Sea Cucumbers

History of the Fishery

Two species of sea cucumbers are fished in California – the California sea cucumber (*Parastichopus californicus*) also known as the giant red sea cucumber, and the warty sea cucumber (*P. parvimensis*). The warty sea cucumber is fished almost exclusively by divers. The California sea cucumber is caught principally by trawling in southern California, but is targeted by divers in northern California. Sea cucumber fisheries have expanded worldwide, and on this coast there is a dive fishery for warty sea cucumbers in Baja California, Mexico, and dive fisheries for California sea cucumbers in Washington, Oregon, Alaska, and the coast of British Columbia, Canada.

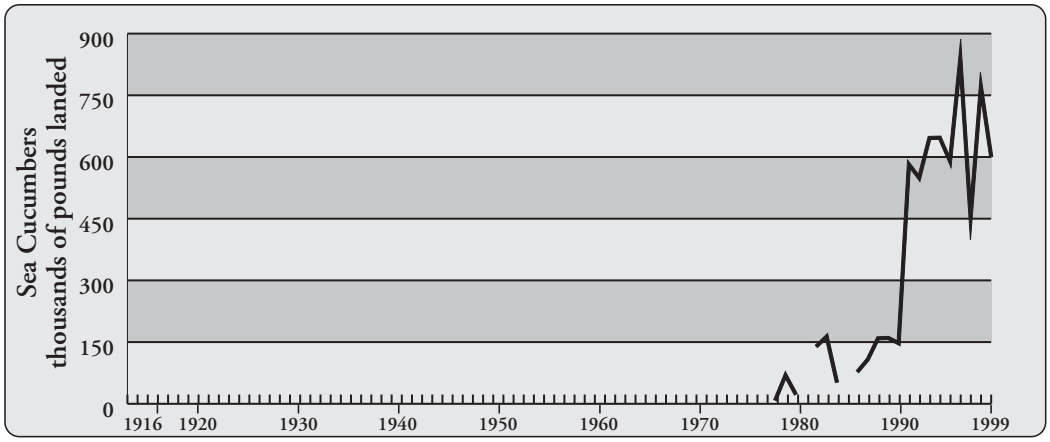
The first recorded commercial landings of sea cucumbers in California were made in 1978 at Los Angeles area ports. Divers fishing sea cucumbers at Santa Catalina Island were the first to make landings, but they were soon joined by trawl vessels. Annual landings remained under 100,000 pounds until 1982 when the principal fishing area shifted to the Santa Barbara Channel. In that year, 140,000 pounds were landed with an ex-vessel value of about $25,000. Recorded landings fluctuated between 52,350 to 160,000 pounds over the next eight years, and in 1991 reached more than 577,390 pounds. Through the first 18 years of the fishery, trawl landings composed an average of 75 percent of the annual sea cucumber harvest. In 1996, combined trawl and dive sea cucumber landings reached an all time high of 839,400 pounds with an ex-vessel value of $582,370. Between 1997 and 1999, sea cucumbers landed by divers accounted for more than 80 percent of the combined dive and trawl landings. During that time period, trawl effort declined substantially, due primarily to court cases pursued by the department which ruled that 16 trawl fishermen had fraudulently obtained their sea cucumber permits. Those fishermen were subsequently excluded from the fishery. Diver effort and landings, in contrast, increased markedly during those three years, driven by both a 1997 moratorium of the abalone fishery, a sea urchin fishery depressed by El Niño conditions, and a poor Japanese export market. Beginning in 1997, many commercial sea urchin or abalone divers, who also held sea cucumber permits, targeted sea cucumbers more heavily than before.

Most of the California and warty sea cucumber product is shipped overseas to Hong Kong, Taiwan, China, and Korea. Chinese markets within the United States also purchase a portion of California's sea cucumber catch. The majority are boiled, dried, and salted before export, while lesser quantities are marketed as a frozen, pickled, or live product. The processed sea cucumbers can sell wholesale for up to $20 per pound. In Asia, sea cucumbers are claimed to have a variety of beneficial medicinal or health enhancing properties, including lowering high blood pressure, aiding proper digestive function, and curing impotency. Studies of the biomedical properties of various sea cucumber chemical extracts, such as saponins, and chondroiton sulfates, are being conducted by western medical researchers investigating the efficacy of these substances for pharmaceutical products.

There is no significant sport fishery for sea cucumbers in California. Few sport fishermen have shown an interest in sea cucumber as a food item, and sport fishing regulations forbid their take in nearshore areas in depths less than 20 feet.

A special permit to fish for sea cucumbers commercially was required beginning with the 1992-1993 fishing season. Qualifications for the permit were based upon meeting a minimum 50 pound landing requirement during a four-year "window" period. In 1997, legislation was enacted that imposed a new regulatory regime on the sea cucumber fishery. The major regulatory changes included creating separate permits for each gear type, and limiting the number of permittees in the sea cucumber fishery. The maximum number of permits allocated was based on the number of permits issued during the 1997-1998 permit year, and the meeting of a minimum landing requirement. There are currently 113 sea cucumber dive permittees and 36 sea cucumber trawl permittees. A permit transfer procedure and transfer fee of $200 was also initiated by the 1997 legislation. Sea cucumber dive permits can be transferred only to other dive fishermen, while sea cucumber trawl permits can be transferred to either trawl or dive fishermen.

California Sea Cucumber, *Parastichopus californicus*
Credit: DFG



Commercial Landings 1916-1999, Sea Cucumbers
1916-1999, Sea Cucumber
No commercial landings are reported for sea cucumber prior to 1978.
Data Source: DFG Catch Bulletins and commercial landing receipts

Status of Biological Knowledge

Sea cucumbers are long, soft-bodied, marine invertebrates in the class Holothuroidea. They are related to other organisms in the phylum Echinodermata such as sea urchins and sea stars. Their skeleton has been reduced to small calcarious pieces (ossicles) in the body wall, which have distinct species-specific shapes.

The California sea cucumber reaches a maximum length of 24 inches and is red, brown or yellow in color with red-tipped papillae. The warty sea cucumber is 12 to 16 inches in length and chestnut brown with black-tipped papillae on the ventral surface. Size however, is difficult to determine, as sea cucumbers can contract, making length measurements unreliable, and they can take up water, rendering body weights unreliable.

The California sea cucumber is distributed from Baja California to Alaska. The warty sea cucumber is distributed from Baja California to Monterey Bay, although it is uncommon north of Pt. Conception. The California sea cucumber is found from the low intertidal to 300 feet and the warty sea cucumber from the low intertidal to 90 feet, generally in areas with little water movement.

Sea cucumbers are epibenthic detritivores that feed on organic detritus and small organisms within sediments and muds. Buccal tentacles trap food particles using an adhesive mucus. Sea cucumbers are non-selective with respect to grain size and ingest only the top few millimeters of sediment. One study of warty sea cucumbers around Santa Catalina Island found that those living on rock rubble were 27 percent smaller and seven times more numerous than those residing on sandy substrates. The detritus on rock rubble was found to have three times more organic material per gram compared to the detritus from the sand substrate, and sea cucumbers on the sand ingested eight times more sediment.

Sea cucumbers can reach moderately high densities and are thought to be important agents of bioturbation. During feeding and reworking of surface sediments, sea cucumbers can alter the structure of soft-bottom benthic communities. The California sea cucumber crawls an average of 12 feet per day with no directional bias, presumably due to the even distribution of detrital food. Tagging studies are difficult since external tags are frequently lost and internal tags can be shed through the body wall. Sea cucumbers are also known to have a predator escape response involving a rapid creeping or swimming behavior propelling the sea cucumber away. Water can also be taken up in the respiratory tree and then forcefully discharged. Predators include sea stars, various fishes such as kelp greenlings, sea otters and crabs. Comparatively few studies have been done with sea cucumbers, and as recently as 1986, a new species, *P. leukothele*, was described that is distributed from Pt. Conception, California to British Columbia, Canada.

Sea cucumbers are broadcast spawners with fertilization in the water column. Sea cucumbers have a distinctive spawning posture, detaching from the substrate and forming an "S" shape to release their gametes up and away from the benthic boundary layer. There are separate sexes and the sex ratio is one to one. Individuals do not form spawning aggregations. Spawning is partially synchronous with a portion of the population spawning simultaneously. Triggers for spawning are largely unknown, however spawning is thought to coincide with phytoplankton blooms during sunny days in late spring and summer. Oocytes are light orange in color and surrounded by a jelly coat. After fertilization, the embryo hatches into the gastrula (64 hours) and starts to swim. A feeding auricularia larva develops 13 days after fertilization and begins ingesting phytoplankton. Auricularia develop into doliolaria larvae (37 days post-fertilization) losing up to 90 percent of its body volume and rearranging its ciliary bands. The final doliolaria larval stage metamorphoses

(51 to 91 days post-fertilization) into newly settled pentactula. Pentactula have five primary buccal tentacles, and attach to the substrate using a single pedicle. In the field, juveniles recruit to a variety of substrates including rock crevices, polychaete worm tubes, and filamentous red algae. Growth is slow in sea cucumbers. Juveniles become reproductively mature at four to eight years.

Both species of sea cucumber undergo visceral atrophy each year. During atrophy the gonad, circulatory system, and respiratory tree are resorbed and reduced in size, and the gut degenerates. Feeding and locomotion stop prior to visceral atrophy, which occurs in the fall. Following the resorption of the visceral tissue, the animal loses 25 percent of its body weight. The weight of the body wall cycles during the year, being the lowest early in the year and the highest in early fall, prior to the start of visceral atrophy. Within two to four weeks regeneration begins, starting with the gut tube, then the respiratory tree and circulatory system, and finally the gonad regrows branched tubules. Juveniles also undergo yearly visceral atrophy; however, they do not have gonads at this stage. In the fall, animals may spontaneously eviscerate internal tissues if handled roughly, although this is not a common occurrence.

Status of the Population

There is presently very little known about populations of California and warty sea cucumbers in California. The distribution of these species on rocky or sandy substrates is characterized as patchy, without any apparent seasonal aggregating, spawning, or feeding behavior. Sea cucumbers undergo sporadic recruitment, have a relatively high natural mortality, and are slow growing. Species with these life history traits tend to have a low maximum yield per recruit and are particularly vulnerable to overfishing.

The Channel Islands National Park Service has been monitoring warty sea cucumbers at 16 sites in the northern Channel Islands and Santa Barbara Island since 1982. These fishery-independent data show that populations of warty sea cucumber are variable but have been declining at fished sites since 1990. Meanwhile, sea cucumber catches from the dive fishery have increased at some of these sites. Recent analytical work comparing population trends at fished sites to those of two small reserves where fishing is prohibited indicate that the population at fished sites range from 50 to more than 80 percent lower than at protected sites.

Fishery-independent sea cucumber density estimates have also been made using underwater video technology. Preliminary observations of California sea cucumbers in an established reserve in northern California (Cabrillo Reserve) at depths of 150 to 180 feet revealed densities averaging around 1,000 per acre. By comparison, densities at a newly established reserve (Punta Gorda Ecological Reserve) were much lower, ranging from 120 to 350 per acre. Only the large size classes were observed in these surveys, suggesting low levels of recruitment.

Management Considerations

See the Management Considerations Appendix A for further information.

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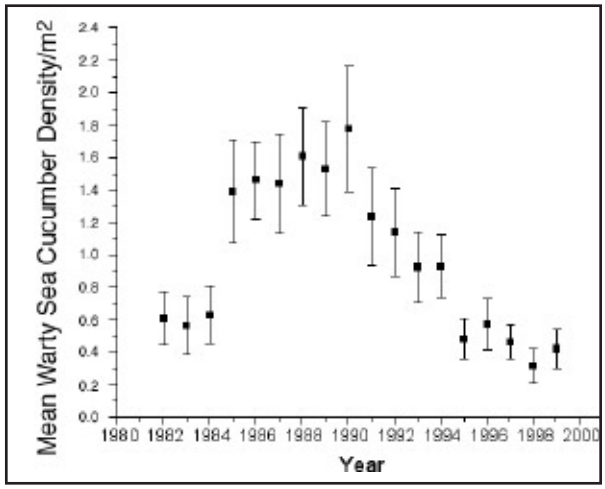
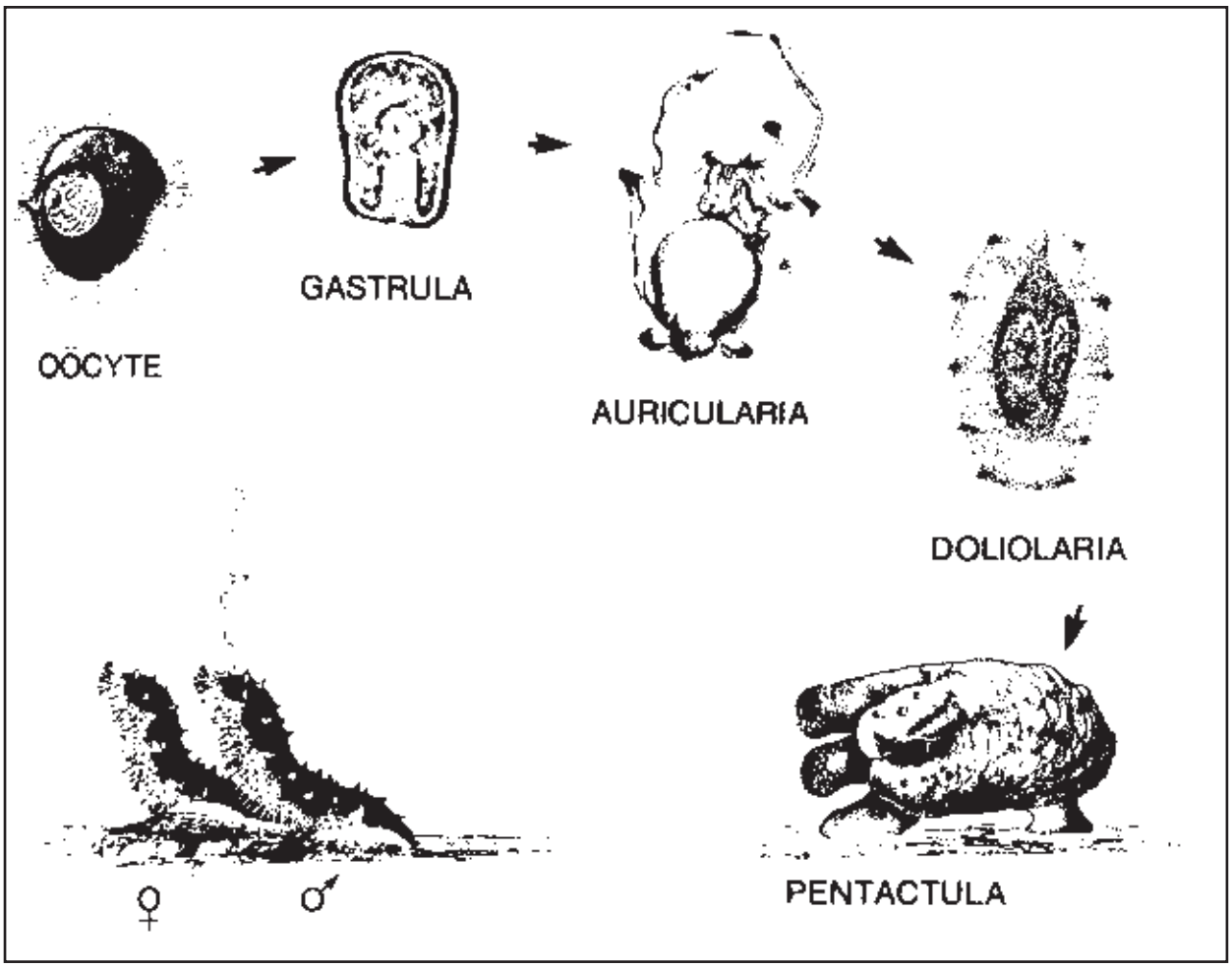


Density of Warty Sea Cucumber, 1982 to 1999
Density of warty sea cucumber from 16 Channel Islands National Park sites at five of the northern Channel Islands, San Miguel Island, Santa Rosa Island, Santa Cruz Island, Ancapa Island, and Santa Barbara Island from 1982 to 1999.
Data Source: California Department of Fish and Game



Representative of spawning and development through settlement and metamorphasis of P. californicus. Development does not deviate significantly from that expected for an aspidochirote holothurian with planktotrophic larvae. Drawing not to scale.

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