Shark Exhibit Design

Designing an aquarium exhibit for a species is not as easy as picking what you like. Each and every animal has requirements for their habitat and space that must be met in order to create a healthy environment for them. In this activity, you will become the exhibit designer, picking a shark species and setting up the space to meet their needs.

Instructions

Using each of the following sections, write down or circle your choices to remember what you have selected:

1. Pick the shark species you want to display.
   _____
2. Select the habitat you will create for the shark to live in.
   _____
3. Select the size of tank you will build.
   _____
4. Choose the shape of the tank.
   _____
5. Decide which temperature range the water temperature will be.
   _____
6. Choose up to two different types of animals to display with your shark.
   _____

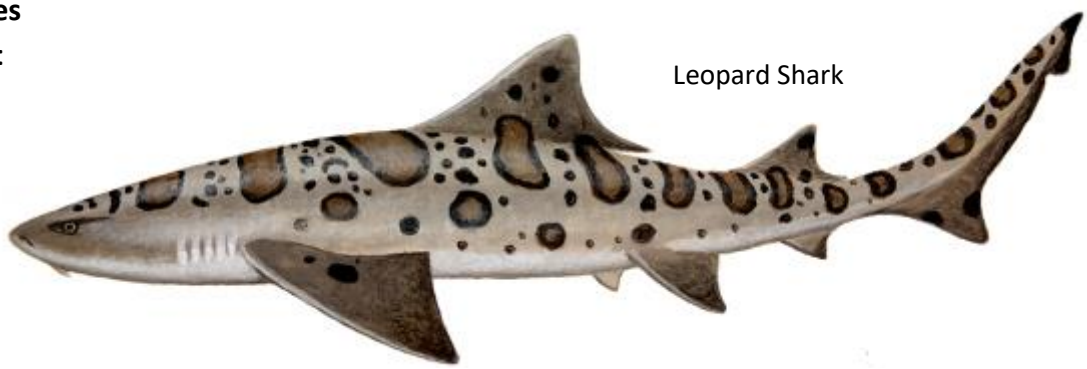
After you have made your selections, go to the last section and read the natural history and biology of the shark species you chose. Answer the following questions:

- Did the habitat you chose fit with the habitat your shark is naturally found in? If not, which habitat would be better?
- Would the size of the tank you picked be large enough for your shark? If not, which size would be a better fit?
- Would the tank shape you selected work well for the shark to get enough exercise, based on how much they move in their natural environment? If not, which shape would be better?
- Did the temperature range you selected fit with what your shark species naturally lives in? If not, which range should it be?
- Considering the diet of the shark, would the shark be likely to eat any of the animals you selected to live in the exhibit with them? Would other animals be more likely not to be eaten by the shark?
- Would your shark species be able to live its whole life in your exhibit? Would you need to move them out if they grew too big?

You can now see that exhibits must fit the needs of the animals to keep them happy and healthy!

Shark species

Choose one:



Leopard Shark

Sand Tiger Shark

Whale Shark

Bonnethead Shark

Wobbegong Shark

Habitat

Choose one:

Open ocean – deep water

Coastal waters – under pier

Coastal waters – kelp

Coastal waters to open ocean - shipwreck

Coastal waters – coral reef bed

Tank Size

Choose one:

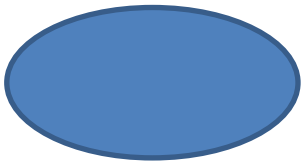
	Depth (in feet)	Width (in feet)	Length (in feet)
Tank 1	5	6	10
Tank 2	10	20	15
Tank 3	18	60	80
Tank 4	35	80	100

Tank Shape

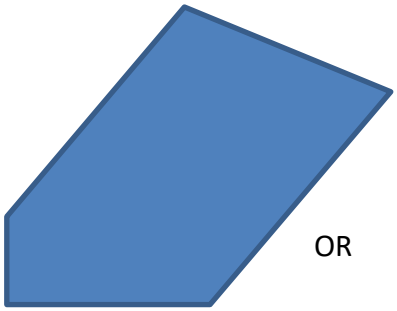
Choose one:

- Rectangle

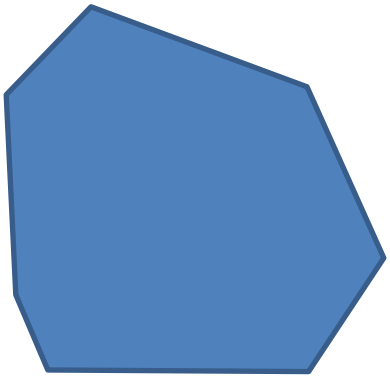
- Oval



- Polygon



OR



Temperature of Water

Choose one:

- Tropical – 75-80° F / 23-27° C
- Temperate – 60-65° F / 15-18° C
- Polar – 38-44° F / 3-7° C

Tankmates

Choose two:

- Coral reef and anemones
- Crabs, snails, and sea stars
- Fish
- Stingrays
- Sea turtle
- Other shark species

Spotted Wobbegong

Orectolobus maculatus

This flat, wide carpet shark has a stocky body and stout tail, with wide, lobed fins. There are dermal lobes along its mouth and sides of its face like a mustache that act as camouflage as well as bait for prey. It is a sluggish, nocturnal shark that likes to live at the bottom of reefs and ambush small bony fish and invertebrates. This wobbegong can be visually identified from other wobbegongs because it is usually a golden sandy to light green color with a dark saddle across its body and a white irregular ring pattern.

Conservation

The spotted wobbegong is currently assessed as "Near Threatened" in waters off New South Wales due to serious declines in population numbers in that region and "Near Threatened" throughout the remainder of its range by the World Conservation Union (IUCN) Red List. The IUCN consists of a global union of state, governmental agencies, and non-governmental organizations in partnership whos goal is to assess the conservation status of different species.

Geographical Distribution

The spotted wobbegong is native to the western Pacific Ocean, particularly in Japanese and Australian waters and in the South China Sea.

Habitat

Occurring on continental shelves, from the intertidal zone down to 360 feet (110 m), the spotted wobbegong is commonly found on or around reefs, under piers, and on sandy bottoms. There have been many sightings of this shark in water barely deep enough to cover its entire body. It is considered sluggish and inactive and is often found resting on the ocean floor.

Biology

Distinctive Features
The body and head of the spotted wobbegong is flattened. The mouth is located in front of the eyes and has a protruding jaw that aids in the capture of prey. It has nasal barbels and 8 to 10 dermal lobes around the mouth and on the sides of the head. The first spineless dorsal fin starts over the pelvic base, and the anal fin originates behind the second dorsal fin origin. The caudal fin is much shorter than the rest of the body, and the pectoral and pelvic fins are broad. Spotted wobbegong sharks are also characterized by the presense of large spiracles, nasoral and circumnarial grooves, and the absence of caudal keels and ridges on the body. While other species of wobbegong are similar in appearance, the pattern of coloration is distinctive for the spotted wobbegong.

Coloration
The spotted wobbegong is generally pale yellow or greenish brown with large, dark saddles down the center of its back and many small, white O-shaped markings over its entire back. The pattern serves as camouflage.

Dentition
The teeth of the spotted wobbegong are described as enlarged fangs; they are long, slender, and sharp. There are two lateral rows in the upper jaw and three lateral rows in the lower jaw.

Size, Age, and Growth
The average size of the spotted wobbegong at birth is 8.3 inches (21 cm) total length. Most adult males mature at 23.6 inches (60 cm) and may reach a maximum length of 126 inches (320 cm) total length. However, the average size of an adult male is 59 to 71 inches (150-180 cm) total length.

Food Habits
Favorite foods of the spotted wobbegong include invertebrates such as crabs, lobsters, and octopi as well as bony fish such as sea bass and luderick. This shark is nocturnal, hunting at night and resting during the day. *O. maculatus* can extend its reach during prey capture by as much as 30% of the nasal distance from its anteriormost point to the anterior edge of the pectoral fin. This is equivalent to the combined length of the head and branchial arches. The spotted wobbegong often sits at the bottom and waits for prey to wander near its mouth. Prey have even been known to nibble on this shark's tentacles before being eaten. Other times this shark has been observed to slowly sneak up on its prey from a long distance.

Reproduction
The spotted wobbegong is an ovoviviparous species, giving birth to a large number of full term embryos. One female was reported to give birth to a record of 37 young. The young measure 8.3 inches (21 cm) total length at birth. During breeding season, the male is attracted to the female by chemical pheromones that she releases into the water. In the mating process, the male often bites the female in the region of the gills and inserts one clasper into the cloaca to deliver sperm.

Predators
Any large fish or marine mammals are potential predators of the spotted wobbegong.

Sand Tiger Shark

Carcharias taurus

These large Lamnidae sharks grow to around 10 feet long, and have rounded triangular fins except for their asymmetrical caudal fin with an enlarged top lobe. They are classically gray to light brown on top and light below, but are often scattered with darker reddish brown blotches also. They prefer hunting fish and invertebrates inshore near reefs, surf, and shallow bays, and migrate north-south with the seasonal temperature changes. Sand tiger sharks are believed to produce one or two pups every few years because of intrauterine cannibalism, where the largest pup eats the smaller ones before birth.

Conservation

Currently sand tiger sharks are regulated in the commercial longline shark fishery on the east coast of the United States by the National Marine Fisheries Service where it is identified as a prohibited species. Any sand tiger caught must be immediately released with minimal harm to the shark. The World Conservation Union classifies the sandtiger as "Vulnerable", which means it faces a high risk of extinction in the wild in the medium term future. This is due to an observed, estimated, inferred or suspected reduction in the population of at least 20% over the last 10 years or three generations. Since the sand tiger's reproductive rate is very low, only one or two pups per mature female every one or two years, the population needs to be closely monitored. Catch rates of populations in Australia and South Africa have shown declines due to commercial fishing, spearfishing and beach meshing. Even with status as a protected species, the recovery of the sandtiger shark off the coast of Australia has been very slow.

Geographical Distribution

The sand tiger shark can be found in most warm seas throughout the world except for the eastern Pacific. In the western Atlantic Ocean it ranges from the Gulf of Maine (U.S.) to Argentina and is commonly found in Cape Cod (U.S.) and Delaware Bay (U.S.) during the summer months. In the eastern Atlantic it can be found from the coast of Europe to North Africa and within the Mediterranean Sea. Its range also extends from Australia to Japan and in the waters off South Africa.

Habitat

Commonly found inshore ranging in depths from 6 to 626 feet (1.8 to 191 m), the sand tiger shark's range extends to a variety of areas including the surf zone, shallow bays, coral and rocky reefs and deeper areas around the outer continental shelves. *C. taurus* is often found on the bottom but can also be seen throughout the water column. The sandtiger is migratory within its region, moving poleward during the summer while making equatorial movements during the fall and winter months.

Biology

Distinctive Features
The sand tiger shark is a large, bulky shark with a flattened conical snout and a long mouth that extends behind the eyes. The first dorsal fin is set back and is much closer to the pelvic fins than the pectoral fins. The anal and dorsal fins are large and broad-based and the second dorsal fin is almost the same size as the first dorsal. Gill

slits are anterior to the origin of the pectoral fins in this species. The caudal fin of the sand tiger shark is asymmetrically shaped with a strongly pronounced upper lobe.

Coloration
Coloration of the sand tiger shark is generally light brown or light greenish–gray above and grayish white below. Many individuals have darker reddish or brown spots scattered on the body.

Dentition
The teeth of the sand tiger shark have prominent narrow cusps with lateral cusplets. The upper anterior teeth are separated by small intermediate teeth. The upper teeth number 44 to 48 and the lower teeth number 41 to 46. The teeth in the corners of the mouth are very small and numerous. The ragged looking teeth give the sand tiger shark a distinct menacing look.

Denticles
Dermal denticles are loosely spaced and ovoid lanceolate shaped with three ridges. The axial ridge is prominent and sharp-edged anteriorly but usually is subdivided and flat-topped posteriorly. In individuals around 3.3 feet (100cm) long denticle sizes are about 0.016 inches (0.4mm) broad by 0.018 inches (0.45mm) long.

Size, Age, and Growth
Average size ranges from four to nine feet with maximum length believed to be around 10.5 feet (320 cm) in females and 9.9 feet (301 cm) in males. Male maturity is reached at 6.3 feet (190-195 cm) at four to five years of age. Female maturity is reached at six years or over 7.2 feet (220 cm) in total length. Individuals in aquariums have lived to be 16 years old.

Food Habits
The diet of this ravenous feeder mainly consists of a wide variety of small bony fish including herrings, bluefishes, flatfishes, eels, mullets, snappers, hakes, porgies, croakers, bonito, remoras, sea robins and sea basses. Other prey items of the sandtiger are rays, squids, crabs, lobsters and other smaller sharks. Cooperative feeding has been observed by schools of sharks surrounding and bunching schooling prey in order to feed on them.

Reproduction
Embryonic development is ovoviviparous with ovophagy and embryophagy occurring in the uteri. Usually only one pup survives in each uteri since the largest embryo ends up eating all of its smaller siblings during gestation. This generally limits litter sizes to two individuals. At 6.7 inches (17 cm) embryos have functional teeth and are feeding and at 10.2 inches (26 cm) they are able to move in utero. Gestation periods are believed to be around eight to nine months long and pups generally measure 39 inches (99 cm) at birth.

Predators
Juveniles are susceptible to predation by larger sharks. Mature individuals have no major predators.

Distinctive Behavior
Since the sand tiger shark is denser than water and lacks a swim bladder like bony fish, it has adopted a behavior that allows it to become neutrally buoyant in the water column. The shark comes to the surface and gulps air, which it holds in its stomach. This allows the shark to hover motionless in the water.

Whale Shark

Rhincodon typus

These sharks are recognizable not just for being the largest fish in the sea, growing longer than 40 feet, but also for their unique pattern of blue-gray to brown coloration with white spots centered between pale horizontal and vertical stripes. They are filter feeders, often swimming near the surface of the open sea, gulping in water and filtering everything from plankton and fish eggs, to crustaceans and schooling fish, to occasional larger prey like squid or tuna. Despite their size, they are considered harmless to humans, and will often interact docilely with divers to the extent of allowing the divers to grab on to a fin and hitch a ride.

Conservation

Some biological characteristics, such as large size, slow growth, late maturation and extended longevity, probably limit recruitment and make whale sharks susceptible to overexploitation. These characteristics also suggest that populations are slow to recover from any overfishing. The whale shark is listed as "Vulnerable" with the International Union for Conservation of Nature and Natural Resources (IUCN), a global union of states, governmental agencies, and non-governmental organizations in a partnership that assesses the conservation status of species. The whale shark is listed by the AFS (American Fisheries Society) as *conservation dependent* (reduced but stabilized or recovering under a continuing conservation plan) in both the U.S. Atlantic and the Gulf of Mexico. However, it is considered *not at risk* in the Gulf of California. In the Maldives and Philippines there is legislation banning all fishing for whale sharks. This protection was introduced because of the possible serious impact that the fishery may be making on whale shark stocks.

The predictable occurrence of whale sharks in a few localities, such as in Western Australia, has led to the development of an expanding tourism industry. In this area the whale shark is a protected species and its tourism has been managed through a system of controls, including the licensing of a limited number of operators tours. In addition, there have been calls from conservation-minded divers worldwide to refrain from riding, chasing, or in any way harassing any large marine animals, including whale sharks. Recently, some observations made on the Ningaloo Reef's whale sharks provided the information that regular diving is a normal behavior of these sharks and not an avoidance reaction during contact with humans. However, the natural variability in whale shark abundance and distribution, the reasons for aggregations at some areas, and the carrying capacity of the industry are still unknown. Consequently, evidence of any impact is difficult to obtain and interpret.

Geographical Distribution

The whale shark has a very widespread distribution, occurring in all tropical and warm temperate seas, except in the Mediterranean. It occurs throughout the Atlantic Ocean, from New York through the Caribbean to central Brazil and from Senegal to the Gulf of Guinea. It also occurs in the Indian Ocean, throughout the region, including the Red Sea and the Arabian Gulf. In the Pacific Ocean it is found from Japan to Australia, off Hawaii, and from California to Chile.

Habitat

In contrast to most sharks from the same order (Orectolobiformes), which are benthic (live on or near the bottom) species, the whale shark is a pelagic (open sea) species. Studies reveal that this shark prefers warm waters, with surface temperature around 21-30º C, marked by high primary productivity (much plankton). It is often seen offshore but commonly comes close inshore, sometimes entering lagoons or coral atolls.

The whale shark is thought to be highly migratory but currently there is no direct evidence to support this hypothesis. Their movements might be related to local productivity and they are often associated with schools of pelagic fish that are probably feeding on the same prey organisms.

Different geographic locations appear to be preferred at various times of the year. Whale sharks alternatively may undertake either fairly localized or large-scale transoceanic migrations, the movements governed by the timing and location of production pulses and possibly by breeding behavior. Seasonal migrations have been postulated for various areas but more information is needed to confirm these patterns. Each March and April, whale sharks are known to be aggregate on the continental shelf of the central western coast of Australia, particularly in the Ningaloo Reef area. A study was done in this area to provide information on the short-term movements and behavior of this species of shark. Whale sharks are thought to migrate to Ningaloo Reef each year to take advantage of the high zooplankton (microscopic animals) concentrations associated with large-scale coral spawning events occurring during the March and April full moons. A few whale sharks were tracked and some behavioral observations were made while snorkeling in the area. The reaction of the sharks to snorkellers varied between ignoring them to slowly diving. At times when water was flowing out from the reef lagoon, possibly transporting potential prey outside the reef, the tracked sharks swam in large circles adjacent to passes in the reef. The whale sharks also made numerous dives throughout the observation period. It appears that these movements, up and down through the water column, were associated with feeding. Whale sharks have smaller livers than most sharks and could conceivably control their buoyancy by swallowing some air as do the sand tiger sharks (*Ondontaspis taurus*).

Whale sharks were also observed near La Paz, Mexico. Researchers reported that when these sharks were not feeding at the surface, they swam practically without the head turning, gulping, and rhythmical opening and closing of the gill slits, seen during feeding behavior. The mouth was held slightly open, and the skin over the gill openings was quivering as water flowed steadily out the gill slits in the typical ventilation of pelagic sharks. Generally, whale sharks are encountered singly but loose aggregations of over 100 animals have been seen, which suggests that schooling activity does occur. Scientists do not know whether sexual segregation, either locally or geographically, occurs.

Biology

Distinctive Features
A streamlined body and a depressed, broad, and flattened head characterize the whale shark. The mouth is transverse, very large and nearly at the tip of the snout. Gill slits are very large, modified internally into filtering screens. The first dorsal fin is much larger than the second dorsal fin, and set rearward on body. The two lobed caudal fin (tail) is semi-lunate in adults; in small juveniles the upper lobe is considerably longer than the lower lobe. The whale shark has a unique "checkerboard" color pattern of light spots and stripes on a dark background.

Coloration
Whale sharks are greyish, bluish or brownish above, with an upper surface pattern of creamy white spots between pale, vertical and horizontal stripes. The belly is white. The function of the distinctive pattern of body mark is unknown. Many bottom-dwelling sharks have bold and disruptive body markings that act as camouflage through disruptive coloration. The whale shark's markings could be a result of its evolutionary relationship with bottom dwelling carpet sharks. Distinctive markings in a pelagic species could be linked to social activities such as postural displays and recognition processes. Another possibility is that these pigment patterns could be an adaptation for radiation shielding, important in a species that may spend a significant proportion of time in surface waters possibly exposed to high levels of ultraviolet radiation.

Dentition
Teeth minute, about 300 rows in each jaw. An individual tooth has a single, hooked cusp. Teeth appear to play no role in feeding.

Dermal Denticles
The whale shark has unique denticles (tooth-like scales structures), each with an extremely strong central keel, no lateral keels, and a tri-lobed rear margin. It would appear that the denticles are hydrodynamically important in its pelagic lifestyle.

Size, Age & Growth
The whale shark is the largest living fish. Maximum size is thought to be 20m. The smallest free-living individuals are from 55cm (21.7 inches) long. Sexual maturity in both sexes may not occur until the sharks are over 9m in length. Age estimates for whale sharks are as high as 60 years, but no one really knows how long this species lives.

Food Habits
Whale sharks feed on wide variety of planktonic (microscopic) and nektonic (larger free-swimming) prey, such as small crustaceans, schooling fishes, and occasionally on tuna and squids. Also, phytoplankton (microscopic plants) and macroalgae (larger plants) may form a component of the diet. Unlike most plankton feeding vertebrates, the whale shark does not depend on slow forward motion to operate its filtration mechanism. Rather, it relies on a versatile suction filter-feeding method, which enables it to draw water into the mouth at higher velocities than these dynamic filter-feeders, like the basking shark. This enables the whale shark to capture larger more active nektonic prey as well as zooplankton aggregations. Therefore, the whale shark may be more dependent on dense aggregations of prey organisms. The denser filter screens of this shark act as more efficient filters for short suction intakes, in contrast to the flow through systems of basking shark. Whale sharks are always seen feeding passively in a vertical or near vertical position with the head at or near the surface.

The whale shark feeds actively by opening its mouth, distending the jaws and sucking. Than it closes its mouth and the water flow out its gills. During the slight delay between closing the mouth and opening the gill flaps, plankton may be trapped against the dermal denticles lining the gill plates and pharynx. The fine sieve-like apparatus, a unique modification of the gill rakers, forms an obstruction to the passage of anything but fluid, retaining all organisms above 2 to 3mm in diameter. Practically nothing but water goes through this sieve. Individuals have also been observed coughing, a mechanism that is thought to be employed to clear or flush the gill rakers of accumulated food particles. Whale sharks move their heads from side to side, vacuuming in seawater rich in plankton, or aggressively cut swathes through schools of prey. Groups of individuals have been observed feeding at dusk or after dark. The density of plankton probably is sensed by the well-developed

nostrils, located on either side of the upper jaw, on the leading edge of the terminal mouth. The frequent turns may keep the whale sharks in the denser parts of the plankton patches, searching and scanning when an olfactory cue weakens on one side or the other. The whale shark's small eyes are located back on the sides of the head. Because of this, vision may play a much smaller role than olfaction in directing the head turns during surface feeding. One live whale shark pup removed from its dead mother was maintained in captivity in Japan. It did not eat for the first 17 days, even though it swam constantly. This suggests that the pup had substantial stores of endogenous (stored) energy.

Reproduction

Historically, there was great scientific debate about the mode of development of whale sharks. It was unclear whether it is oviparous (egg cases expelled from the female's body and hatched on the sea floor) or ovoviviparous (egg cases hatching in the mother's uteri, with the female giving birth to live young). Finally in 1995, an 11-meter female whale shark was harpooned off the eastern coast of Taiwan and 300 fetal specimens, ranging in length from 42 to 63cm, were taken from the two uteri. This discovery proved that the species is a live bearer, with an ovoviviparous mode of development. The egg-capsules of this whale shark were amber colored, with a smooth texture, and possessed a respiratory fissure (opening) on each side. The sex ratio was approximately 1:1. It would appear that female whale sharks give birth as they feed in the rich waters of the Kuroshio Current. It is also apparent that the southeast waters off Taiwan are an important birthing area during summer months. It is believed that the young measure 21.7-25.2 inches (55-64 cm) total length at birth.

Predators

A juvenile specimen was found in the stomach of a blue shark (*Prionace glauca*). Another specimen was found in the gut contents of a blue marlin (*Makaira nigricans*).

Leopard Shark

Triakis semifasciata

This long, slim shark likes the sandy bottoms of bays or estuaries in the eastern Pacific Ocean. It has a broad, short snout, triangular fins, and a notched, asymmetrical caudal (tail) fin. On top it is a silver or bronzed-gray, fading to white underneath, with distinct dark saddles and blotches on its back and sides, as well as on its fins. It generally can be found between 50 and 60 inches long, but can grow up to 7 feet long, eating invertebrates and small fish. Because of the high mercury content of its flesh, there are warnings about consuming this shark.

Common Names

Triakis semifasciata is known as the leopard shark in the US and the UK, and is sometimes referred to as a cat shark. It is also known as leopardhai in Germany, leopardihai in Finland, luipaardhaai in the Netherlands, tiburón leopardo in Mexico, tollo leopardo in Spain, turbarão-leopardo in Portugal, and virli léopard in France.

Despite the fact that the two sharks do not share the same geographic distribution, the zebra shark (*Stegostoma fasciatum*) is sometimes confused with the leopard shark (*Triakis semifasciata*) as both animals are referred to by the common name leopard shark in Australia and South East Asia.

Importance to Humans

Commercial and sport fishermen harvest the leopard shark. The shark is used primarily as a food source, and is sold both fresh and frozen.

Danger to Humans

The leopard shark poses virtually no danger to humans. The International Shark Attack File has a single report of an incident involving a human and a leopard shark. This incident did not reportedly cause any significant damage to the victim, and no bite was involved. However, leopard sharks do contain high levels of mercury and should not be consumed regularly, as per the warnings of the California Department of Fish & Game.

Conservation

Due to the relatively late age of first reproduction, the slow growth rate, and the low reproduction rate, the leopard shark is potentially threatened by over-fishing. However, the shark is not currently listed as an endangered or threatened species. Management of this species in recent years is thought to have protected the core population of this species in waters off California and Oregon (US). The status of stocks off Mexico is currently unknown.

The leopard shark is considered to be at "Least Concern" by the World Conservation Union (IUCN). The IUCN is a global union of states, governmental agencies, and non-governmental organizations in a partnership that assesses the conservation status of species.

Geographical Distribution

Leopard sharks have a relatively narrow range, found in the Eastern Pacific Ocean from Oregon to the Gulf of California in Mexico. Large populations occur in San Francisco Bay, and other large estuaries.

Habitat

The leopard shark is most commonly found in sandy or muddy bays and estuaries either at or near the bottom. The shark is most commonly encountered in 20 feet (6.1 meters) of water or less, but has been sighted up to 300 feet (91.4 meters) deep. Leopard sharks seem to prefer cool and warm temperate waters.

Biology

Distinctive Features
The leopard shark has a relatively broad and short snout. The prominent rounded dorsal fin of this shark originates over the inner margins of its pectoral fins. The second dorsal fin is pointed and averages about three-quarters the size of the first dorsal fin. The anal fin is diminutive in comparison to the leopard shark's second dorsal fin. The pectoral fins of the leopard shark are rather broad and roughly triangular in shape. The upper lobe of the tail is notched and elongated.

The leopard shark could possibly be mistaken for the swell shark (*Cephaloscyllium ventriosum*), which is reddish-brown and has a flattened head.

Recent research indicates that the erythrocytes (red blood cells) of the leopard shark are more diminutive and numerous than those of its relatives, the brown smooth-hound (*Mustelus henlei*) and the gray smoothhound (*Mustelus californicus*). This could theoretically provide the leopard shark with an edge over its chief competitors in estuarine environments by allowing the leopard shark to more easily absorb oxygen from the water.

The leopard shark is a strong swimmer and it often forms large nomadic schools that sometimes include brown smooth-hounds (*Mustelus henlei*), gray smooth-hounds (*Mustelus californicus*), and spiny dogfish (*Squalus acanthias*).

Coloration
The leopard shark is conspicuously covered with dark saddles and splotches. The dorsal surface of the animal varies in coloration from silver to a bronzed gray. The ventral surface of the animal is lighter and sometimes white.

Dentition
Leopard sharks produce tooth sets that form overlapping ridges between different tooth rows. The resulting effect is a large flattened and ridged surface on the upper and lower jaws. This type of dentition is often referred to as "pavement-toothed." The pointed surfaces of the toothed ridges of the leopard shark are capable of puncturing human skin. However, there are no reports of humans being bitten by this shark.

Size, Age, and Growth
Leopard sharks can reach lengths of up to 7 feet (2.13 meters), but it is rare to find an individual larger than 6 feet (1.83 meters). The average size of an adult leopard shark is between 50 and 60 inches (120cm to 150 cm).

Pups are born at a size of 8 to 9 inches (0.20 to 0.23 meters). The sharks reach maturity at a size of 3 to 3.5 feet (0.91 to 1.07 meters).

Food Habits
Leopard sharks feed primarily on benthic invertebrates and small fish. Their diet includes invertebrates such as crabs, shrimp, octopi, fat innkeeper worms (*Urechis caupo*), clam siphons, and fish such as midshipmen, sanddabs, shiner perch, bat rays, smoothhounds, and a variety of fish eggs. Leopard sharks have been known to mutilate their prey, taking only parts of the animals they ingest, leaving the rest. For example, a number of clam siphons have been found in multiple specimens of leopard shark. However, a body of a consumed clam has not been reported to be found.

Reproduction
Female leopard sharks are ovoviviparous and can produce litters of 4 to 33 pups. The gestation period of the shark is between ten and twelve months, and birth usually occurs between April and May.

Predators
Marine mammals prey upon young leopard sharks, and both juvenile and adults are vulnerable to large fish, including the white shark (*Carcharodon carcharias*).

Bonnethead

Sphyrna tiburo

Although a type of hammerhead shark, the bonnetheads have a much smaller, shovel-shaped head, but it does have the classic shark-shaped body and distinctly taller first dorsal fin of other hammerheads. They are gray-brown above, fading to white underneath, and grow to around 48 inches long but rarely as much as 59 inches. These warm-water coastal sharks migrate with the seasons, and have excellent senses for hunting and communication with other bonnetheads.

Conservation

Currently, this species is categorized as a species of "Least Concern" due to its high population numbers by the World Conservation Union (IUCN). The IUCN is a global union of states, governmental agencies, and non-governmental organizations in a partnership that assesses the conservation status of species.

Geographical Distribution

The bonnethead is limited to warm waters of the Northern Hemisphere, ranging in the Atlantic Ocean from New England (U.S.) (rare) south to the Gulf of Mexico and Brazil. It is common throughout the Caribbean Sea including Cuba and Bahamas. This shark is rare in Bermuda. In the Pacific, this shark can be found from southern California to waters off of Ecuador.

Summertime finds the bonnethead commonly residing in the inshore waters off the Carolinas and Georgia (U.S.) while during the spring, summer, and autumn it is found off the coast of Florida and in the Gulf of Mexico. Bonnetheads move closer to the equator, as waters grow colder during the winter months.

Habitat

Bonnetheads reside on continental and insular shelves, over reefs, estuaries and shallow bays from depths of 32-262 feet (10-80 m). They usually occur in small schools of up to 15 individuals, however during migration events they are seen in groups of hundreds or thousands. As spawning time approaches, bonnetheads tend to group by gender. During pupping season; females predominate in shallow waters where they give birth. Bonnetheads travel long distances everyday, following changes in the water temperature. This preference for water temperatures over 70°F (21°C) leads to migrations to warmer waters during the winter months. As a result, the bonnethead is found closer to the equator during the winter, moving back to higher latitudes during the summer.

This species must swim continuously so that its gills receive oxygen from the water, otherwise it will sink. Although this shark is not territorial, it appears a hierarchy exists within groups of bonnetheads. Another interesting aspect of this species is a cerebrospinal fluid used in chemical communication among individual bonnetheads, informing others when there is a bonnethead in the area. Further studies are needed to learn more about this communication system.

Biology

Distinctive Features
The shovel- or bonnet-shaped head is a distinguishing characteristic of this species, making it easy to identify among hammerhead sharks. The eyes are located at the ends of the evenly rounded lobes of the flattened head, increasing the field of vision. When the bonnethead swims, the head rolls from side to side. The arched mouth is located ventrally. The body is moderately compact and lacks a mid-dorsal ridge. The high first dorsal fin originates just behind the base of the pectoral fins. The second dorsal fin is slightly less than ½ as long as the base of the first dorsal fin with a slender free rear corner. The pectoral fins are short and the anal fin has only a slight indentation. The caudal fin has a nearly straight upper margin with a lower lobe about 1/3 as long as the upper lobe with a nearly straight rear edge. Bonnetheads lack air bladders and have strong digestive chemicals in their specialized intestines.

Bonnetheads can be distinguished from other species by the flattened, bonnet-shaped head that is rounded between the eyes rather than hammer-shaped. Also, the head lacks a notch at the midline. It is the smallest of the hammerhead-type (family Sphyrnidae) sharks, reaching an average of 3-4 feet in length in comparison to the scalloped hammerhead which grows to an average of 6 feet and the great hammerhead growing to almost 20 feet in length.

Coloration
Coloration of the bonnethead ranges from gray to gray-brown, occasionally with a green tint. Dark spots are sometimes seen on the sides of the body. Viewed from the side, the color changes from top to bottom to a lighter gray and then white on the underside. There are no conspicuous markings on the fins.

Dentition
Dentition of the bonnethead includes small, sharp teeth located in the front of the mouth used for cutting up prey and flat, large molars in the back for grinding hard prey items. The sharp front teeth have short, stout cusps lacking serrations, followed by teeth with oblique cusps and then the flat molars in the back of the mouth. As with all sharks, the bonnethead has additional rows of teeth that are used as the older teeth become lost or worn.

Denticles
The dermal denticles are larger than those found in the smooth hammerhead (*S. zygaena*) and vary greatly in arrangement from closely overlapping to loosely spaced. The blades are steeply raised with 5 ridges and 5 sharp marginal teeth.

Size, Age, and Growth
Bonnetheads reach an average size of 36-48 inches (100-120 cm) with a maximum length of approximately 59 inches (150 cm), with females reaching greater lengths than males. The maximum recorded weight of a bonnethead is 24 pounds (10.8 kg). Males mature between 20-30 inches (52-75 cm) and females mature at 33 inches (84 cm) or less in length.

Food Habits
Bonnetheads feed during daylight hours primarily on crustaceans, dominated by blue crabs. They also feed on mantis shrimp (*Squilla empusa*), pink shrimp (*Penaeus durorarum*), mollusks, and small fishes. Occasionally bonnetheads will also feed on seagrasses as documented by stomach contents of some individuals. This species has been reported burrowing under coral heads in search of small fishes and invertebrates in the waters of

southern Florida. Females tend to feed more often due to the need for increased amount of energy budgeted for reproductive efforts.

Prey items appear to be correlated with seasonality as well as habitat. Although crustaceans are the primarily food source throughout the year, during the autumn diversity of prey items increases with the inclusion of spider crabs (*Libinia dubia*), purse crabs (*Persephona punctata*), stone crabs (*Menippe mercenaria*), and various cephalopods including octopus. Bonnetheads residing inside bays feed on a less diverse array of prey items than those caught off beaches in open waters.

The bonnethead has evolved well-developed sensory and nervous systems that allow them to be efficient predators. Vision and hearing capabilities are exceptional as well as the sensitivity of the lateral line to small vibrations, alerting them to nearby potential prey. Upon locating a prey item, the bonnethead swims slowly within range followed by a quick acceleration to attack that item. The item is then crushed with the molariform teeth. There are two jaw closing phases, continuing the closure of the jaws. This differs from the capture event typical of other sharks, where the jaws are initially closed and biting ceases at jaw closure. This allows the bonnethead to take advantage of prey that is not available to other species of sharks. After the prey is crushed, it is moved by suction to the esophagus.

Reproduction
In Florida waters, bonnetheads are believed to mate during the spring and autumn or perhaps even year-round. In the waters off the coast of Brazil, mating occurs during the spring. After mating, the females can store sperm for up to four months prior to actually fertilizing the eggs. The control over the fertilization period is believed to be an adaptation to ensure that the pups are born during optimal conditions for their survival.

Bonnetheads are "viviparous", or livebearing. Female bonnetheads produce eggs that are maintained and nourished by a yolk-sac during the initial phase of gestation.

The eggs withing the female are tough but elastic with folded ends allowing for growth of the embryos. The embryos released from the eggs absorb the yolk-sac. This sac attaches to the uterine wall of the mother forming a yolk-sac placenta. Blood vessels running through this placenta provide nourishment until birth of the embryo. Also, after hatching, sections of the uterine wall come together to separate each embryo and its placenta in its own uterine compartment. The gestation period, shortest among all sharks, is only four to five months.

Females move to shallow inshore waters during pupping season, giving birth in late summer and early fall. Litter sizes average 4-14 pups, each approximately 14 inches (35 cm) in length and 0.4 pounds (0.2 kg) in weight. During this time, the females lose their desire for food, which prevents them from feeding on their pups. Males move to a different location, also an adaptation to avoid feeding upon their own young.

Predators
Larger sharks are potential predators of the bonnethead.

Parasites
The monogenean *Erpocotyle tiburonis* has been reported to cause gill lesions on bonnetheads. Other parasites include copepods such as *Eudactylina longispina* collected from the gill filaments of a bonnethead caught in Tampa Bay, Florida.