fragments. We were unable to communicate with the victim.

The victim, an adult male 30-year-old Caucasian, was free diving for abalone at Shelter Cove in ca. 30 ft of water. He and his partner, an adult male, were wearing wet suits and had been diving for about three hours and had swum into a “seal rookery.” The victim had made a dive to the bottom and captured an abalone; at 1630 he surfaced and was leaning on his kayak and placing the

abalone in a dive bag when a shark bit into the bottom of his left leg and swam to the surface. The victim pulled his leg and foot from the water and observed the shark. Tobias reported that “the shark then swam down and tugged at Hillenburg’s leg before letting go. (His) diving partner . . . Michael Burns . . . was surfacing when he saw part of the shark’s body — from behind the gills to the tail fin — swim away after the attack.” His partner aided him at that time and tried to control the bleeding. Three nearby (ca. 50 yds) breathhold abalone divers had finished diving and were in a small aluminum skiff. Tobias reported that they “saw Hillenburg swim frantically back to his kayak and climb out of the water.” Hillenburg and his partner entered the skiff and towed the kayak to shore. They were able to control Hillenburg’s bleeding and he was then taken by ambulance to a hospital. The bite was deep into the victim’s calf (a tooth penetrated the bone) about 10 cm above the ankle. Four teeth remained imbedded in his leg and were removed during surgery. The largest tooth was 14 mm long and 9 mm in width with fine marginal serrations, clearly that of a white shark. Fifty staples were applied to the victim during the 3½ hour surgery, which involved the repair of torn flesh, tendons, and nerves. Tobias reported that “a great white estimated at 12-feet long had been seen several times in the area,” and Jerry Hartman, the Shelter Cove Fire Chief, related that “we do have a great white that stays here.” One previous white shark attack (CA #64, D. Abernathy) occurred at Shelter Cove on 4 Dec. 1991, involving a hookah diver at the surface.

75. MICHAEL J. SULLIVAN, windsurfer; 29 September 1995; Santa Cruz County, Davenport Landing, ca. 24 km north of Santa Cruz. This account is based on advice from S. Van Sommeran, G. Balazs, foreign newsclips, and Collier’s (2003) report.

Sullivan, a 25-year-old male Caucasian, was riding a 2.5 m lime-green sailboard with a clear Mylar sail trimmed with a red and black margin. He wore a black wetsuit. The sky was clear and sea conditions were rough with 2–3 m waves caused by a 20 kt northwesterly. Sullivan said that he usually saw pinnipeds at that location but saw none on that day. Collier (2003:153) reported that “several dense kelp canopies were 100 m south and shoreward of the attack location, but there were no kelps in the immediate area . . .” Sullivan entered near the lower reef at Davenport Landing at 1645 and had been windsurfing with approximately twelve others. Due to reduced wind conditions, Sullivan turned toward the shore, his speed about 5–8 kts. At that point the board and rider were lifted by a shark and Sullivan fell upon the shark’s back. The shark then shook the board free from its teeth and slapped its tail wildly; Sullivan then swam about 10 m before turning to investigate his board. The shark had left and Sullivan then swam back to his board, righted it, and sailed to shore. His only injury was an abrasion on the top of his right foot. Sullivan and other observers estimated the shark’s length to be ca. 4 m. Considering the shark’s behavior and its size and its locality, it is unlikely that it was other than a white shark.

This represents the first verified attack on a windsurfer by a white shark. An attack upon a windsurfer (Tony Donoghue, 30 May 1999) off South Australia’s Yorke Peninsula may well have involved a white shark; however, only the shredded wetsuit, scratched sailboard, and torn harness of the missing victim were recovered, so it is impossible to know the behavior of the shark or the victim at the time of attack. Other attacks on windsurfers, such as that on Jean Goenvec on 15 August 2000 at Kanaha Beach, Maui, would be better categorized as “an attack on a paddleboarder.” Mr. Goenvec, presumably attacked by a tiger shark (*Galeocerdo cuvier*), was not underway but rather was sitting on his board with his legs dangling when one leg was severely bitten.

76. COLUM TINLEY, breathhold surface abalone diver; 13 August 1996; Marin County, Tomales Point, Bird Rock. This report is based on the victim’s report to us, including photographs of the removed tooth fragments, several newspaper articles, and a report filed by Ralph Collier on the Shark Research Committee website (<www.sharkresearchcommittee.com>).

Tinley, a 35-year-old male Caucasian, was attacked while freediving for abalone on the south

side of Bird Rock, located southwest of Tomales Bluff. (His age has been variously reported as 35, 36, or 37. His 36th birthday occurred the day after the attack. Other reports erroneously cited the location as within Tomales Bay; it was outside and south of the bay's entrance.) Tinley was diving along with two other adults (Karol Knox and Charles Wilson) using a 4 m inflatable Avon boat. They had made several dives along the east side of Bird Rock and then relocated to the south side. Collier reported that "Tinley was 30 meters from shore in water 5 to 6 fathoms deep with 5 meters of visibility and a estimated temperature of 12°C. The ocean floor was primarily rocky, with some scattered short-stature kelps. The sea was calm with a 0.5-to-1 meter groundswell. The sky was overcast and foggy with a temperature of about 16°C." At 1110, Tinley, alone, spent 5 minutes diving from the Avon and collected two red abalone. He surfaced, examined a third abalone, then dove to about 6 m depth and observed a large white shark, 4–5 m in length by his estimate, beneath him. The shark turned, rapidly ascended and bit the victim who had by then attempted to push away from the shark by extending his arms. The shark lifted him, then released him, bit him again, then released him and swam away. From the boat, Wilson observed the shark coming out of the water with Tinley, its tail thrashing, and then releasing the victim. Wilson estimated the attack to have lasted 7 seconds. Bleeding profusely, Tinley swam 5 m to the boat and was assisted aboard. Once aboard, the Coast Guard was called by VHF radio and a Sheriff's Department helicopter was dispatched quickly. Tinley was airlifted to Santa Rosa Memorial Hospital where he arrived and was treated approximately 75 minutes after the attack. Collier described the injuries: "He had received five tooth lacerations involving the deep tissue of his left shoulder, six lacerations to his left forearm, two lacerations of his left hand, and a large cut to the left side of his lower abdomen. Several hours of surgery was required to repair the damage to Tinley's nerves, ligaments, tendons, vascular vessels, and the soft tissue of his shoulder, arm, hand, and abdomen. During the operation, surgeon James Harwood removed three small tooth fragments from the laceration in the diver's left shoulder. The fragments not only substantiate Tinley's identification of his attacker, but also assist in determining the length of the attack shark to be about 6 meters."

77. MARK QUIRT, 5 Oct. 1996, surfer; Marin County, Dillon Beach, Lawson's Resort. This account is based on a communication through the internet with Mr. Stuart Dole, a close friend of the victim, and on an article published by Anne Baker in the *Point Reyes Light* on 10 October 1996. The victim, a 22-year-old male Caucasian, was surfing at 0930 with his father and six friends near rocks north of Lawson's Resort day beach, in the vicinity of Dillon Beach. Wave height was "overhead" and water depth was 10 ft. The victim was straddling his board when attacked. His father, Steve, was 50 ft away and heard the victim scream "shark." The father described the shark as very big, with a dorsal fin more than three ft tall. Another nearby surfer said he saw the victim's leg in the mouth of the shark. The father helped Mark back onto his board and got him aimed towards shore, and stayed with him all the way in. Dole reported that "the shark circled very close to them after the attack — Mark looked right into its eye — he 'saw its face.' When it swam off its wake was like a submarine." A surfer in the group was a physician and started an intravenous fluid injection about 15 minutes after the attack. A Fire Department rescue team arrived very quickly and a helicopter then transferred him to Santa Rosa Memorial Hospital. Emergency Medical Technician Steve Truttman attended to Quirt and reported that the victim was bitten on the left leg, suffering incisions up to 3" long from his ankle to his knee, as well as a puncture wound to his right hand from trying to fend off the attack. Truttman said that it was "as if someone had taken a straight-razor and made slash marks diagonally across the flesh almost to the bone." Stuart Dole, an associate of Quirt's, reported that "no major tendons, nerves, or blood vessels were cut, despite massive muscle shredding. His brand new wetsuit was shredded . . . it cut the leash too." It is remarkable that despite the traumatic wounds that Quirt suffered, none of his major tendons, nerves, or blood vessels were

cut. He was hospitalized and received 180 stitches. Quirt's attack occurred two days after a shark is said to have bumped a surfer at Salmon Creek, approximately 14 km north of Dillon Beach. Neither the surfer nor the board were damaged in that incident and we have not included it in our listing of unprovoked attacks.

78. GREG FERRY, surfer; 29 November 1996; Sonoma County, Salmon Creek. This report is based on JMc's telephone conversations (2–3 December 1996) with the victim and Rob Robinson, a surfer with Ferry at the time of the attack, the victim's response to our forms, and an article by Eileen Clegg, *Santa Rosa Press Democrat* (30 Nov. 1996).

Ferry, a 45-year-old Caucasian, and Robinson and Robinson's brother entered the ocean at 0730. Ferry was bitten at 0830. He was wearing a thick black O'Neill neoprene wet suit and black booties; his hands were exposed. His surfboard was an 8 ft *Maury Doyle* cloud cell board (not fiberglass) with a single skeg and a square tail. It was blue above and yellow below. The other surfers were riding 8.5 ft and 9 ft teardrop-shaped boards. The water was cold, its visibility ca. 1 m, the sky was clear, there was little or no wind, and the surf was ca. 1.3 m in height. Salmon Creek was dry at its ocean entrance. No marine birds, pinnipeds, or other wildlife were seen in the area. No other surfers were in the water. Ferry and the Robinsons went ca. 200–300 m offshore to the breaking surfline. The other two were 10 m shoreward of Ferry, one ca. 25 m south and the other ca. 45 m to the north. Ferry pushed through a wave, kicked to get back up on his board, and felt a sharp pain to his left ankle. He suspected that his left leg had brushed against a shark's open mouth as it attacked the board. A single tooth cut his left ankle very cleanly but not deeply. The shark continued to bite the board, thrashed twice, became momentarily entangled in Ferry's leg leash, and then departed. Ferry did not see the shark at any time and the others saw none of the event. Ferry then rode a wave to shore and was taken to Palm Drive Hospital in Sebastopol where Dr. Peacock applied 8 stitches to a clean laceration on his left ankle. Peter Klimley examined the tooth impressions left in Ferry's surfboard and estimated the attacking shark to have been a 3–5 m white shark.

Salmon Creek is a popular surfing location and the site of previous (#13, D. Vogensen, swimmer 20 Aug. 1961) and subsequent (#85, M. Casey, bodyboarder 28 Nov. 2002) white shark attacks.

79. SCOTT YERBY, surfer; 24 August 1997; Humboldt County, Moonstone Beach, directly off the mouth of the Little River. This incident was incorrectly reported by some news media as having occurred at Clam Beach, which is the long expansive beach south of Moonstone. This account is based on the form returned to us by the victim, an article written by Rhonda Parka, *Eureka Times Standard* (25 Aug. 1997), and Collier (2003).

Yerby, a 29-year-old male Caucasian, was wearing a full black neoprene wetsuit and used a surfboard with a white underside and blue top. Yerby reported that the sky was clear, the air warm, the sea calm, the tide had ebbed (-1 m) and the water was warmer and clearer than he was accustomed to at that location. Yerby and a companion, David Yun, paddled out over a channel to ca. 70 m from shore; they were ca. 50 m apart. Between 1300–1330 Yerby left his board to discover the water depth (ca. 2 m), then returned to his board and sat upright upon it just beyond the surfline. Collier (2003: 159) reported that "there was a splashing sound as the shark struck his surfboard, left leg and hand, biting deeply into the leg. The shark came up out of the water, shaking the surfer violently for several seconds. Yerby struck the shark's head with his right hand, whereupon it released its grip and swam off. The shark was not seen again." Yerby, assisted by Yun, paddled to shore. Upon arrival they were aided by two emergency medical technicians and a nurse who were picnicking on the beach. They administered first aid and then carried him to a nearby ambulance which transported Yerby to Mad River Community Hospital in Arcata. Yerby was alert and not in shock upon arrival, whereupon he was treated for severe lacerations to the tendons and muscles of his left hand and leg. He had lost ca. 5 pints of blood by the time he arrived at the hospital. Teeth had pen-

etrated his leg to the femur and tibia and the wounds were arranged in a large crescent.

Three shark tooth fragments were removed from his tibia and they, along with the measured intertooth distances, indicated that the attacker was an ca. 4–5 m white shark (Yerby estimated the shark to be 3–4 m in length). The location of the attack, Moonstone Beach at the mouth of the Little River near Eureka, has now experienced four white shark attacks upon surfers.

80. JONATHAN KATHREIN, bodyboarder; 26 August 1998; Marin County, Stinson Beach. This report is based on numerous conversations by JMc with the victim and the victim's family members, a telephone interview with lifeguards and a physician at the site and time of the attack, and is also taken from newspaper accounts.

Kathrein, a 16-year-old male Caucasian, 5'11" tall and 155 lbs, was bitten while riding a bodyboard along the southern shore of Stinson Beach. This general location is perhaps the most-frequented beach by bathers, surfers, and bodyboarders in the San Francisco Bay Area, and although white sharks have been observed from the water by boaters, fishermen, and from the shoreline, this is the first known unprovoked attack at that site. The victim, an athletic, robust and healthy high school student, was ca. 50 m directly offshore from the south lifeguard tower. He rode a Morie bodyboard, 107 cm in length, 50 cm wide, and 6.4 cm thick. It was bright yellow above and orange below, with a turquoise band on its lateral margin. A black 1 m elastic cord was attached from the board to his wrist. He wore a blue and black neoprene wet suit (blue covering his upper body and buttocks, black from thighs to knees) that ended before his knees and wrists. He was not wearing fins or a watch. The sky was partly cloudy and overcast, but fog-free. The water was fairly dirty with visibility estimated at ca. 1 ft. Wave height was ca. 3–4 ft. There was no notable weather change while he was in the water. He entered the water at 1345, paddled south and parallel to shore, caught a wave, swam offshore again, and rested upon his board for five minutes, and then contacted a firm object alongside his board about 1 ft beneath the water with his right hand. He looked, saw nothing, began to paddle, and 6–8 seconds later a shark rose from beneath his right side, flipped him and the board over, and held him underwater for ca. five seconds while "thrashing its head" several times. The victim recalls grabbing the shark's gills and inserting two fingers into its gill slits, at which point the shark released him. Still attached by leash to his board, he mounted the board, swam ca. 125 ft to knee-deep water without stopping, at which time rescuers took him ashore and applied first aid. He was then helicoptered to a trauma center. His injuries were traumatic and required more than 300 stitches. A single wound of 47 cm width on the back side of his right thigh cut through muscle and tendons and penetrated to his femur. The tooth insertion scars are ragged; the upper jaw apparently penetrated his flesh from his dorsal hip surface to the top of his knee, the lower jaw teeth penetrating the anterior portion of his knee. There was no significant tissue loss and no damage to his nervous tissue. Neither teeth nor tooth fragments were left in the victim or his board. Based on the attack scenario and the appearance of his wounds, we have no doubt that Mr. Kathrein was bitten by a white shark. The width of the bite scars on his right thigh would indicate that the shark was about 3.5–4.5 m in length.

McCosker visited the attack site the following week and discovered an adult male California sea lion (*Zalophus californianus*), dead along the shoreline, that had been bitten in midbody by a white shark. Sightings of white sharks from the shoreline by lifeguards and beach visitors kept the beach closed for several days following the attack on Kathrein. The following year, at approximately the same period, video photographs taken by a beach visitor near the lifeguard tower at Stinson Beach clearly evidenced an adult white shark swimming at the surface beyond the breaker zone. The beach was again closed. At the time of this writing Mr. Kathrein is again healthy, robust, and swimming regularly.

81. PAUL "PECK" EUWER, surfer; 29 September 2000; San Mateo County, Pillar Point,

Mavericks. The investigation of this attack is based on the form returned to us by Euwer, interviews by JMc with Michael Kasic, a fishery biologist who was surfing alongside the victim during the attack, an analysis of Kasic's photograph's of the victim and his surfboard after the attack, and additional information that was posted on the internet under: sharksurvivor.com/interviews ("Peck" Euwer, California, USA"); surflife.com ("Sneaker set"); and mavsurfer.com ("Mavericks defines the food chain" by Jake Howard).

Euwer, a 34-year-old male Caucasian, 6'0" tall, 180 lbs, was attacked at 0900 while paddling his surfboard to the surfbreak at Mavericks, a location know for its very large surf and an offshore break. The day was described as "opening day" in that the wave heights had increased (to about 4 m) on that day. The water visibility was poor (ca. 60 cm) and the water temperature about 13°C. Euwer was joined by two adult male surfers, Michael Kasic and Mark Sponsler, who were preceded at some distance by four other surfers. Sponsler, an experienced Mavericks surfer, was riding a 274-cm board and went ahead of Euwer and Kasic. Euwer was on a 211-cm fiberglass surfboard that was white with three blue skegs. Kasic was on a longer (241 cm), more slender board that had three black skegs. Euwer's and Kasic's boards were attached to the surfers' ankles by leashes. Both were wearing black full wet suits but wore neither gloves nor booties. Euwer was wearing a wedding ring on his left hand and a black Timex digital watch that was mostly covered by his wetsuit sleeve. Kasic related that they passed "6 or 7 harbor seals" (*Phoca vitulina*) and they paddled beyond the nearshore rocks; Kasic was ahead of Euwer as they passed "Mushroom Rock" by ca. 100 m (ca. 1 km from shore), and they paused for about a minute with their legs dangling. They then began paddling, with Kasic about 6 m to Euwer's side and slightly ahead of him when Kasic heard a loud thump ("like a watermelon hitting cement") and turned to see the lower jaw of a large shark bite the underside of Euwer's board and lift the board and rider about 1 m in the air. As Euwer held the nose of the board, his legs were hinged above the board, and the shark then bit the topside of the board with its upper jaw teeth. Euwer then fell on the shark's nose and slid along its back beyond its first dorsal fin and then, at the level of the caudal peduncle, he slipped off. The shark, with its mouth open, then swam toward Kasic and descended beneath him; its dorsal fin at that time was 2 m from Kasic. Both Euwer and Kasic clearly presumed that the shark had risen nearly vertically (rather than from the side) when it first struck the board. Euwer was unhurt by the attack but the left leg of his wetsuit had been punctured by the shark's lower jaw teeth as it raked his leg. The board (Fig. 2) evidenced deep raking grooves on its underside and the topside had a 36 cm wide arc from the upper jaw teeth. Euwer and Kasic remounted their boards and paddled rapidly ca. 400 m to shore, and did not see the shark again.

The vicinity of Mavericks includes a rocky coastline and modestly protected embayments, and is inhabited by numerous resident pinnipeds (mainly California sea lions and harbor seals). Jake Howard of mavsurfer.com quoted



FIGURE 2. P. Euwer displaying the underside of his 211 cm surfboard that was bitten by a white shark. (Photograph by Debra Goodshall, *Half Moon Bay Review*.)

Frank Quirate's (a Rescue Boat Operator at Mavericks) account that "the rocks where he was hit is home to a pod of seals, including some huge bulls that patrol that very area There was video shot of two whites chomping on a whale carcass that was filmed a year ago just north of Mavericks. A kayaker last year reported a great white cruising past his twelve foot kayak and dwarfing it." Howard added that "last winter also presented Pacifica locals with a treat as a great white hit a seal in the middle of the line-up. Most recently a kayaker spotted a shark around Mushroom Rock just a week prior to the attack." In consideration of the location, the conditions of the attack, and the dental pattern left in Euwer's surfboard, it is obvious that the attacking shark was *Carcharodon carcharias*.

82. CASEY STEWMAN, surfer; 4 November 2000; Humboldt County, Bunkers. This report is based on newspaper reports. We were unable to contact the victim.

Stewman, a 27-year-old male Caucasian, was surfing north of the North Jetty of Humboldt Bay. His board was white and 224 cm long. He spent about an hour surfing before he moved farther north, ca. 0.9 km, to an area known as the Bunkers, which was less crowded. He was about 250–300 yds offshore in water 10–15 ft deep for about 30 minutes (ca. 1630) when he sensed something beneath him. The board was then hit directly from below by a shark that grasped his legs and the board, and pulled them into the water. The shark almost immediately released the victim and the board and apparently swam off. The victim, separated from his board, now floating upside down, grabbed it and pulled himself onto it, then paddled and rode a wave to shore as quickly as possible. He was treated as an emergency patient at Mad River Hospital for wounds to both thighs, which required 31 stitches. The shark, although not seen clearly, was estimated to be 8–10 ft long. Based on the shark's behavior and the condition of the wounds we presume that the attacking shark was a white shark.

The attack on a surfer on 30 Oct. 1993 (#70, R. Williams) also occurred at this locality, north of the North Jetty of Humboldt Bay.

83. LEE FONTAN, surfer; 31 May 2002; Marin County, Stinson Beach. This report is based on conversations by JMc with the victim's father, the victim, and with a surfer who was alongside the victim, and is also taken from newspaper accounts.

Fontan, a 24-year-old male Caucasian, 5'7" tall and ca. 175 lbs, was surfing ca. 50 m offshore from Seadrift at the south edge of the Stinson Beach/Bolinas Estuary Channel. It was a warm day with clear sky, the water was said to be warmer than usual, wind and swell from the south, surf height was 6–8 ft, and water depth was ca. 10 ft. Fontan rode a 6'8" yellow, triplefin fiberglass surfboard which had a "no sharks" decal on its underside. He wore a black neoprene wetsuit with hood and booties, but his hands were naked. He entered the water at noon, paddled beyond 12–15 other surfers, and sat upright on his board with his feet (but not his hands) suspended and faced the sun. He was then lifted from the water by a 12–14-ft shark (its size estimated by nearby surfer John Gilbert of Stinson Beach). Gilbert advised (pers. comm. to JMc) that "I looked over and this guy was about three or four feet out of the water in the shark's mouth. You could see its teeth, its gums. Its eyes were shut. Its gills were wide open, like shutters. The whole dorsal fin on its back was out of the water." The shark then released the surfer and swam away. Fontan did not see the shark prior to the attack and claims to have struck it on the snout during the attack. He was assisted to shore by nearby surfers and quickly taken by ambulance and helicopter to a nearby hospital. He required 100 stitches and suffered a 20 cm gash to his left thigh and wounds to his left shoulder and chest, and there were three obvious holes beneath his ribs. No teeth were left in the board or the victim. We assume from the attack scenario that it was a white shark. The victim has recovered and is surfing again.

84. REED RICHARDS, surfer; 22 September 2002; Humboldt County, Moonstone Beach. This

account is based on RNL's telephone conversation with Richards and a report from the *Ukiah Daily Journal* (21 Aug. 2004).

Richards, a 35-year-old male Caucasian, was surfing off Moonstone Beach early Saturday morning. He was straddling his board just outside the breakers in about 8' of water when he felt a tremendous force against his leg and observed a shark he estimated to be 10–12 ft in length. The shark then bit into the front of the 6 ft surfboard and violently thrashed up and down several times. Richards described this as feeling “like a rodeo ride.” At this time Richards' leg was pinned between the surfboard and the shark's side. Richards reached out and hit the shark in the head, at which time the board was released and the shark rolled away. Richards fell off the board and into the water. He was leashed to the board and immediately swam back to it, then caught a small wave that took him to shore. During this period he felt he was going to be hit again by the shark; however, the shark did not return. Other surfers in the area of the encounter also quickly exited the water. Several surfers and kayakers arrived later in the morning, entered the water at the site of the encounter, but did not observe a shark. Others, however, chose to stay out, at least for the day.

Richards was not injured but his surfboard was badly damaged. Moonstone Beach is the site of two previous attacks on surfers, on 18 October 1976 and 17 October 1980. This is the tenth shark-human interaction recorded in Humboldt County; six of these incidents involved surfers.

85. MICHAEL J. CASEY, bodyboarder; 28 November 2002; Sonoma County; Salmon Creek. This account is based on our conversations and correspondence with the victim and his wife, and his response to our report form within three weeks of the attack.

The location of the attack, Salmon Creek Beach, south of the town of Bodega Bay and just south of Bodega Dunes, is one of the most popular surfing locations in Sonoma County. Casey, a 48-year-old male Caucasian, is 5'10" tall and weighs 175 lbs. He was attacked while bodyboarding ca. 150 yds from shore in water about 10 ft deep. He was wearing a black wet suit, booties and gloves. His board was 107 cm long, 56 cm wide, and 6.4 cm thick, and blue above and white below. The sky was clear, offshore winds were blowing, and the surf height was 3–4 m. The water was relatively clear and about 12°C. Neither kelp canopy nor pinnipeds were observed by Casey in the vicinity of the attack. (Other surfers did report seeing pinnipeds at this location on previous occasions.) The victim entered the water at about 0715 and had been surfing for 1.5–2 hours. He advised us that “after catching a wave, I paddled back to the line-up. I was laying on my bodyboard, facing the horizon, waiting for the next set. My legs were dangling in the water. There were 4–5 other surfers within 15–20' of me. I was not doing anything, i. e., paddling, swimming etc. All of a sudden, I felt this tremendous surge of power from beneath the water. And at the same time I felt a sharp pain in both my legs. I did not see the shark before the bite nor was there any indication of anything in the water before this incident. I instinctively yelled and kicked my legs to separate myself from the shark. I then saw the shark for the first time. The shark's mouth was open and I could see its teeth. I observed it from the side and it was withdrawing into the water after it bit me and let me go . . . its body was somewhat curved toward me The shark disappeared into the water and I never saw it again This whole incident did not last longer than 2–3 seconds.” The victim, bleeding profusely, then swam to shore, using his board and with some assistance from a nearby surfer. He suffered severe lacerations to both thighs, his left calf, and his right foot. He received emergency aid at the beach within 15 minutes and was then helicoptered to a nearby hospital. Radiographs demonstrated that the shark's teeth had penetrated to his femurs and other leg bones. There were no teeth or fragments left in the board or the victim. Other surfers in the water estimated the shark to be 16 ft long. We have no reason to doubt that the shark was a white shark. At the time of this writing, the victim is healing and despite some nerve damage will apparently regain the use of his limbs.

86. DEBORAH B. FRANZMAN, swimmer; 19 August 2003; San Luis Obispo County, Avila Beach. Fatality. This account is based on RNL's examination of the victim at the San Luis Obispo County Coroner's Office, JMc's conversations with Jay Elder (Avila Beach Harbor Master), several media correspondents, and reports in the *Los Angeles Times* and the *San Francisco Chronicle*.

Franzman, a 50-year-old athletic female Caucasian, swam most mornings along the offshore buoys 75 yds from shore south and east of the Avila Pier. On the morning of the attack she observed sea lions in the vicinity of a buoy in 18 ft of water and, wearing a black wet suit and fins, swam out to play with them. After swimming with the pinnipeds she began to swim back to the beach and was taken at 0820 by a large shark. A friend watching from shore observed the pinnipeds to scatter suddenly and "the swimmer was engulfed in a large breach of white water" (*Los Angeles Times*, 20 Aug. 2003). Her friend shouted for help and four lifeguards at the scene sprinted to her location, swam out and retrieved her, and began CPR. Paramedics from the California Division of Forestry soon arrived, but because their ambulance could not cross the beach sand, a lifeguard truck had to ferry the victim to the street where, on arrival, she was pronounced dead from massive blood loss resulting from her severed femoral artery. Radiographs were taken but no teeth or tooth fragments were found in the victim.

Later that day (ca. 1300) the crew of a local sportfishing boat (the *Patriot*) returned to the dock and observed a large shark chasing "seals" and jumping out of the water in the vicinity of the Avila Pier. Jay Elder reported that four days after the attack local fishermen had observed a large shark (reported to be 18 ft in length) take an adult harbor seal within 400 yds of the attack site. The fishermen related that three harbor seals leapt out of the water, followed by a shark that "came out of the water" and took the last seal by its fin, got it into its mouth, and took it under. This occurred due south of the south-flowing San Luis Obispo Creek, about 1200 ft from shore (water depth was 28 ft). At that time, there had been a large shoal of anchovies and sardines in the area as well as a large increase in the number of harbor seals and sea lions (they counted 40 juvenile sea lions and 8–10 adult harbor seals within 0.5 mile of the attack site). We presume from the attacks upon the victim and the pinnipeds that the shark(s) involved was a white shark. Such a scenario involving increased fish prey being pursued by pinnipeds, which are in turn pursued by white sharks, is not uncommon in California, as well as in other parts of the world.

In Oregon

OREGON 11. ROB MACKENZIE, surfer; 21 September 1994; Tillamook County, Short Sand Beach. This account is based in part on Collier (2003), on an article in *The Oregonian* (22 September 1994), and on conversations with John Griffith.

Short Sand Beach is located in Oswald West State Park between Arch Cap and Manzanita, near Seaside in northern Oregon. MacKenzie, a 43-year-old male Caucasian, entered the ocean at ca. 1630 on a cloudless day. Sea conditions were calm, 1 m swell, and a light breeze, with water temperature at ca. 14°C and air temperature at 18°C. He was 100 m from the shore above a sand and rock 4 m bottom. No pinnipeds were observed. He was using a 2 m yellow surfboard, and he and companion Greg Movsesyan had been surfing for 75 minutes when they observed a gray whale breaching about 1.6 km offshore. Collier (2003:146) reports that Movsesyan "noticed a gray form passing diagonally under my board which, because I had surfed often with dolphins in California didn't alarm me. The form approached Rob less than 15 ft away and, before I could say anything, it surfaced and bumped the side of Rob's board about three-quarters of the way forward. Rob went flying into the air, still attached to his board by a seven-foot leash, and came down in the water just in front of the shark. The board had become impaled sideways on the shark's lower jaw and, to dis-

lodge it, the shark raised its back half out of the water and slammed its head on the surface until the board floated free. Then the shark dived, getting its tail caught on the leash and pulling Rob and his board under as it swam for deeper water. Under the strain, the leash broke, shooting the board high in the air and allowing Rob to surface and retrieve it. We headed for shore, paddling until we reached waist-deep water. Rob had not been bitten and his wetsuit had only a graze-mark on the right hamstring, presumably from a shark tooth.” Collier (2003) further reported that the underside of MacKenzie’s board had been punctured by lower jaw teeth, forming a 35 cm wide arc. The mid-line of the arc, presumably the center of the shark’s jaw, was located near the front of the board, about a third of the distance along its overall length.

Movsesyan stated (*The Oregonian*, 22 September 1994) that “the shark measured about 7 feet long from his dorsal fin to the fluke.” The shark is presumed to have been a white shark, ca. 5 m in length.

OREGON 12. JOHN FORSE, surfer; 21 April 1998; Lincoln County, Glededen Beach State Park. This account is based primarily on our form returned by the victim, our conversations with J. Griffith, and Collier (2003).

Forse, a 50-year-old male Caucasian, was using a 3 m black surfboard and wearing a black neoprene wetsuit and booties. He entered the water at about 0800. The sea was calm, depth ca. 3–4 m, visibility ca. 2–3 m, and sea surface temperature ca. 12°C and air temperature ca. 18°C. The seabed was sand with numerous sandbars. Forse had observed several seals close to shore prior to the attack. At 0930 he paddled out to four other surfers located ca. 100–150 m from shore. The five surfed together for about one hour and then the others returned to shore leaving Forse in the water alone. The victim reported that between 0930 and 1000 and 5 minutes before the attack he saw something break the surface of the water about 20 feet away, but he thought that it was a seal. As Forse was lying prone on his board, the shark bit the board and his upper right leg and pulled him beneath the surface. He reported that he was shaken underwater and then released and he surfaced, whereupon he saw a large white shark alongside himself, its dorsal fin an arm’s length away. He then struck the shark’s back ahead of its dorsal fin 4–5 times, and it then dove but pulled the board’s ankle leash and Forse beneath the surface again. The leash then severed, the board erupted from beneath the sea surface, and Forse surfaced and swam 10 ft to his surfboard, then rode a wave and paddled with his arms to the beach. Forse’s two friends on the beach had seen the attack and assisted him from shallow water to a vehicle and drove him to North Lincoln Hospital in Lincoln City. Emergency room physician Dr. Bruce Watanabe applied 50 stitches to the wounds, which consisted of 8 tooth punctures from 2.5–5 cm in length. The board experienced a 30 cm bite along its right side.

The attacking shark was a white shark, estimated by observers to be 4–5 m in length, which was corroborated by the tooth impressions left in the board. This is the first known white shark attack to have occurred in Lincoln County.

OREGON 13. GARRY TURNER, bodyboarder; 21 September 2002; Tillamook County, Cape Kiwanda. This account is based on conversations with J. Griffith and an AP wire story.

Turner, a 24-year-old male Caucasian, was bodyboarding with two friends ca. 60 m offshore at Cape Kiwanda. He was wearing fins and sitting on his board and talking with friends when something grabbed his left foot and pulled it strongly downward. Not immediately realizing that he had been bitten, he attempted to free his foot by kicking vigorously and pulling himself back onto his board. At this time the three surfers realized that a shark was involved. The shark appeared at the surface, headed again toward the surfers, and one of them yelled “shark, shark” as it submerged and disappeared. They then paddled quickly to shore. Turner was taken to Samaritan North Lincoln Hospital in Lincoln City and then by ambulance to Legacy Emmanuel Hospital in Portland. He suf-

ferred deep wounds to the bones of his left ankle but did not have tendon damage.

Witnesses reported the shark to be “about eight feet long and seemed to lunge out of the water.” The AP story reported that “area fishermen said it was likely a blue or a sand shark”; we find those identifications to be unlikely. Although the shark, as described, would be smaller than most attacking white sharks, we presume on the basis of the attacker’s behavior that it was a white shark. This is the third reported shark incident at Cape Kiwanda. The two previous incidents, both involving surfers, occurred on 20 August 1983 (OR #4, R. Weldon) and on 30 September 1984 (OR #5, R. Rice); both involved white sharks and were non-injury encounters.

ATTACKS WHICH WE DO NOT CONSIDER TO HAVE BEEN PROVOKED

A badly-wounded, naked corpse found floating 200 ft offshore from Sunset Cliffs, Point Loma, San Diego County, on 15 April 1994 was widely-reported to have been the result of an attack by a white shark. The body was later identified as that of Michelle Von Emster, a 25-year-old Caucasian woman. Our investigation of this incident is based on JMc’s conversations with R.H. Rosenblatt of the Scripps Institution of Oceanography and with N.D. Sperber of the San Diego County Medical Examiner’s Office, and JMc’s examination of 100 photographs taken of the corpse. Ms. Von Emster was of average height, slender, and weighed 59 kg. Both of her shoulders had been severely bitten, flesh had been removed from her left thigh, calf and buttocks, and her right leg was severed at mid-thigh and removed. Those injuries were indicative of partial consumption by sharks, either a white shark and/or blue sharks (*Prionace glauca*). As well, she had a broken neck, broken pelvis, a fractured rib, and three other bruised ribs. She was last seen alive the previous evening and could have been in the water as long as 16–18 hours before she was found the following afternoon. The presence of sand and water in her lungs suggests that drowning was the cause of her death, and the apparent shark bites were subsequently inflicted. The extensive tissue damage appeared consistent with feeding by blue sharks. However, the removal of the right leg exposed much of the femur, and it lacked the scratches that one would expect from a feeding white shark or blue shark. The cliff-side location where her personal belongings were found after her death, Sunset Cliffs, are dangerous and friable and about 25 m in elevation. Investigators have suggested (Matthews 1994) that her broken neck, pelvis and rib injuries, followed by her drowning, could have resulted from a fall from the cliff. Lacking evidence that would clearly indicate shark activity other than opportunistic scavenging upon a nearshore corpse, we do not consider this to be an unprovoked shark attack.

We also discount the purported attack by a shark upon Larry McCash while surfing at Sunset Cliffs, Point Loma, San Diego County, on 9 January 2001. Our knowledge of this incident is based on JMc’s conversations with R.H. Rosenblatt of the Scripps Institution of Oceanography and newspaper articles in the *San Diego Union Tribune* (10 Jan. 2001, “Novice surfer claims shark attack”) and the *San Diego Peninsula Beacon* (18 Jan. 2001, “Unconfirmed shark attack gnaws at skeptics”). Mr. McCash, 27, claims that while paddling toward shore a 6–8-ft shark grabbed the tail of his surfboard (a 2 m split tail, twin skeg board) and pulled him back suddenly and violently. He claims to have struck the shark’s snout three times with his fists. The shark was said by him to have a large, triangular-shaped dorsal fin and appeared to be entangled in a rope attached to a red-and-white buoy. There were neither tooth fragments nor tooth marks left on his board. Mr. McCash was not injured and his hands were not abraded. We find the evidence inadequate to demonstrate that a shark attack had occurred.

On 23 September 1997 it was widely reported on San Francisco Bay Area television news programs that an unidentified male swimmer thought he was attacked by a shark while swimming across the Golden Gate. JMc spoke with the boat tender, Mr. George Roach, who had accompanied

the swimmer, and who saw a “fin” and said that the animal bumped the boat. The animal did not contact the swimmer. It was said to be 6-ft long and its behavior, as described, was most likely that of a California sea lion.

We report the incident involving a shortfin mako (also called a bonito shark) (*Isurus oxyrinchus*) and a Southern California spearfisher on 28 August 1999, but do not consider it to have been an unprovoked attack. According to the *San Diego Union* newspaper (29 August 1999, pages B-1, B-3), Stewart Graham, 39, was freediving south of Coronado Island among kelp beds in approximately 30 ft of water when he observed a shark in the distance. The newspaper reported that “. . . when he dove under the surface again, he saw a large mako shark — its mouth wide open and sharp teeth shining — charging straight at him. With only a moment to think and the shark only about 15 ft away, Graham said, he grabbed the spear gun at his side — loaded with a thin, 6-foot metal spear — and aimed it at the fish’s mouth. As the spear shot through the water, he said, the shark seemed to sense the danger and jerked its head to one side. The spear sank in the gills of the 10-foot-long animal, which then passed Graham without touching him.” The shark subsequently died, was taken to shore, and found to weigh 193 kg. To date, there is but one reported unprovoked attack on a human involving what was most likely a shortfin mako (Randall and Levy 1976), wherein a 20-year-old menstruating woman was bitten approximately 12 times while swimming nearly 500 m offshore from Eilat, Israel, in the northern end of the Red Sea. The shark, said to be 2 m in length, was not captured at the time, but the penetrations in her flesh indicated that it was a mako, and two days after the attack a 2.3-m *Isurus oxyrinchus* was captured nearby. This then is the only report of an attack by what appears to be a shortfin mako; the purported attack of a “mako shark” on John Mark Regan at San Onofre, Orange County, on 29 November 1992, lacked any evidence or authenticity and has been discredited (McCosker and Lea 1996). In summary, although we do not discount that the mako shark might have attacked Mr. Graham (we are familiar with similar near-encounters by spearfishers with mako sharks, and none have resulted in attacks upon humans), we are not convinced that had Mr. Graham not acted as he did he would have been attacked.

And, finally, we relate the curious tale of Steve Rosenbloom, 33, who on 7 March 1994 was bitten by a 4-ft lemon shark (*Negaprion brevirostris*) as he prepared to move the shark from its tank at the Shark Club Billiard Hall in Costa Mesa. The handler grabbed the shark’s tail, it broke free, and bit him on the forearm. The wound required 100 stitches to close.

DISCUSSION

In our previous analysis of the biological and human aspects of white shark attacks (McCosker and Lea 1996:430–433), we attempted to identify and correlate factors responsible for the trends and patterns of attacks. The additional 20 unprovoked attacks in California and Oregon that we herein report have not significantly altered but have in fact reinforced our conclusions.

Those 20 attacks involved 18 men and 2 women; all were either teenagers or adults (age range 17–50 years); victims comprised 11 surfers, 2 free divers, 1 commercial sea urchin diver, 3 bodyboarders, 1 scuba diver, 1 swimmer, and 1 windsurfer (Table 1). Two attacks were in southern California, 15 were in central and northern California, and 3 were in Oregon. All occurred at the surface except for that of the scuba diver (CA #73, M. Flagg) who was being towed by an electric scooter. (The depth of the fatal attack upon CA #71, J. Robinson, who was also using an electric scooter, is not known.) All wore black or black and blue neoprene wet suits. All victims, with two exceptions (CA #73 scuba diver M. Flagg and CA #76 abalone diver C. Tinley), did not see the shark prior to the attack. All known attacks occurred during daylight hours and were more prevalent at midday and in the afternoon (Fig. 3). Lacking comparable data for the time of day spent at

TABLE 1. Confirmed unprovoked attacks by *Carcharodon carcharias* upon humans in the eastern North Pacific, 1950–2003. Attacks at San Miguel Island are considered to be in “Central California.” “Surface divers” includes scuba divers, breathhold divers, and a hookah diver who were attacked while at the surface. Note that in this and subsequent tables, the attacks on D. Webster and J. Greenlaw (2 Sept. 1974) and on T. McAllister and R. Stoddard (26 Jan. 1989) presumably, in each case, involved the same shark and each pairing is therefore counted as one.

	Swimmer	Surface Divers	Surfer	Hookah	Scuba	Kayaker	Wind-surfer	Body-boarder
Washington			1					
Oregon			12					1
California								
Central & Northern	6	32	23	6	5	3	1	2
Southern						2		
Guadalupe Island		2						
Total (n=95)	6	34	35	6	5	5	1	3
Fatalities (n=9)	4	3	1			1		

risk by humans in the water, we are unable to draw any significant conclusions. Attacks occurred during April (1), May (1), June (2, representing the first NE Pacific attacks during June, if one discounts the 1959 attack on R. Pamperin), August (4), September (6), October (2), November (3), and December (1) (Table 2). As we previously reported, we found no correlation between seasonal timing and latitude or other factors, and again conclude that factors associated with human behavior most likely skew the preponderance of attacks during late summer. It is more likely that factors such as vacations, sea temperatures, and conditions that enhance recreational activities, and commercial sea urchin and sport abalone seasons, contribute to the likelihood of attacks. Human activity at the time of attack has not changed significantly, with surfers remaining as the primary victims (Table 1). A sailboarder and two bodyboarders were attacked for the first time in the ENP. This seems to reaffirm the hypothesis that those victims are also mistaken for pinnipeds by patrolling white sharks (for further discussion see Tricas and McCosker 1984; McCosker 1985; and McCosker and Lea 1996). And, despite the abundance of surfers, bodyboarders, sailboarders, and scuba divers in southern California, the absence of significant pinniped aggregations (with the exception of

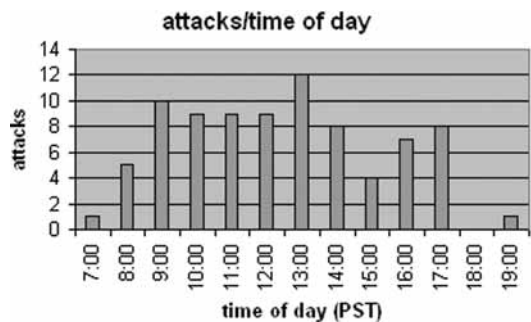


FIGURE 3. Known time of attack (PST corrected for Daylight Savings in North America) by *Carcharodon carcharias* in the eastern North Pacific. N= 87.

TABLE 2. Monthly record of confirmed attacks by *Carcharodon carcharias* in the eastern North Pacific, 1950–2003.

Month	California & Baja California	Oregon & Washington	Total
January	5	1	6
February	3	1	4
March	2	1	3
April	3	2	5
May	6	0	6
June	2	0	2
July	8	0	8
August	14	2	16
September	18	4	22
October	9	1	10
November	6	2	8
December	7	0	7

San Miguel Island and San Nicholas Island) and coastal river entrances (as occur in central and northern California, Oregon, and Washington) seems to explain the rarity of white shark encounters south of Point Conception (Table 3).

It is curious that a decreasing trend in attacks has occurred since 1991–1995 (Fig. 4). The historic high of 19 attacks during that period was followed by six in 1996–2000, and five in 2000–2003 (six attacks, which we do not include herein, occurred in 2004). It appears that recreational water use continues to rise in the NE Pacific, although we lack data to support this assumption. And, since the passage of California legislation in 1994 (AB 522), which prohibits the take of white sharks, it appears that their abundance is modestly increasing at some locations (see page 482 as concerns southern California sightings). We previously suggested, and remain convinced, that these discrepancies may be explained by: (a) humans having learned to avoid some locations where previous attacks have occurred with higher frequency, particularly the Farallon Islands, Tomales Point, and Año Nuevo Island, California; (b) educational programs which emphasize change in diver and swimmer behavior, such as avoidance of offshore exposed reefs and swimming among pinnipeds (CA #84, D. Franzman, being an obvious example); and (c) spearfishermen being less likely to attach their catch to themselves.

The occurrence of an extreme El Niño (ENSO) event during 1997–1998 provided additional opportunity to evaluate the relationship of warm water conditions with white shark attacks. It has been suggested that white shark attacks are more frequent during ENSO events (three during the 1957–1959 ENSO and 4 during the 1982–1984 ENSO); however, only 3 attacks occurred during the 1997–1998 ENSO. In fact, the most extreme attack years in the NE Pacific (7 in 1974 and 5 in 1993) occurred during normal or cool oceanographic periods. We are unable to correlate an increase in attack occurrence with ENSO events.

A controversy involving the practice of attracting white sharks to caged sport divers using bait and blood (“chumming”) within the Monterey Bay National Marine Sanctuary arose in 1993. A central California dive operator who had successfully attracted several white sharks near Año Nuevo Island met vociferous opposition from numerous surfing, diving, and conservation organizations who felt that chumming would endanger human water users (and, as a result, sharks as well). A decision was made in 1994 to prohibit chumming in central California waters in that it was illegal under the recently enacted white shark protection bill (AB 522). Fortunately, no shark/human encounters occurred at that time or in the vicinity of the chumming activity.

A remaining question concerning white shark encounters is the rarity of consumption of human victims. Consumption has occurred elsewhere (Martin 2003) but not to our knowledge in California, Oregon, or Washington among the victims that we have researched. However, three bod-

TABLE 3. Confirmed attacks by *Carcharodon carcharias* in the eastern North Pacific by state and county, 1950–2003. Not included are the attacks on Peixotto in 1926 and Pamperin in 1959 (shark identity not confirmed in both cases).

WASHINGTON	
Grays Harbor Co.	1
OREGON	
Clatsop Co.	2
Tillamook Co.	5
Lincoln Co.	1
Lane Co.	0
Douglas Co.	3
Coos Co.	1
Curry Co.	1
CALIFORNIA	
Del Norte Co.	1
Humboldt Co.	10
Mendocino Co.	6
Sonoma Co.	9
Marin Co.	12
San Francisco Co.	1
SE Farallon Island	6
San Mateo Co.	10
Santa Cruz Co.	4
Monterey Co.	9
San Luis Obispo Co.	6
Santa Barbara Co.	3
San Miguel Island	4
Ventura Co.	0
Los Angeles Co.	1
Orange Co.	0
San Diego Co.	1
BAJA CALIFORNIA	
Guadalupe Island	2

ies that we have reported on in previous papers have not been recovered. It is certainly possible that humans reported as “missing at sea” or “drowned but not recovered” in the NE Pacific might have been consumed by white sharks. We explain the low fatality rate in the NE Pacific (ca. 10% of victims), as compared to much higher rates (McCosker and Lea 1996) in Chile (80%), Australia (62%), and South Africa (24%), by the nearly universal usage in the NE Pacific of the “buddy system,” whereby a victim is taken to shore soon after attack, and where rapid transportation and expert medical attention is generally available soon after the attack. And among the majority of the known fatalities, the victim died prior to or soon after being taken to shore. As well, we feel that the “bite and spit behavior” (Tricas and McCosker 1984; McCosker 1985; Martin 2003), employed by *C. carcharias* when attacking both pinniped and human victims, provides an opportunity for humans to survive if the initial attack does not kill the victim. We are unable to correlate defensive human behavior during and after the attack with the shark’s behavior. Whereas several victims (e.g. CA #70, 80, 81, 83, 84, and OR #12) report to have struck the snout, jabbed the eye, grabbed the gills, fell upon, or kicked the shark, other victims did nothing and were also released. Hypotheses suggesting that human flesh and/or neoprene is distasteful to white sharks (not supported by evidence presented in Martin [2003], and elsewhere) and/or the bite-and-spit behavior is responsible for the temporary release of the victim, have yet to be convincingly proven.

We conclude our analysis of this last decade by reiterating our previous axiom (McCosker and Lea 1996:433), that “the potential for attack on humans by white sharks remains extremely low, and it is our hope that, by better understanding the behavior of *Carcharodon carcharias*, we can reduce this likelihood even further.”

ACKNOWLEDGMENTS

Many individuals have contributed to our study. In particular we thank the willing survivors and witnesses who provided us with invaluable information and advice. We thank many other individuals, including but not limited to the following, for their advice and assistance with this project: Eric G. Anderson, George Balazs, George Burgess, Ralph Collier, Ken Goldman, Debra Goodshall, John Griffith, Burr Henneman, Michael Kasic, Tom Kendrick, Christine Pattison, Alex Peabody, Joan Pont, David Powell, Richard H. Rosenblatt, Norman D. Sperber, Chris Tellis, Dorothy Thompson, and Sean Van Sommeran.

LITERATURE CITED

- ANDERSON, S.D., AND K.J. GOLDMAN. 1996. Photographic evidence of white shark movements in California waters. *Bulletin of the California Department of Fish and Game* 82:182–186.
- ANDERSON, S.D., AND P. PYLE. 2003. A temporal, sex-specific occurrence pattern among white sharks at the South Farallon Islands, California. *Bulletin of the California Department of Fish and Game* 89:96–101.
- BONFIL, R., M. MEYER, M.C. SCHOLL, R. JOHNSON, S. O'BRIEN, H. OOSTHUIZEN, S. SWANSON, D. KOTZE AND

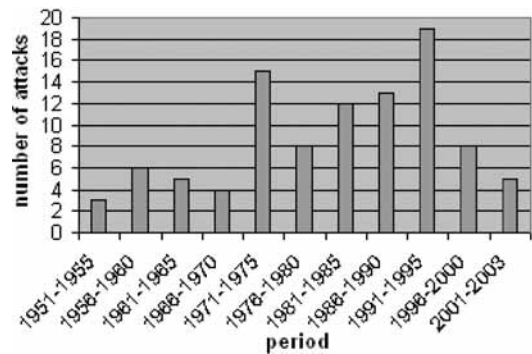


FIGURE 4. Confirmed attacks by *Carcharodon carcharias* in the eastern North Pacific, recorded in 5-year intervals.

- M. PATERSON. 2005. Transoceanic migration, spatial dynamics, and population linkages of white sharks. *Science* 310:100–106.
- BOUSTANY, A.M., S.F. DAVIS, P. PYLE, S.D. ANDERSON, B.J. LE BOEUF AND B. BLOCK. 2002. Expanded niche for white sharks. *Nature* 415:35–36.
- COLLIER, R. 1964. Report on a recent shark attack off San Francisco, California. *Bulletin of the California Department of Fish and Game* 50:261–264.
- COLLIER, R. 1992. Recurring attacks by white sharks on divers at two Pacific sites off Mexico and California. *Environmental Biology of Fishes* 33:319–325.
- COLLIER, R. 1993. Shark attacks off the California islands: review and update. Pages 453–462 in F.G. Hochberg, ed., *Third California Islands Symposium*. Santa Barbara Museum of Natural History, Santa Barbara, California, USA. 661 pp.
- COLLIER, R. 2003. *Shark attacks of the twentieth century from the Pacific coast of North America*. Scientia Publishing, Chatsworth, California, USA. 263 pp.
- DAVIS, C. 1995. Shark attacks diver. *The Monterey County Herald*, 1 July 1995. pp. 1A, 4A.
- EGAÑA, A.C., AND J.E. MCCOSKER. 1984. Attacks on divers by white sharks in Chile. *Bulletin of the California Department of Fish and Game* 70:173–179.
- ELLIS R.E., AND J.E. MCCOSKER. 1991. *Great white shark*. HarperCollins Publishers, New York, New York, USA. 270 pp.
- ESTES, J.A., B.B. HATFIELD, K. RALLS, AND J. AMES. 2003. Causes of mortality in California sea otters during periods of population growth and decline. *Marine Mammal Science* 91:198–216.
- FOLLETT, W.I. 1974. Attacks by the white shark, *Carcharodon carcharias* (Linnaeus), in northern California. *Bulletin of the California Department of Fish and Game* 60:192–198.
- GOLDMAN, K.J., AND S.D. ANDERSON. 1999. Space utilization and swimming depth of white sharks, *Carcharodon carcharias*, at the South Farallon Islands, central California. *Environmental Biology of Fishes* 56:351–364.
- KELLY, J.T., AND A.P. KLIMLEY. 2003. The occurrence of the white shark, *Carcharodon carcharias*, at the Point Reyes Headlands, California. *Bulletin of the California Department of Fish and Game* 89:187–196.
- KLIMLEY, A.P., AND D.G. AINLEY, EDS. 1996. *Great white sharks: The Biology of Carcharodon carcharias*. Academic Press, San Diego, California, USA. 517 pp.
- KLIMLEY, A.P., B.J. LE BOEUF, K.M. CANTARA, J.E. RICHERT, S.F. DAVIS, S. VAN SOMMERAN, AND J.T. KELLY. 2001. The hunting strategy of white sharks (*Carcharodon carcharias*) near a seal colony. *Marine Biology* 138:617–636.
- LEA, R.N. 1987. Pacific coast shark attacks: What is the danger? *Proceedings of the Conference: Sharks, An Inquiry into Biology, Behavior, Fisheries, and Use*. Oregon State University Extension Service, Corvallis, Oregon, USA. 95 pp.
- LEA, R.N., AND D.J. MILLER. 1985. Shark attacks off the California and Oregon coasts: an update, 1980–84. *Memoirs of the Southern California Academy of Sciences* 9:136–150.
- MARTIN, R.A. 2003. *Field guide to the great white shark*. ReefQuest Centre for Shark Research, spec. pub. 1. 185 pp.
- MARTIN, R.A. 2005. Northerly distribution of white sharks, *Carcharodon carcharias*, in the eastern Pacific and relation to ENSO events. *Marine Fisheries Review* 66:16–26.
- MARTIN, R.A., N. HAMMERSCHLAG, R.S. COLLIER AND C. FALLOWS. 2005. Predatory behaviour of white sharks (*Carcharodon carcharias*) at Seal Island, South Africa. *Journal of the Marine Biological Association of the U.K.* 85:1121–1135.
- MATTHEWS, N. 1994. A great white? Or a great wrong? Exclusive Investigative report. Who killed Michelle Von Emster? *Boating* September 1994:112–116.
- MCCOSKER, J.E. 1981. Great white shark. *Science* 81 2:42–51.
- MCCOSKER, J.E. 1985. White shark attack behavior: observations of and speculations about predator and prey strategies. *Memoirs of the Southern California Academy of Sciences* 9:123–135.
- MCCOSKER, J.E., AND R.N. LEA. 1996. White shark attacks in the eastern Pacific Ocean: an update and analysis. Pages 419–434 in A. P. Klimley and D. G. Ainley, eds., *Great white sharks: The Biology of Carcharodon carcharias*. Academic Press, San Diego, California, USA. 517 pp.

- MILLER, D.J., AND R.S. COLLIER. 1981. Shark attacks in California and Oregon, 1926–1979. *Bulletin of the California Department of Fish and Game* 67:76–104.
- MYRBERG, A.A. 1978. Underwater sound — its effect on the behavior of sharks. Pages 391–417 in E.S. Hodgson and R.F. Mathewson, eds., *Sensory Biology of Sharks, Skates, and Rays*. Office of Naval Research, Arlington, Virginia, USA. 666 pp.
- PARDINI, A.T., C.S. JONES, L.R. NOBLE, B. KREISER, H. MALCOLM, B.D. BRUCE, J.D. STEVENS, G. CLIFF, M.C. SCHOLL, M. FRANCIS, C.A.J. DUFFY, AND A.P. MARTIN. 2001. Sex-biased dispersal of great white sharks. *Nature* 412:139–140.
- RANDALL, J.E., AND M.F. LEVY. 1976. A near-fatal attack by a mako in the northern Red Sea. *Israel Journal of Zoology* 25:61–70.
- TRICAS, T.C., AND J.E. MCCOSKER. 1984. Predatory behavior of the white shark (*Carcharodon carcharias*), with notes on its biology. *Proceedings of the California Academy of Sciences*, ser. 4, 43:221–238.