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SHARK ATTACKS IN CALIFORNIA AND OREGON, 1926–1979 [1]

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Analysis of 47 unprovoked shark attacks (45 in California and 2 in Oregon) since 1926 has clarified aspects of shark attacks on humans, especially by white sharks, *Carcharodon carcharias*. Eighty-seven percent of the victims were interviewed and precise details of these attacks are available. Data of attacks on skindivers were compared with skindiver effort and catch derived from California Department of Fish and Game surveys of skindivers conducted in 1960 and 1972. Information on victim activity, location of attacks, time of day, seasonal occurrence, water visibility, depth and temperature, species of sharks involved, attack patterns of sharks, and degree of injury to the victims is presented. Possible shark attack motivation is discussed. The principal attacking species from Point Conception and San Miguel Island northward was the white shark.

There appears to be an increase in the frequency of shark attacks both in California north of Point Conception and in Oregon. This increase may be due to the increase of prey marine mammal populations and a concomitant increase in the white shark population. The frequency of shark attacks in the 100-mile area between Año Nuevo Island and Bodega Bay is 10 times greater than the frequency of attacks over the remainder of the California coastline. Contrary to the findings of world-wide shark attack data analysis, northern California attacks occur more frequently in clearer water at temperatures less than 60°F. We found no correlation of attacks on spearfishermen with speared fish. No shark attacks occurred in either California or Oregon in kelp beds; most of the attacks were on freediving skindivers who were looking for abalone. There were four fatalities—three swimmers and one skindiver.

INTRODUCTION

Those people seeking exotic flora and fauna to observe, photograph, research, and harvest have found the marine habitat an exciting new world to invade, but this invasion of the sea has not been without hazard. Most dangers encountered by skindivers and boaters are accepted as part of the endeavor, as are the dangers of bicycling, skiing, flying, etc. However, the hazards of shark attacks, as rare as they are, have not been accepted calmly and have probably inhibited many individuals from participating in marine water contact activities. Shark attacks present humans with a most terrifying experience, i.e., being attacked and possibly eaten in a physical element in which they cannot easily escape.

Even before the recent shark "horror" movies, there has been concern about shark attacks, such as in Australia, when swimming and surfing became popular in 1919 (Coppleson 1958). The horror stories of shark attack victims from ships sunk during World War II triggered world-wide anxiety among swimmers and

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those involved in the newly developed sports of surfing and skindiving. In 1957 and 1958 there was an unprecedented number of attacks in South Africa waters (Smith 1963; Davies 1964) and, in this same period, there appeared to be an increase in shark attacks on both the Atlantic and Pacific coasts of the United States (Gilbert, Schultz, and Springer 1960; Schultz and Malin 1963). Llano (1957) posed questions and possible answers as to why sharks attack humans, analyzing reports of shark attacks and shark behavior throughout the world. In 1958, the American Institute of Biological Science and the Office of Naval Research initiated intensive research on sharks, including physiology, behavior, taxonomy, and a collation of world-wide shark attack data (Gilbert 1960). Most of the results of subsequent studies appears in *Sharks and Survival* (Gilbert 1963*a*) and *Sharks, Skates and Rays* (Gilbert, Mathewson, and Rall 1967). Several popular publications related some of the findings, especially the information on shark attacks (Helm 1961; Matthiessen 1971; Baldridge 1974; Ellis 1976).

The results of research through the early 1970's yielded considerable data on physiology and taxonomy, but serious information gaps on shark behavior persisted. Ethological studies were initiated on some of the more important and easily observed species (Johnson and Nelson 1973; Myrberg 1976; Gruber and Myrberg 1977; Gilbert 1977). The spring 1977 issue of *American Zoologist* presented the goals and results of current shark research. There now is less emphasis on collection and analysis of shark attack information and more effort on behavioral and life history studies. However, until more descriptive behavioral studies are completed, especially on the more dangerous species such as the white; tiger, *Galeocerdo cuvier;* and bull, *Carcharhinus leucas,* sharks, continued and more detailed analysis of shark attack data is needed to determine cause and effect parameters of shark attacks. Anti-shark measures are apparently effective in South Africa (Smith 1963), Australia (Springer and Gilbert 1963), the Hawaiian Islands (Tester 1969), but for mainland North America we are still confronted with continuing shark harassment and attack.

The Navy's Shark Attack File (SAF) information (Schultz and Malin 1963; Schultz 1967) allowed little opportunity for those analyzing the data to interview the attack victims. Much of the information was available only from news clipping services. Another drawback was the lack of control data to determine cause and effect relationships between shark attacks and human activities, such as comparison of diving and swimming effort with frequency of attacks. Many of the general conclusions were based upon analysis of a collation of world-wide data, lumping together all shark species and geographical areas; however, we found that generalized attack patterns based on world-wide data may not be applicable to California and Oregon, where unique oceanographic conditions occur.

Shark attack data presented in this paper are unique because a majority of the victims were interviewed by the authors and comparative data of skindiving effort and activity are available from Department surveys in 1960 and 1972 (Miller and Gotshall 1965; Miller, Geibel, and Houk 1974).

SOURCES OF DATA

Shark Attack File records (Schultz and Malin 1963) listed 28 unprovoked shark attacks for California from 1926 through 1962. Perry Gilbert (Mote Marine Laboratory, pers. commun.), submitted updated California SAF records through

1975, totalling 46 attacks. Of these 46 attacks we considered 16 to be special cases, provoked, or unconfirmed (Appendix I). In addition, California Department of Fish and Game files included information on 17 additional unprovoked attacks through 1979. In all, we considered 47 attacks on humans to be valid, unprovoked attacks for California and Oregon (Appendix II).

Initially, we reviewed the SAF data to determine whether an attack was provoked or unprovoked; part of this process was to locate as many of the victims as possible, even if they had been previously interviewed by other fisheries researchers. Twenty-seven (57%) of the victims were interviewed by the authors, 13 were interviewed immediately after the attacks by other researchers, and 1 was reported by Navy personnel; data for the remaining 6 attacks were available only from newspaper articles. Thus, 87% of the attack victims were contacted first hand in our analysis. This is compared with the world-wide SAF records in which 7.4% were from first hand interviews of the victims (Baldridge 1974). Details of eight California shark attacks on humans have been published in scientific journals (Bolin 1954; Fast 1955; DeWitt 1955; Collier 1964; Follett 1974; Collier, in press). Identification of the shark species was determined from tooth fragments, dentition patterns on the victims or their diving and surfing equipment, and by description of the sharks by victims and witnesses.

LOCATION OF ATTACKS AND SPECIES OF SHARKS INVOLVED

Shark attacks occurred irregularly from the Mexican border to Cannon Beach, Oregon (Figure 1). There are two general water regimes within these boundaries, each typified by characteristic fish assemblages. The cold-temperate zone (central California into Oregon) extends northward from San Miguel Island and Point Conception. The warm-temperate zone off southern California encompasses the inshore area south of Point Conception except for San Miguel Island. San Miguel Island is not totally within the influence of the warm southern California gyre and the fish populations at San Miguel are more similar to those along central California than those to the south. The southern range limits of 6 cold-temperate fish species are recorded at San Miguel Island (Miller and Lea 1972), whereas the northern range limits of 13 subtropical fish species occur at Point Conception, demonstrating the sharp, persistent demarkation of the two temperature regimes.

Recognition of these temperature regimes is important in the analysis of shark attacks since there appears to be dissimilar attack patterns in each of the two water masses, involving different shark species. It appears that most, if not all, the unprovoked attacks (Appendix II) from San Miguel Island and Point Conception northward may have been by white sharks whereas south of these areas the attacks may have been by sharks in families Carcharhinidae (requiem sharks), Sphyrnidae (hammerheads), and possibly Squatinidae (angel sharks). Of the 40 shark attacks in the cold-temperate zone (Table 1), 21 were by white sharks, 12 were presumably by white sharks, 5 were by large sharks of undetermined species, and 2 attacks were by sharks for which there was no description as to size or kind. Two of the seven attacks in southern California were reported by the victims to be by blue sharks, *Prionace glauca,* one by a hammerhead, *Sphyrna* sp., and one was most likely by a tiger shark, *Galeocerdo cuvier.* Shark species in three southern California attacks were unidentified.

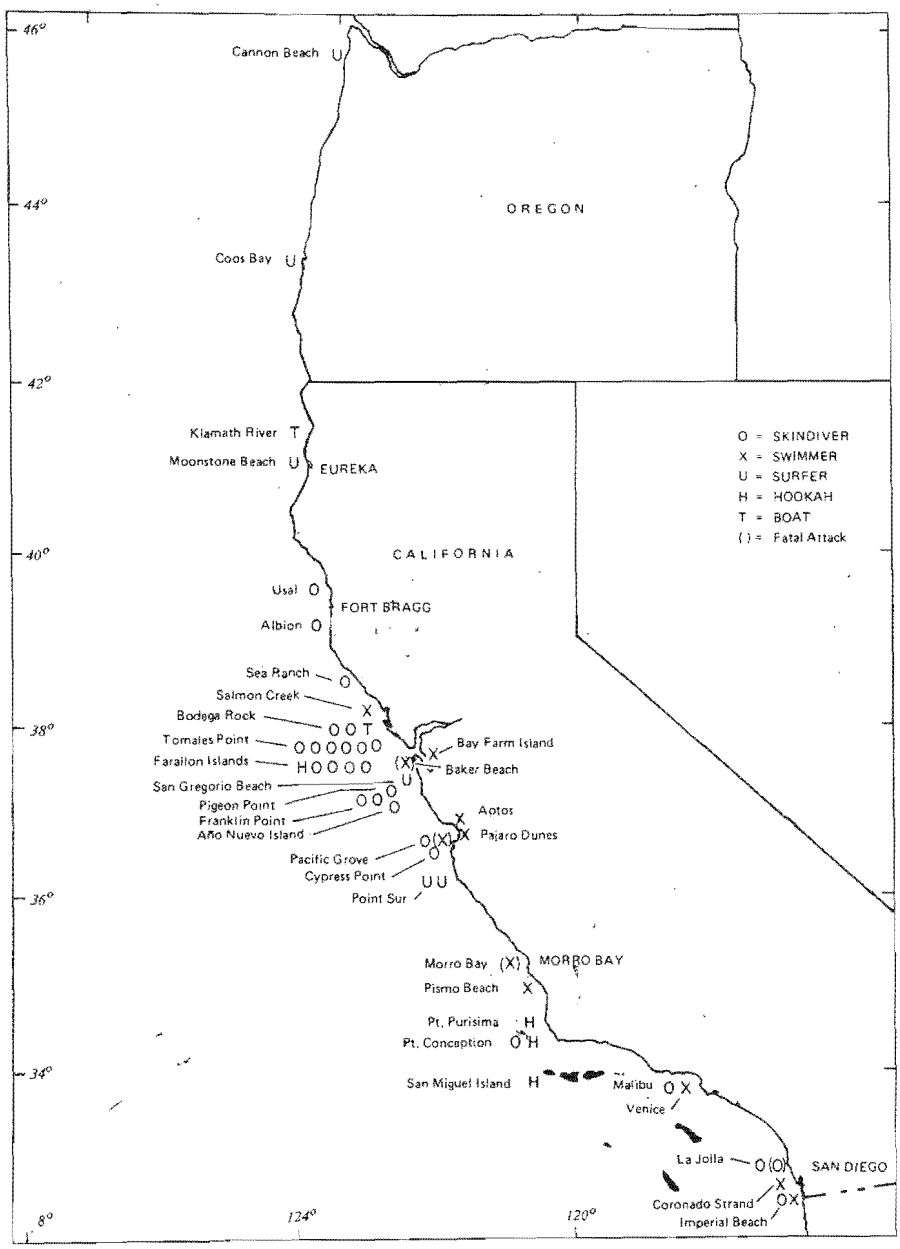

FIGURE 1. Location of unprovoked shark attacks on humans and boats in California and Oregon. (Attack locations are in lower case, initial caps.)

The seven unprovoked southern California attacks occurred between 1950 and 1959. Four attacks took place during the exceptionally warm water years of 1958 and 1959, indicating a possible abnormal influx of subtropical shark species (such as the tiger shark, which is rarely seen in southern California).

TABLE 1. Number of Unprovoked Shark Attacks on Humans Per Year in the Cold-Temperate (N) * and Warm-Temperate (S) * Water Regimes of California and Oregon by Victim Activity, 1926–1979.

Year	Swimming			Skindiving			Hookah Surfing		Totals		
	S	N	Total	S	N	Total	N	N	S	N	Total
1926	–	1	1	–	–	–	–	–	–	1	1
1950	1	–	1	–	–	–	–	–	1	–	1
51	–	–	–	–	–	–	–	–	–	–	–
52	–	1	1	1	–	1	–	–	1	1	2
53	–	–	–	–	–	–	–	–	–	–	–
54	–	–	–	–	–	–	–	–	–	–	–
55	1	–	1	–	1	1	–	–	1	1	2
56	–	1	1	–	–	–	–	–	–	1	1
57	–	1	1	–	–	–	–	–	–	1	1
58	1	–	1	–	–	–	–	–	1	–	1
59	–	1	1	3	1	4	–	–	3	2	5
1960	–	1	1	–	1	1	–	–	–	2	2
61	–	1	1	–	1	1	–	–	–	2	2
62	–	–	–	–	2	2	–	–	–	2	2
63	–	–	–	–	–	–	–	–	–	–	–
64	–	–	–	–	1	1	–	–	–	1	1
65	–	–	–	–	–	–	–	–	–	–	–
66	–	–	–	–	1	1	–	–	–	1	1
67	–	–	–	–	–	–	–	–	–	–	–
68	–	–	–	–	1	1	–	–	–	1	1
69	–	–	–	–	2	2	–	–	–	2	2
1970	–	–	–	–	–	–	–	–	–	–	–
71	–	–	–	–	1	1	–	–	–	1	1
72	–	–	–	–	1	1	1	1	–	3	3
73	–	–	–	–	–	–	–	–	–	–	–
74	–	–	–	–	4	4	1	2	–	7	7
75	–	–	–	–	3	3	1	–	–	4	4
76	–	–	–	–	–	–	1	2	–	3	3
77	–	–	–	–	1	1	–	–	–	1	1
78	–	1	1	–	–	–	–	–	–	1	1
79	–	–	–	–	1	1	–	1	–	2	2
Total	3	8	11	4	22	26	4	6	7	40	47

* Cold-temperate zone encompasses San Miguel Island and Point Conception north into Oregon; the warm temperate zone is south of this area.

Another grouping of possible shark attacks may also represent yet another type of shark interaction with humans in southern California. Five of the southern California unconfirmed attacks (Appendix I) along with two of the confirmed listings (Appendix II) appear to have unique similarities. The attacking sharks were not observed, the attacks were along sandy beaches in shallow water, and the wounds were all minor. Five were swimmers (Appendix I: SAF #234, 849, and Balldean; Appendix II: SAF #243 and 845) and two were surfers (Appendix I: Caldwell and Mullimax). The attack on the two surfers (Los Angeles Times 1975) was guessed by a lifeguard to have been by "barracudas", but this is unlikely in that there has never been a confirmed attack on a human by the California barracuda, *Sphyraena argentea*. It is possible that some, if not all, of

these seven southern California cases could have been attacks by the Pacific angel shark, *Squatina californica*. This shark reaches 5 ft in length, is an inconspicuous, sandy bottom dwelling form with a skatelike body, and has small but sharp-pointed teeth that could cause the type of cuts and abrasions reported in these cases. These sharks can be quite aggressive (Limbaugh 1963; J. Fitch, Calif. Dept. Fish and Game, pers. commun.) and have been known to strike at skindivers and commercial fishermen when disturbed. In July 1980, Charles Sloan, (scuba diver, Mountain View, CA, pers. commun.), reported being bitten by an angel shark he unintentionally provoked. While swimming along a sandy bottom in 50 ft of water off Santa Cruz Island, Sloan struck something on the bottom with a flipper and a few seconds later an angel shark bit one of his flippers. The shark identification was positive. The dive was at night (2100) and several angel sharks were observed by other divers. The attack occurred on 9 February 1980.

The small sharks that "attacked the feet" of Davis (Appendix I) were identified by Davis as leopard sharks, *Triakis semifasciata*, leading to an alternate possibility that at least some of these unconfirmed attacks (see also the facial bumping of Adams, Appendix I) could have been by leopard sharks. Other possible causes of minor cuts and abrasions in the surf area are several species of stingrays or unseen hard objects which can often be encrusted with sharp barnacles.

Other than the possible attack on Balldean in 1978 (Appendix I), there has not been an unprovoked attack in southern California south of San Miguel Island since 1959, demonstrating the rarity of attacks in southern California. Attacks in the northern cold-temperate zone, on the other hand, appear to be increasing. Numbers peaked in 1974 and 1975 but attacks have continued each year through 1979 (Table 1). Attacks on commercial abalone divers using hookah diving apparatus (skindiving equipment with an air supply from an air compressor on a tending boat) and surfboarders were first recorded in 1972. During more than 20 years of hard-hat diving for abalone, involving hundreds of divers over much of central and southern California, there were no reports of harassment or attack by sharks on these divers.

Except for the attacks in the area between Año Nuevo Island and Bodega Bay (Figure 1), shark-human interaction along the California and Oregon coastline has been rare and apparently random. Of the 40 unprovoked shark attacks on humans recorded for the northern cold-temperate area, 21 occurred within the 100-mile section from Año Nuevo Island to Bodega Bay. In addition, there were two attacks on boats in central and northern California, one off the Klamath River in 1959 (Follett 1974) and one off Bodega Bay in 1952 (Caras 1964). Since 1926, there has been an average of 0.20 attacks on humans per linear mile of outer coastline (San Francisco Bay excluded) between Año Nuevo Island and Bodega Bay. Outside this zone in California, the number of attacks has been 0.02 per linear mile of coastline, including the Channel Islands. The greatest number of attacks has been around Tomales Point, where eight attacks have been recorded over a 17-year period; five attacks have been recorded at the Farallon Islands over the same period.

There is anthropological evidence to indicate that the highest incident of shark attacks on swimming Indians in California was off Marin and Sonoma counties. D. Travis Hudson (Santa Barbara Museum of Natural History, pers. commun.)

has noted that the only coastal Indian tribe making magical reference to sharks (a prayer before entering the water) was the Coast Pomo (Loeb 1926), the tribe just north of the Bodega-Tomales area. One of the hunting procedures of north coast Yuki Indians was to swim to offshore rocks to kill harbor seals and sea lions with spears and arrows and then tow the animals to shore (Gifford 1939).

One of the problems in previous shark attack analysis has been lack of data on frequency of shark attacks in relation to the number of humans in the water. In our study, the attack ratio of Saturday-Sunday-Holiday (SSH) to Weekday (WD) was 1.75:1; however, we do not have estimates of swimming intensity for SSH and WD. A 1972 skindiving survey (Miller, Geibel, and Houk 1974) supplied an accurate count of SSH and WD effort at nearly all skindiving access areas between Pismo Beach and Eureka. In 534 sampling days, totalling 12,245 skindiver interviews in which SSH and WD data were recorded in the same monthly periods, the mean values of all sampling units of SSH effort was 33.2 divers, whereas the daily mean values of WD effort was 2.9 divers. Thus, in the 113 SSH days in a year, a mean total of 3,747 diving days was expended, and in 252 WD days of the year there was a mean total of 752 diving days expended, yielding a SSH:WD ratio of diver use of 4.98:1. The ratio of SSH:WD attacks by sharks was 5.25:1.

Even though there is a strong correlation between the SSH and WD attack frequency and skindiving effort, there is no positive relationship between the total number of skindivers utilizing a particular area and the number of shark attacks there. Skindiving effort for 1960 (Miller and Gotshall 1965) and 1972 (Miller, Geibel, and Houk 1974) were collated by county from San Luis Obispo County north to the Oregon border. A comparison of shark attacks on skindivers in these counties demonstrates no positive correlation of attacks with the annual skindiving effort (Figure 2). The highest skindiving effort was recorded for Monterey County, but only two attacks on skindivers occurred in this county. The greatest number of shark attacks occurred at Tomales Point (Marin County) and Farallon Islands (San Francisco County), areas of the coast with relatively little skindiving effort. Shark attacks seem to occur consistently (although infrequently) at Tomales Point, the Farallon Islands, and near Año Nuevo Island, but appear to occur more randomly throughout the remainder of the coastline. There has not been an attack in California and Oregon within the canopy of a giant kelp, *Macrocystis pyrifera*, bed. There was one attack (Sloan, Appendix II) in a bull kelp, *Nereocystis leutkeana*, area near Año Nuevo Island. In this case the shark removed the flipper from a descending diver 20 ft below the surface near the edge of a bull kelp area in which the plants were scattered about 20–30 ft from each other, forming a sparse surface frond cover. There have also been several shark harassments reported and, in two separate cases, the divers who were being circled by a large shark (reported as whites) headed for nearby kelp beds. Once the divers entered the canopy the sharks were not seen again. That is not to say that sharks may not enter giant kelp canopies. California Fish and Game divers encountered several sharks (presumed to be soupfin sharks, *Galeorhinus zyopterus*), well within a thick canopy of giant kelp on the bottom; however, this shark species has not been known to attack humans.

If skindiving effort increased in the areas of high attack incidence, it would be logical to assume that the number of attacks would rise in proportion. However,

Coppleson (1963) reported that there rarely were shark attacks in Australia at beaches where over a hundred swimmers were active. When attacks did occur at swimming beaches, it was usually the swimmers away from the concentration who were attacked. A comparable situation is reported for South Africa (Smith 1963). In California, except possibly for the attack on Pamperin at La Jolla (Appendix II), all skindivers were attacked in areas of relatively light annual skindiving use. No divers have been attacked or harassed in any of the over 100 spearfishing competition meets that have been held since 1956 at many different sites from San Diego to Fort Bragg. The highest concentration of skindiving effort in central and northern California occurs in Carmel Bay and along Cannery Row, Monterey. White sharks occur in these localities, but there has never been an attack on a human in these heavily utilized areas. The area of highest incidence of traumatized dead sea otters, *Enhydra lutris*, coming ashore with white shark teeth fragments in the wounds is in Carmel Bay (Orr 1959; Ames and Morejohn 1980). A similar situation appears to be the case with surfboarders. All the attacks on surfboarders have been in areas in central and northern California and Oregon that are lightly or rarely used by surfers. We are not indicating that if large groups of skindivers start utilizing the Tomales Point and Farallon Island areas that there might be fewer attacks in these areas, nor are we indicating that it would be safer to dive in these areas in a large group.

ACTIVITY OF ATTACK VICTIMS

We used four activity categories to classify attacks: swimming (includes body surfing), skindiving (which includes both freediving and scuba), surfboarding, and commercial abalone diving (hookah). The largest number of unprovoked attacks was on skindivers (Table 1), with 26 attacks (55 % of the total), followed by 11 attacks on swimmers (23%), 6 attacks on surfboarders (13%), and 4 on hookah divers (9%). Activities of skindivers reveal that abalone diving was the activity most associated with shark interaction in California (Table 2). In California only 4 of the 26 skindivers (15%) had taken a fish before being attacked. In a world-wide analysis (Baldridge 1974), there was a positive relationship of the presence of speared fish with shark attack.

TABLE 2. Activities of Skindivers Attacked by Sharks in California.

	Abalone Diving			*Spearfishing*					
	With abalone	*Without abalone*	*Total*	*With fish*	*Without fish*	*Total*	*Other*	*Total*	*%*
Freediving	7	5	12	2	1	3	2	17	65
Scuba	0	1	1	2	2	4	4	9	35
Totals	7	6	13	4	3	7	6	26	100
Percent of total skindiver activity	27	23	50	15	12	27	23	100	
Percent of total activity (47 attacks)	15	13	28	8	6	15	13	55	

When the percentage composition of skindiving activity recorded in 1972 (Miller, Geibel, and Houk 1974) is compared to the percentage of shark attacks by skindiver activity (Figure 3), abalone divers were attacked at a rate 2.5 times greater than their representation. Skindivers in training sessions were never attacked, although this category comprised 30% of all skindiving activity in the

study area. There was no apparent correlation with the possession of abalones and attacks.

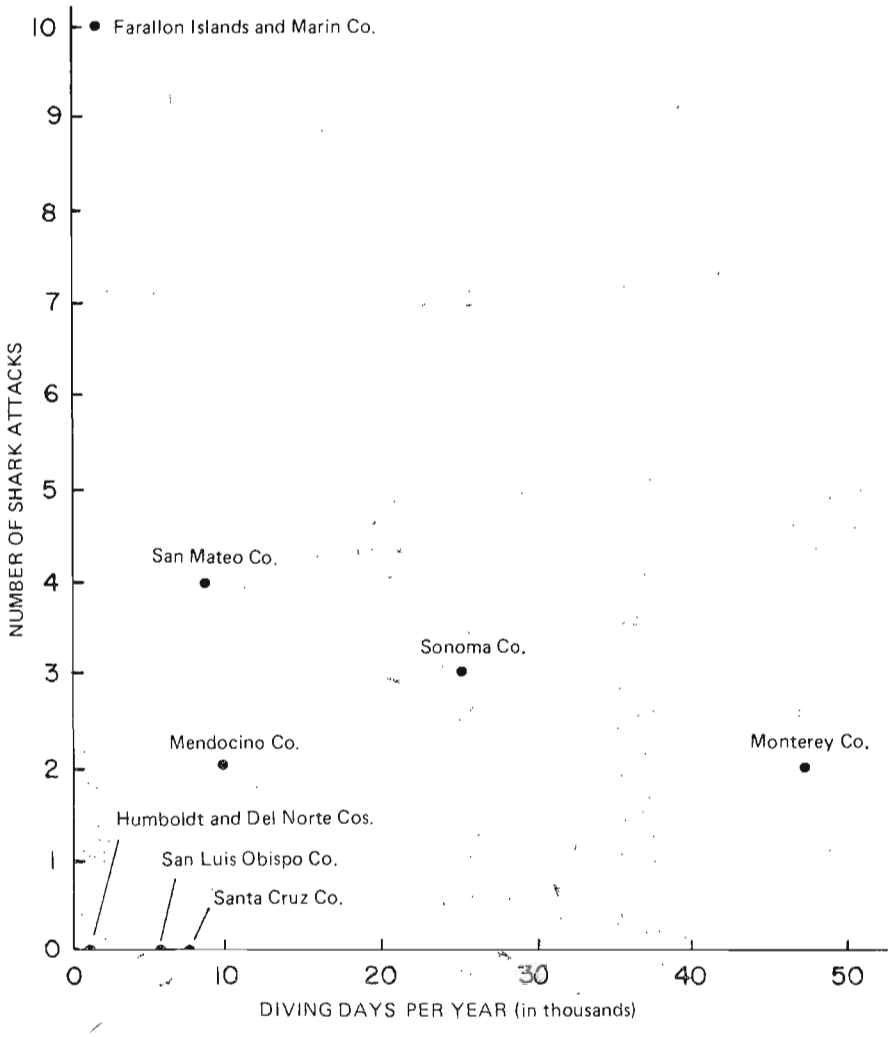

FIGURE 2. Number of unprovoked shark attacks on skindivers by central and northern California counties (1955–1979) compared to mean diving days expended by county (1960 and 1972 census data).

DEPTH OF ATTACKS

Attacks were over bottom depths ranging from 3 ft to 120 ft, with a peak depth range of 11 to 20 ft. There is no way to determine if these attack depth frequencies reflect shark distribution or behavior or represent the depths most frequented by the victims.

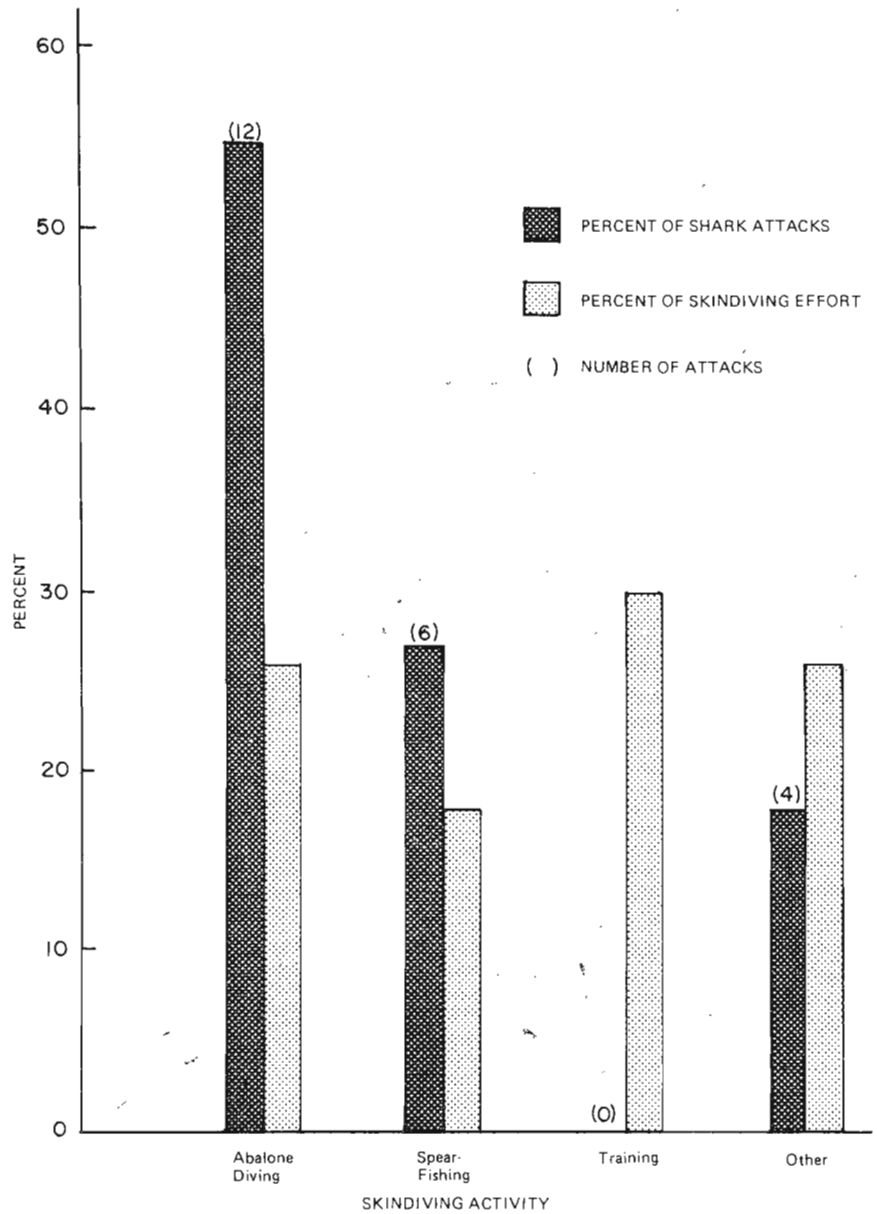

FIGURE 3. Percent and number of shark attacks on skindivers by activity compared to percent of skindiving hours expended in each activity.

A more meaningful presentation of attack depth data is the grouping of the number of attacks at or near the surface, at mid-depth, and at or near the bottom (Table 3). Seventy-nine percent of all victims and 76% of skindivers were at or

near the surface when attacked. In a world-wide analysis (Baldridge 1974), 90% of all shark attacks were at the surface, with only 31% of the world-wide attacks at the surface for skindivers. The high percentage of surface attacks for skindivers in California is probably due to the fact that 65% of the attacks were on freedivers who spend most of their diving time at the surface. In the 1972 skindiving survey, 49% of skindiving effort in central and northern California was by freedivers, demonstrating a greater tendency for freedivers to be attacked as opposed to those using scuba. Scuba gear cannot be used when taking abalones north of Yankee Point, Monterey County. Freediving for abalones in central and northern California thus results in a greater amount of diving time expended at the surface, where shark attacks are more likely to occur (Table 3).

TABLE 3. Number of Attacks at Surface, Mid-depth, and Bottom Categorized by Activity of Victims

	Skindiving											
	Number				*Commercial Abalone*		*Surfboarding*		*Swimming*		*Totals*	
Depth	*Freediving*	*Scuba*	*Total*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Surface	14	6	20	76	0	0	6	100	11	100	37	79
Mid-depth	1	2	3	12	1	25	0	0	0	0	4	8
Bottom	2	1	3	12	3	75	0	0	0	0	6	13
Total	17	9	26	100	4	100	6	100	11	100	47	100

WATER VISIBILITY

Water visibility is a difficult parameter to analyze because of the subjective nature of estimates made by the victims and witnesses. Shark attack data and skindiving survey results show shark attacks to occur frequently in clear water (20 ft or more visibility) north of Point Conception (Figure 4). Of the 21 attacks on skindivers for which we have data, 7 (33%) were in the 0 to 10 ft category, but 6 (29%) were in water visibilities of over 30 ft, which are relatively uncommon in central and northern California. Skindiver estimates of water visibility were recorded by Department researchers in 1960 and 1972, yielding 2,863 data points for all the major diving areas from Pismo Beach to Oregon. A chi-square test was used to compare these data with the subjective estimates of visibility reported by shark attack victims. Results were highly significant at the 99% level ($X^2 = 26.29$; 4 df), indicating that the actual number of attacks are not the same as the expected number of attacks.

Baldridge (1974), in his world-wide survey, points out that there is about a 50–50 chance of being attacked in clear water as opposed to turbid water. We could not compare our data directly with the SAF data because "clear" and "turbid" were not defined. If the dividing line of "clear" and "turbid" is arbitrarily set at 20 ft then, in California, 38% of the attacks were in "clear" water, with only 17% of the skindiving effort expended in this visibility category.

TIME OF YEAR OF ATTACKS

Shark attacks in California and Oregon have occurred in each month of the year (Table 4). All the attacks south of Point Conception were from June through November. Attacks north of Point Conception were scattered throughout the year, with a peak occurring from July through September. However, all the

attacks on hookah divers, surfboarders, and five of eight swimmers attacked in the northern area occurred from July through December. There is no obvious reason why most of the attacks have taken place in the latter half of the year. Even though there are predictable seasonable fluctuations in oceanographic conditions, marine mammal migrations, weather patterns and human activity, we do not know enough about shark behavior to reveal possible cause and effect relationships in seasonal trends. Blue sharks appear in large numbers off central and northern California during most of the summer and fall and the rare subtropical carcharhinids and sphyrnids (hammerheads) occur only in southern California. Little is known of the behavior of the white shark, the principal (and possibly only) attacking shark north of Point Conception.

TABLE 4. Shark Attacks by Month and Activity of Victims in Southern (S) and Northern (N) California.

	Swimming			*Skindiving*			*Surf-Hookah boarding*		*Total*		
	S	*N*	*Total*	*S*	*N*	*Total*	*N*	*N*	*S*	*N*	*Total*
January	–	–	–	–	3	3	–	–	–	3	3
February	–	–	–	–	1	1	–	–	–	1	1
March	–	–	–	–	1	1	–	–	–	1	1
April	–	1	1	–	1	1	–	–	–	2	2
May	–	2	2	–	3	3	–	–	–	5	5
June	–	–	–	1	–	1	–	–	1	–	1
July	–	1	1	1	4	5	2	–	1	7	8
August	–	3	3	–	2	2	–	2	–	7	7
September	1	–	1	–	3	3	1	2	1	6	7
October	2	–	2	–	2	2	–	1	2	3	5
November	–	–	–	2	1	3	–	1	2	2	4
December	–	1	1	–	1	1	1	–	–	3	3
Total	3	8	11	4	22	26	4	6	7	40	47

One data series for white sharks is available from daily commercial shark spotter logs kept by a pilot looking for basking sharks, *Cetorhinus maximus,* in Monterey Bay from 1948 through 1950 (Squire 1967). The data for this 3-year period were smoothed by a running average of three and plotted with comparably handled data on the number of shark attacks by month for central and northern California (Figure 5). There was a close relationship between the two frequencies, with strong peaks of white shark sightings in Monterey Bay and shark attacks throughout the area north of Point Conception during July and August. In spite of the obvious differences in data base between these series, it is tempting to assume some relationship between the increased seasonal abundance of sharks observed at the surface and attacks on humans.

TIME-OF-DAY OF ATTACKS

Time-of-day data are available for 37 of the 47 attacks. All the attacks were in the daytime, occurring fairly evenly between 0710 and 1830, with a slight peak from 1200 to 1500. These attack times probably reflect intensity of human activity.

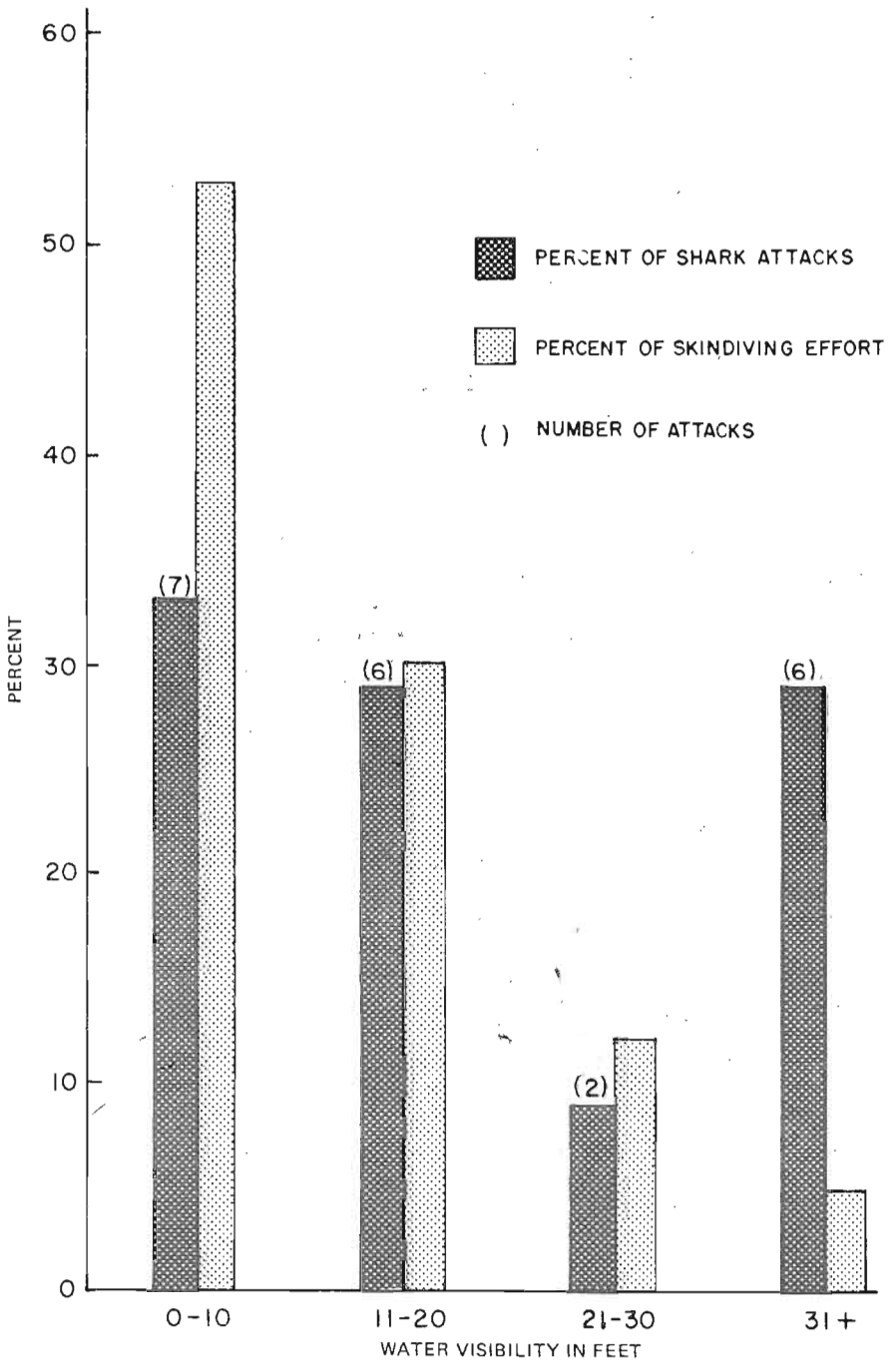

FIGURE 4. Percent and number of shark attacks on skindivers in 10-ft water visibility categories compared to percent of skindiving hours expended in each 10-ft category.

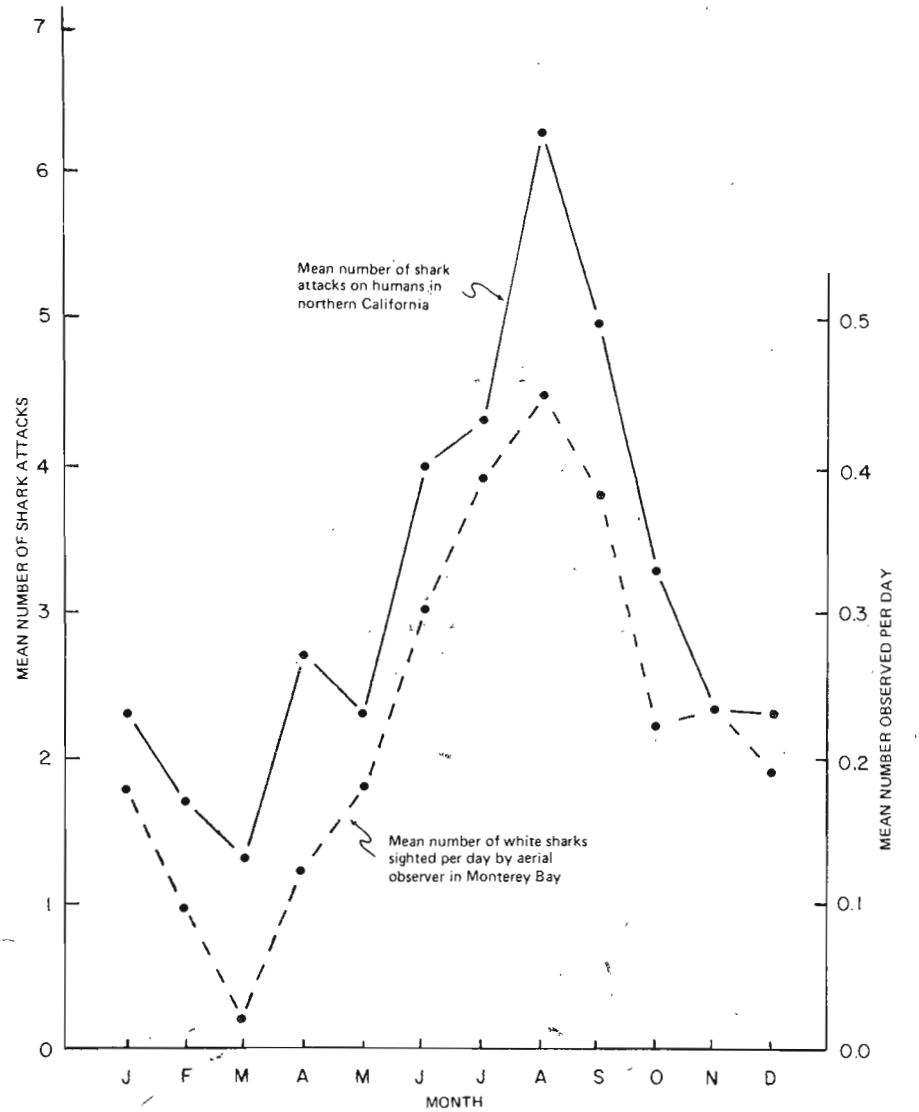

FIGURE 5. Mean number of shark attacks on humans north of Pt. Conception (1926–1979) compared to mean number of white sharks sighted per day by an aerial observer in 1948–1950.

WATER TEMPERATURE

Water temperatures were measured after only 4 of the attacks; an additional 12 surface temperatures were estimated by victims and witnesses. That attacks occurred in all seasons in northern and central California is evidence that at least some white sharks are probably residential. World-wide attacks (Coppleson

1963; Smith 1963; Baldridge 1974) are skewed toward temperatures warmer than those encountered north of Point Conception. The southern California trend compares with the world-wide conditions, with most attacks occurring where surface temperatures are in excess of 65°F. In southern California surface temperatures at the scene of four attacks ranged from 60 to 70°F and northern California surface temperatures for 12 attacks ranged from 50 to 60°F.

SHARK ATTACK PATTERNS

Key data were the direction of the attack in reference to the victim, the ferocity or casualness of the shark, the number of bites on the victim, whether the wounds were from a "bite" or "slash", and the reaction of the shark to the victim's actions before, during, and after the attack. Attack patterns and their possible motivations can also be revealed from underwater studies (Limbaugh 1963; Nelson 1969; Johnson and Nelson 1973; Myrberg 1976; Gruber and Myrberg 1977). Other indirect sources of shark feeding behavior include stomach analysis (Strasburg 1958; Springer 1967) and observations of the commercial shark fishery (Springer 1967; Tester 1969). We do not intend to present a complete summary of current shark behavioral studies in this paper, but rather to present apparent shark attack behavior patterns for this section of the coastline and relate them to findings in various behavioral studies.

Direction of Attack and Extent of Damage to Victims

In only eight instances did the victim observe the shark before being attacked (Table 5), amounting to 19% of 43 attacks. Of the 42 attacks for which information is available, only three were frontal attacks on skindivers on the surface. Feet and legs were the parts of the body first attacked in 56% of the occurrences, followed by arms and hands (24%), and the torso (20%). A large majority of the wounds (65%) required extensive stitches, required hospitalization, resulted in permanent damage to tendons and nerves, or were fatal. The body was not cut by the shark on four of the victims.

Resistance of Victims and Behavior of Sharks

Evidence on whether resistance by the victim inhibited continued interaction by the shark is inconclusive. We could not determine whether eight of the victims (including the four fatalities) actually resisted (i.e., faced the attacking shark and engaged in aggressive activity by kicking at or striking at the shark). In some instances, it was not possible for the victim to resist because the shark did not remain in the area. For those who did resist, there was a slightly greater number of instances in which the shark remained in the area and attempted to bite rather than retreat. In 28 of the attacks (60% of the total) the sharks did not remain in the area (Table 6). In nine attacks (19%), the only bite was a prolonged grasp in which considerable damage was inflicted and which prevented the victim from resisting. In eight cases (17%), mostly involving swimmers, the shark inflicted more than one bite. Nineteen of the attacks consisted of one quick bite (16) or a slash (3), totalling 40% of the attacks. We defined a bite as a grasping of the victim with teeth of both upper and lower jaws; a slash was any wound or mark in which it was not possible to determine if teeth of both jaws were involved.

TABLE 5. Frequency of Occurrence of Whether the Victims Saw the Shark Before the Attack, the Direction of Attack in Respect to the Victim, the Area of Body First Hit, Whether the Victim Resisted, and Degree of Injury by Activity.

	Skin-diving	*Swimming*	*Surf-boarding*	*Hookah*	*Totals*
Shark Seen Before Attack:					
Yes	5	2	1	0	8
No	21	5	5	4	35
Unknown	0	4	0	0	4
Total	26	11	6	4	47
Attacked From:					
Rear	18	5	3	3	29
Side	5	1	3	1	10
Front	3	0	0	0	3
Unknown	0	5	0	0	5
Total	26	11	6	4	47
Area of Body First Hit:					
Feet-legs	19	3	2	1	25
Arms-hands	5	4	1	1	11
Torso	2	4	2	1	9
Unknown	0	0	1	1	2
Total	26	11	6	4	47
Victim Resisted Attack:					
Yes	16	3	0	2	21
No	9	4	3	2	18
Unknown	1	4	3	0	8
Total	26	11	6	4	47
Degree of Injury:					
None	2	0	1	1	4
Minor	9	2	2	0	13
Major	15	9	3	3	30
Total	26	11	6	4	47

TABLE 6. Attack Intensity and Patterns by Sharks by Victim Activity.

	One quick bite or slash then departed	*More than one bite*	*No second bite but attempted to bite again, or remained in area*	*One prolonged bite then departed*	*Total*
Skindiving	12	2	6	6	26
Swimming	4	4	2	1	11
Surfboarding	3	1	1	1	6
Hookah	0	1	2	1	4
Total	19	8	11	9	47
Percent	40	17	23	19	99

Forcefulness of Attacks

Most of the attacks were apparently slow, deliberate movements which could be described as an investigatory interaction of the shark with an "object". A typical attack in central and northern California was on a freediver who had been diving to the bottom several times, resting or slowly swimming on the surface and, without warning, had a flipper, foot or leg grasped by a shark. Shaking of the victim by the shark was reported in five cases. In 16 cases the skindiver fought back and, in about half of these encounters, the shark departed. Most of the victims were provided with immediate help from other divers in the water or in boats. In 23 cases, including 4 of the 5 attacks on surfboards, the attacks were forceful. The two attacks on boats (Caras 1964; Follett 1974) were forceful (the 14-foot skiff off Bodega Bay rammed and sunk and the 40-ft salmon troller receiving deep gashes in the hull above the water line). In two of the fatal cases, a swimmer (Savino, Appendix II) and a skindiver (Pamperin, Appendix II), the victims were apparently never released and were presumed eaten. The unconfirmed attack on a swimmer (SAF #417, Appendix I) off Dillon Beach (near Tomales Bay) may have also been by a large shark which carried the victim away. The Marin County sheriff's files showed the body was never recovered. Discussions with victims and the surgeons attending some of the victims revealed that in several cases severe damage to major arteries (and, in one case, the backbone) was narrowly missed. Several of the divers were extremely lucky to have survived.

POSSIBLE INCREASE IN WHITE SHARK ABUNDANCE

There appears to be an increased frequency in shark attacks within the past decade from Point Conception northward. The peak years of 1974 and 1975 have been followed by years in which one to three attacks have occurred on humans each year. This trend has continued although fewer divers are frequenting the Farallon Islands (Ainley 1979) and Tomales Point due to the notoriety of these areas as being shark attack localities. The senior author and other fishery biologists believe the population of large sharks in central and northern California is increasing. More frequent reports of sharks sighted and taken by commercial fishermen, sport anglers, and mammalogists confirm this belief. The senior author accompanied partyboat anglers to Año Nuevo Island during the 1958–1964 period. Angler's lines were occasionally harassed by blue sharks but not by white sharks. In recent years partyboat operators have reported they often move several times during a day to avoid white sharks. Partyboat, as well as sport skiff anglers off Año Nuevo Island report that white sharks will attack large lingcod, *Ophiodon elongatus,* when they are caught on hook and line. These large sharks will often surface and circle the boat, especially if fishing stops. Color photographs of the circling fish have confirmed these were at least two different large white sharks.

There have been more white shark attacks on sea otters in recent years (Ames and Morejohn 1980) and Burney LeBoeuf (Univ. of Calif. at Santa Cruz, pers. commun.) reports scarred, shark bitten elephant seals, *Mirounga angustirostris,* are commonly observed at Año Nuevo Island. Ainley (1979) notes that no attacks on pinnipeds were observed at the Farallon Islands from 1968 through 1972, but that from 2 to 12 attacks on pinnipeds, presumably by white sharks,

have been observed each year from 1973 through 1979 (D. Ainley, Point Reyes Bird Observatory, pers. commun.). Whenever it was possible to identify the pinniped being attacked, it was an elephant seal, and usually younger ones. Stomach contents of several large white sharks taken in southern and central California in recent years have contained remains of harbor seals, *Phoca vitulina,* and elephant seals. Elephant seal, harbor seal, and California sea lion, *Zalophus californianus,* populations have increased along the California coastline in the last 20 years, enhancing the food supply of large sharks. Harbor seals have reoccupied the Farallon Islands, with the first reproduction in recent years noted in 1974. Elephant seals first returned to the Farallones in 1959 but it was not until 1973 that the first pupping was observed. The elephant seal population has subsequently increased, with approximately 500 currently utilizing the Farallon Islands (D. Ainley, pers. commun.). Skindivers were attacked for the first time at the Farallones in 1962 and near Año Nuevo Island for the first time in 1974. All but two of the nearly 30 observations of sharks foraging on pinnipeds at the Farallones occurred during the winter, primarily December and January, when elephant seals return to the breeding grounds. The attacks on humans at the Farallones were from September through January, with four of the five attacks taking place from November through January. At nearby Tomales Point and Bodega Bay, attacks occurred during all seasons of the year, with four of the eight attacks occurring during April and May. There is a residential population of over 200 harbor seals in the Tomales-Bodega area.

MOTIVATION OF SHARK ATTACKS

Shark researchers debate the motivation of an attacking shark. Historically, we have assumed an attacking shark was feeding, but Baldridge and Williams (1969) and Johnson and Nelson (1973) report motivations other than feeding which elicit aggressive behavior in certain sharks. Agonistic behavior can be exhibited by posturing, which includes lowering of pectoral fins, arching the body, and swimming in figure-eight and S-patterns in front of the object being intimidated. These postures and displays warn an intruder to not approach further. Johnson and Nelson (1973) and other investigators have noted this behavior between sharks, as well as toward humans when the sharks were partially prevented by the divers from easy access out of a cove or cave in coral reef areas. Aggressive posturing can escalate into actual contact, sometimes a slashing with the upper teeth as has been observed in captive situations (Baldridge and Williams 1969) and in the wild (D. Nelson, Calif. State Univ., Long Beach, pers. commun.), or an outright biting attack.

The revelation that sharks may attack another shark, a human, and possibly a boat for other than foraging purposes has resulted in various interpretations of attack data on humans. Baldridge and Williams (1969) postulated:

> "The possibility is therefore very real that a significant fraction of shark attacks on man may well be the result of aggressive behavior directed at the victims in an attitude of fighting rather than feeding."

They did not present detailed behavioral observations or criteria to differentiate agonistic and feeding patterns and unless the victim was actually eaten or severely wounded in a vicious attack, they apparently did not consider the attack to be feeding behavior: "If hunger motivated this and other similar attacks, then

the shark or sharks involved were certainly highly inefficient feeders." Ellis (1976) has also projected the exceptionally-efficient-predator syndrome to the white shark:

> "The number of survivors of attacks by whites—about two out of three—seems to support the theory that the shark was not trying to eat the victim. . . . The white shark cannot be such an inefficient feeder that its prey, once in its mouth, escape approximately two out of three times."

Baldridge (1974) concludes his analysis of Navy shark attack data: ". . . 50–75 percent of all recorded attacks upon man were motivated by a drive or drives other than feeding." Considering the paucity of ethological information on the key species of sharks responsible for many of the attacks on humans, i.e., white, tiger, bull shark, and mako or salmon shark, *Lamna oxyrinchus,* this conclusion seems premature. This is especially so since Baldridge and Williams (1969) considered that any attack on a non-food item was not a feeding attack:

> "Occasionally a shark will strike a surfboard or at the relatively flat skin of a boat. Surely, in these cases, the shark is not trying to eat the boats."

The implication that "attacks" on non-food items are not feeding behavior can be qualified. Strasburg (1958) relates:

> "Pelagic sharks as a group are opportunistic feeders, commonly taking about any available food, and often ingesting articles of little or no nutritional value."

Some items found in shark stomachs include clothing, purses, and various other inedible items thrown over the side of vessels. There have been six surfboards attacked in California and Oregon and several others elsewhere in the world. Surfboards, about the size of large pinnipeds, silhouetted on the surface and propelled by the surfer's arms and legs, could be interpreted by a shark as something edible. Unlike most of the attacks on skindivers, shark interactions with surfboards have been quite forceful.

Sufficient observations have not been made to define a feeding attack on natural objects in the wild. There have been feeding patterns recorded on some of the larger tropical pelagic sharks. Limbaugh (1963) notes:

> "Two distinct types of feeding behavior were observed in both the Galapagos and whitetip reef sharks. The most common pattern was to simply swim in and take the bait with varying degrees of speed. The other slightly less common method was to nose and/or maul a piece of bait as if they were playing with it. The former behavior was usually observed when more than one shark was in the area. A quick movement of another shark in the area, or even of a startled fish, triggered the behavior."

Springer (1967) relates similar behavior and mentions the buildup of interaction between members of a group of feeding sharks which can evolve into a feeding frenzy:

> "Shark feeding appears to be an automatic process that always starts slowly and gathers momentum if a series of feeding stimuli occur. The solitary shark, predisposed to feed for whatever reasons, moves about investigating the environment, sometimes testing objects by bumping them with its snout. Occasionally, it makes short dashes after prey and, whether successful or not, returns to a leisurely inspection of the area. If another shark of similar size appears, setting up the possibility of competition for food, the bumping of inanimate or slow-moving objects is discontinued and these are taken

into the mouth for testing. When food is found, especially when more than one shark is present, the rate of swimming and attack by all members of the group increases. If the prey is large, and if its struggles produce a commotion in the water, the tempo and ferocity of the attack increase further."

The senior author has observed sharks foraging on small pelagic fishes floating on the surface after fish kills off Baja California. The sharks deliberately circled about, ingesting a few fish at a time, without much frenzy in their actions. Limbaugh (1963) reports similar feeding activity:

"The Galapagos sharks swam slowly to dead or injured fishes, almost stopped, and then bit or swallowed them. If several fish were after the same food, they raced for it, with the largest shark usually winning and the smaller ones taking the pieces. A whitetip reef shark made a quick rush at a fish, bit it in three pieces, and left two of the pieces behind."

These experiences cast doubt about the "efficient predator" concept for sharks. Possibly white sharks are opportunistic feeders as described for other species above and that they may not have a difficult time finding sufficient food along the California coastline with its present large populations of residential pinnipeds and fishes. Springer (1967) postulated:

"If we accept the proposition that sharks with plump livers that contain a high proportion of oil are well fed, we must conclude that sharks usually have little difficulty in finding enough food, despite annual and seasonal fluctuations in supply. . . . Sharks are able to go without food for long periods, . . . It does not greatly affect a shark's well-being to wait for the right conditions for feeding."

Nelson (1969) points out that older sharks become more cautious when approaching an unfamiliar object and will tend to more carefully investigate it. Limbaugh (1963) noted that almost invariably it was the younger sharks in an area that would be first to investigate the divers and approach much closer than larger members present. Thus, a general scenario of large shark feeding behavior appears to be one of cautious approach to items for investigation when by themselves with varying degrees of attack pressure invoked by the type of prey item. In addition to feeding interaction, agonistic behavior can be exhibited to other sharks and objects in its "territory."

Feeding attacks on marine mammals result in escape of some individuals. There are many records of sea otters and pinnipeds escaping an attack, evidenced by the number of these marine mammals observed dead with shark wounds, as well as from observations of living marine mammals with scars from shark attacks. Orr (1959) was first to note the sea otters attacked by white sharks in Carmel Bay. Through 1979, 61 sea otters that have been certain or near certain victims of shark attacks, have been found dead or badly wounded on central California beaches; another 40 sea otters may have been lacerated by sharks (J. Ames, Department of Fish and Game, pers. commun.). Thirteen of the 61 yielded fragments of white shark teeth when necropsied and two others contained tooth fragments too small for identification. The occurrence of various pinnipeds with obvious shark attack scars indicates sharks are not totally successful when attacking fast moving objects. Sharks may *not* be efficient feeders because, in some shark families, a nictitating membrane can cover the eye when the shark nears an object. The white shark does not have this membrane.

However, the junior author noted in the film *Mysteries of the Deep* (by photographers Ron and Valerie Taylor) that, when a white shark neared an object, the eye rolled upwards and slightly backward, exposing a white opaque covering. This covering probably protects the eye in the same manner as the nictitans. Gilbert (1963*b*) considers the function of the nictitans to be protection from abrasion and mechanical injury to the eye. Thus, it could be possible that some sharks are blind in the last stages of an attack and moving objects may be able to escape encounters because of this.

The attack patterns on humans in this study are quite varied. Most of the attacks, especially on skindivers, were a deliberate grasping of a part of the body, usually the legs, and the occasional shaking of the victim. Only three attacks could be considered slashes; the remainder were bites, some of them quite forceful. We reached the general conclusion that most of the attacks resemble the feeding behavior of an isolated, large shark that appears to be investigating an object. In most cases the shark left, but in 32% of the encounters, the shark continued the attack until the victim escaped on a board, onto a boat, or through the surf onto the beach. Schultz (1967) reported that 94% of the unprovoked attacks in his world-wide analysis were by solitary sharks. All the attacks north of Pt. Conception were by solitary sharks (at least no other sharks were seen in the area at the time) and in southern California one attack by a blue shark occurred when a diver approached a feeding frenzy of about 15 blue sharks, with one of the sharks coming to the diver, biting his arm, then leaving when struck. All other attacks in southern California were by solitary sharks. In only one case, the hammerhead attack off La Jolla, did a shark exhibit an agonistic display at the diver. After biting the victim's thigh and then retreating after being warded off, the shark made several figure-eight patterns in front of the diver, then left.

It is little consolation to a skindiver or swimmer whether a shark encounter is investigatory, feeding, or "fighting." Many of the initial attacks we report resulted in major injuries and damage to the victims or their equipment. It would be dangerous for divers to think that if the shark is merely attempting to drive the intruder out of its "territory," there is less danger. Divers might then be tempted to swim in shark infested areas when they would not otherwise do so if they felt a shark was going to attack for feeding. Our survey demonstrates clearly that any attacking shark can be highly dangerous regardless of its supposed motivation.

SUMMARY

1. There have been 47 unprovoked shark attacks in California and Oregon since 1926. Skindivers comprised the largest group, with 26 attacks (55% of the total), followed by 11 attacks on swimmers, 6 attacks on surfboarders, and 4 on commercial abalone divers. The two attacks in Oregon were on surfboarders.
2. There appears to be a division of shark attack areas off California. Shark attacks in the area south of Point Conception and San Miguel Island were typified by shark species which are tolerant of warmer water. The attacks occurred rarely (7 out of the 47 total). Most have occurred during periods of abnormally warm water. Possibly all the attacks north of Point Concep-

tion were by white sharks; attacks occurred during all months of the year. Of the 40 attacks in this area, 21 were by white sharks, 12 presumably by white sharks, and 7 by unidentified species.

3. A number of shark attacks in southern California may have involved the Pacific angel shark; however, species identification was unconfirmed or doubtful.
4. Shark attacks appear to be increasing in the cold-temperate area north of Point Conception, with the highest numbers occurring in 1974 and 1975. It is possible that this increase could be associated with the increase in pinniped populations along the coast over the past 20 years. The elephant seal, which is a favored food item of the white shark, has increased dramatically during this period.
5. Data from attacks on skindivers were compared with skindiving effort and catch from two surveys conducted by the Department of Fish and Game in 1960 and 1972. There was a close relationship between the number of skindivers in the water in SSH and WD strata and the number of shark attacks in these strata; however, there was no positive correlation between the number of annual diving days expended by county and the number of shark attacks by county. Shark attacks have occurred repeatedly only in certain areas (the Bodega Bay-Tomales Point area, the Farallon Islands, near Año Nuevo Island, at Pt. Sur, and Pt. Conception). The mean number of attacks from Año Nuevo Island to Bodega Bay was 0.20 attacks/linear mile, compared with 0.02/linear mile for the remainder of California.
6. With skindivers, there was no strong correlation with the presence of speared fish (only 4 of the 26 skindivers attacked had speared fish); most of the skindiver attacks occurred on abalone divers. Nearly 80% of all attacks were at the surface. There were no attacks within *Macrocystis* kelp beds.
7. There was no correlation with depth; attacks occurred over bottom depths ranging from 3 to 120 ft. In southern California attacks occurred in temperatures of 60°F or greater. Attacks in central and northern California occurred in temperatures at 60°F or less.
8. There was a highly significant number of attacks in very clear water, especially by white sharks.
9. No attacks occurred during nighttime; attacks during daytime ranged from 0710 to 1830, with a slight mid-afternoon peak. Even though attacks occurred during every month of the year, a majority occurred during the July to September period.
10. Only eight of the victims observed the shark before being attacked; and only three attacks were frontal attacks. Sixty-five percent of the wounds were considered major. There were four fatalities: three swimmers and one skindiver.
11. The belief that large white sharks are extremely efficient predators has not been substantiated by our data. The escape of large numbers of marine mammals indicates large sharks may not be able to capture all fast moving prey they attack.

12. Hopefully, divers will not think that some shark attacks may be agonistic territorial behavior rather than feeding behavior and thus feel they are safer in shark infested areas. This survey demonstrates that any attack, regardless of motivation, can be highly dangerous.

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APPENDIX I. Unconfirmed, Provoked, Special case, and Drowning Victim Shark Attacks in California. (An "*" placed before the name denotes the attack was listed as unprovoked by Schultz and Malin (1963).

Unconfirmed Attacks

*"man." SAF #234; 27 May 1952; Coronado Strand, San Diego Co. This attack was reported in Coppleson (1958). The only information available is: "Swimmer struck on foot by shark . . . not seriously injured."

*"man." SAF #849; 30 August 1955; Venice Beach, Los Angeles Co. This is a hearsay report by a lifeguard in a newspaper article. There was no interview of the victim or witness of the attack on the swimmer. The injuries were "minor."

*"girl." SAF #435; 1950's; Capistrano, Orange Co. A fisherman was quoted by a lifeguard in a newspaper article that an attack "took place here several years ago."

W. Davis. SAF #1709; 5 July 1972; Laguna Beach, Orange Co. Davis could not be reached for confirmation of the attack. The SAF report quoted the skindiver: ". . . saw two small sharks (2–3 ft) cruising towards me. Before I could get out of the water they started attacking my fins and legs. I speared one of them and made the I.D." There was no indication that the victim was actually bitten by what he identified as leopard sharks.

M. Caldwell. 4 October 1975; Seal Beach, Orange Co. This was one of two attacks (see Mullimax below) on two surfers at this spot within a few minutes of each other. The victims could not be reached for confirmation. Caldwell received a deep laceration on the leg. A lifeguard guessed the attack was by a barracuda but the surfer thought it might have been a stingray.

J. Mullimax. 4 October 1975; Seal Beach, Orange Co. The surfer received one laceration which he thought was probably from a shark. The attacking animal was not seen.

M. Balldean. 3 September 1978; Santa Barbara, Santa Barbara Co. This swimmer was bitten in 3 ft of water on a sandy beach. The attacking animal was not seen but shook the victim's leg before letting go. The victim could not be reached for confirmation. Injury was minor.

Provoked Attacks

*C. Leeper. SAF #239; 21 September 1954; La Jolla, San Diego Co. Quoting from Coppleson (1958): "Shark brushed against leg. When it came near again he grabbed it and brought it ashore . . . "Five-foot sand shark." There is no evidence that the swimmer was actually bitten, and if so it would be considered provoked.

*R. Yeargin. SAF #242; 8 May 1955; Malibu Beach, Los Angeles Co. Only information is: "Hit a 6 ft shark on nose . . . right forearm injured slightly." There is no evidence that the skindiver was actually bitten.

*D. Strand and two other lifeguards. SAF #244; 30 August 1955; Zuma Beach, Los Angeles Co. An investigation by Gene Helfman revealed the following: ". . . a lifeguard went out on a surfboard . . . when he got out in the water he found a thresher shark which he grabbed by the tail. The shark turned around and bit him." Two other lifeguards got into the act and were bitten while bringing the shark to the beach, where it was killed.

*K. Harris. SAF #1059; 29 August 1962; Solana Beach, San Diego Co. Report in the SAF file states: ". . . he struck the shark with his pry bar to scare it away from an abalone bed . . . turned and bit Harris and hung on." This was a horn shark (*Heterodontus francisci*); known to be aggressive when hit or grabbed.

Special Case Attack

*J. Adams. SAF #1030; 10 February 1955; Trinidad Bay, Humboldt Co. This was a skindiver with a bleeding nose. A leopard shark bumped the diver on the side of the face and was warded off when it approached again. There was no bite.

Drowning Victims

*A. and B. Wilkes. SAF #967; 27 July 1935; Santa Barbara, Santa Barbara Co. These were drowning victims from a boat accident. The bodies were mutilated by sharks but there is no way of knowing whether the attacks occurred before or after the victims had drowned.

C. Jahne. SAF #417; @ 1955; Drakes Bay, Marin Co. This was a drowning victim whose body was attacked by two sharks when being towed to shore. The story was related by a deputy sheriff to a reporter when investigating the drowning of McNeil (see below). This attack was reported by the deputy to have taken place "several years ago."

T. McNeil. SAF #417; 13 June 1959; Dillon Beach, Marin Co. The swimmer disappeared after diving into a deep hole inside the main surfline. The body was never recovered after extensive search.

M. Samut. SAF #1930; 25 April 1965; Pacifica, San Mateo Co. this was a surfer who drowned and his body was never recovered. Sharks were sighted in the area later that day.

APPENDIX II. Confirmed, Unprovoked Shark Attacks on Humans in California and Oregon.

N. Peixotto. SAF #215; 8 July 1926; San Leandro Bay, Alameda Co.; lat 37°44'N, long 122°15'W. The swimmer and his dog were swimming off Bay Farm Island when a 5 ft shark first attacked the dog, then the swimmer. Injuries were serious and the victim was rescued with help from a boat launched from shore.

R. Campbell. SAF #733; 8 October 1950 at 1200; Imperial Beach, San Diego Co.; lat 32°34.0'N, long 117°08.0'W. Victim was one of four swimmers (body surfing) treading water in 12 ft of water. Shark bit victim on leg then attacked a second time from in front. Victim kicked at shark on second attack and was apparently bitten on thigh; wounds were major. Aid to victim was immediate; a nearby lifeguard placed the victim on his board and brought him ashore. The shark was reported to be "large."

Navy Diver. SAF #722; November 1952 at 1000; Imperial Beach, San Diego Co.; lat 32°34.7'N, long 117°08.4'W. This was one of 24 demolition team divers swimming towards shore on the surface in 100 ft depth. A reported 4.5 ft blue shark bit diver's flipper and foot from below and behind. The shark remained in area. The diver grabbed his knife and, along with a diving buddy, went toward the shark. There was no second attack. Wounds were minor.

B. Wilson. SAF #236; 7 December 1952 at 1400; Pacific Grove, Monterey Co.; lat 36°37.6'N, long 121°54.8'W. The body surfer was treading water in 20–30 ft depth when a large white shark attacked from below then attacked a second time from in front. The victim was pulled below the water by the shark then was attacked again as the rescuers were towing victim to shore. Wounds were major and fatal.

P. Jacobs. SAF #240; 6 February 1955 at 0900; Pacific Grove, Monterey Co.; lat 36°37.6'N, long 121°54.8'W. Skindiver was on the surface in 20 ft depth when a white shark attacked from behind, resulting in minor wounds to a foot and loss of a flipper and sock from the other foot. Victim had speared a cabezon and was swimming slowly on the surface. The shark did not return.

E. Vaughters. SAF #243; 4 September 1955; Venice Breakwater, Los Angeles Co.; lat 33°57.6'N, long 118°27.4'W. The swimmer was attacked in 4–6 ft depths. There is no description of the shark which bit his foot while he was moving on the surface. Wounds were minor.

D. Clark. SAF #246; 14 August 1956 at 1630; Pismo Beach, San Luis Obispo Co.; lat 35°08.3'N, long 120°38.6'W. The 10-yr old swimmer was in 3 ft depth when a large shark attacked from the side, resulting in wounds on thigh, side, and hand. Victim was rescued by girl nearby on a rubber raft and brought to shore. The shark was reported to be large, about "nine feet."

P. Savino. SAF #249; 28 April 1957; Morro Bay, San Luis Obispo Co.; lat 35°22.5'N, long 120°51.6'W. The tired swimmer was being aided through the surf by a swimming companion when he revealed that something hit him. After seeing the victim hold up an injured arm, the companion lost sight of him. The body was not recovered.

J. Allman. SAF #845; 12 October 1958; Coronado Strand, San Diego Co.; lat 32°41.1'N, long 117°13.0'W. The swimmer was near the jetty in 6 ft of water when bitten on his left arm, hips, and leg. The victim was helped to shore by a companion. There is no description of the shark.

A. Kogler, Jr. SAF #372; 7 May 1959 at 1745; Baker Beach, San Francisco Co.; lat 37°48.0'N, long 122°28.6'W. The swimmer and his girlfriend were swimming parallel to the shore outside the surfline when a white shark struck the victim's shoulder and chest area pulling him under the water. His companion brought him to shore; attack was fatal.

R. Pamperin. SAF #376; 14 January 1959 at 1710; La Jolla, San Diego Co.; lat 32°51.2'N, long 117°16.0'W. The abalone freediver was swimming at the surface in 30 ft of water when a large shark, most probably a tiger shark, grabbed the victim from behind or lower side. The initial (probably only) attack raised the victim partly out of the water; the shark then submerged and was seen with victim held between the jaws. The body was not recovered.

V. Fleet. SAF #434; 28 July 1959 at 1830; La Jolla, San Diego Co.; lat 32°51.2'N, long 117°16.1'W. The freediving spearfisherman was swimming on the surface in 30–40 ft depths when attacked by a small hammerhead shark. The shark attacked the victim's left thigh, resulting in minor bites. The diver had speared a barracuda which was attached to his right side. After the initial contact the shark made three figure eight patterns in front of the diver, then left.

J. Hay. SAF #554; 4 October 1959 at 1500; Bodega Rock, Sonoma Co.; lat 38°17.7'N, long 123°02.8'W. The abalone freediver was swimming on the surface in 15 ft depth when a white shark bit the diver's swimfin and pulled the diver under the water. After shaking the victim's flipper, the shark released its hold and swam away. The diver's foot was not cut.

D. Fryling. SAF #620; 10 November 1959 at 1330; Malibu, Los Angeles Co.; lat 34°01.4'N, long 118°47.0'W. The lobster freediver was swimming on the surface in 40 ft depth when he approached a feeding frenzy of about 15 blue sharks. He attempted to swim toward shore but one of the sharks was in the way and bit the victim on the arm. The victim grabbed the shark by the snout and pried the jaws open.

F. Gilbert. SAF #683; 24 April 1960 at 1400; Tomales Point, Marin Co.; lat 38°13.7'N, long 122°59.5'W. The abalone freediver was lying on the surface kicking lightly in 18 ft depth when a white shark attacked from behind, biting the victim's foot and swim fin. The victim boarded his rubber float and went to the skiff. The wounds were minor; the swim fin was lost.

S. Theriot. SAF #686; 19 May 1960 at 1300; Aptos, Santa Cruz Co.; lat 36°57.9'N, long 121°53.9'W. The girl swimmer was one of four students swimming in 8 ft depth on a sandy beach. The victim was circled by a large shark, probably a white shark, then bit on the leg. Two nearby companions on a large inner tube and a fourth swimmer brought the victim to shore. Injury resulted in loss of leg below knee.

R. Orr. 21 May 1961 at 0930; Tomales Point, Marin Co.; lat 38°14.7'N, long 122°59.3'W. The abalone freediver was attacked near the bottom in 25 ft depth. The victim saw the shark coming slowly toward him. The shark picked up speed and hooked the diver's suit from behind. Victim then came to surface and got on his inner tube; the diver's skin was not cut.

D. Vogensen. SAF #917; 20 August 1961 at 1530; Salmon Creek, Sonoma Co.; lat 38°21.3'N, long 123°04.1'W. The swimmer was waiting for a wave to ride when he saw a large form approach him. The shark circled then bit victim in groin and on foot. Injuries to the foot were major; the shark was presumed to be a white.

F. Pair, Jr. SAF #1001; 14 January 1962 at 1030; Farallon Islands, lat 37°42.1'N, long 123°00.5'W. The scuba diver was spearfishing (no fish had been speared by the victim) in 30 ft depth with about 20 other divers. A companion observed the large shark heading toward the victim who was on the surface, but the victim did not see the shark until it had bitten his leg from behind. The shark remained in the area to attack again but was fought by the victim who thrust his spear at the shark's snout. Leg wounds were major.

L. French. SAF #1115; 11 November 1962 at 1345; Farallon Islands, lat 37°43.4'N, long 123°02.3'W. The scuba diver had just reached the surface when a white shark (tentative identification) bit the victim in the thigh and leg area, shook him, and dragged him below the surface. The victim then fought back with his speargun and the shark swam away. Injuries were major.

J. Rochette. SAF #1247; 11 January 1964 at 1200; Farallon Islands; lat 37°41.5'N, long 123°00.0'W. The scuba diver had speared a rockfish and had just reached the surface in 50 ft depth when a white shark bit the victim's thigh and legs. The shark continued to attack for several minutes while being hit in the snout at least nine times by the victim. Injuries were major. Prior to the attack, one of the victim's companions was harassed by the shark. After the attack two other scuba divers were visited by the shark on the bottom but it left when they remained in a cavelike area.

D. Barthman. SAF 1398; 22 January 1966 at 1000; Cypress Point, Monterey Co.; lat 36°35.0'N, long 121°58.7'W. The freediver spearfisherman (had not speared fish) was resting on the surface in 60–65 ft depth when a shark bit the diver's arm, then attacked his thigh and shook the victim. The victim struck at the shark with his speargun and it departed after the second attack. Injuries were major. The victim thought it could have been a blue shark, but the wounds indicated a small white shark.

F. Logan. SAF #1569; 27 July 1968 at 1100; Bodega Rock, Sonoma Co.; lat 38°17.7'N, long 123°02.8'W. The abalone freediver was attacked by a white shark near the bottom in 20 ft depth. The attack was from the side, with the shark holding the victim's torso between its jaws and shaking. The pressure was intense and prevented the victim from moving. The weight belt was severed and presumed to be swallowed by the shark. After the prolonged bite the shark departed. Injuries were major.

R. Colby. 20 July 1969 at 1300; Pigeon Point, San Mateo Co., lat 37°10.8'N, long 122°23.6'W. The abalone freediver was resting on the surface when a large shark (thought to be a white shark) bit the victim's foot and partially dragged the diver under. A companion saw the shark just before the attack. The first newspaper accounts reported this as a killer whale attack, but examination of the boot revealed razor-like cuts made by a large shark. Injuries were minor.

D. Joslin. SAF #1647; 6 September 1969 at 1120; Tomales Point, Marin Co.; lat 38°14.5'N, long 122°59.7'W. The abalone freediver was nearing the surface in 25 ft depth when a large shark (presumably a white shark) bit the victim's leg and raised his body almost out of the water. The shark returned to attack again and the victim hit the snout area with an abalone iron; the shark departed. Injuries were major.

C. Ward. 2 October 1971 at 1200; Sea Ranch, Sonoma Co.; lat 38°42.1'N, long 123°27.0'W. The scuba diver was observing along the bottom in 15 ft depth when a large shark grasped both legs of the victim in its mouth, released them, and then departed. Cuts were deep on one of the legs.

H. Himmrich. SAF #1474; 28 May 1972 at 1430; Tomales Point, Marin Co.; lat 38°13.7'N, long 122°59.5'W. The abalone freediver was attacked while lying face down on the surface in 15 ft depth. The white shark seized the right thigh area, shook the victim, then released its grip. The victim was pulled immediately into a skiff; the injuries were major.

K. Gray. 19 July 1972; Pt. Purisima, Santa Barbara Co.; 34°45.0'N, long 120°38.5'W. The commercial abalone fisherman using hookah gear was pinned on the bottom in 20 ft depth by a large shark (probably a white shark). The shark made several attacks before the diver could be pulled to the surface by the boat tender. Injuries were major.

H. Kretschmer. 9 September 1972 at 1000; Point Sur, Monterey Co.; 36°18.0'N, long 121°59.0'W. The surfboarder was resting on his board in about 30 ft depth when a white shark attacked, destroying the board and resulting in major damage to one of the surfer's legs. The victim saw the shark approaching on the surface before the attack. This attack was reported to be by a killer whale but tooth marks in the neoprene suit proved this attack was by a large white shark.

L. Hancock. 26 May 1974 at 1130; Tomales Point, Marin Co.; lat 38°13.0'N, long 122°59.6'W. The abalone freediver was attacked on the surface in 10 ft depth immediately after jumping into the water. The white shark

bit his leg and the diver immediately grabbed the shark in both arms. The shark then broke free and remained in the area between the victim and the boat until the diver could be reached and brought aboard. Hospital treatment of wounds was necessary.

R. Kehl. SAF #1725; 26 July 1974; Albion, Mendocino Co.; lat 39°13.7'N, long 123°47.1'W. The abalone freediver was descending when attacked at 20–30 ft in 40–50 ft depth by a white shark. The shark swirled in front of the victim, who struck its gill area with an abalone iron. The shark left. The diver's foot was slashed, resulting in minor injuries.

R. Sanders. 5 August 1974; San Gregorio Beach, San Mateo Co.; lat 37°19.1'N, long 122°24.5'W. The surfboarder was lying on his board outside the surf when he observed a large shark heading toward him on the surface. The victim slid off the board but the shark slashed his hand. The shark held the surfboard, submerged with it, and upon releasing it, the board flew into the air. Injuries to the victim were minor.

D. Webster. SAF #1726; 2 September 1974 at 1730; Franklin Point, San Mateo Co.; lat 37°09.0'N, long 122°21.5'W. Three scuba divers, Webster, Greenlaw (see below) and a third party were swimming on the surface toward shore in 30–40 ft depth when a large shark (probably a white shark) bit Webster on the foot and flipper then surfaced between the three divers. The shark came slowly to Greenlaw and slashed his hand when passing by. Injuries to both divers were minor.

J. Greenlaw. SAF #1726; 2 September 1974 at 1730. (see Webster above).

J. Holcomb. SAF #1727; 14 September 1974 at 1335; Farallon Islands, lat 37°45.8'N, long 123°05.8'W. The commercial abalone diver using hookah gear was attacked by a white shark near the bottom, which was 25–35 ft in depth. The initial attack was from the side, followed by another attempt to bite as the diver resisted by grabbing and hitting at the snout and mouth area. Injuries were major.

K. Johnston. 28 September 1974 at 0720; Point Sur, Monterey Co.; lat 36°18.0'N, long 121°54.5'W. The surfboarder was sitting on his board in about 9–10 ft depth when a white shark attacked from the side, injuring the victim's thigh and lower abdomen and damaging the surfboard. Injuries were major.

G. Johnson. 19 July 1975 at 1330; Point Conception, Santa Barbara Co; lat 34°26.6'N, long 120°28.5'W. The commercial abalone diver using hookah gear was attacked by a large shark (probably a white shark) on the bottom in 25–30 ft depth. The shark made five additional passes before the tender pulled the diver to the surface. A flipper was bitten; the diver's skin was not cut.

R. Rebstock. SAF #1739; 23 July 1975 at 1430; Point Conception, Santa Barbara Co.; lat 34°26.6'N, long 120°28.5'W. The scuba diver went to the same location as G. Johnson above and was attacked by a white shark on the surface shortly after jumping into the water. The diver was going to dive for abalone. The attack was a forceful upward thrust, knocking the diver out of the water. Injuries were major.

G. Brown. 9 August 1975 at 1330; Usal Creek, Mendocino Co.; lat 39°50.0'N, long 124°44.9'W. The abalone freediver was working out of a skiff with other divers. The attack by a white shark occurred when surfacing in 25–30 ft depth. The shark bit the victim's arm and the diver hit the shark in the belly area with his abalone iron; there was no second attack. Injuries were major.

R. Buckley. SAF #1745; 6 December 1975 at 1200; Farallon Islands; lat 37°42.1'N, long 123°00.5'W. The spearfishing scuba diver, who had speared a lingcod, was attacked at about middepth in 40 ft depth by a white shark. The victim observed the attacking shark before contact and received a bite on one leg after the victim had dropped the spear with the fish. The victim did not resist and the shark departed after the initial attack. Injuries were major.

M. Shook. 24 August 1976 at 1400; Coos Bay, Oregon; lat 43°21'N, long 124°21'W. The surfboarder was lying on the board attempting to catch a wave in 8 ft depth and noted a "bump" on the rear of the board. A few moments later there was a more forceful bump and the surfboarder looked back to see a large shark with the rear portion of his board in its mouth. The white shark pushed the board and diver along the surface and finally broke the end section off. The surfer then swam to the jetty with the broken section still tied to his foot. The surfer was not bitten.

W. Kennedy. 18 October 1976 at 1230; Moonstone Beach, Humboldt Co.; lat 41°02.5'N, long 124°07.5'W. The surfboarder was bitten on the leg by a white shark in 8–10 ft depth. Injuries were minor. (Information from newspaper report and unpublished data supplied by Ron Warner, Department of Fish and Game, Eureka, and Ralph Collier).

J. Worrell. 18 December 1976 at 0900; San Miguel Island; lat 34°04.3'N, long 120°22.6'W. The commercial abalone diver using hookah gear was attacked by a white shark when 15–20 ft under the surface in 35–40 ft depth. The attack was from behind, with the shark seizing the leg and buttock area. The air hose was severed, which apparently startled the shark; it swirled in front of the diver. The victim then hit the shark with his abalone iron and the shark swam away. Injuries were major.

G. Friedman. 14 August 1977 at 1300; Tomales Point, Marin Co.; lat 38°11.5'N, long 122°57.8'W. The abalone freediver was nearing the surface in 35 ft depth when a white shark seized the victim's leg. Injuries were major.

P. Dunah. 5 August 1978 at 1230; Pajaro Dunes, Santa Cruz Co.; lat 36°51.8'N, long 122°49.2'W. The swimmer was wading in 5 ft depth in the surf when he felt a tug on his leg. The minor lacerations on both sides of leg indicate a small shark.

C. Sloan. 11 March 1979 at 1000; Año Nuevo Island, San Mateo Co.; lat 37°06.3'N, long 122°20.0'W. The scuba diver was observing about 20 ft below the surface in 30 ft depth when a white shark seized a flipper and spun him around. The shark then surfaced near the anchored skiff, then left. The diver's skin was not cut.

K. Doudt. 26 November 1979 at 1030; Cannon Beach, Oregon; lat 45°50.3'N, long 123°58.3'W. The surfboarder was attacked by a white shark in 8 ft depth while lying on the board. The attack was forceful, with major injuries to the victim. There were repeated attacks on the board and victim.

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