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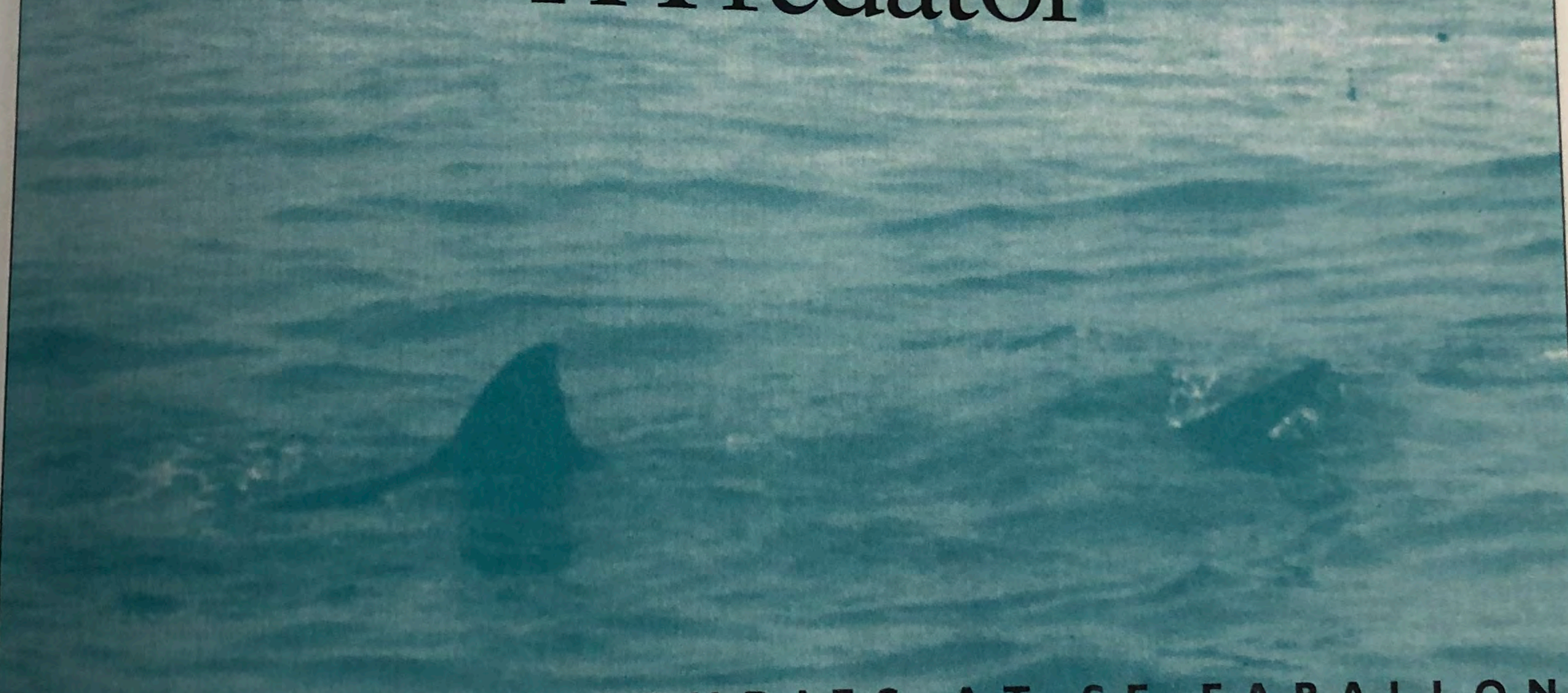
Observer

THRESHOLDS, P 4

Palomarin Match! p 5

Sympathy For A Predator



WHITE SHARK STUDIES AT SE FARALLON

Peter Pyle

RARELY THESE DAYS does raw primal fear completely control our neural circuitry. It has happened to me but once: upon my first close encounter with a great white shark. Just off Southeast Farallon Island in the fall of 1985, I was performing a routine "boat-day," the weekly operation during which we transfer supplies and personnel from a supply boat to the island via our 11-foot Boston Whaler and a crane that swings over a leeward gulch. I had just hooked up a box of provisions in the Whaler when I noticed, about 20 feet away, the shark's distinctive dorsal and tail fins meandering in my general direction. Although it was a "small" white shark — an estimated 12 feet long — I was stricken with panic and recklessly retreated as close to shore as the surge and rocks would allow. I finished the landing by darting out from the depths of the gulch until, at last, the crane lifted the Whaler and my unsettled self to safety on the island. Nothing before or since has evoked in me such aboriginal fear as did the sight of those swaggering fins.

It was thus with some hesitation that, four years later, I considered Scot Anderson's request that we go out in the Whaler to observe a 16-foot white shark eating an immature elephant seal. As part of PRBO's ongoing research on white sharks, Scot had just witnessed the attack on the seal from the lighthouse atop the island. As is often the case, the shark had temporarily left its quarry drifting on the surface before returning to consume it. It was a calm, cloudy day in early October 1989, the type of day when the surrounding ocean is full of magic and the island comes to life. Though my fear of white sharks remained intact — I had briefly met them twice off the landing since that first encounter — the calm seas, a growing understanding of the shark's feeding behavior, and a sense of adventure became our deciding factors to go.

As our Whaler is lowered upon the sea, that sense of foreboding begins to consume me. Somewhere under the mirrored surface prowls a dispassionate hunter significantly

SCOT ANDERSON

LACK OF KNOWLEDGE, ACCOMPANIED BY PRIMAL FEAR, HAS HELPED PROMOTE A UNIVERSAL LACK OF COMPASSION FOR SHARKS.

larger than our boat. How will it react to our approach? Will we frighten it off, or will it consider us a rival to be challenged? We approach the carcass and make a quick discerning pass. The six-foot seal is half decapitated, with impressive parallel gashes extending across its neck and chest. Our sense of vulnerability heightened, we retreat from the scene and await the shark's return. Although the ocean is eerily still, my mood becomes surprisingly detached. Have nine white shark seasons made me impervious to their presence, or am I just losing my mind? While admiring the island's austere silhouette, I contemplate the steady progress we are making in understanding this infamous but misrepresented predator.

AS PART OF A COOPERATIVE agreement with the U.S. Fish and Wildlife Service, PRBO has provided personnel and conducted research on Southeast Farallon Island (SEFI — part of the Farallon National Wildlife Refuge) every day since April 1968. On September 9, 1970, PRBO biologists witnessed their first white shark attack; the victim was a Steller's sea lion. Fifteen years of opportunistic observation ensued, during which time we logged nearly 100 predatory events and published three scientific papers. We learned that shark activity at SEFI corresponds to that of its preferred prey, the immature northern elephant seal. About 20% of the attacks involved California sea lions, and bite scars were also noted among the smaller numbers of Steller's sea lions and harbor seals that take refuge on SEFI. Numerous shark bites also pocked the carcass of an adult male Orca that washed up on the island in 1972. Both the size of individual sharks and the number of attacks we witnessed increased through the 1970s and early 1980s, perhaps in response to an expanding elephant seal population during this period; strong peaks of both shark activity and numbers of immature elephant seals occur in the fall (Figure 1).

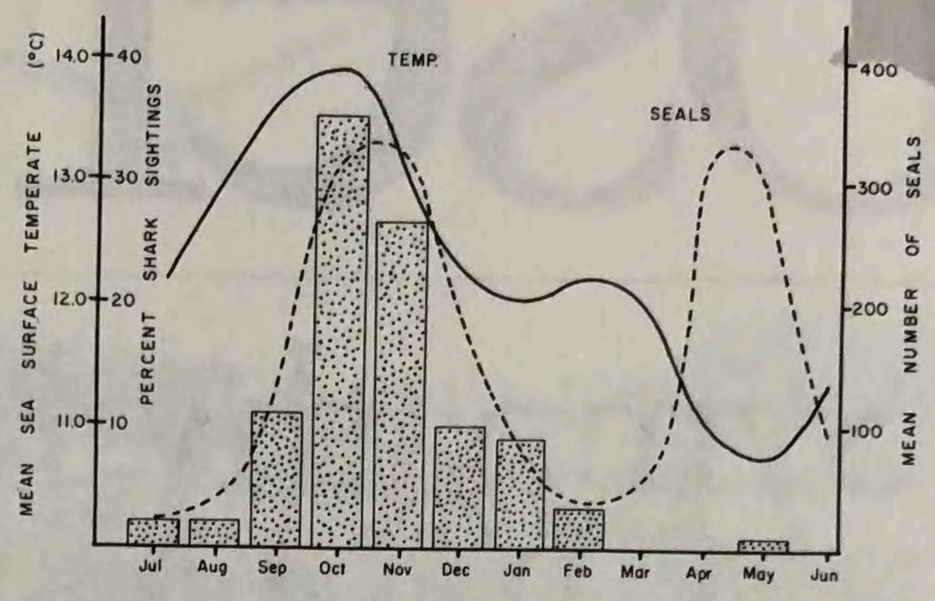
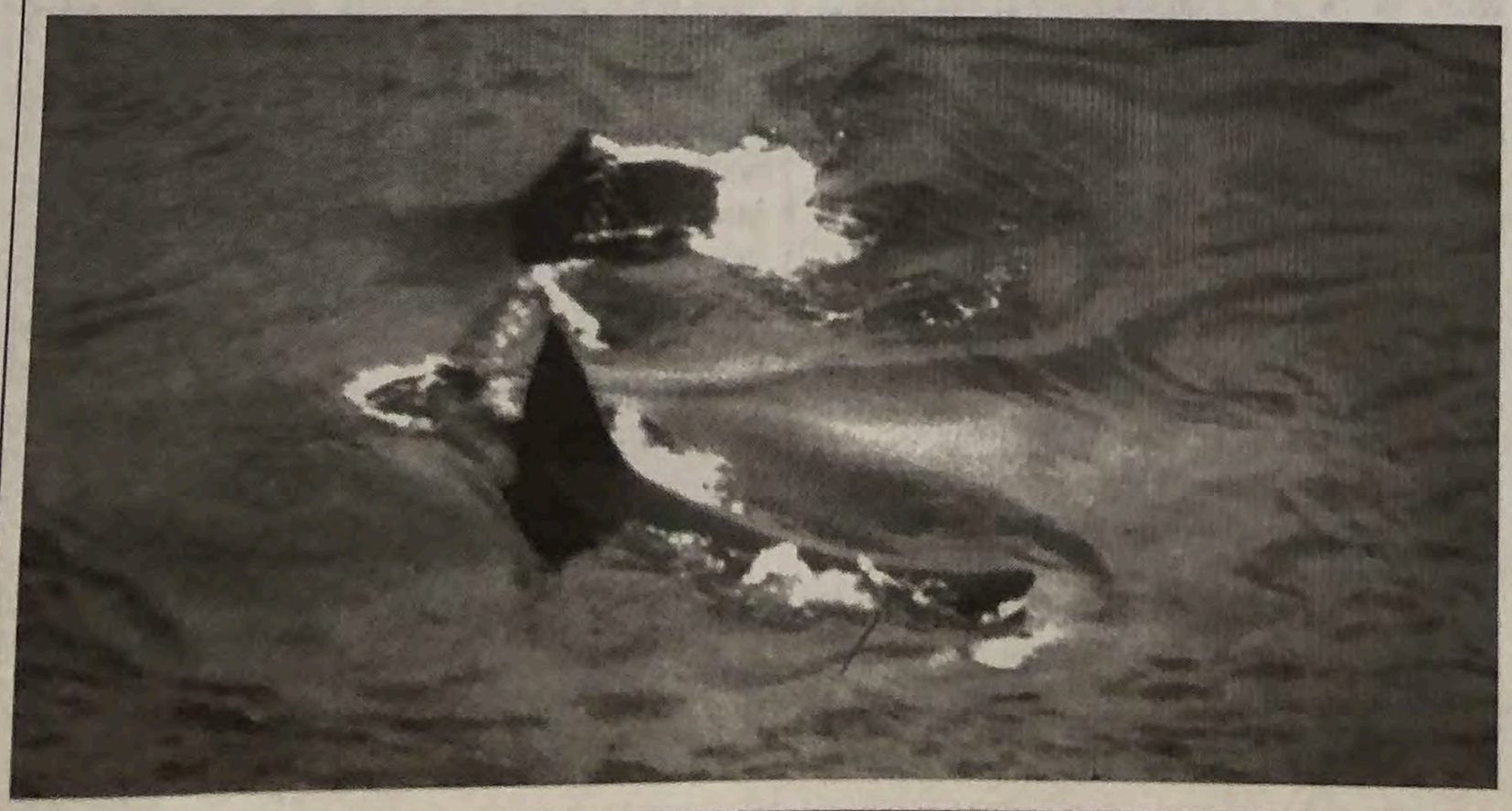


Figure 1. White sharks at Southeast Farallon, 1971-72 to 1982-83. The columns show the proportion of shark sightings by month, the solid line shows mean monthly sea surface temperature (in °C), and the dashed line the mean monthly number of subadult elephant seals present. Reprinted from D. G. Ainley et. al. *In Biology of the White Shark*, S. Calif. Acad. of Sciences, 1985.

White shark strikes a pinniped near Southeast Farallon, its snout raised as it rotates its upper jaw and protect its upper teeth.



SCOT ANDERSON

Despite the white shark's public notoriety, little is known of its natural history. Except for our studies, almost all scientific knowledge has been derived from specimens, attacks on humans, or sharks baited with blood and large hunks of meat. Specimens of juveniles suggest that pups are about four feet in length when born. As revealed by stomach samples, white sharks prey on fish and benthic organisms until they reach 10-12 feet in length (at an unknown age), at which time their prey switches to marine mammals, including pinnipeds, sea otters, dolphins, and whale carcasses. To accommodate this dietary shift, the shape of the white shark's teeth changes from narrow and pointed to broad and knife-edged, the latter form enabling the shark to remove blocks of meat through the outward and downward rotation of its upper jaws. Although lengths of 25+ feet have been reported, the largest documented white shark was a 21-foot specimen captured near Cuba in 1945.

Typical of apex predators (those at the top of the food web), the white shark is rare, with local concentrations restricted to temperate areas inhabited by pinnipeds. Most of the worldwide adult population occurs off northeastern and western North America, South Africa, Japan, and southern Australia. Along the Pacific North American coast, juvenile specimens have been found only south of Point Conception, suggesting that pupping grounds are located primarily off southern and Baja California. But surprisingly, no pregnant females have been found here, and virtually nothing is known about such integral aspects of white shark natural history as population size, longevity, age at reproductive maturity, and migratory habits. This lack of knowledge, accompanied by primal fear, has helped promote a universal lack of compassion for sharks.

The PRBO Shark Team

REALIZING OUR UNIQUE opportunity to study the white shark in its natural setting, PRBO intensified its research on SEFI with the formation of a "shark

WHAT DEFINES THE OPTIMAL DEPTH AND TOPOGRAPHIC BOTTOM FEATURES FROM WHICH WHITE SHARKS STALK THEIR PREY?

team" — Farallon biologists David Ainley, Phil Henderson, and I, joined by shark biologist Peter Klimley of Bodega Marine Lab and Scot Anderson, a regular island volunteer since 1987. We began in the fall of 1985, with a program aimed at tracking long- and short-term movement patterns of Farallon white sharks by attaching directional transponders to the dorsal fins of baited animals. Day after day, Peter Klimley resolutely transferred blood and sheep carcasses from our 12-foot Zodiac inflatable to his 22-foot research dory and then set the bait in likely spots. Initially we discovered that the sharks were not as interested in the bait and blood as they were in live swimming animals. Several times while Peter and his helpers were attempting to coax sharks to the surface, island biologists saw natural attacks within 500 feet of the bait. Late in the season Peter successfully attached a transponder to a 14-foot female, but just as he was tuning his receiver to it, an 18-foot shark known to us as "The Cadillac" (due to its size and wide girth) paid a brief portentous visit to the dory. The tagged female quickly departed the island, and we never heard the transponder again. We then found our Zodiac, tied to a buoy, bitten and partially sunk by a white shark. Subsequent measurements of the bite indicated that an 18- to 20-foot animal, perhaps "The Cadillac," was responsible. We were rapidly discovering why more is not known about white sharks.

Successful ecological inquiry requires a healthy combination of focused technical research and ample field observation. Turning our attention to the latter, we standardized and expanded our observation program in 1987 by stationing one to two observers at the lighthouse during all daylight hours in fall, specifically to search for shark activity. Initiated by Scot Anderson, the shark watch has now produced five years of fall surveillance, during which time we have witnessed 40-60 predatory events per year. Standardizing our observations will enable us to compare the occurrence of attacks with oceanic conditions, such as temperature, salinity, and water clarity, which vary widely in the vicinity of the Farallones. Preliminary analyses suggest, for example, that attack frequency increases with colder sea surface temperatures in fall, disputing the general belief that warmer waters (such as those associated with El Niño) bring more sharks into our region. Our findings also suggest that white shark attacks are positively correlated with water turbidity: perhaps the lack of visibility impairs the ability of pinnipeds to detect and escape the sharks. One or both of these correlations may be coincidental, however, as both colder water and higher turbidity result from coastal upwelling. We will soon perform multivariate analyses to see which oceanic conditions have the greatest effect on shark behavior.

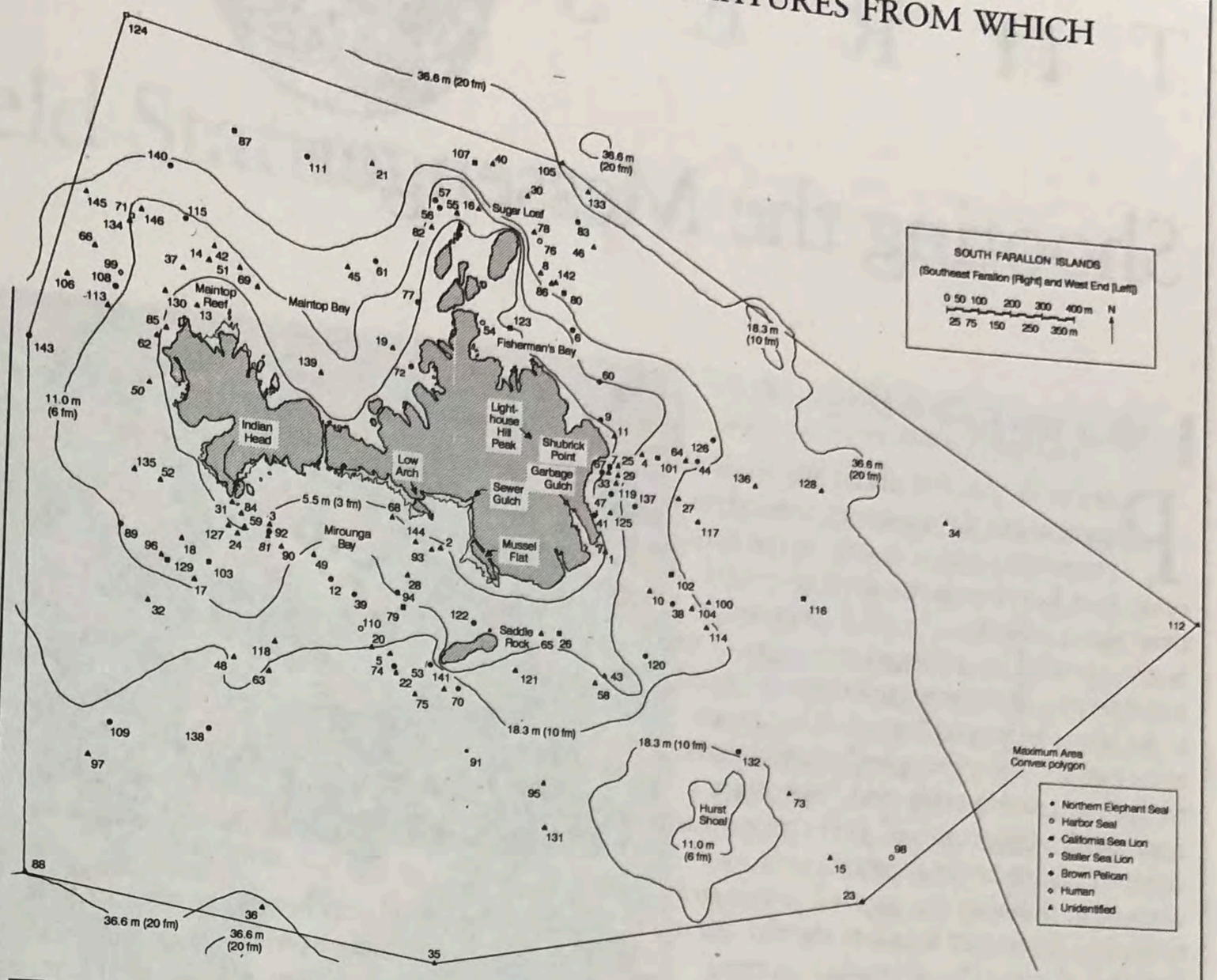
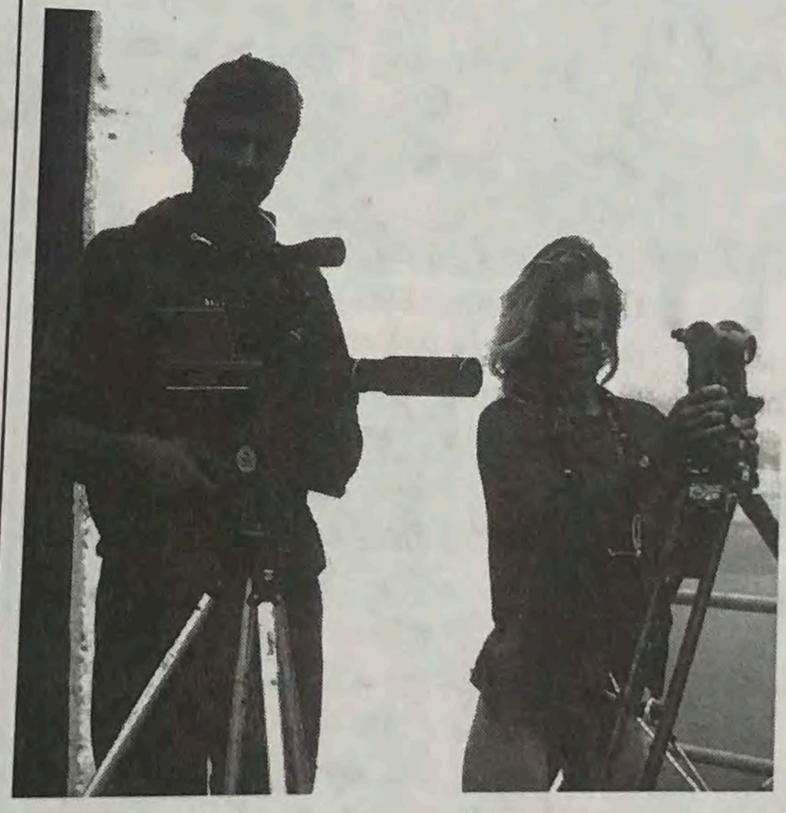


Figure 2. Plotting the shark attacks near the island reveals a "high-risk zone," especially pronounced near the pinnipeds' favorite haul-out areas. All the recorded attacks have taken place within the polygonal area.



PRBO field biologists watch for shark activity from the Farallon lighthouse and record events with a video camera and theodolite (for angle and distance).

Predator and Prey

OF GENERAL INTEREST to humans is the manner in which white sharks handle their prey, as this will help define appropriate responses for surfers or others who have been attacked. To further understand the white shark's feeding behavior, we are now videotaping attack sequences from the Farallon light house. Relying strongly upon the element of surprise, sharks typically accelerate to strike a pinniped from below or behind. Even though most attacks occur at or near the surface, we are rarely lucky enough to see the first strike and have yet to videotape this event. But what happens after the initial hit? Steinhart Aquarium's John McCosker has developed a theory, suggested by David Ainley, that the shark waits for its prey to bleed to death, to avoid risking injury from a live and struggling animal.[1] Thus, if the first strike is not fatal, the prey is able to escape. Some of our observations are consistent with this theory. We

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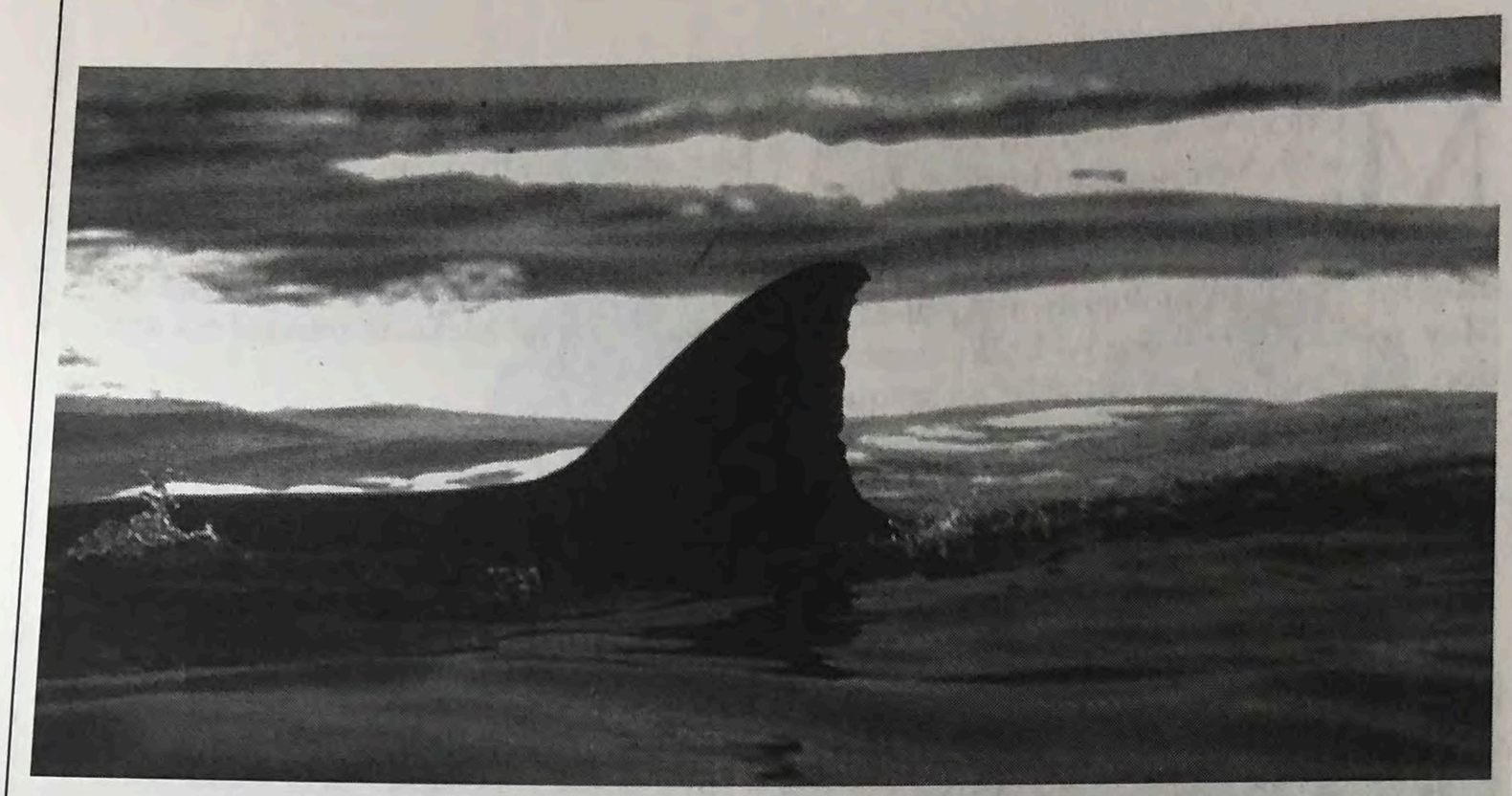
PETER KLIMLEY

PETER PYLE

WITH GROWING RESPECT, WE CALMLY WATCH AS THE SHARK IN LEISURE CONSUMES ITS PRIZE.



Unperturbed by the presence of PRBO biologists in a boat, a white shark consumes its meal.

White Sharks

Continued from page 3

have often watched bleeding carcasses float for 10-60 minutes after the initial hit before the shark returned to feed, and we have catalogued many pinnipeds hauled out on the island displaying distinct and at times surprisingly large, crescent-shaped scars — escapees of the first hit. But we have also observed white sharks apparently pursuing wounded animals, and at times they seem to hold and asphyxiate their prey below the surface. An alternate theory explaining the pause in the predatory sequence might be that the shark itself is partially stunned by the hit, or is in an agitated state and waits to recoup before feeding. By analysing our videotape footage we can ascertain how often and under what conditions each prey-handling strategy is employed.

Surfers have long known that certain locations or backdrops are "sharkier" than others. What, exactly, defines the optimal depth and topographic bottom features from which white sharks stalk their prey? To investigate this we are pinpointing the locations of attacks from the lighthouse using theodolites, geological instruments that yield precise horizontal and vertical angles. We hope to confirm Peter Klimley's hypothesis that the sharks use their cryptic dorsal coloration to stalk pinnipeds. The white shark, named for the color of its undersides, is actually dark gray, even blackish, on its upper surface and may be able to exploit rocky and dark (versus sandy and light) areas found around the island. The surface waters above rocky ridges or precipices seem to be especially favorable locales for attacks. With the theodolite data we are defining a "high risk zone" in which a majority of the attacks on pinnipeds occur (Figure 2). Using our findings,[2] we hope to define high-risk conditions, both topographic and oceanic, for humans as well.

Using the exact distance from the lighthouse to attacks (as calculated from theodolite readings), we can estimate the lengths of individual sharks and their prey, measuring their images on a video monitor. This will help us confirm suspicions that shark size and prey size are directly related. The size data can also be combined with video and photographic images of the fins to identify individuals. Like the color designs on the flukes of whales, the exact pattern of notches and scratches on the trailing edges of white shark fins are unique to each animal. Using these patterns, Scot has identified 10-15 individuals near the island from 1987 to 1991; at least five of these have been observed in multiple years. We have found returning individuals at about the same time and in the same areas around the island each season, and we have recorded as many as three elephant seals taken by one known shark in a single year. The known-individual data will also be critical to accurately estimating and monitoring the population of white sharks at SEFI.

1. McCosker expounds on this theory in an engaging compilation of information, *Great White Shark* by R. Ellis and J. McCosker, 1991, Stanford University Press.

2. Some will appear in the summer 1992 issue of the scientific journal *Copeia*.

Seals in the High Risk Zone

OUR ULTIMATE RESEARCH GOAL is to document coevolved life-history patterns in the white shark and its pinniped prey. What domestic and regional strategies do the sharks employ to track and feed on pinnipeds? In turn, how have the pinnipeds adapted locally and evolutionarily to the presence of the sharks? During detailed observations of pinnipeds from the lighthouse we have noticed a distinct difference in pinniped behavior relative to the "high risk zone." We rarely see elephant seals within the zone in the fall, and we suspect that they commute through this area underwater, possibly along the bottom where the shark would lose its calculated advantage. Sea lions traverse the high risk zone during the fall in large, porpoising groups that move too quickly for a shark to strike. Within the safety zone close to the island, in contrast, both pinniped species frolic and float lazily on the surface. Likewise, their behavior is more relaxed in the spring, when white sharks are absent from the area. Recently weaned elephant seals first learning about the ocean, for instance, venture frequently into the high risk zone in March-May, when white sharks are not present at SEFI. Such seasonal differences in the pinnipeds' behavior supports a theory developed by David Ainley that the timing of the northern elephant seal's winter pupping season has evolved in response to the white shark's occurrence patterns along the California coast.

As amply demonstrated by PRBO's other research at SEFI, the answers to such questions can only result from long-term studies. Thus we will maintain our vigils and, when opportunities occur, continue

PETER PYLE

BIRDERS AT ALL LEVELS OF EXPERIENCE ARE NEEDED TO HELP CONDUCT BASELINE BIRD INVENTORIES, PARTICIPATE IN SINGLE-SPECIES CENSUSES, AND DEVELOP CHECKLISTS.

AMERICAN BIRDING ASSOCIATION

Opportunities

Cindy Lippincott

North America's largest association of birders, the ABA, recently published an article about PRBO and an excerpt and review of Rich Stallcup's Ocean Birds of the Nearshore Pacific. *Cindy Lippincott, manager of the ABA bookstore and mail order office, contributes this note for the interest of PRBO members.* — Editor

IN 1969, A SMALL GROUP of dedicated birders joined together to form the American Birding Association, the only North American organization dedicated to birds, birders, and birding. ABA members, whether professional ornithologists or beginners, have a common enthusiasm for their avocation.

The ABA currently has over 9600 members throughout the world, a world much changed in the past 23 years. Concerned about how environmental changes affect birds, ABA members look for ways to use their birding expertise and experience to help assess the status of birds in North America. To help members find such opportunities, the ABA has formed partnerships with various federal agencies, such as the U.S. Forest Service and the Bureau of Land Management, and recently published a listing of 135 volunteer programs in 1992. Birders at all levels of experience are needed to help conduct baseline bird inventories, participate in single-species censuses, and develop bird checklists. (To receive the Directory of Volunteer Opportunities for Birders, send $1.00 to the address below.) Another partnership project will be the 1993 publication of a book detailing birding opportunities in over 40 National Forests.

A Spotted Owl might oversee some birders helping in U.S. forests, as part of an ABA volunteer program.

In addition to publishing *Birding*, a bi-monthly magazine, and *Winging It*, a monthly newsletter, the Association holds conventions every other year in prominent birding locations. Their popularity has led to regional conferences, such as one held in 1991 in Monterey, California, where David Ainley and Rich Stallcup of PRBO were among the speakers.

ABA's mail/phone-order bookstore provides a full line of bird books, including the highly regarded ABA/Lane bird-finding guides, several of which are newly revised, and top-quality optical equipment. Write the American Birding Association at P.O. Box 6599, Colorado Springs, CO 80934-7736, or call (800) 634-7736. Dues are $30 for individuals, $37 for families.

to investigate post-strike events from our trusty Boston Whaler.

The distant cry of a Western Gull sharply punctuates the stillness. Glancing toward the hapless seal, we note the impressive head and back of the shark as it gently thrusts itself into the carcass, preparing to take its first bite. The irony does not escape us as we circle slowly in, approaching within 15 feet: oddly, there seems no danger to us at all. Unlike the initial strike, the feeding is performed in peace. With a casual eye on us, the shark glides along the surface, first to nudge the carcass, then to take a healthy bite. Both shark and prey submerge, after which the carcass, missing another section, rises back upon the surface. With growing respect, we calmly watch as the shark in leisure consumes its prize. Even as it passes directly under the Whaler, briefly mistaking us for its prey, we are not alarmed. This is not the indiscriminate killer that the media portrays, but simply one of the ocean's many organisms, tending to its livelihood.

With increased understanding, our fear of the white shark has been replaced by a fear *for* it — for its survival. The field biologist's bane is to see well-intentioned research findings used to commercially or otherwise exploit a species. In the fall of 1982, four white sharks were killed by a thrill-seeker in Farallon waters, resulting in a noticeable decline in attacks observed from the island. In 1988, another was killed for trophy, and further attacks on sharks by humans have occurred each year since. Due in part to a lack of natural predators, sharks take a long time to reach sexual maturity. The white shark, at the top of the ocean's ecological hierarchy, probably takes the longest of all. The removal of but a few white sharks can thus have profound effects on both its own population status, already considered tenuous, and the demographic balance of all species under its apogee. Such upheaval has already happened in Australia, Africa, and the Atlantic coast of the U.S., where fishermen in misguided valor have wiped out white shark populations. We are currently using our scientific knowlege in efforts to legally protect the white shark. But more importantly, we wish to instill a fundamental change in human attitude.

The white shark may be the last of Earth's primary predators capable of invoking irrational fear and response in humans. Although landbound predators such as lions, tigers, and wolves once held this authority, they have all been subdued, nearly eradicated, or restricted to wildlife preserves where we point at them from the safety of our automobiles. But *Homo sapiens* remains out of its element on the ocean, and it is from this perspective that the white shark still lurks in the primal quarters of the human mind. By revealing the white shark's natural story, we hope to supplant fear and vindictiveness with respect and understanding for this beleaguered citizen of the sea.

JOHN SCHMITT