

STOCK ASSESSMENT OF THE MARKET
SQUID FISHERY IN CALIFORNIA
SOUTH OF PT. CONCEPTION

By

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Overview

The market squid resource is poorly known, and estimates of abundance, potential yield, and stock status are tentative. Abundance off California may be in the vicinity of 1 million metric tons. Potential yield estimates range from 90,000 to 180,000 metric tons for the southern California region from Pt. Conception to the US/Mexico border. Acceptable Biological Catch (ABC) and Optimum Yield (OY) are 45,000 metric tons during the developmental phase of the fishery. Recent statewide catches have ranged from 9,000 to 17,200 metric tons, leaving room for fishery expansion. It is doubtful that increased catches can come from some intensely fished traditional areas such as Monterey. Increases in fishing effort should be directed at previously unexploited or lightly fished areas.

The Resource

The market squid (Loligo opalescens Berry) is distributed along the Pacific coast of North America from British Columbia to central Baja California. Major known spawning grounds are from Point Sur to Monterey, and around the southern California Channel Islands, but lesser concentrations of spawning squid occur widely along the coast. Egg masses are attached to the ocean bottom. Upon hatching, larvae begin a pelagic existence that lasts one or two years (Spratt 1978). At the end of this period, mature squid return to the coastal spawning areas, reproduce and die.

There is no clear morphological evidence for or against the existence of subpopulations (Kashiwada and Recksiek 1978). Electrophoretic studies have been inconclusive (Ally and Keck 1978). Because the market squid, like Pacific salmon (Oncorhynchus spp), is a terminal spawner, there has been speculation regarding possible spawning/hatching site fidelity.

Squid feed upon crustaceans (largely euphausiids) and fishes, including northern anchovies, Engraulis mordax (Fields 1965, Karpov and Caillet 1978). In turn, adult market squid are consumed by fishes, seabirds, marine mammals, and to some extent others of their own species (Fields 1965, Morejohn, Harvey and Krasnow 1978). Market squid are prey, predators, and competitors, whose role in the marine food web is not clearly defined.

Published estimates of abundance are anecdotal. Based on personal at-sea experience, Mais (1974) estimated squid resources off California to be at least 1 million short tons. We have derived a crude estimate of squid biomass as follows: If we assume that predatory fishes consume whatever

prey they encounter, and that stomach contents reflect the proportions of various species, we may compare squid consumption to a better-known species such as northern anchovy. Of the fish species examined by Pinkas, Oliphant and Iverson (1971), the Pacific bonito (Sarda chiliensis) was the most inshore, and consumed the most squid (Oliphant 1971), and therefore will give the most liberal estimate. Assuming food volume in the stomach to be equivalent to biomass consumed, market squid contributed 18.0 percent of the total food volume, while northern anchovy contributed 75.9 percent. This gives a ratio of 0.24 units of squid per unit of anchovy. Huppert et al. (1980, Appendices I and III) estimated the 1969 anchovy spawning biomass of the central subpopulation at 2.721 million metric tons (2.999 million short tons). Of this amount, 54.5% or 1.48 million metric tons of anchovy can be attributed to the southern California inshore region from Pt. Conception to the US/Mexico border. Applying the above ratio gives an estimate of 360,000 metric tons of market squid in southern California.

The Fishery

Squid are caught for live and frozen bait by bait suppliers and by fishermen themselves. There is also a small recreational fishery in Monterey. The main fishery is for a fresh, frozen and/or canned product. These squid are captured immediately preceding and during spawning in nearshore waters at night. Lights may be used to attract and concentrate the squid, which are captured by lampara or purse seine nets. At times the use of a net is unnecessary, and squid can be dip netted or pumped directly from the ocean to the vessel.

Use of nets is known to result in dislodging previously spawned cases from the bottom. The extent of this disruption and its effect on reproductive success is unknown.

There are presently two geographic fishery areas, southern California and Monterey Bay. The southern California fishery catches squid nearshore around the Channel Islands, and lands them at San Pedro and Port Hueneme. The Monterey fishery operates mostly near the city of Monterey. Annual squid catches are given in Table 1. The Monterey fishery has been supply limited in recent years and has fluctuated greatly, whereas the southern California fishery has been demand limited, and has been relatively stable while slowly growing.

Potential Yield

J.R.R. Ally (California Department of Fish and Game, pers. comm.) has estimated potential yield of market squid to be 145,000 metric tons for the southern California region from Pt. Conception to US/Mexico border. This is based on the assumption that the Monterey fishery, which had an average annual yield of approximately 5,000 metric tons for the 1966-1975 period, is fully exploited, and that per unit of spawning area in the southern California region is similar to the annual yield per unit area for the Monterey spawning grounds.

Another crude estimate of potential yield may be obtained by the potential yield rule-of-thumb $Y_{pot} = 0.5 M \bar{B}$ where Y_{pot} is potential yield, M is coefficient of natural mortality, and \bar{B} is the virgin mean biomass.

As a cautionary note, this approximation may not be appropriate for a terminal spawner. Based on fishes of similar trophic position (anchovies, sardines), M may range from 0.5 to 1.0. Using a virgin mean biomass of 360,000 metric tons, this give potential yields of 90,000 to 180,000 metric tons for the southern California fishery. However, the Monterey fishery has shown large variability in annual catches. If these fluctuations are due to variability in resource abundance, the above potential yields may not be strictly sustainable, but rather long-term average harvests.

Acceptable Biological Catch

The above potential yield estimates for the southern California region from Pt. Conception to the US/Mexico border are tentative, and are not based on actual fishery experience. As the fishery develops, productivity of the resource can be assessed directly. In the interim, a safe or acceptable biological catch is one-half of the most conservative potential yield estimate, or 45,000 metric tons. As the fishery approaches this level of harvest, the condition of the stock can be reassessed.

Optimum Yield (OY)

Since the commercial fishery harvests squid at the end of their natural life, there is little direct competition with predators. Long-term ecosystem effects cannot be forecast due to the complicated food web relationships of the market squid (see Morejohn et al. 1978). The conservative level of ABC established above should prevent severe consequences while experience is being gained. Optimum yield is equal

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to ABC during the developmental phase of the fishery.
45,000 metric tons.

There is presently no reason to expect significant conflict between segments of the fishery (commercial, recreational, bait) as a result of increased harvesting. There may, however, be conflict within the commercial segment if increased effort is directed toward already intensely fished spawning areas. It is unlikely that increased yield can be obtained from some traditionally fished areas, such as Monterey. Rather, if the fishery is to expand, increased fishing effort should be directed at previously unexploited or lightly fished areas. Regulations may be necessary in the future to prevent over harvest at some locations.

Recent statewide harvests have been in the range of 9 to 17 thousand metric tons. There appears to be ample room for increased harvest. Because the harvest occurs almost entirely within the state of California 3-mile limit, participation in this expansion will be limited to domestic fishermen. Any foreign fishing would have to be pelagic in nature, and recent experience aboard a Spanish cooperative research vessel has shown prospects for success to be very poor (Stauffer 1979).

Acknowledgement

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Table 1. Market squid landings (metric tons)

<u>Year</u>	<u>Monterey</u>	<u>Southern California</u>	<u>Total</u>
1945	6,883	24	6,907
1946	17,238	10	17,248
1947	6,552	43	6,595
1948	8,671	64	8,735
1949	3,092	19	3,111
1950	2,718	1	2,719
1951	5,276	341	5,617
1952	1,608	57	1,665
1953	1,599	2,446	4,045
1954	3,391	308	3,699
1955	6,404	69	6,473
1956	8,434	404	8,838
1957	5,423	223	5,646
1958	1,770	1,613	3,383
1959	6,465	2,450	8,915
1960	1,014	148	1,162
1961	1,672	2,994	4,666
1962	2,564	1,686	4,250
1963	3,064	2,180	5,244
1964	4,129	3,326	7,455
1965	4,022	4,424	8,446
1966	4,630	3,547	8,177
1967	5,096	3,796	8,892
1968	6,613	4,697	11,310
1969	5,244	4,181	9,425
1970	3,914	7,241	11,155
1971	7,551	6,746	14,297
1972	5,560	3,583	9,143
1973	562	4,908	5,470
1974	6,575	6,536	13,111
1975	2,263	8,453	10,716
1976	2,271	6,933	9,204
1977 ¹	2,027	10,785	12,812
1978 ¹	9,368	7,821	17,189
1979 ¹	10,522	6,673	17,195
1980 ¹	6,241	8,275	14,516

¹Preliminary

Source: California Department of Fish & Game