INDICES OF THE AVAILABILITY OF MARKET SQUID, *LOLIGO OPALESCENS*, TO THE MONTEREY BAY FISHERY

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ABSTRACT

The availability of market squid to the Monterey lampara fleet has fluctuated grossly in the past two decades, causing considerable economic hardship in recent years. Fishermen and scientists have since 1970 become increasingly curious about the cause of these fluctuations in squid availability. The authors have shown squid to be relatively unavailable to the Monterey fishery in 1952, 1958, 1960, 1961, 1966, 1970, 1973, and 1975. Several indices of the availability of squid to the Monterey fishery suggest an inverse relationship between squid availability and the previous fourth-quarter sea elevation.

INTRODUCTION

The Monterey market squid fishery is one of California's oldest fisheries. About 113 years ago Chinese immigrants began fishing for squid in Monterey Bay with small hand-hauled purse seines. In 1905 Italians introduced the lampara net, which is still in use today. Squid were dried for shipment to the Orient in the early years of the fishery. Canning and freezing began in the early 1920's (Scofield 1924; Classic 1929). Catch records date back to 1916, and prior to 1943 the annual Monterey squid catch averaged 2.4 million pounds. During and immediately after World War II, Monterey landings increased to an average of 17.8 million pounds/year. The principal use of this squid was for export under the Marshall Plan. Landings dropped after 1948, but the large exports from 1943 to 1948 established a considerable market for canned squid. The export of canned squid and the increased demand for frozen squid since 1960 accounts for the bulk of the present fishery. Annual landings at Monterey from 1950 to 1975 have averaged 9.1 million pounds. The peak year was 1956 when 19.6 million pounds were landed, and the worst year was 1973 when 1.2 million pounds were landed.

Since 1960, the squid fishery in southern California has been competing with the Monterey Bay fishery and now accounts for over 50% of the statewide catch.

An attempt to identify the years of poor squid availability to the Monterey fishery and a search for a hypothesis to explain these changes in availability are presented in this paper. A look at Monterey squid landings reveals several years in the past three decades when landings were exceptionally low.

It has been reported as recently as 1972 (Crooke) and 1974 (Norberg) that fluctuations in squid catches are primarily a result of changing canners' demand. This statement may hold true for southern California squid landings, but those close to the Monterey fishery know very well that fluctuations in the Monterey squid landings since 1969 have been due to the changing availability of squid to the fishermen, not due to fluctuations in demand.

Fishermen at Monterey in 1970 were being offered as much as ever for their squid, but landings remained low and fishermen and dealers alike were demanding an investigation by scientists. The senior author set out in July of that year to discover whether the poor availability of squid in Monterey that summer was a new occurrence or whether a similar situation had occurred previously.

INDICES OF AVAILABILITY

Annual Monterey Catch

Catch may be a good indicator of availability of squid to the fishery in years where landings are extremely high or low. The catch may not give an indication of availability in near-average years. Availability could be high but landings depressed because of lack of demand. Availability could also be low and landings good because of increased fishing effort. The annual Monterey landings indicate that 1949, 1950, 1952-53, 1958, 1960-61, 1967, 1970, 1973, and 1975 were years of poor availability (Figure 1).

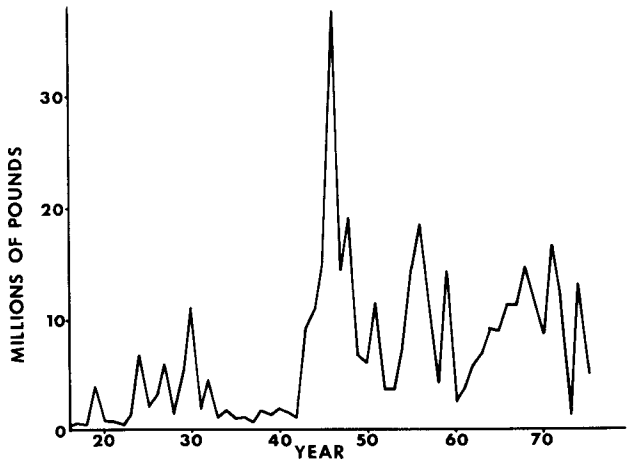

Figure 1. Monterey squid landings, 1916-76.

Catch Per Delivery Day

The best measure of the availability of fish to the fishery is catch per unit of effort. The squid fishermen at Monterey have never filled out daily activity logs, and data are not available to calculate total fishing effort. We do have records of daily landings by boat since 1960, but this includes only boats that were successful in catching squid. When the availability of squid is poor, even successful boats can be expected to reflect this with poor catches. The annual landings at Monterey were divided by the number of boat delivery days. The average catch per delivery day is higher than it should be because unsuccessful boats are not included. When availability is good, limits are placed on boats by fish buyers, which tends to depress the catch per delivery day. Catch per delivery day is a better indicator of poor availability than good availability.

Monterey squid fishermen have fished for squid every summer since 1950. Their success reaches its peak in May, June, and July. They become very upset if they cannot catch squid in these months. Years of low catch per delivery day were 1960, 1961, 1970, 1973, and 1975 (Figure 2). Early catches during the 1976 season indicate this will also be a poor year.

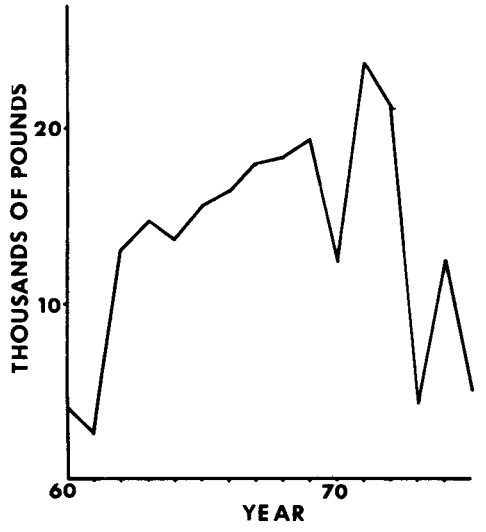

Figure 2. Monterey squid landings per delivery day, 1960-75.

We must look to less precise measures of availability for the years prior to 1960, as the data have not been stored in a manner that will permit retrieval of catch-per-delivery-day data.

Price Paid to Fishermen and the Percent Canned

The price paid to fishermen varies indirectly with availability of squid to the Monterey fishery. The price for squid is negotiated before the fishing season begins—before it is known how available squid will be to the fishery—and price does not change during the season.

The reason the mean annual price paid to fishermen is high when availability is poor can be seen when the uses for squid are examined. Squid sold to fresh fish markets and squid sold for freezing purposes command two to three times the price of squid sold to canneries for canning. Fishermen sell all they can at the higher fresh and freezing prices before selling any squid to the canneries. Thus, in years of poor availability, nearly all squid is sold at the higher fresh and freezing prices, which raises the mean annual price paid to fishermen. In good years the mean annual price is usually lowered because canneries buy more squid at the lower canning price. This is the mechanism that has resulted in an increase in the price paid to fishermen when landings are poor.

Increases in mean annual prices paid to fishermen have occurred in 1952, 1956, 1958, 1960 and 1961, 1963 and 1964, 1966, 1969 and 1970, 1972 and 1973 (Figure 3), and few squid were canned in 1952, 1960, 1961, 1970 and 1973 (Figure 4). However, price increases and reduced canning are not enough to indicate poor availability since a reduced demand for canned squid would also cause increases in the mean annual price paid to fishermen. Some indices other than price fluctuation and volume of squid canned are necessary to measure the availability of squid to the fishery.

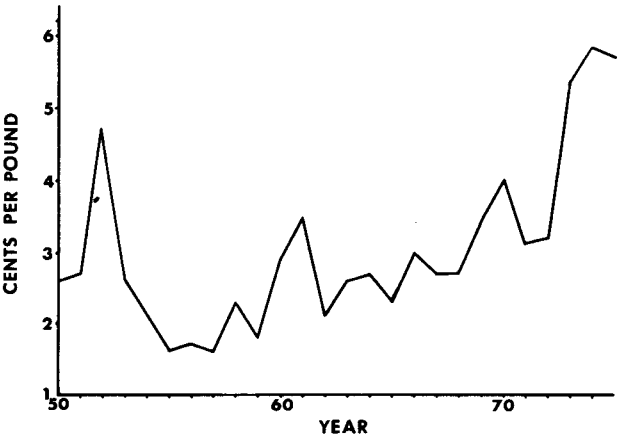

Figure 3. Mean annual price paid to Monterey fishermen for squid, 1950-75.

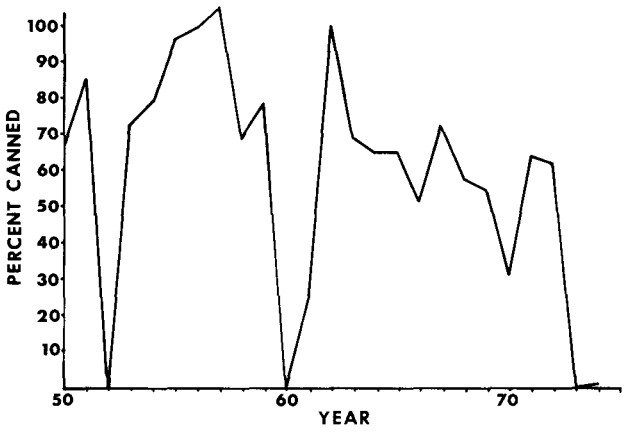

Figure 4. The percent of Monterey squid landings canned, 1950-75.

Figure 6. Southern California mean monthly squid landings, 1955-74.

Ratio of Monterey to Southern California Landings

Squid are usually most available to Monterey fishermen from May through July (Figure 5). They are most available to southern California fishermen from December through February (Figure 6). The Monterey fishery is much older than the southern California fishery, and dealers and brokers have traditionally tried to fill orders for squid with landings from Monterey. They fill orders with southern California squid when they are unable to fill them with Monterey squid. Poor Monterey landings are usually followed six months later by good southern California landings. The seasonal landings at Monterey compared with the following seasonal landings in southern California should be an index of the availability of squid to the Monterey fishery (Figure 7). High landings in southern California following poor squid landings at Monterey would be expected to indicate poor availability at Monterey.

One problem with this index is that once dealers and brokers have found a source of squid in southern California they may return to that source to fill future orders rather than going back to the Monterey sources, resulting in reduced demand at Monterey for several years following a year of squid unavailability. Therefore, a sharp decline in this availability index is a better indicator of the unavailability of squid at Monterey than a continuing low index. Squid were very likely unavailable to fishermen at Monterey in 1952, 1958, 1960, 1961, possibly 1964 and 1966, 1970, 1973, 1974, and 1975. We know from personal experience with the fishery at Monterey that fishermen had difficulty finding squid in 1970, 1973, and 1975.

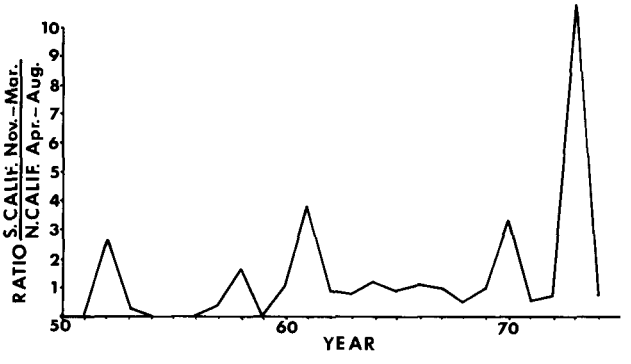

Figure 7. The ratio of southern California November-March squid landings to the previous northern California April-August landings.

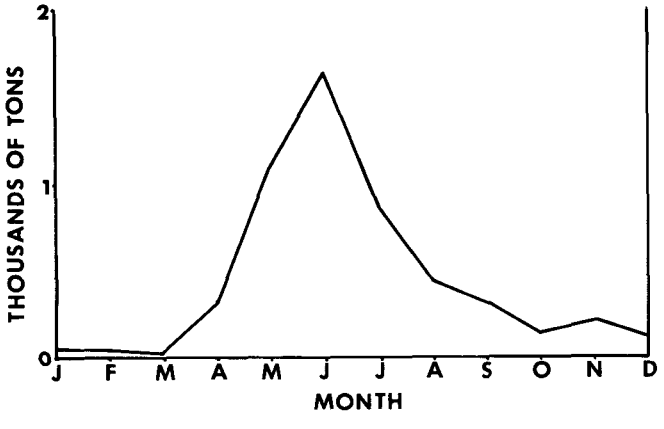

Figure 5. Monterey mean monthly squid landings, 1955-74.

DISCUSSION

The junior author has combined four indices of availability into a single index (Figure 8). The four indices are annual Monterey landings, ratio of Monterey to southern California landings, catch per delivery day, and price paid to fishermen. Each year is a numerical value equivalent to the number of indices indicating poor squid availability to the Monterey fishermen. The maximum pos-

sible value for the years 1950 to 1959 is 3 as catch-per-unit-of-effort data are unavailable for those years. The maximum value possible for the years 1960 to 1975 is 4. This index indicates that 1952, 1958, 1960, 1961, 1966, 1970, 1973, and 1975 were years of poor squid availability to the Monterey fishery (Table 1).

Monterey landings were poor in 1950. The southern California landings were also poor, and the price paid to fishermen did not change from 1949. Lack of demand caused by large inventories of squid that remained from the good years of 1946-48 very likely suppressed the catch at Monterey. If poor availability at Monterey was the reason for poor catches, the southern California catch would have increased.

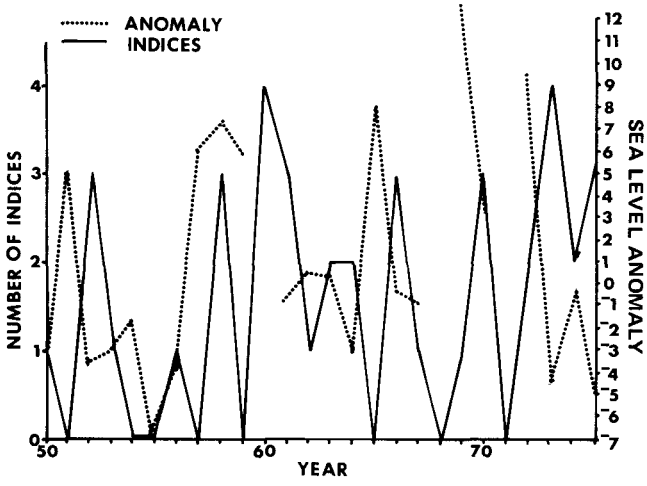

Figure 8. The number of indices indicating poor availability of squid to the Monterey Bay fishery and the Avila fourth-quarter sea-level anomalies.

The next year of poor catch at Monterey was 1952. The price increased at Monterey, and the southern California catch also increased. All three indices indicate squid were not available at Monterey in 1952.

In 1953 the Monterey squid catch was again poor, but southern California landings also dropped from 1952. The price also dropped during 1953, indicating that lack of demand was an important factor in 1953.

From 1954 to 1957, catches were good and prices were stable, indicating good availabilty.

Catches dropped during 1958 at Monterey and triggered inceased catches in southern California. The price also increased in 1958 and all three indices indicate that poor availability caused the poor catches at Monterey.

The 1960 catch was the lowest at Monterey since 1942. All indices indicate that poor availability was the cause. These same conditions prevailed in 1961; the catch was low, southern California landings increased,

TABLE 1.

Indices of the Availabiliy of Squid to the Monterey Bay Fishery

Year	Pounds landed	May-July lbs/delivery	¢/lb	Percent canned	S. Cal. Nov-Mar N. Cal. Apr-Aug	No. of indices*
1950	5,922,571		2.6	67	0.00	1
1951	11,632,468		2.7	86	0.00	0
1952	3,545,653		4.7	0	2.50	3
1953	3,526,829		2.6	73	0.26	1
1954	7,477,922		2.1	79	0.02	0
1955	14,120,513		1.6	97	0.02	0
1956	18,594,241		1.7	100	0.02	1
1957	11,956,541		1.6	105	0.34	0
1058	3,902,936		2.3	69	1.59	3
1059	14,252,042		1.8	89	0.01	0
1960	2,235,935	4,069	2.9	0	1.03	4
1961	3,686,284	2,601	3.5	25	3.78	3
1962	5,652,857	13,100	2.1	100	0.83	1
1963	6,754,463	14,831	2.6	69	0.72	2
1964	9,101,623	13,777	2.7	65	1.15	2
1965	8,865,195	15,580	2.3	65	0.89	0
1966	11,207,349	16,423	3.0	52	1.06	3
1967	11,233,271	17,849	2.7	73	0.94	1
1968	14,578,281	18,445	2.7	58	0.47	0
1969	11,560,220	19,396	3.4	55	0.96	1
1970	8,627,115	12,455	4.0	31	3.26	3
1971	16,646,620	23,749	3.1	64	0.50	0
1972	12,258,278	21,198	3.2	62	0.67	2
1973	1,240,970	4,188	5.3	0	10.78	4
1974	14,495,217	12,462	5.8	1	0.71	2
1975	5,000,000	5,160	5.7	0	10.92	3

*% canned is not included in number of indices indicating unavailability.

and price increased. The catch per delivery day rose slightly at Monterey but remained below 4 tons/day, indicating that poor availability caused the reduced catches.

Landings increased in 1962 but were still below 3,000 tons, and southern California followed with a good catch. But the mean annual price at Monterey dropped, whereas the catch per delivery day was better than 5 tons/day. This year the catch was probably suppressed because of lack of demand caused by loss of overseas markets during 1960 and 1961.

In 1966, an unusual set of circumstances took place. The catch was good, but all other indices show it was a poor year. Prices were high, but the catch per delivery day was low and the demand was not met, which resulted in good catches in southern California. Even though squid catches were good at Monterey, the demand for squid could not be met, indicating limited availability of squid.

In 1970, the same situation developed. The landings were relatively good, but the other indices indicated a poor season. The southern California catch reached record amounts in 1970.

In 1973, the Monterey squid fishery experienced its worst season in history. Annual prices paid to fishermen were high, but the catch per delivery day dropped very low, and southern California catches remained good.

Availability of squid at Monterey in 1973 was extremely poor.

The Monterey squid fishery rebounded in 1974 and experienced an excellent year with good catches and high prices. The price paid to fishermen remained high due to the high demand for frozen squid caused by low inventories from the 1973 season. The Monterey catches dropped in 1975 at a time when prices paid to fishermen were very high. Southern California had another record year, and clearly poor availability prevailed at Monterey.

The search for the cause of fluctuations in squid availability can now be approached with some knowledge of when squid yields have been poor. Red crabs, *Pleuroncodes planipes,* washed up on Monterey Peninsula beaches in the winter of 1969-1970 and 1972-1973. They had also been reported to have washed up on Monterey Peninsula beaches in the winter of 1959-60 (Glynn 1961). Many oceanographers explained the occurrence of these red crabs as a consequence of a strong Davidson current. Mean sea-level height is the best available measure of the strength of coastal currents (Reid and Mantyla 1976), and Avila is the closest station to Monterey at which data have been gathered over a sufficient time span. Regression of the catch per delivery day from 1960-1974 against the previous Avila fourth-quarter sea levels yielded a correlation coefficient of -0.63, meaning that 40% of the variability in catch per delivery day is associated with variations in sea level. There were few years in which fall sea-level heights were not inversely related to the success of the following summer fishery (Figure 8). High sea-level heights in the fall of 1958 were followed by a successful season in 1959, and the unsuccessful seasons of 1975 and 1976 were not preceded by high sea levels in the falls of 1974 and 1975.

CONCLUSION

The poor availability of squid at Monterey during 1952, 1958, 1960-61, 1966, 1970, and 1973 and 1975 was the primary reason for poor catches those years. Catches were also low in 1950, 1953, and 1962, but this was apparently due to lack of demand caused by a glut of canned squid from the peak World War II seasons and to a loss of overseas markets due to the poor years of 1960 and 1961.

High fourth-quarter sea levels and a strong Davidson current appear to be one set of factors often associated with poor availability of squid to the Monterey fishery the following summer.

ACKNOWLEDGMENTS

We wish to thank Betty Lou Hardwick and Rodney R. McInnis for the time-consuming evaluation of catch-per-delivery-day data and Mrs. Nancy Durell for typing the manuscript. Douglas R. McLain of the Pacific Environmental Group, National Marine Fisheries Service, supplied the sea-level data.

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