

California Market Squid

History of the Fishery

Distinguished by its volatility, success of the California market squid (*Loligo opalescens*) fishery fluctuates as a consequence of El Niño conditions and rapid changes in the export market. With significant expansion of fishing activity in southern California waters during the 1980s and 1990s, the market squid fishery has emerged as one of the most important in the state. During the 1990s, squid ranked as the largest California commercial fishery by volume in six years of the decade and ranked three times as the state's most valuable fishery resource in value of the catch. Among U.S. exports of edible fishery products in 1999, market squid ranked sixth by volume and sixteenth in value, higher than any other California commercial fishery.

The vast majority of squid is frozen for human consumption. Much of this is exported to China, Japan and Europe. Other uses include fresh and canned squid for human consumption, and fresh or frozen squid for bait. The role of international buyers in the temporal success of the California market squid fishery is substantial. After decades of generally low catches, volume increased during the 1990s because of new (primarily Asian and European) markets and higher prices paid for California squid. However, landings and ex-vessel revenue declined during the 1997-1998 El Niño when squid became harder to catch and as overseas markets collapsed due to poor economic conditions in Asia. Currently, there has been some recovery of the Asian market, although demand is affected greatly by performance of other worldwide fisheries, particularly the Falklands *Loligo* fishery. In 1999 and 2000, California squid processors generally limited the daily catch from individual vessels to 30 tons per load, as supply of California squid could have exceeded international demand.

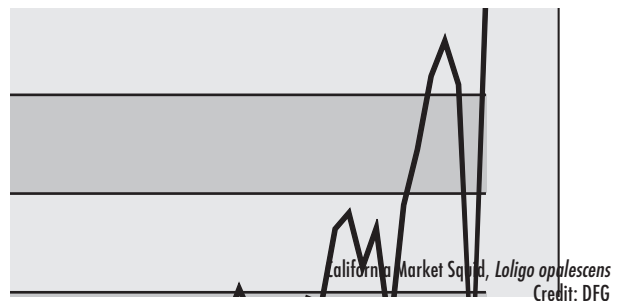
Although the volume of squid produced by California markets is dependent on the international market, the price paid to fishermen can influence both effort exerted toward fishing operations and overall volume of catch. Additionally, price paid to fishermen for their catch depends not only on market demand but availability of the resource. When volume of catch is low, the price paid per ton is high, exceeding \$500 per ton during some months of the 1997-1998 El Niño when squid were scarce. When volume is high, as in the year 2000, the price is driven down and has been recorded at \$100 per ton paid to some vessels bringing in full loads. Price paid for squid taken by brail and for squid purchased in low volumes by smaller local dealers tends to be significantly higher. Often times, the price of fish will start high at the beginning of the southern California season in November and decline as

frozen product begins to accumulate in cold storage facilities. Consequently, there is often less incentive for fishermen to fish later in the season, and as a result, declines in landings for springtime months may not just reflect a reduction in the availability of squid, but also a lack of effort to fish for it. Additionally, many vessels participating in summer salmon fisheries will return to other ports during spring months.

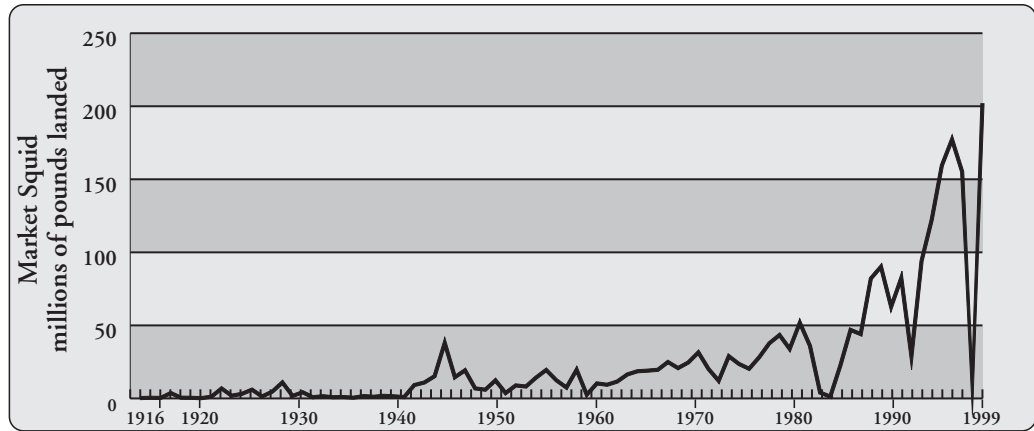
California markets also play a role in determining the composition of the market squid fleet. Although there are many California vessels which have historically participated in the fishery that are still active, there is an increasing proportion of fishery participants from Alaska, Washington and Oregon, reflecting a willingness of the markets to employ these vessels. During peak seasons, approximately 75 round haul vessels have produced about 95 percent of the California squid catch

Since 1961, the California squid fishery has experienced a major change. Prior to 1961, the fishery had been centered mainly in the Monterey Bay area, while a much smaller fishery existed off southern California. Central and southern California have distinctly different fisheries for market squid. Starting in 1961, the southern California squid fishery began to expand with a dramatic rise in landings in Santa Barbara area ports. Since 1985, the southern California fishery has dominated statewide landings while fishing areas have expanded, particularly in the Channel Islands. In recent years 90 percent of landings have occurred south of Point Conception, in sandy near-shore areas, when spawning activity is predominantly during winter months. Conversely, squid taken in the central California fishery, still centered in Monterey Bay, tend to aggregate and spawn during summer months.

Vessels fishing squid target schools that are aggregated in shallow water areas (from 50 to 150 feet deep) to spawn. Unlike other squid fisheries worldwide, the California fleet utilizes two vessels in fishing operations; a light vessel is used to locate and concentrate a school of squid using strong lights to attract squid to the surface. There they are caught using round haul nets deployed by a second vessel. A small fraction of squid sold commercially is caught by light vessels using brail gear. Additionally, a small volume of squid is taken by the live bait industry



Commercial Landings
1916-1999, Market Squid
 Data Source: DFG Catch
 Bulletins and commercial
 landing receipts.



While attracting lights have been used in the southern California fishery for many years, in the central California fishery a regulation was enacted which prohibited their use between 1959 and 1988. Fishermen sponsored the ban for protection from dealers who used lights in conjunction with dip nets on their piers and on floating unloading platforms. In this manner, they had effectively eliminated the need for many fishing boats. Some fishermen also believed that attracting lights disrupted squid spawning activity, but no studies to date have addressed that issue. In 1988, fishermen were allowed to use attracting lights in the Monterey Bay area, except in the southern portion of the bay. The following year, attracting lights were permitted throughout the area.

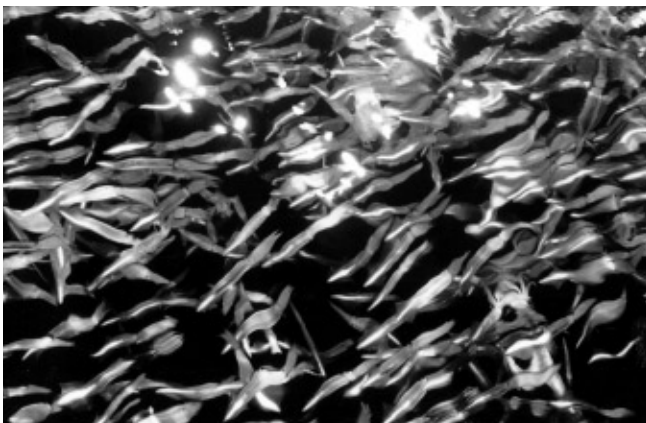
In 1999, the National Park Service brought to the attention of the Department of Fish and Game an apparent increase in nest abandonment and chick predation among shorebirds at the Channel Islands. The park service questioned whether the abundance of vessels lighting for squid near these islands during the nesting season in 1999 could be responsible. As an interim measure, the California Fish and Game Commission placed a statewide wattage restric-

tion on vessels fishing commercially for squid, limiting both light boats and round haul vessels fishing squid to a maximum of 30,000 watts. Additionally, the Commission required these vessels to shield their lights to prevent emission of light onto shore.

Starting in 1989, fishermen were allowed to use all types of round haul gear (purse seine, drum seine, etc.) in the southern bight of Monterey Bay, which previously had been restricted to lampara nets for squid. By the end of 1990, nearly the entire fleet had switched over to purse seine or drum seine gear and the use of lampara nets had virtually ceased in Monterey Bay.

The market squid fishery was an unregulated, open access fishery prior to April 1, 1998. In order to assure sustainability of the resource, new legislation placed a three-year moratorium on the number of vessels in the fishery. This legislation required the purchase of a \$2,500 per year permit for three years to land more than two short tons per trip or to attract squid by light for commercial harvest. In addition, participants must have purchased a permit the previous year. For the 2000-2001 squid fishing season (April 1 to March 31), 197 market squid vessel permits and 50 light boat permits were sold, down from originally 248 vessel permits and 54 light boat permits sold during the first season of the moratorium. The sale of market squid permits provided funds for scientific research and biological assessments of the resource for development of recommendations for a market squid conservation and management plan.

The same legislation provides for two committees, the Squid Fishery Advisory Committee and the Squid Research and Scientific Committee, established in 1998. These advisory groups serve to provide recommendations to the Director on squid research and monitoring, as well as to provide management recommendations for the fishery. In addition to the lighting restrictions, management measures recommended by either of the committees and



Squid under lights
 Credit: Jim Hardwick, DFG

approved by the Fish and Game Commission during 1999 included mandatory logbooks for squid vessels and light boats and statewide weekend closures for the fishery to allow for uninterrupted spawning activity.

Status of Biological Knowledge

The California market squid (*Loligo opalescens*) ranges from southeastern Alaska to Bahia Asunción, Baja California, Mexico. This pelagic mollusk attains a length of 12 inches, including its eight arms and two feeding tentacles. Several other squid species occur off the California coast, but these are normally associated with deeper offshore waters.

Spawning market squid tend to congregate in semi-protected bays, usually over a sand bottom with rocky outcroppings. Mass spawning starts around April in central California waters and ends about November. In southern California waters, mass spawning starts around October and ends about April or May. During some years, however, squid spawning, and landings, may occur throughout most of the year.

During spawning activity, the male transfers a bundle of spermatophores with a specialized left ventral arm into the female's mantle cavity near the oviduct. The eggs are laid within elongated, cigar-shaped capsules, each of which may contain as many as 300 eggs embedded in a gelatinous matrix. Each female produces from 20 to 30 egg capsules, attaching one end of each capsule to the sea floor or other suitable site. Females are visually stimulated to lay their eggs by the presence of other egg masses, resulting in egg capsule clusters covering vast areas, appearing to carpet the sandy substrate. Small red polychaete worms have been observed boring in the capsules' gelatinous substance, but apparently do not feed on the developing embryos. Bat stars and sea urchins, however, prey upon the eggs.

Depending on the ambient water temperature, squid eggs hatch in two to five weeks, with newly hatched paralarvae already resembling miniature adults. Squid feed predominantly on euphausiids and copepods, as well as other small crustaceans, gastropods, polychaete worms, small fishes and smaller squid. Squid are an important prey item for many fishes, birds and marine mammals, and studies indicate the market squid plays an important role in the food web of many organisms along California's coast.

Since 1998, research objectives being conducted by the department for market squid include: 1) collecting fishery and biological data through port sampling efforts; 2) conducting fishery independent surveys (i) utilizing a remotely operated vehicle (ROV) to characterize spawning habitats and measure egg density and (ii) midwater trawl

surveys for relative abundance estimates; 3) culturing eggs and paralarvae to determine lowest viable temperature to resolve spawning range constraints; and 4) analysis of satellite data to track growth of the market squid fishery since 1992. Preliminary port sample data indicate that the average squid taken in the commercial fishery has a length of 5.2 inches and is approximately 185 days old.

Status of the Population

Little is known about the present size, structure or status of the population, but historical evidence from research cruises, as well as recent catch data, indicate the biomass is large. The California fleet fishes only spawning populations and in limited geographic areas, mostly in central and southern California. Other fishable concentrations of squid have been found occasionally along the coast from central California to British Columbia and southeastern Alaska, and short-term fisheries sometimes have developed in these areas.

Historically, the squid resource was considered by some to be underutilized; recently demand has sometimes exceeded the catch. Until more objective estimates of abundance are available, the true status of the population will remain unknown. Past work, and work elsewhere, has included acoustic surveys and various collection techniques. Acoustical assessment of squid has been attempted off the central Oregon coast. However, with the scientific research program initiated in 1998, efforts to model the population began which may eventually give rise to thorough and detailed stock assessments similar to those undertaken for other coastal pelagic species. It is hoped the preliminary modeling work, fishery-independent surveys and information from scientific research will allow for development of an effective management strategy for the resource by the year 2002.



Hauling a lampara net in Monterey Bay
Credit: Jim Hardwick, DFG

The market squid fishery is often subject to extreme fluctuations in availability due to El Niño events or other environmental conditions, and demand is largely dependent on international market forces. However, as typically seen in short-lived, highly fecund animals, the squid population seems to have the ability to recover fully in a relatively short period of time. Consequently, squid can probably be more intensively harvested than longer-lived marine fish.

Marci Yaremko

California Department of Fish and Game

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Packing squid in the Monterey Bay area
Credit: Jim Hardwick, DFG