

## Sharks Hawaii

- What makes sharks tick?
- Do sharks come near shore?
- Are all sharks carnivorous?
- How are sharks born?
- How fast can a shark swim?
- What kind of sharks live in Hawaiian waters?
- Can you tame a shark?
- What role did sharks play in Hawaiian mythology and religion?

Written in an engaging, question-and-answer format, *Sharks Hawaii* introduces the reader to this most feared and misunderstood ocean creature. Covering everything from mating and eating habits to shark legends in ancient Hawaii, *Sharks Hawaii* is a handy guidebook for anyone interested in sorting fact from fiction in the fascinating world of sharks.

Arnold Suzumoto has worked in the Ichthyology collection of Bishop Museum since 1975, starting as a volunteer. A University of Hawaii graduate, he is now collections manager for the museum's Zoology Department.

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Bishop Museum Press

# SHARKS HAWAII

BY ARNOLD SUZUMOTO



Contributions by  
Rowland B. Reeve and  
Richard L. Pyle

LIBRARY OF  
GEORGE H. BALAZS



# *Sharks Hawaii*

Arnold Suzumoto

*with contributions by  
Rowland B. Reese and  
Richard L. Pyle*



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## Introduction

There are a million things to know about sharks. Many of these things are already known, others will be discovered, and some probably will elude human understanding forever. This brief guide attempts to answer often-asked questions about this most feared and misunderstood ocean creature, and it especially offers information about sharks—and human interactions with them—in Hawai'i.

To provide the most accurate information possible, my colleagues and I have drawn on personal experience, on books written by shark researchers over the past decade or two, and on the expertise of many colleagues. Any errors are my responsibility, not that of my fellow authors or of the advisors who have given freely of their time to help make this guide possible: Patience (Pat) Bacon, George H. Balazs, PJ Bennett, Toni L. Har, Nancy King, Matthew and Daniel Kishinami, John E. (Jack) Randall, and Leighton R. Taylor. I wish to extend a special *mahele* to Mari Uchida, without whose kind support this guide would probably never have been written.

I hope this guide will add to the reader's understanding of sharks, shed light where little is known, and, above all, stimulate young and old minds alike to wonder and seek to discover more about these most splendidly adapted fishes. It is dedicated to Minoru and Dorothy Suzumoto, who raised their son and daughter never to stop exploring the world around them.

—Arnold Suzumoto

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## *Shark-Bits: Food for Thought about Sharks*

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### *Are sharks really fishes?*

Yes. Sharks belong to a special group called the cartilaginous fishes, along with skates and rays. Like the reef fishes with which most of us in Hawai'i are familiar, sharks are aquatic vertebrates with gills and fins. Unlike other fishes, however, sharks have skeletons made of cartilage instead of bone. While their bodies make them look more like porpoises and dolphins than tropical fishes, the fact that sharks have gills (while porpoises, dolphins, and all other mammals have lungs) is sufficient to distinguish them from the aquatic mammals.

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### *How big do sharks get?*

Most of the world's sharks are medium sized—that is, around 0.6 to 1.5 meters (2 to 5 feet) long. A few species get larger, and a few are smaller. One of the smallest sharks in the world is the Dwarf Dog-shark, a deep-water Caribbean species that measures only 17 centimeters (7 inches) long as an adult. A similar looking deep-water shark, the Pygmy Shark, is probably the smallest shark in Hawaiian waters, typically growing to a length of 20 centimeters (8 inches). The largest shark is also the largest fish in the world: the Whale Shark. This fish is reported to attain lengths as great as 18 meters (59 feet), but most of those sighted have been between 4 and 12 meters (13 and 39 feet). The second largest fish in the world is the Basking Shark, which may attain a length of 15 meters (49 feet) but is more commonly seen at lengths of around 10 meters (33 feet).

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### *How many kinds of sharks are there? How do they differ?*

About 370 species of sharks are currently known, a relatively small number compared to the 21,000 marine and freshwater fish species known.

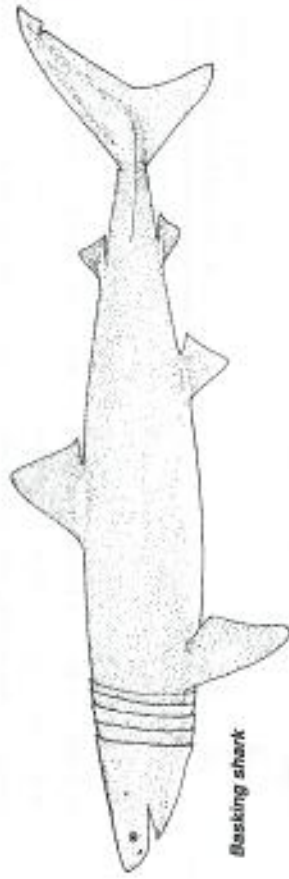
To most people, *all* sharks look alike, and a few shark species are so similar in appearance that even shark experts have



*Pygmy shark*



*Whale shark*



*Basking shark*

trouble telling them apart. To those who know what to look for, however, most shark species have distinctive features. Besides differing in adult size, they vary in coloring, in the number of gill slits on the sides of their head (most species have five gill slits per side, but a few have six or seven), and in the shape of key body parts, including their fins and teeth.

#### **What's the most unusual shark?**

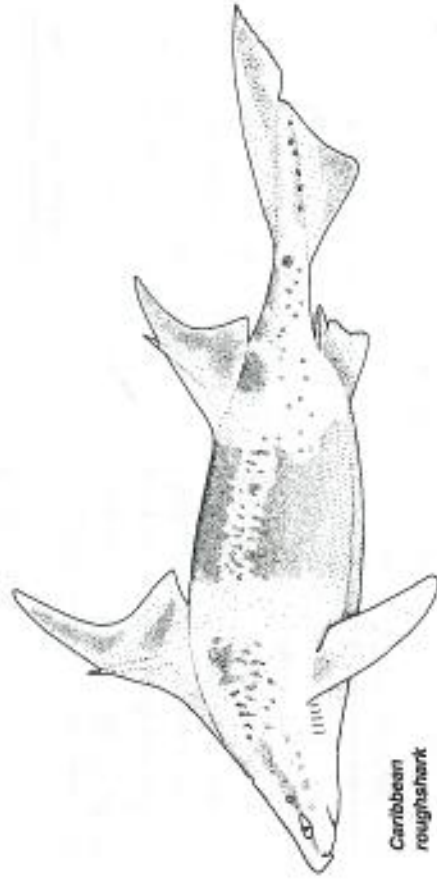
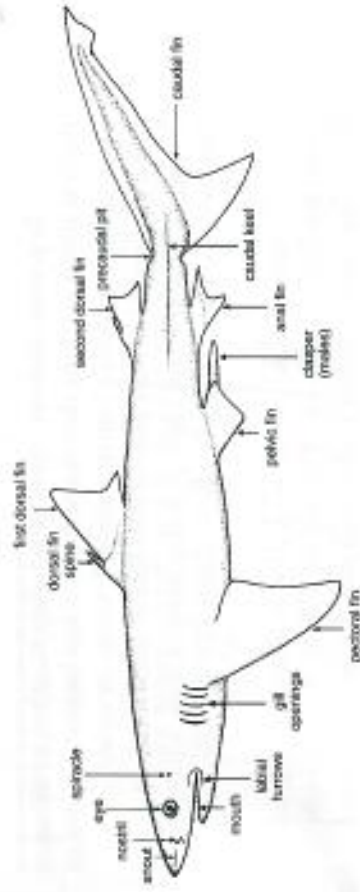
Practically every shark species has something unusual about it, but good candidates for most unusual shark might be the Caribbean Roughshark, with its very high dorsal fins and body covered with prickles, and the Goblin Shark, with its surfboardlike snout and protrusible jaws filled with long, slender teeth.

#### **How old do sharks get?**

Nobody really knows, but research on certain species and observations of sharks in aquariums and oceanariums suggest that sharks are long-lived animals, and that, at least in captivity, they grow very slowly, only a few inches per year once they reach adulthood. If this is true for sharks in the wild, then most large sharks are very old (estimates range from 30 to 70 years or more). Attempts to correlate shark length with age by counting vertebral "growth rings" (deposits laid down in the cartilage of the spine as the shark grows) have been only moderately successful because not all shark species deposit rings annually. Much more needs to be done in the way of tag-release-and-recapture programs and the like before we fully understand growth and aging in sharks.

#### **What do sharks like to eat? How often do they feed?**

Most sharks are piscivorous—that is, they feed primarily on fishes. Some sharks feed on crabs and mollusks, however, and some of the larger ocean-dwelling sharks will occasionally catch a roosting seabird, or a seal, or may even try to take a bite out of a whale. The Tiger Shark has evolved teeth that enable it to eat such hard-bodied creatures as sea turtles and lobsters. Three species (the Whale Shark, the Basking Shark, and the Megamouth Shark) eat planktonic animals, tiny crustaceans and larval fishes that also are the basis of whale diets.



**Caribbean roughshark**



**Goblin shark**

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**Is it all right to keep a shark as a pet in an aquarium?**

As long as a shark is adequately fed, protected from disease and parasites, and kept in a well-filtered and aerated aquarium suitable to its size, it seems to do reasonably well. But one has to consider whether it is fair to limit a shark's world to an aquarium. Most sharks are thought to patrol and feed in large areas—from several square kilometers for some reef species to entire oceans for the pelagic sharks. Since captivity so limits a shark's range, some people feel it is cruel and unjustifiable. Others feel that the educational value of keeping a shark, especially in a public setting, may outweigh these concerns.

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**Do sharks come near the shore?**

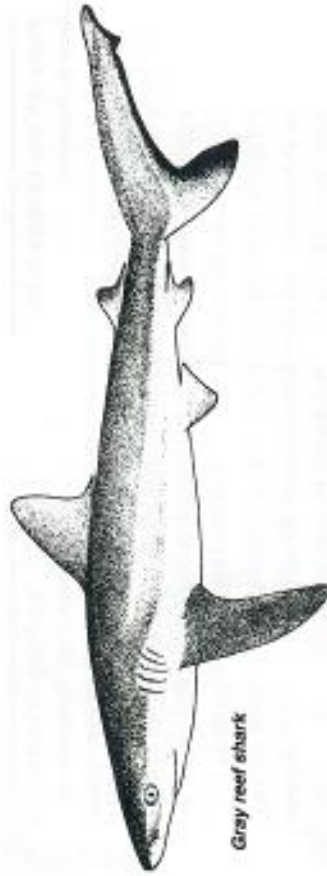
They do, but when and where seems to depend a lot on the time of day and on other conditions. During daylight, there have been reports of sharks coming very close to shore at Lanikai and Hanauma Bay and at other places around O'ahu, but these sightings are rare. Sharks are, by nature, curious, and a few seem territorial, but so many swimmers and divers have claimed the inshore habitats of O'ahu and the neighbor islands that sharks, over the years, have learned to stay farther offshore, off the reef face.

While sharks are content to patrol this deep-water habitat during the day, during the night, when most of our beaches are deserted except for net and line fishers, sharks may feel comfortable enough to come closer to shore in search of prey. Many researchers and ocean veterans believe that sharks do most of their feeding at night, preying on sleeping or injured fishes. Swimmers, surfers, and snorkelers who venture out at night should be aware of this and exercise caution.

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**If sharks are staying away from shore, are they as afraid of people as people are afraid of sharks?**

Maybe so. Certainly when people are present, some sharks show signs of fear: fleeing, biting defensively, or swimming in an agitated manner. One can only guess at the animal's physiologic responses, but they are probably similar (chemically) to what people experience. However, people react emotionally as well as physically to sharks and other per-



Gray reef shark

ceived threats. This emotionalism appears to be lacking in sharks, so in that sense it is probably true that people have more intense fears of sharks than sharks do of people.

Some research suggests that the aggressive shark species (most notably the Gray Reef Shark, which exhibits unique "agonistic" behaviors before attacking) are really indicating a high level of fear, which, if not assuaged, may result in a form of aggression, most commonly a lunge and bite. Other than these telltale signs on the part of only a few shark species, sharks show little or no fear at all.

It is difficult to ascribe most sharks' avoidance of divers to fear. It is probably best interpreted as wariness of a potential predator.

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**Are there sharks at Sharks Cove? Is it dangerous to swim there?**

Sharks Cove gets its name more from geological features than from any past or present shark activity. (Some say its name comes from rocks in the area, which supposedly look like sharks; others say it looks as if a huge shark took a bite out of the coastline.) It's generally a safe place for swimmers and divers in the summer months but can be dangerous in the winter, when large swells from the north pose a serious threat to the unprepared. As at other beaches in Hawai'i, it's also wise to check daily tidal fluxes at Sharks Cove before entering the water, and other transient conditions such as rip currents and offshore currents should be kept in mind.

Since Sharks Cove is a marine reserve, fishes are numerous and somewhat accustomed to people. The abundance of fish would seem to make it attractive to sharks, but during the summer, numerous divers have investigated the waters around Sharks Cove, even at night. Reports of sharks have been few.

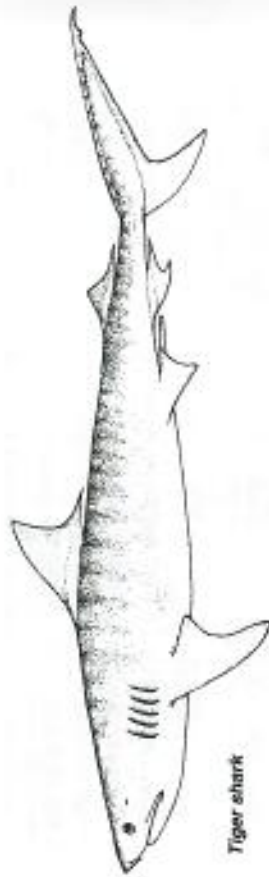
**Where are sharks likely to be seen in Hawaii?**

Sharks in Hawaii spend nearly all their daylight hours well offshore, over the reef face or reef slope and farther out to sea, so they are seldom sighted. In recent memory, a single shark (either a Gray Reef or Sandbar Shark) swam into the "keyhole" swimming area at Hanauma Bay. Lifeguards spotted the shark in the early morning and closed the bay to swimmers, and after several hours the shark returned to deeper waters outside the bay. Scalloped Hammerhead Sharks have been fished from Kaneohe Bay and Peard Harbor. Tiger Sharks have been seen off Lanikai, and more than a few have been caught off the Ewa Beach area, but considering all the people and water activities at these places, the chances of an inshore shark encounter in Hawaii are slim.

Surfers occasionally see sharks, usually well offshore in the wave zone, where waves crest as they reach the reef front. One surf spot where sharks used to be seen with some regularity is Point Panic off Kewalo Basin. A nearby tuna processing plant (long since closed) and the associated fish blood in the water apparently made the site attractive to sharks.



Scalloped hammerhead



Tiger shark

**Why would sharks feed more at night? Isn't it harder for them to see their prey?**

Maybe it's harder for them to see, but remember that sharks are equipped with other senses that are not affected by darkness. Feeding at night increases their chances of catching sleeping fishes. Also, dusk and dawn are thought to be times of confusion among active fishes. At dusk, daytime fish species are looking for a place to settle for the night, and nighttime species are just making their appearance, and at dawn the reverse situation is occurring. This period of unsettledness may offer good opportunities for sharks to hunt actively for weak or injured prey.

**How can you tell a male shark from a female shark?**

From the moment of birth, all male sharks have a small pair of "claspers," tubelike organs on the inner edge of the pelvic fins (the paired fins just behind the belly). Claspers grow longer and larger as the male reaches maturity. They are absent in females.

**How do sharks mate? Do they always mate with members of their own species?**

Shark reproduction involves internal fertilization and a ritual activity, probably different for each species, but usually involving one male and one female. While not much is known for most sharks, for a few species mating has been observed in the wild or in aquariums. From these observations, scientists speculate that general shark reproduction probably follows a similar pattern: the male bites and holds one of the female's pectoral fins in his mouth, then wraps his body around hers and inserts one of his claspers into her cloaca, or urogenital opening. After a short period (2 to 35 minutes), during which the male discharges sperm into the female, he releases his grasp of the female and both swim off.

In most bony fishes, reproduction occurs through the synchronous release of clouds of eggs and sperm into the water. This process creates possibilities of cross-breeding between similar or related species that spawn at the same time. We can't say that sharks never interbreed, but it isn't known to have happened, and the way sharks mate makes it unlikely.

### **How many babies can a female shark produce?**

The number of baby sharks (called "pups") produced in a single pregnancy can range from one to a hundred, depending on the species of shark. In general, however, sharks give birth to only a few pups each year, and only a small number of the pups survive to adulthood.

No one yet knows how many times a female shark can reproduce over a full lifespan of 30 to 70 years. The number of eggs in her ovaries is finite, as it is in humans, so at an advanced age she will no longer be able to conceive. A typical female in her prime probably gives birth to pups every other year, since a pregnancy averages 9 to 12 months and a female is usually not sexually active the year following a successful pregnancy.

### **Do sharks lay eggs, or are pups born alive?**

Depending on the species, either answer is correct. Some sharks lay eggs. The eggs are tough (leathery or hornlike) and in different species take a variety of shapes, from rectangular pouches to toplike spirals.

Other sharks give birth to one or more live pups. In some species, the embryos mature in leathery eggcases, then "hatch" inside the mother. In other species, the embryos develop much as human embryos do: they attach to the uterine wall by placentas and umbilical cords formed from modified yolk sac material.

Sharks that lay eggs are called "oviparous" (Latin: *ovum parere*, "egg-birth"). Species that produce eggs that hatch inside the mother are "ovoviviparous" (Latin: *ovum vivus parere*, "egg-living-birth"). Sharks whose embryos attach to the mother by placentas and umbilical cords are "viviparous" (Latin: *vivus parere*, "living-birth"). Most sharks are ovoviviparous.

### **Do newly born sharks depend on their mothers?**

No. As soon as a shark is born, it has all the basic equipment and instincts necessary to survive. A shark is born with a full set of fairly sharp (though small) teeth, which will continue to grow as the animal feeds and develops.

Some shark pups actually make their first "kills" before leaving the womb! This occurs in a few ovoviviparous species, when several eggs develop during one pregnancy. The first embryo to hatch and

become active feeds on undeveloped eggs and embryos while waiting to be born. This behavior may seem repulsive to us, but it improves the chances of survival of the strong pups by giving them a head start on life and by reducing competition for scarce food resources after they are born.

### **How many teeth does a shark have?**

On average, a shark has more than 200 teeth in its jaws at any given time in its life. Of these, only the first one or two outermost rows (perhaps 40 teeth or so) are functional. The others lie under the gum tissue, developing as they move forward in the jaw, getting harder and stronger. As a shark loses the functional teeth in the outer rows, the new teeth move up from behind to take their place.

A shark produces new teeth continuously throughout its life. They grow fastest when the shark is a juvenile, slowing down as the shark matures. Sharks may lose teeth quickly (by biting down on very hard objects), or their old teeth may simply fall out after a period of time. In some species, whole rows are replaced at once, while in others, each tooth is replaced more or less independently. Replacement of a single tooth may take as little as one day, and certainly no longer than a week. Although data are scarce, the total time for a complete row of teeth to replace itself likely averages about a week for young sharks, so the teeth sharks are born with are probably all gone and replaced by the time they are a month old. In adult sharks, replacing an entire row may take as long as 6 to 12 months.

### **When did sharks first evolve?**

The earliest sharks appeared about 400 million years ago, during the Paleozoic Era. They are among the first fishes found in the fossil record and predate the dinosaurs by 200 million years. They seem to have evolved from primitive armored fishes with sievelike mouths and spiny fins. Because sharks have no bones, little except shark teeth survived in the fossil record, so it is hard to know exactly what kinds of body changes have occurred in sharks since their first appearance. All the shark species living today appeared during the Mesozoic Era, about 200 million years ago. They are believed to have remained virtually unchanged throughout their history. The only predator that has ever posed a serious threat to their existence is humankind. In recent years, due to human predation, there has been a decline in the populations of some species of sharks.



### **Do sharks travel alone or in groups?**

Some species of sharks have been observed in huge schools. For example, hammerhead shark schools perhaps comprising hundreds of individuals have been seen off Baja California and elsewhere. Gray Reef Sharks occasionally congregate in large schools, presumably to mate, though this has not been confirmed. Whitetip Reef Sharks have been seen "sleeping" in small groups in reef caves off Maui. Typically, however, sharks are observed singly, or in groups of two to five.

### **Don't sharks ever hunt and feed in groups?**

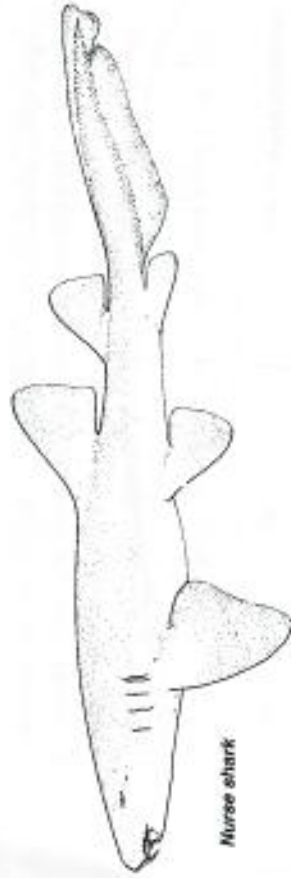
Typically, sharks hunt and feed alone. But some species of sharks are known to feed in large groups, sometimes demonstrating "feeding frenzy" behavior, wherein they become extremely excited and bite at anything nearby, food or not. Not much is known about why such frenzies occur or about the hunting or social behavior of these sharks. How each shark behaves in relation to others in its group is particularly unclear.

### **Do sharks sleep?**

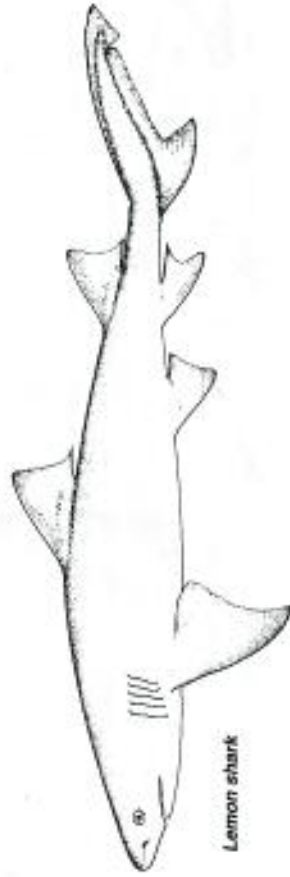
Not as we think of sleep. All but a few species must continually swim in order to respire, depending on their forward motion to pass oxygenated water over their gills; they suffocate if they stop swimming. Sharks probably rest and revitalize during the process of patrolling their ranges, going "on alert" when sensory stimuli signal feeding opportunities, social interactions, or danger, but otherwise switching to a lower level of alertness.

Some sharks, such as Whitetip Reef Sharks, Nurse Sharks, and Lemon Sharks, can actively pump water over their gills. These sharks are seen "sleeping" (resting inactive) in caves in the reef, but only further study will determine if this behavior parallels sleep in humans.

A few species of requiem sharks (the gray sharks) may lie motionless in caves in areas where percolating fresh water has altered the water chemistry, presumably allowing oxygen transfer to take place in their gills. It may be that such an environment also helps rid the shark of parasites.



*Nurse shark*



*Lemon shark*

### **What kinds of sharks occur in Hawaiian waters?**

More than two dozen shark species are known to inhabit Hawaiian waters, but many of these are uncommon except in very deep water, in the channels between the major islands, or around the smaller islets of the Hawaiian archipelago, northwest of Kauai. Based on observations by divers and swimmers, the sharks most likely to be seen around the major Hawaiian Islands are Whitetip Reef, Scalloped Hammerhead, Sandbar, Tiger, Galapagos, Blacktip, and Blacktip Reef. Other sharks occur only rarely. Among them are the White Shark and the Whale Shark. Perhaps the rarest shark in Hawaii is the Megamouth Shark, a deep-water shark that made history when the first individual known to modern science became ensnared in the lines of a research ship's parachute sea anchor off Kahuku, Oahu, in November 1976.

### **What happened to the Megamouth?**

It is preserved in the Ichthyology collection at Bishop Museum. Unfortunately, only limited viewings are possible because of the scientific importance of this "first-ever-seen" specimen.

List of common, scientific, and family names of sharks in this guide (in alphabetical order by common name)

Basking Shark	<i>Cetorhinus maximus</i>	CETORHINIDAE	
Blacktip Shark	<i>Carcharhinus limbatus</i>	CARCHARHINIDAE	
Blacktip Reef Shark	<i>Carcharhinus melanopterus</i>	CARCHARHINIDAE	
Blue Shark	<i>Prionace glauca</i>	CARCHARHINIDAE	
Bull Shark	<i>Carcharhinus leucas</i>	CARCHARHINIDAE	
Caribbean Roughshark	<i>Oxymotus caribbaeus</i>	OXYNOTIDAE	
Dwarf Dogshark	<i>Etmopterus perryi</i>	SQUALIDAE	
Galapagos Shark	<i>Carcharhinus galapagensis</i>	CARCHARHINIDAE	
Goblin Shark	<i>Mitsukurina owstoni</i>	MITSAKURINIDAE	
Gray Reef Shark	<i>Carcharhinus amblyrhynchus</i>	CARCHARHINIDAE	
Great Hammerhead Shark	<i>Sphyrna mokarran</i>	SPHYRNIDAE	
Lemon Shark	<i>Negaprion brevirostris</i>	CARCHARHINIDAE	

Megamouth Shark

*Megachasma pelagios*

MEGACHASMIDAE

Nurse Shark

*Ginglymostoma cirratum*

GINGLYMOSTOMATIDAE

Oceanic Whitetip Shark

*Carcharhinus longimanus*

CARCHARHINIDAE

Pygmy Shark

*Euprotomicrus bispinatus*

SQUALIDAE

Sandbar Shark

*Carcharhinus plumbeus* (= *milberti*)

CARCHARHINIDAE

Scalloped Hammerhead Shark

*Sphyrna lewini*

SPHYRNIDAE

Shortfin Mako Shark

*Isurus paucus*

LAMNIDAE

Silky Shark

*Carcharhinus falciformis*

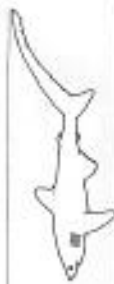
CARCHARHINIDAE

Smooth Hammerhead Shark

*Sphyrna zygaena*

SPHYRNIDAE

Thresher Shark

*Alopias vulpinus*

ALOPIIDAE

Tiger Shark

*Galeocerdo cuvier*

CARCHARHINIDAE

Whale Shark

*Rhincodon typus*

RHINCODONTIDAE

White Shark

*Carcharodon carcharias*

LAMNIDAE

Whitetip Reef Shark

*Trienodon obesus*

CARCHARHINIDAE

### Is the threat of shark attack exaggerated?

Yes. Except under certain circumstances and in certain places—notably in Australia, South Africa, California, and other areas where repeated shark incidents have occurred—the risk of shark attack is low. Human lives have been lost to sharks, but people pose far more danger to sharks than the reverse.

According to a survey of shark incidents in Hawai'i from 1979 through 1990, a total of 85 reported incidents occurred, resulting in 36 fatalities. Many (32) involved people engaged in some form of fishing (18 fatalities); others (22) involved swimmers or waders (9 fatalities); still others (18) involved people engaged in boardsurfing, bodysurfing, or riding air mattresses (4 fatalities); a few (8) involved divers (5 fatalities). Overall, despite the enormous number of Hawai'i residents and visitors engaged in marine sports and work, shark incidents have averaged around 1.5 per year in the last 40 years, compared with an average of around 28 attacks per year world-wide.

### When sharks do attack people, what kinds of sharks are involved, and what prompts these attacks?

Only a few species world-wide have been implicated in fatal attacks on people. These include the most sensational and fear-inspiring White Shark (commonly called the "great white"), as well as the Oceanic Whitetip, the Tiger, and the Bull Shark. Other species to be wary of include the Blacktip Shark, Blacktip Reef Shark, Gray Reef Shark, Galapagos Shark, Shortfin Mako Shark, and Great Hammerhead Shark.

Of the few encounters with sharks that result in fatalities, most may be attributed to "miscommunication" between swimmer or diver and shark. Sharks are, in large measure, guided by instinctively recognized signals: the spastic thrashing of a wounded fish; the distinctive smell of blood or other body fluids; the flailing appendages of weakened prey. If a person inadvertently produces these signals, and a shark in the area senses them, an encounter may ensue. A few shark incidents have been analogous to encountering an aggressive dog that bites to discourage an intruder. From records of shark attacks, it becomes clear that people are not a usual item on sharks' menus.

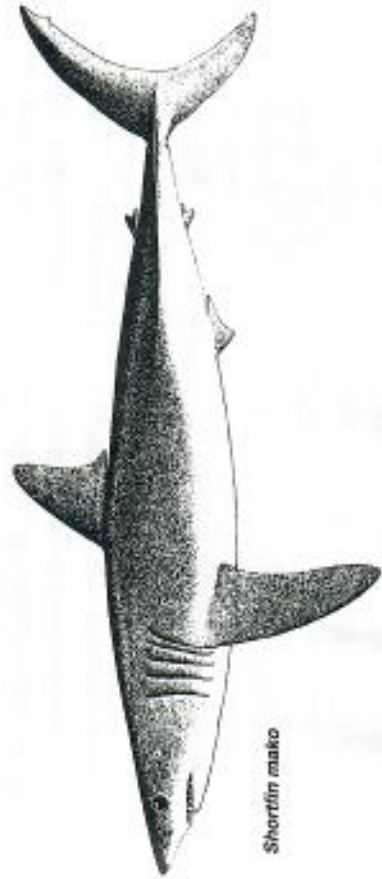
### What can swimmers do to avoid a shark attack in Hawai'i?

Given the rarity of shark encounters in Hawai'i, it seems unnecessary for a swimmer to do anything special to ward off sharks. Historically, swimmers have been advised to avoid swimming alone; to wear low-contrast clothing (that is, bathing suits that blend with one's skin color so as not to provide a visually stimulating high-contrast target for sharks); to avoid wearing shiny jewelry that might reflect light in visually stimulating ways; to avoid wild splashing and erratic swimming; to stay close to shore and away from murky areas and deep channels; and to avoid swimming at night.

Keep in mind that sharks *are* in Hawaiian waters and any action that creates the signals that sharks find attractive should be avoided.



Bull shark



Shortfin mako

**Aren't surfers at greater risk than swimmers? Is there anything they can do to protect themselves?**

Although statistics indicate more shark incidents have involved swimmers than surfers, there are far more swimmers in our waters than surfers, and proportionally, surfers are at greater risk. From below, surfers (especially those on short boards), may resemble seals or turtles, normal prey of sharks. Also, some sharks feed just outside the wave zone, chasing fast-moving fishes, so a surfboard ripping through a wave might stimulate certain sharks to attack.

It seems sensible to understand these dangers and to minimize them by getting to know a surfing area well and periodically scanning for sharks as well as for great waves. If you see a shark, paddle calmly toward shore; don't try to outsurf the shark. Sharks can burst-swim much faster than a surfer can travel.

**What about divers and people who are spearfishing?**

In Hawai'i, divers who see sharks are probably not in danger, unless the shark is behaving aggressively towards them. When diving using SCUBA in shark-infested waters, the safest procedure is to dive closely with someone else, each watching out for the other. Most sharks will inspect multiple divers but will rarely attack. In most cases, a shark will simply swim close enough for a good look, then swim off without returning. After such an encounter, divers should look around once in a while to see if the shark keeps returning. If it does, the divers should leave the water as calmly and quickly as possible. Some of the reef species, such as the Whitetip Reef Shark, are not aggressive except when disturbed, but all sharks should be given a wide berth.

Spearfishers often place themselves at risk by keeping bags of bleeding or struggling fish tied to their bodies. It's wiser to tie the bag to a float and to tow the float on a long line. If a shark appears and attacks the bag, the diver or snorkeler should accept the loss and swim calmly and deliberately to shore.

**What about shark repellents and other self-defense methods?**

Some have recommended fending off sharks with prods, striking sharks on the nose with a club or a fist, or using weapons against them. Unless such means are absolutely necessary, it is better to swim away calmly toward shore. Most sharks will leave you alone. The most effective weapon against sharks is the McNair powerhead, a pole spear with a specially manufactured explosive charge. (This device has been out of production for a number of years.) The next best is the shark prod, as used by Jacques Cousteau's divers.

The best survival device for someone stranded at the surface of the ocean, too far out to swim to shore, is a shark bag developed by C. Scott Johnson. This large plastic bag, filled with water and supported by its flotation ring around the opening, provides safe haven for a swimmer in a life vest. Sharks can neither see nor smell the swimmer, nor sense any movement, since the bag encases body fluids and reduces the vibrations of the swimmer. The bag is black so as to be unattractive to a shark and has no corners for the shark to bite. To the shark, the bag appears as a large floating buoy. Unfortunately, the swimmer is at the mercy of ocean currents, as no directional swimming is possible while in the bag.

A chemical method of protection has yet to be successfully developed. A flatfish found in the Red Sea called the "Moses Sole" has a chemical defense against sharks—a toxin, released just as a shark is about to bite, that affects the gills of the shark and causes it to break off the attack. Synthetic compounds similar to the sole toxin have been developed, tested, and shown to be more effective against sharks than the original toxin, but these are not feasible for normal use. In the ocean, too much of the chemical would have to be carried (and properly dispersed) to achieve a suitable level of protection.

**What should I do if bitten by a shark?**

Try not to panic. In many recorded cases, a shark has bitten only once, perhaps to test the suitability of the prey or to incapacitate it, letting it bleed to death before the shark returns to feed. Despite such bites, victims have been able to swim slowly and steadily to shore or to defend themselves (repeatedly hitting the shark's snout, for example) until help arrived. People rescuing shark attack victims have rarely, if ever, been bitten, even in those few cases where a shark continued the attack.

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### Hawaiian Shark Traditions

Rowland B. Reeve

In the Hawaiian language, the general term for shark is *manō*. Specific species were named for their outstanding characteristics, such as the Thresher Shark, *manō bi'ū ka* (literally, "tail-hitting shark"). The Whitetip Reef Shark was named *manō lā'ā kea* ("white-fin shark"). As these names indicate, the Hawaiians were well acquainted with sharks and keenly observant of them. Sharks had many uses in ancient Hawaiian society and figured prominently in its religion, legends, and oral literature.

A number of the shark species found in local waters were caught and eaten by the early Hawaiians. Those most commonly captured were the *manō kīhikīhi* (hammerhead), the *lā'ā kea*, and the *nīnibi*, a large gray man-eating shark. (In some accounts, it seems clear a White Shark is being described, while in others a Tiger Shark fits the story better.) The *manō kīhikīhi* and small *lā'ā kea* were often caught in nets, while the larger *lā'ā kea* were taken with special large hooks (*mahele manō*) that range up to almost 30 centimeters (12 inches) in length. The hooks were usually carved of hardwoods such as *nīnibi*, *koati*, or *'āweawe* and were often tipped with bone points. In the Bishop Museum collection are two rare shark hooks carved completely of bone, possibly whale bone. Shark hooks were usually baited with chunks of pig meat and trolled behind a moving canoe. Once a shark had taken the hook, hauling it in often required two or more men.

Catching sharks in nets or on hooks was dangerous work. Far more dangerous, however, was the sport of *kūmanō* (shark roping). In ancient times, this technique was used in capturing the man-eating *nīnibi*. Because of the courage and skill required to undertake it, *kūmanō* was commonly regarded as a sport of chiefs.

To catch the *nīnibi*, a net bag filled with baked or decomposing flesh was dragged through the water behind a canoe. The scent of this bait served to attract any sharks in the vicinity, and when a shark did appear, it was fed more meat until it lost its fear of the canoe and swam in close. Often *'āweawe*, a mild narcotic, was mixed with the pig flesh to stupefy the shark. Once it was close alongside, a noose was slipped cautiously over its head and down around its body. During this process, care had to be taken to keep the palms of the hand turned

away from the shark, as it would snap at anything white. When the nose was in place, it was drawn tight, and the shark was dragged into the shallows, where it was stranded and killed.

The men of O'ahu were said to be famous for catching sharks in this manner. Hawaiian historian Samuel Kamakau, writing in the 1870s, mentioned that "I have seen men skilled in herding sharks riding a shark like a horse, turning the shark to this side and that until carried to shore, where the shark died."

According to Hawaiian custom, the flesh of the *ninohi* shark was *kapu* (forbidden) to women. This was but one of many foods, including certain bananas, coconuts, and pork, that women were not allowed to eat.

The ancient Hawaiians not only ate *manō*, they also used sharkskin and teeth for making tools and other artifacts. Captain Portlock, an English voyager who visited the Islands in 1787, wrote that on Kauai: "I found that sharks were esteemed valuable, as they answered a variety of purposes; they salt the shark [meat], and seem very fond of it, the skin serves as a cover for their drum-heads, and the teeth they fix in wooden instruments which they use as knives."

Thin but immensely strong, sharkskin was ideal for use on *pahu*, large wooden drums used in temple ceremonies and in accompanying performances of the *hula*, the traditional dance of the Islands. Being naturally rough, it also served very well as an abrasive, fulfilling the same function as modern sandpaper. The ancient Hawaiians used it to polish bowls and wrapped it around wooden handles to form rasps for fine woodworking.

Shark teeth, designed by nature for piercing and tearing flesh, furnished the Hawaiians ready-made cutting tools. Often they were mounted on wooden handles and used as knives or awls. Shark teeth were also incorporated into weapons and ritual objects. Rows of teeth were set along the edges of wooden clubs or lashed together with cord to form a particularly nasty local equivalent of brass knuckles. One of the few surviving Hawaiian feather gods, or *ʻaumakua hula manua*, has a mouth rimmed with shark's teeth.

Sharks played a conspicuous role in Hawaiian mythology and religion. Among the ancient Hawaiian's innumerable lesser gods were many who appeared in the form of sharks. One such shark god, Kūhaimoana, is said to have been thirty fathoms long, with a mouth as big as a thatch house. He was the king shark of the broad oceans and lived in deep waters near Kāʻula islet, off Ni'ihau.

Two other shark deities, the goddess Ka'ahupāhau and her brother Kahi'ukā, are said to have lived in a cave at the entrance to



*Pahu heiau* with sharkskin membrane. This large temple drum in Bishop Museum was associated with Kamehameha I and known by the personal name Naniuaola.



Shark-tooth club.

Shark-tooth hand weapon.



Pū'uloa, the bay now known as Pearl Harbor. Friendly to humans, they were fed by the people of Ewa and guarded them against man-eating sharks. When a newly constructed dry dock collapsed at Pearl Harbor in 1914, many believed that the shark guardians of the basin were responsible, and the damaged structure was never rebuilt, being replaced instead by a floating dock. One of these shark guardians is remembered in a Hawaiian proverb about wrongdoers who try to pass blame onto others:

Hō'ahewa nā niuhi iā

Kā'ahupā hau.

*The man-eating sharks blamed*

*Kā'ahupā hau.*

Evil-doers blame the person who safeguards the rights of others.

The most celebrated of the ancestral shark gods (*manō kamūpa'a*) was Kamohoali'i, elder brother of the volcano goddess Pele. It was he who piloted the canoe that brought Pele from Kahiki, the land of her birth, to the shores of her new home in Hawai'i. Kamohoali'i had his primary place of residence at Kilauea, on a cliff overlooking the crater of Halema'uma'u. This place was deemed so sacred that not even Pele dared blow smoke across it. Legend relates that Kamohoali'i also had a home in a cave on the island of Kaho'olawe. Among the many shrines built to honor him is one at Hā'upu Bay on the north coast of Molokai.

Sharks were also regarded as *āumākua*, the family or personal gods whom the ancient Hawaiians looked to as guardian spirits, protecting the various members of the *ōhana* (extended family). These ancestral gods often manifested themselves in physical form, taking on the appearance of a shark or certain other animals or plants, enabling their descendants to recognize and interact with them. Among fishing families, it was not uncommon for an *āumākua* to take the form of a shark, and any shark that had been recognized by its *ōhana* as an *āumākua* was treated as an honored member of the family. It was cared for by a *kāhū*, or "keeper," who fed it daily, often offering it such delicacies as roast pig and *āwa*.

It is said that such a shark *āumākua* helped its *ōhana* by driving fish into the nets and by protecting any family member whose canoe was swamped or capsized. Many stories exist of men and women who have been saved from drowning by the intervention of their shark

*āumākua*. Anyone born into an *ōhana* that had a shark as its *āumākua* was forbidden to eat shark flesh or to use tools, weapons, or images made with shark teeth or skin.

Martha Beckwith, a folklorist who grew up in the islands during the early years of this century, collected many stories of sharks and shark encounters for her book *Hawaiian Mythology*. Among these is one concerning a family that lived in the Kā'u district, on the island of Hawai'i (italics and diacritical marks added):

It is related that a girl of thirteen years of age, living at Waikapuna, a long sandy beach directly below Nā'alehu, Kā'u, dreamed that a lover appeared to her out of the ocean. Every morning when she told her parents this dream her father thought she had allowed someone liberties and wanted to conceal it, so he kept her carefully guarded. After a time the girl gave birth to a shark. Her parents recognized this as the offspring of an *ākua manō* (shark god) called Ke-'i'i-kau-o-Kā'u, a cousin of Pele, and did not hold the girl responsible.

The young mother took the baby, wrapped it in green *pohākea* (a coarse seaweed) and cast it into the sea. The young shark was always recognizable by its green coat, and became the *āumākua* of that particular family. From that time they were careful not to partake of either shark flesh or *pohākea* moss. Swelling of the abdomen would have followed the breaking of the shark taboo; incurable sores attacking the mouth, the breaking of the seamoss taboo.

As the shark never ate human flesh, it was a favorite in the neighborhood. One day a stranger, Kahikina by name, went out fishing and was attacked by two sharks. When he cried out for help, he saw a small green shark coming toward him with great speed, which quickly attacked the man-eaters, slashing them with its tail until they fled. It then slipped under the canoe and carried it safely to the shore. So grateful was Kahikina that he returned next day with a huge *āwa* root as offering and he also cleaned from the shark's back the barnacles and pebbles which had accumulated there. Ever after that the shark and the man became great friends. The shark would chase schools of fish toward the shore and all that the man caught he would divide between them.

Many local legends tell of men who could transform themselves into sharks. These *manō kānaka* (shark-men) were usually man-eaters who preyed upon unsuspecting bathers swimming in the waters near their home. Often a "wereshark" succeeded in passing himself off as a simple farmer or fisherman, ravaging swimmers for years before his identity was discovered. Even in human form the mouth of a *manō kānaka* was visible between his shoulder blades, so shark-men always wore *kapa* cloaks to conceal their true identity.



Such was the case of Kawelo, a shark-man who lived in Mānā on the island of Kaua'i. When in human form, he had not only a shark mouth on his back but also a tail attached to the lower part of his body, both of which he hid beneath a long cloak of *kapa*. Kawelo's house lay alongside the path to the beach, where he could keep an eye out for people wandering down to swim. As soon as a traveler went by on his way to the ocean, Kawelo hurried down to the water and there, assuming his shark form, indulged his taste for human flesh. It is said that the tender flesh of children was his favorite food.

Eventually, the disappearance of so many bathers began to raise suspicion. On consulting a soothsayer, the local people were informed that their neighbor Kawelo was actually a shark-man, and acting on the soothsayer's advice, they spread an immense net of great strength around his favorite feeding place. Lured into assuming his shark form, Kawelo was captured in the net and thrown into a great oven to be cooked alive.

Another legendary shark-man was Manōnihōkā hi, who lived along the shore between La'ie and Kahuku on O'ahu. Whenever he saw a woman going to the sea to fish or gather *limu* (seaweed), he would warn her against sharks, then come himself, in his shark form, and kill her. Suspecting that a *manō kōnaka* was responsible for the death of these women, the local chief gathered together all the men in the area. Each was examined for the sign of the shark. When Manōnihōkā hi refused to remove his *kapa* cloak, it was torn from his shoulders, revealing the mouth of the shark on his back. After a great struggle, he was captured and killed.

A large stone slab in a courtyard at Bishop Museum is said to be the transformed body of a shark-man who was killed by fishermen while attacking bathers at Kohala on the Big Island.

Many Hawaiian proverbs and poetic sayings about sharks appear in *Ūkēlo No'ōau*, a book compiled by Mary Pukui, one of the foremost modern translators and interpreters of Hawaiian lore. Among these are:

He manō holo 'ā ina ke ali'i.

*The chief is a shark that travels on land.*

The chief, like a shark, is not to be tampered with. [It may also mean that a chief devours the wealth of the land as ravenously as a shark devours the fishes of the sea.]

Ke pau ka moa, kā kā i ka nuku;  
ke pau ka 'iole, ahu kuka'e;  
ke pau ka manō, lana i ke kai.

*When a chicken finishes [eating] he cleans his beak; when a rat finishes, he leaves a heap of excreta; when a shark finishes, he rises to the surface of the sea.*

A description of the table manners of people. Some are clean like the chicken; others are unclean and careless, like the rat; and still others, like the shark, loll around without offering to help.

Pau Pele, pau manō.

*[May I be] devoured by Pele,*

*[may I be] devoured by a shark.*

An oath, meaning "If I fail...." It was believed that if such an oath were not kept, the one who uttered it would indeed die by fire or be eaten by a shark.

Uliuli kai holo ka manō.

*Where the sea is dark, sharks swim.*

Sharks are found in the deep sea. Also applied to men out seeking the society of the opposite sex.

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**Sharks: A Diver's Perspective**

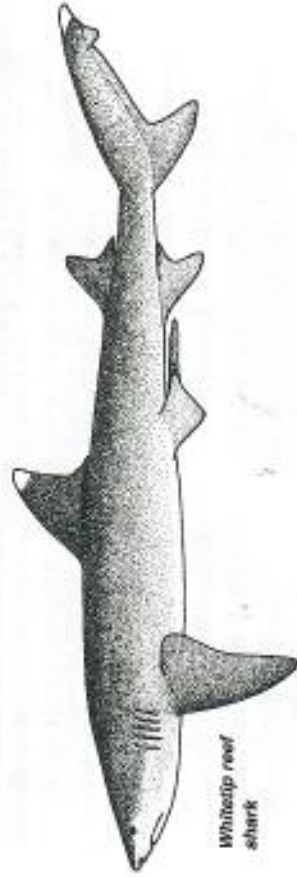
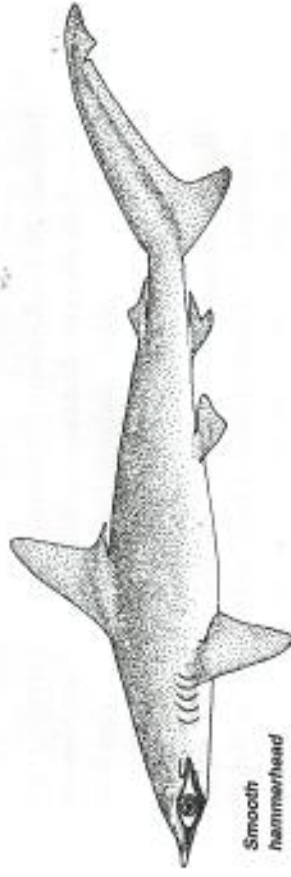
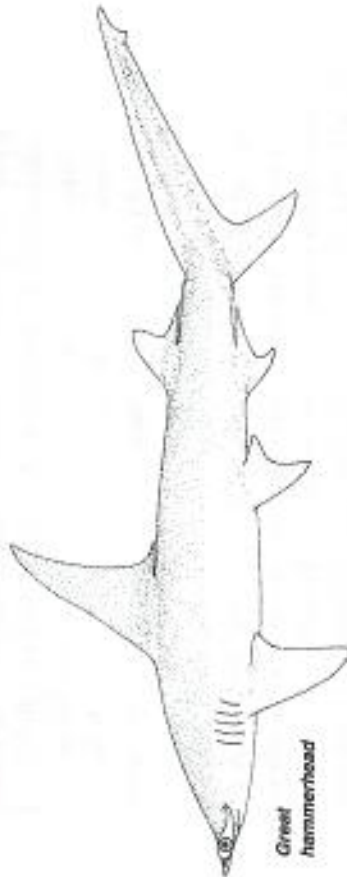
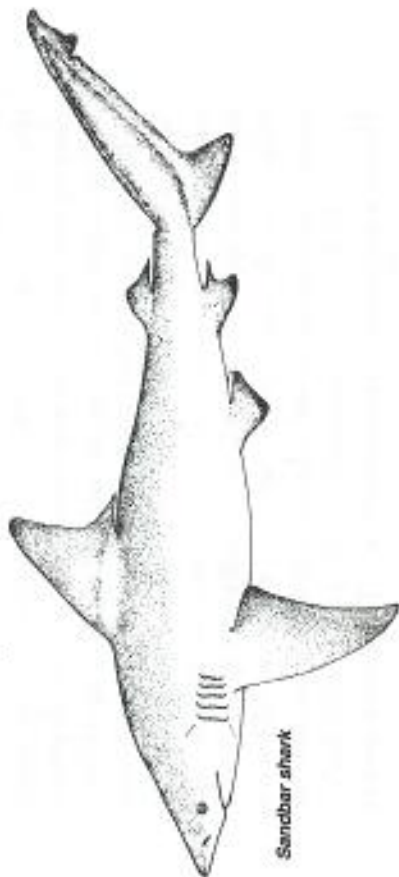
Richard L. Pyle

Compared with coral reefs of many islands elsewhere in the Pacific, Hawaiian reefs do not harbor large populations of sharks. While divers swimming through the tropical waters of Micronesia or the Central Pacific may encounter several sharks on a single dive, shark encounters are much rarer in subtropical Hawai'i. At places such as Kalama (Johnston) Atoll or Kiritimati (Christmas) Island, for example, I typically see from five to ten sharks in a single dive, but in fifteen years and thousands of dives on Hawaiian reefs, I have observed fewer than thirty sharks.

There are a number of possible explanations for this paucity of sharks. Perhaps our cool, northern waters are less than ideal for many species of reef sharks. Reports from long-time divers in Hawai'i indicate, however, that populations of sharks were greater two decades ago than they are now. This seems to indicate that intense fishing pressure or pollution over the years has reduced the availability of food that sharks need to survive. It is even possible that sharks themselves have been over-fished. Whatever the reason, an encounter between a diver and a shark around the main Hawaiian Islands is now an uncommon event.

When it does happen, the species of shark involved is most frequently the Whitetip Reef Shark. This relatively docile shark seldom exceeds 1.8 meters (6 feet) in length. This species is usually encountered by divers in shallow to moderate depths (9 to 24 meters, or 30 to 80 feet) in areas of strong basalt reef formations. Unlike most other species of sharks, the Whitetip Reef can get oxygen by actively pumping water over its gills, so it does not have to constantly swim in order to breathe. Instead it spends much of its time resting in caves or under ledges, occasionally in groups of two or more. At certain localities throughout the islands, "resident" Whitetip Reef Sharks have been seen by divers again and again, sometimes over a period of years. This shark is generally not aggressive (unless speared and bleeding fish are in the area) and will almost never bother a diver if unprovoked, but prudence is recommended, as with all potentially dangerous marine life.

Perhaps the next most frequently encountered shark in Hawai'i is the Scalloped Hammerhead Shark. This unusual species is

Whitetip reef  
sharkSmooth  
hammerheadGreat  
hammerhead

Sandbar shark

most readily identified by the broad lateral extensions on its head, with a slight depression in the middle of the leading edge. Although this classic "hammer" head is not always obvious when viewed from the side, the species is also distinctive in having an extremely tall dorsal fin and a shiny, bronzelike body color. The Scalloped Hammerhead is most frequently seen by divers either along the outer reef slopes (such as off the Kona Coast of Hawai'i or in the vicinity of Manana Island) or in calm, protected inshore bays and estuaries (such as Ka ne'ohē Bay). They are most often encountered in the latter type of habitat during the spring and summer months, when adult females move inshore to bear their young. Although juvenile hammerhead sharks are caught by the hundreds in nets and on hook and line in these areas, they are almost never seen by divers; virtually all confrontations are with adults.

The Scalloped Hammerhead attains a relatively modest maximum size of about 3 meters (10 feet), but two larger species of hammerhead also occur here. The Smooth Hammerhead Shark has been reported at lengths up to 4 meters (13 feet), and the Great Hammerhead Shark may exceed 6 meters (20 feet). One of the three largest flesh-eating fishes on earth, the Great Hammerhead is rare in Hawai'i, generally inhabiting deeper, more pelagic waters, but it has been occasionally observed by divers off the islands of O'ahu and Hawai'i. None of the three hammerhead species are usually aggressive, but a few divers have had harrowing encounters, so caution in their presence is strongly advised.

Nearly as common as the Scalloped Hammerhead Shark is the Sandbar Shark. Often misidentified as a Gray Reef Shark, this species is distinguishable by its relatively large dorsal fin, somewhat flattened snout, and absence of black markings on its fins or tail. This is the shark most often seen off Waikiki, along the Kona Coast of Hawai'i, at Ewa Beach, or outside Ka ne'ohē Bay. The Sandbar Shark was once abundant off the Wai'anae coast of O'ahu but now is seldom seen in that area. In most cases, it will not bother divers unless there is blood (such as from a speared fish) in the water.

Somewhat less common, but perhaps the most dreaded of all sharks that frequent Hawaiian waters, is the Tiger Shark. Attaining a length of 6 meters (20 feet) or more, this species is probably responsible for more attacks on humans in Hawai'i than any other. Although it is often considered a scavenger, it also feeds on sea turtles, monk seals, and sea birds. This species is especially abundant in the Northwestern Hawaiian Islands, where its normal prey are relatively plentiful. During the summer months at Midway Island, when large numbers of albatross chicks learn to fly, Tiger Sharks are frequently seen feeding on

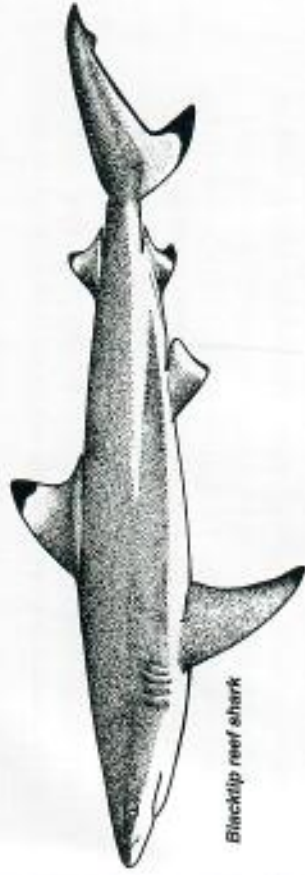
In Hawai'i, many Tiger Shark attacks are directed toward surfers, whom the sharks probably mistake for seals or turtles. Tiger Sharks are occasionally encountered by divers, especially off the Wai'anae Coast of O'ahu, in the vicinity of Ka'ena Point, off the Kona Coast of Hawai'i, and in the channels between islands. Once in a while, they have been reported or captured around inshore areas such as Ka ne'ohu Bay and Kewalo Basin. Tiger Sharks seldom attack divers, but these large sharks should be avoided if seen.

Another shark species sometimes encountered by divers in Hawai'i is the Galapagos Shark, which like the Sandbar Shark is also frequently misidentified as a Gray Reef Shark. This species is distinguishable from the Gray Reef Shark by the shape of its dorsal fin (broader, with a vertical posterior margin) and its larger size—3 to 3.6 meters (10 to 12 feet) in length. The Galapagos Shark is usually found in deep, offshore, more pelagic regions such as the Penguin Bank off the west coast of Moloka'i, and thus it is rarely encountered by divers except those who frequent outer reef areas. This is reportedly an aggressive species, and divers should steer clear of them if possible.

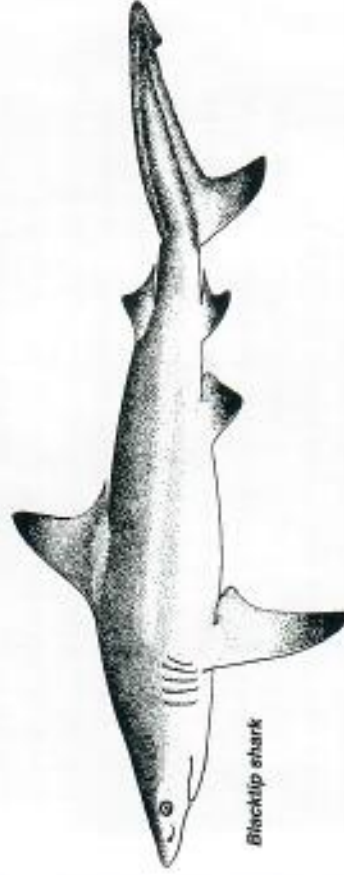
Gray Reef Sharks themselves are strangely uncommon around the main Hawaiian Islands, although they are by far the most abundant across the tropical Pacific. In Hawaiian waters this shark appears to prefer small islands, such as Molokini Crater off Maui and the Northwestern Hawaiian Islands, rather than the larger main islands. This species can be aggressive towards divers and before attacking often exhibits a "posturing" display characterized by lowered pectoral fins, arched back, and agitated sinusoidal swimming. Divers who observe any shark displaying such behaviors should calmly but quickly leave the area without hesitation.

Although the above-mentioned shark species are by far the most frequently encountered by divers, they are not the only ones ever seen near the islands of Hawai'i. For example, two species of "blacktip" sharks are observed by divers on rare occasions. These are relatively small reef sharks that can be distinguished from others by the black markings on the dorsal fins. One, the Blacktip Reef Shark, is considered more skittish than the other and is distinguished by a band of cream coloration beneath the broad black tip of its first dorsal fin. The other, the Blacktip Shark, has small black areas on the tips of its fins. This species is more likely to approach a diver.

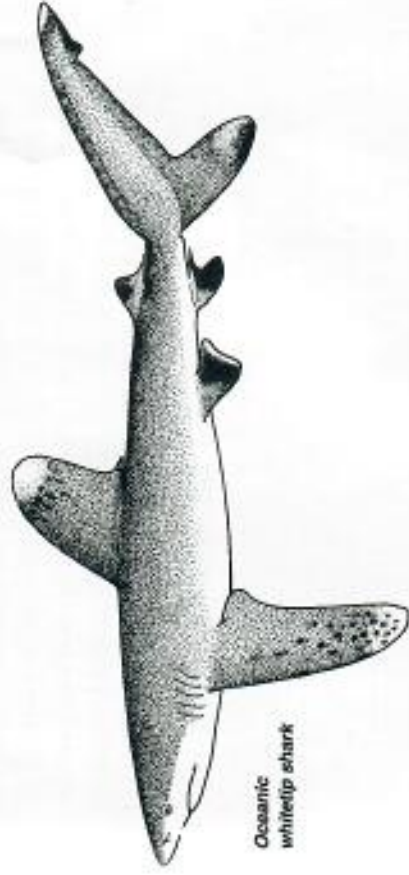
Divers who find themselves in offshore pelagic waters such as in the channels between islands may also encounter Oceanic Whitetip Sharks or Silky Sharks. The former are characterized by large, rounded fins with speckled white tips, and the latter by an extremely elongated body and long, pointed snout. These sharks are perhaps most famil-



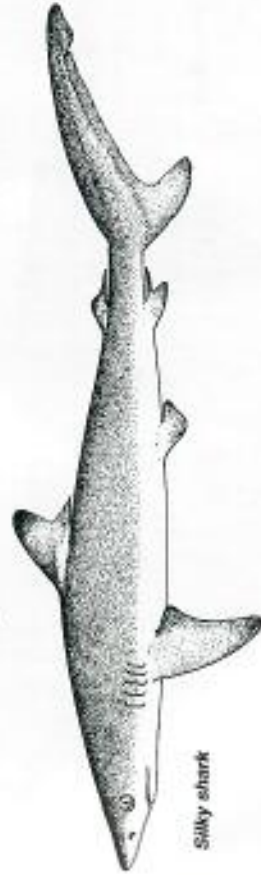
Blacktip reef shark



Blacktip shark



Oceanic whitetip shark



Silky shark

iar to deep-sea fishermen, who sometimes land only the head of a large fish, the rest having been devoured by one of the aforementioned pelagic sharks. Both these species can be very aggressive and divers should retreat to the relative safety of their boats if either is seen.

A few, very lucky divers in Hawai'i have experienced one of the greatest thrills in diving—an encounter with a Whale Shark. These largest of all fishes feed on tiny plankton and pose no threat to divers. They are occasionally sighted off of the islands of Lana'i, Kaho'olawe, and Hawai'i, and one was known to frequent an area off Makapu'u, O'ahu, several years ago.

Fortunately, the notorious White Shark, one of the most feared creatures on earth, is exceedingly rare in Hawai'i. They have been captured around these islands, however, both by ancient Hawaiians and in more modern times, and they have been seen by divers on rare occasions. White Sharks, which are responsible for several fatal attacks on humans in California each year, may be especially prone to attack humans in Hawaiian waters because the animals that would be their natural prey, mostly monk seals, are very scarce.

Divers should view all sharks with caution, for they are all capable of inflicting serious wounds, but at the same time, an encounter with a shark is no cause for panic. Divers are advised to cautiously observe any sharks they may see and under no circumstances to do anything to provoke an attack, such as lunging at, grabbing, chasing, spearing, or cornering a shark. They should leave the water calmly but immediately if a shark appears aggressive, makes close passes, or if blood (either from the diver or from speared fish) is in the water. Otherwise, divers who see a shark in Hawai'i should consider themselves fortunate to have witnessed one of the most graceful creatures of the sea.



White shark