WALL MAP SUPPLEMENT: THE UNITED STATES (page 220)

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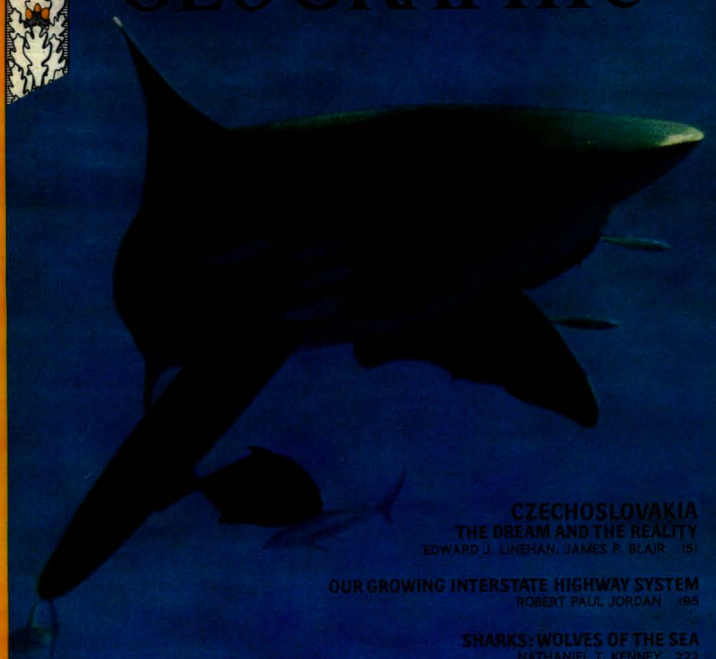

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SHARKS: Wolves of the Sea

By NATHANIEL T. KENNEY
National Geographic Senior Staff

BARING RAZOR-SHARP TEETH, *a nine-foot great hammerhead prowls off Key Largo, Florida. Placement of eyes and nostrils on the ends of lobes, coupled with the head's swinging movements, broadens this shark's food-scenning swath through the sea. The flattened head, like an airplane's wing, aids maneuverability* (painting, page 212).

IN MASK AND SNORKEL I was diving in 15 feet of water off the western shore of North Bimini, tiny Bahama Island. A jumble of coral-encrusted boulders lies on the bottom sands at this point, among them dwell [illegible] of brilliantly colored small fishes.

One moment I was surrounded by these vivid jewels of the warm tide seas. In the next I was utterly alone, for my small friends had all dashed for shelter into crevices in the rocks or to concealing jungles of grass and sea fans. Turning seaward to discover what had alarmed them, I saw a shadow in the depths grow into an eight-foot long [illegible] headed directly at me.

Until it fell away it turned breathable. An eye the size

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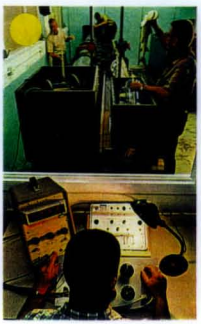
With a blink—the upward movement of a nictitating membrane that serves as an eyelid—the lemon shark responds to a shaft of light. Infrared detector enables scientists to observe each "wink" during the experiments in a darkened testing room at the institute. As the shark's eyes gradually become adapted to the darkness, its pupils begin to expand (right).

How sensitive is a shark to sound? It can hear moving objects in the water at a greater distance than it can see them, test- on young lemon shark- reveal, and its ability to locate the source of the sound is highly developed—vital to a predator (diagram, pages 230-31). A scientist at the institute prepares to place a live specimen in a water-filled tube into which sounds will be projected from the electronic equipment in foreground. Conditioning the shark with electric shocks, the researchers learn what frequencies the fish can hear and its degree of sensitivity to sounds.



Testing the vision of a young lemon shark, research assistant Samuel Gruber of the University of Miami's Institute of Marine Sciences employs an ingenious apparatus that he devised. The shark is lashed down in a tank of circulating water, its nose fitting into a Plexiglas hemisphere. At intervals the lamp at right flashes filtered light of varying color and intensity; at the same time a mild electric shock causes the fish to blink. Eventually, the shark becomes so conditioned that it blinks when only the light is flashed, an indication that it can see that particular color or level of light. Utilizing this approach, scientists hope to determine whether sharks distinguish colors. The knowledge would be invaluable in designing garments and gear for use in the open sea.

impersonal level, the shark's inroads on commercial and sport fisheries, and you have a malefactor of some consequence. But it was not until fairly recently that science organized to study sharks and seek ways of controlling them.

Disasters at Sea Spur Shark Research

Blood-chilling mass attacks on survivors of torpedoed ships and crashed airplanes in World War II gave the initial impetus to the search. After the war, interest in sharks not only increased but broadened. We not only wanted to know how to protect swimmers and divers; we also sought an insight into the undoubtedly large part sharks play in the ecology of the seas.

The postwar human population explosion spurred this interest in sharks. One day, we realized, earth's soil might no longer support us all, and we must exploit the waters—71 percent of the world's surface—or perish.

Divers in unprecedented numbers began searching the depths for oil and metals and ways to farm the oceans, in which are locked vast quantities of protein yet to be tapped; some worked from self-contained sea bottom communities pioneered by Edwin A. Link, the U. S. Navy, and Jacques-Yves Cousteau.*

Encounters with sharks became everyday occurrences. Plainly, more knowledge of the fish was needed. In 1958, the American Institute of Biological Sciences, Washington, D. C., agreed to meet the challenge. It offered to serve as an international clearinghouse and repository for shark knowledge, and formed

*See, in the GEOGRAPHIC: "Working for Weeks on the Sea Floor," April, 1965; and "At Home in the Sea," April, 1964, both by Capt. J. Y. Cousteau; and "Outpost Under the Ocean," April, 1965, by Edwin A. Link.

1965, when a surfer suffered a minor bite on one thigh. Attacks on surfers, incidentally, appear to be on the increase.

"Because a shark can swim over or past a net, it was a mystery at first how meshing protected bathers," said Beulah Davis of Natal Province's Anti-Shark Measures Board. "One reason may be that our sharks mostly belong to a local, nonmigratory population, and the nets caught just about all of them."

Sharks off Hawaiian beaches also appear to be nonmigratory. Last year, under Dr. Tester's direction, the 50th state opened a three-year campaign to eradicate them so far as possible, using set lines with hooks at 60-foot intervals. One of the first results was a noticeable decrease in a concentration of large tigers off Honolulu harbor.

Some 40 miles north of Durban, the golden sands of Zinkwazi Beach used to be lonely, unused because sharks swarmed in the creaming surf. Now they are meshed, and holiday-seekers come in increasing numbers.

Len Flowers, a professional fisherman, tends the nets. I went with Len to overhaul them. They held only a small cow-nosed ray.

"I don't believe you have sharks around," I remarked.

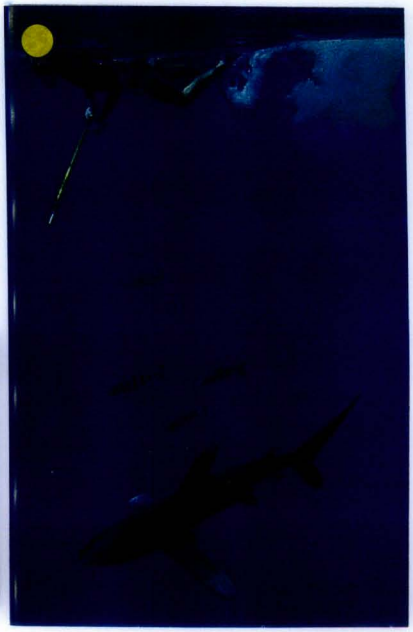
"No?" said Len. "Hang on." With that he headed the boat seaward.

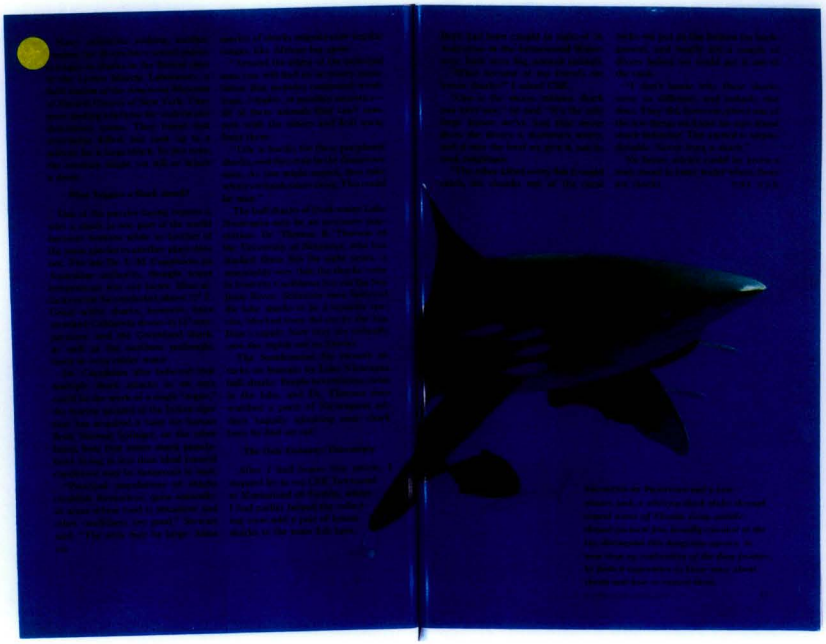
Choosing a spot over a reef a mile offshore, he dropped the anchor, and we began fishing. Immediately we caught several five-pound Cape salmon, or geelbek. We stunned them and tossed them overboard. Within seconds the sea boiled with sharks, some six feet and more long.

"Here are our friends," said Len. "We'll be lucky now to catch a single whole salmon."

We scarcely had a chance to try before the ravenous sharks began banging against the boat. Fear gripped me. Even Len confessed to some nervousness.

To get through the surf without swamping, the boat had been decked over. We sat on it, not in it. Handholds were few. The sea that day was high. An eight-foot shark struck at the outboard propeller, although we had taken the precaution of tilting the motor to bring the propeller out of water.





(painting, pages 232-4). I am forced to say "about". Here is yet another gap in the body of shark knowledge, and the figure could be wrong by at least 10 either way.

Of all the shark species known at present, only a handful can be listed as proven eaters of man. Against some of these there is the incontrovertible evidence of human remains found in stomachs, teeth left in wounds of victims, and eyewitness identification by unimpeachable experts. Against others stands the strongest kind of circumstantial evidence, including the characteristics of wounds and the proven presence of the shark species at the scene of attack.

Nine Killers Admit No Argument

Every list of proven man-eaters agrees on nine sharks. These are the great white, which also bears the name "man-eater"; mako; bull; lemon; tiger; dusky; blue; the largest hammerheads; and the whitetip, a pelagic shark, meaning one that dwells at or near the surface of the open seas away from land. All these sharks have attacked living humans as well as corpses.

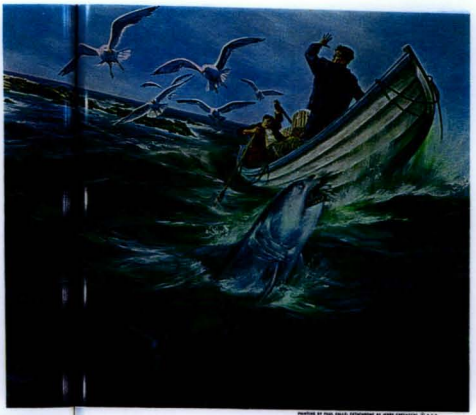
To the sinister roster, some authorities add the Pacific Ocean gray and the Australian whalers. Several species may share these same names, and some of these may prove to be sharks known under yet other names in different parts of the world.

In addition to the "proven" man-eaters, there is a category of sharks—and the experts don't always agree on the individual species—best characterized as "reasonable suspects." The porbeagle is one, and the sandbar, or brown, is another. So is the silky, named for its relatively glossy skin, a rarity in the shark world. Confusingly, there is another whitetip which might be dangerous, but it is a coastal or reef species, not the pelagic shark of the same name.

One other shark group can be called "potentially dangerous to humans," and all the experts agree on its members. They cite every shark which because of size, power, armament, and general disposition might be expected to make a meal of a man if the man got in its way. An example is the big Greenland shark. But it lives in waters too cold for swimmers and divers, and no one knows what it might do if it chanced upon a human.

The thresher and sand tiger could kill or injure humans, but both appear to feed entirely on small living fishes. The sand tiger once had a bad, but undeserved, reputation in South Africa, where it is named ragged-tooth (page 244), and in Australia, where it is called grey nurse—and it should be pointed out that this is not the small-mouthed, bewhiskered nurse shark that ranges most of the world's tropical and subtropical waters.

Add all the sharks on these lists and you come up with no more than 40 or 50 species. The others, it can safely be said, never dine on human flesh at all, or do so more or less accidentally, as when they bite in self-defense. In spite of this, no shark should be described as entirely "harmless," and a wise swimmer treats them all with the same respect he accords a strange fox terrier.



Real-life Moby Dick, a great white shark matches the fury of fiction's famous whale in a sudden attack off Canada's Cape Breton Island. Seas swamped the splintered dory of two lobstermen; one of them drowned, and the other clung to the wreckage until rescued. Apparently scorning them, the animal swam away to seek a meal elsewhere.

The painting re-creates the harrowing experience of John MacLeod, who survived, and John Burns, who died, on a summer morning in 1963. A tooth embedded in the battered boat identified the species. The shark's length was estimated at about 12 feet, and its weight probably exceeded 1,000 pounds.

Mr. MacLeod still fishes the same North Atlantic waters.

Ravenous silky shark charges diver Donald Nelson. Frantically, Nelson pushes away the six-foot attacker with one hand and with the other aims his short-handled underwater gun at the shark's head. An instant later the would-be killer swam away to thrash out its own death agony.

Photographer Greenberg, swimming with Nelson off Florida, snapped this remarkable picture even as he himself desperately maneuvered to avoid attack.

PAINTING BY PAUL CALLE, COURTESY OF JERRY GREENBERG © N.G.S.

Sharks are close relatives of skates, rays, sawfish, and guitarfish, the latter named because of their unusual shape. All these have skeletons of cartilage and are called elasmobranchs; the other (far more numerous) fish, the teleosts, have true bones.

Between bony fishes and cartilaginous sharks lie many other differences. Most shark species produce live young, although some lay eggs. The horny egg cases from which skates and certain small sharks have hatched in the water are the "mermaids' purses" washed up on ocean beaches.*

No other fish can match a shark in jaw power. Perry Gilbert has measured this force with ingenious apparatus. The readings came out in tons, not mere pounds (pages 250-51).

From 20 to several hundred teeth, depending upon the species, stand in the ready-for-business rows at the front of shark jaws (page 229). Normally, five or six sets—but in some species as many as 15—wait in reserve behind, continuously moving forward so that when front teeth drop out, new ones take their place; in the young of at least one species, this occurs as often as every eight days. New teeth are always larger than the old to match the shark's growth.

One of the most persistent shark myths holds that, to use these teeth, the animal must roll over on its back or side. Not so. Of hundreds of sharks I have watched feeding, not one ever turned over to attack its prey. Sharks, however, are agile, and could do so if they chose.

Rough Hide Once Used as Sandpaper

Shark teeth grow not only in the jaws, but on nearly every square inch of hide, in a crude form called placoid scales, or dermal denticles. Abrasive shark hide, known as shagreen, was once used as sandpaper in cabinetmaking.

Air-filled swim bladders give bony fishes buoyancy. Sharks have no such thing. If they stop moving, they no longer plane on their bellies and fins, and they sink to the bottom.

Most sharks swim from birth to death for an even more vital reason. Their breathing machinery lacks adequate pumping apparatus; only forward movement passes oxygen-bearing water over their gill surfaces.

Dropping dynamite into a school of bony fishes will injure their swim bladders and kill or cripple them. Unless it is a direct hit, an explosion doesn't appear to harm sharks. In fact, it seems to attract them.

*See "Miracle of the Mermaid's Purse," by Ernest L. Libby, NATIONAL GEOGRAPHIC, September, 1959.

Descending into the blue underwater world in a protective cage he designed, diver J. G. Stemples finds himself surrounded by aggressive silky sharks. Bag in his hand, containing pieces of herring, attracts the pack into camera range as the strong but lightweight cage dangles 15 feet below the surface in Tongue of the Ocean. Plastic floats at the top keep the cylinder almost weightless. If the buoy line snapped, Stemples would escape through a hatch.

At work on a photographic study of the shark population in these infested waters, Stemples looked down once to see a small silky shark halfway inside the cage, and quickly kicked it out. Jerry Greenberg, outside the cage, found "one nipping at my swimming fins, and another giving my light meter a taste test."

PAINTING BY JERRY GREENBERG © N.G.S.