= Pacific angelshark =

The Pacific angelshark (Squatina californica) is a species of angel shark , family Squatinidae , found in the eastern Pacific Ocean from Alaska to the Gulf of California , and from Ecuador to Chile , although those in the Gulf of California and southeastern Pacific may in fact be separate species . The Pacific angelshark inhabits shallow , coastal waters on sandy flats , usually near rocky reefs , kelp forests , or other underwater features . This species resembles other angel sharks in appearance , with a flattened body and greatly enlarged pectoral and pelvic fins . Characteristic features of this shark include a pair of cone @-@ shaped barbels on its snout , angular pectoral fins , and a brown or gray dorsal coloration with many small dark markings . It attains a maximum length of 1 @.@ 5 m (4 @.@ 9 ft) .

An ambush predator , the Pacific angelshark conceals itself on the sea floor and waits for approaching prey , primarily bony fishes and squid . Prey are targeted visually and , with a quick upward thrust of the head , snatched in protrusible jaws . Individual sharks actively choose ideal ambush sites , where they stay for several days before moving on to a new one . This species is more active at night than during the day , when it stays buried in sediment and seldom moves . Reproduction is viviparous , with the embryos hatching inside the mother 's uterus and being sustained by a yolk sac until birth . Females give birth to an average of six young every spring .

Pacific angelsharks are not dangerous to humans unless provoked , in which case their bite can cause a painful injury . They are valued for their meat and are captured by commercial and recreational fishers across their range . A targeted gillnet fishery for this species began off Santa Barbara , California in 1976 and ended in 1994 , after overfishing and new regulations led to its near @-@ collapse . This species is now mainly fished in Mexican waters . The International Union for Conservation of Nature (IUCN) has assessed this species as Near Threatened , as the Californian population is largely protected and recovering , while the impact of Mexican fisheries is unknown .

= = Taxonomy and phylogeny = =

The Pacific angelshark was first scientifically described in 1859 by William Orville Ayres , the first Curator of Ichthyology at the California Academy of Sciences . He gave it the specific epithet californica , as the originally @-@ described specimen was caught off San Francisco . Locally , this species may also be referred to as angel shark , California angel shark , or monkfish .

The Chilean angelshark (Squatina armata) of the southeastern Pacific was synonymized with this species by Kato , Springer and Wagner in 1967 , but was later tentatively recognized as a separate species again by Leonard Compagno . The taxonomic status of angel sharks in the southeastern Pacific ? whether they are S. californica , S. armata , or if there is more than one Squatina species in the region ? remains unresolved . The angel sharks inhabiting the Gulf of California may also represent a different species , as they mature at a much smaller size than those from the rest of their range .

A phylogenetic study based on mitochondrial DNA , published by Björn Stelbrink and colleagues in 2010 , reported that the sister species of the Pacific angelshark is the sand devil (S. dumeril) of the western North Atlantic . The two species are estimated to have diverged approximately 6 @.@ 1 Ma , close to when the Isthmus of Panama first began to form . The authors also found that Pacific angelsharks from the Gulf of California differed genetically from those elsewhere , though they were equivocal as to whether this represented a species @-@ level distinction .

= = Distribution and habitat = =

Pacific angelsharks are found in cold to warm @-@ temperate waters from the southeastern corner of Alaska to the Gulf of California , including the entire Baja peninsula , and are most common off central and southern California . It may also occur from Ecuador to the southern tip of Chile (see taxonomic uncertainty above) . This bottom @-@ dwelling shark prefers habitats with soft , flat bottoms close to shore , such as estuaries and bays , and are often found near rocky reefs ,

submarine canyons , and kelp forests . On occasion , they have been seen swimming 15 ? 91 m (49 ? 299 ft) above the sea floor . Off California , the Pacific angelshark is most common at a depth of 3 ? 45 m (9 @.@ 8 ? 147 @.@ 6 ft) , but has been reported from as deep as 205 m (673 ft) .

 A number of genetically discrete subpopulations have been identified across the northern range of the Pacific angelshark . Several subpopulations exist along the coast from Point Conception northward to Alaska . In the Southern California Bight , there are at least three separate subpopulations off the mainland and northern and southern Channel Islands . The subpopulation along the Pacific coast of Baja California are distinct from those in the Gulf of California . These subpopulations have diverged from one another over time because Pacific angelsharks do not undertake long migratory movements outside of their preferred home areas , and deep waters serve as effective geographical barriers to population mixing . Heterozygosity , a measure of genetic diversity , is higher in the Pacific angelshark than in other shark species that have been examined .

= = Description = =

 With its flattened body and wing @-@ like pectoral fins , the Pacific angelshark superficially resembles a ray . Unlike in rays , its five pairs of gill slits are located on the sides of the head rather than underneath , and the expanded anterior lobes of its pectoral fins are separate rather than fused to the head . The eyes are located on top of the head , with the spiracles behind . There are folds of skin without triangular lobes on the sides of head . The mouth is very wide and placed terminally (at the front of the snout) ; a pair of cone @-@ shaped barbels with spoon @-@ like tips are located above . There are 9 tooth rows on either side of the upper jaw and 10 tooth rows on either side of the lower jaw , with toothless gaps at the middle of both jaws . Each tooth has a broad base and a single narrow , smooth @-@ edged cusp .

 The pectoral and pelvic fins are broad and angular with pointed tips . The two dorsal fins are located far back on the body , and there is no anal fin . The lower lobe of the caudal fin is larger than the upper . A row of small thorns runs down the middle of the back and tail ; thorns are also present on the snout and over the eyes . As the shark ages , the thorns decrease in size and may disappear . The dorsal coloration is gray , brown , or reddish brown with scattered dark markings : large blotches surrounded by a ring of tiny spots in adults , and pairs of ocelli in juveniles . The underside is white , extending to the margins of the pectoral and pelvic fins . This species measures up to 1 @.@ 5 m (59 in) long and weighs up to 27 kg (60 lb) .

= = Biology and ecology = =

 During the day , Pacific angelsharks are almost never seen in the open , instead resting motionless on the sea floor buried under a thin layer of sediment that disguises their outlines . At night some individuals remain motionless , waiting for prey , while others may be encountered on the bottom unburied or actively swimming . Large sharks , including the great white shark (Carcharodon carcharias) and the broadnose sevengill shark (Notorynchus cepedianus) , and the northern elephant seal (Mirounga angustirostris) are known to consume Pacific angelsharks . Known parasites of this species include the copepod Trebius latifurcatus , which infests the skin , the myxosporidian Chloromyxum levigatum , which infests the gall bladder , and the tapeworm Paraberrapex manifestus , which infests the spiral valve intestine . The leech Branchellion lobata may be attached around this shark 's cloaca , inside the intestine , and even inside the uterus and on developing embryos .

= = = Feeding = = =

 A sedentary ambush predator , the Pacific angelshark feeds mainly on bony fishes , including kelp bass , croakers , flatfishes , damselfishes , mackerels , and sardines . During the winter and early spring , spawning squid are abundant and become the primary source of food . In the southern Gulf of California , the most important prey species are , in descending order , the mackerel Decapterus

macrosoma , the toadfish Porichthys analis , the lizardfish Synodus evermann , the soldierfish Myripristis leiognathus , and the shrimp Sicyonia penicillata . At Catalina Island , this species feeds mainly on the blacksmith (Chromis punctipinnis) and the queenfish (Seriphus politus) . Adults and juveniles have similar diets .

 Individual sharks choose sites giving them the best ambush success . They prefer junctions of sandy and rocky substrates near reefs (used by many fishes for shelter) usually orienting themselves either toward or parallel to nearby vertical structures . They tend to face upslope , which may facilitate burying via falling sediment , bring more fish swimming downstream from the reef , or ease targeting by silhouetting prey against the sunlight .

 Once settled at a successful site , an angelshark may remain there for ten days , re @-@ burying itself on or near the same spot after every strike . As the local prey eventually learn to avoid the stationary predator , the shark periodically shifts at night to a new site several kilometers away . One study off Santa Catalina Island found that over 13 ? 25 hours , nine sharks together used only 1 @.@ 5 km2 (0 @.@ 6 mi2) . A later , longer @-@ term study found that the sharks ' sporadic position changes covered as much as 75 km (47 mi) over three months , almost circling the island . Single individuals swam up to 7 @.@ 3 km (4 @.@ 5 mi) in a night .

 The Pacific angelshark is primarily a visual hunter ; experiments in nature show that they strike at fish @-@ shaped targets without any electrical , chemical , vibrational , or behavioral cues . At night , they are guided by the bioluminescence of planktonic dinoflagellates and ostracods disturbed by moving prey . This species ' visual system is attuned to the wavelengths of light emitted by these planktonic organisms , showing the importance of night hunting . Pacific angelsharks are more likely to strike at prey approaching from the front . It usually waits until the prey approaches to 15 cm (5 @.@ 9 in) , as its attack is less accurate beyond this distance . The strike is a stereotyped behavior in which the shark presses the forward lobes of its pectoral fins against the bottom and thrusts its head upwards at up to a 90 ° angle . Its mouth forms a tube when opened , creating a suction force , while its jaws protude forward to secure the prey between sharp teeth . During the strike , the eyes roll backward into the head for protection . The strike is often completed in under a tenth of a second .

= = = Life history = = =

 The Pacific angelshark is aplacental viviparous with the unborn young nourished by a yolk sac ; reproduction occurs on an annual cycle . Most females have a single functional ovary (on the left side) , though some have two ; the oviducts are often filled with yolk , which has been speculated to be from unfertilized eggs being resorbed . Young embryos 35 mm (1 @.@ 4 in) long have translucent skin , protruding eyes , and exposed gill filaments . Spots of pigment have developed when the embryo is 70 mm (2 @.@ 8 in) long , and the first row of teeth have appeared when the embryo is 110 mm (4 @.@ 3 in) long . By the time the embryo is 150 mm (5 @.@ 9 in) long , the mouth has migrated to a terminal position and the color pattern has fully developed ; the external yolk sac begins to shrink as the yolk is transferred to an internal yolk sac , which holds it until it can be transferred to the intestine for digestion . The internal yolk sac is fully resorbed before birth ; if the pup is released prematurely , it does not feed until this process is complete .

 Off Santa Barbara , birthing takes place from March to June after a gestation period of ten months , and the females mate again shortly afterward . The average litter size is 6 with a range of 1 ? 11 (rarely 13) ; there is no correlation between female size and number of offspring . The young are born in water 55 ? 90 m (180 ? 295 ft) deep , probably to protect them from predators . Pacific angelshark embryos grow at 45 mm (1 @.@ 8 in) per month when young , slowing down to 10 mm (0 @.@ 39 in) per month just before birth , and are born at a length of 25 ? 26 cm (9 @.@ 8 ? 10 @.@ 2 in) . Newborn pups in captivity grow at a rate of around 14 cm (5 @.@ 5 in) per year , while adults in the wild grow at around 2 cm (0 @.@ 79 in) per year . Both sexes mature at 90 ? 100 cm (3 @.@ 0 ? 3 @.@ 3 ft) long , corresponding to an age of 8 ? 13 years . Gulf of California sharks , which may be another species , mature at 78 cm (2 @.@ 56 ft) long for males and 85 cm (2 @.@ 79 ft) long for females . About 20 % of newborns survive to maturity . The maximum lifespan

has been estimated at 25 ? 35 years . Unlike other sharks , the growth rings on the vertebrae of this species are deposited in proportion to the shark 's size rather than yearly , making age determination difficult .

= = Human interactions = =

Although usually sedate and approachable underwater , Pacific angelsharks are quick to bite if touched , captured , or otherwise provoked , and can inflict severe lacerations . Commercial fisheries for this species exist off Baja California and to a lesser extent off California (see below) ; the meat is considered excellent and is sold fresh or frozen . This species is captured in limited numbers by recreational fishers using hook @-@ and @-@ line , spears , or even by hand , particularly off southern California . It is also taken as bycatch in shrimp trawls operating in the Gulf of California , and processed into fishmeal . The capacity of this species to withstand a focused fishing effort is limited , due to its low rates of reproduction and movement .

In 1976 , the commercial gillnet fishery for the California halibut (Paralichthys californicus) , operating off Santa Barbara , expanded to include the Pacific angelshark as well . The sharks had become valuable due to their promotion as a substitute for the seasonally available common thresher shark (Alopias vulpinus) , and the development of new processing techniques . Around 50 % of the shark was used , while the skin , cartilage , and offal were discarded . In the 1980s , rising demand led to the introduction of gillnets with a medium @-@ sized mesh , designed specifically for this species . Fishery landings increased from a dressed (post @-@ processing) weight of 148 kg (326 lb) in 1977 , to 117 @,@ 000 kg (258 @,@ 000 lb) in 1983 , to 277 @,@ 000 kg (611 @,@ 000 lb) in 1984 . The fishery peaked in 1985 and 1986 , when 550 @,@ 000 kg (1 @.@ 2 million lbs) were taken annually , making this species the number one shark fished off California . This level of exploitation was unsustainable , and despite a minimum size limit imposed in 1986 , catches fell to 112 @,@ 000 kg (247 @,@ 000 lb) in 1990 .

In 1991 , the use of gillnets in nearshore Californian waters was banned by a voter initiative (Proposition 132) ; the restricted area included much of the Pacific angelshark 's habitat and reduced fishing pressure on the species . As a result , Pacific angelshark landings dropped further to 10 @,@ 000 kg (22 @,@ 000 lb) dressed in 1994 , when the central Californian halibut / angel shark fishery was closed completely , and have remained low since . The decline of the Californian fishery led to the industry shifting to Mexico , where gillnet pangas (artisanal fishing vessels) targeting this species now meet most of the angel shark demand in California . The International Union for Conservation of Nature (IUCN) has assessed this species as Near Threatened ; Pacific angelshark numbers off California appear to be increasing and demographic modeling suggests the stock is healthy . However , the impact of the intense , unregulated Mexican fishery on the global population is yet undetermined . There is continuing interest in California for a resumption of the commercial fishery , though conservation concerns have thus far taken precedence .