THE STATUS OF THE PACIFIC SARDINE RESOURCE AND ITS MANAGEMENT

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Charles W. Haugen

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ABSTRACT

The Pacific sardine fishery has declined from a catch of almost 8 hundred-thousand tons in the nineteen thirties to relative insignificance at present. This decline was primarily due to the decline of the northern subpopulation.

Scientists feel that the only remedial measure which would be effective is a complete ban on sardine fishing in California and northern Baja California.

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HISTORY OF THE FISHERY

A sustained fishery for Pacific sardines first developed in response to the demand for food during World War I. From 1916 to 1936, fishing effort and sardine landings grew with increased demand. During the 1936-37 season, Pacific Coast sardine landings reached 791,334 tons, and from the 1937-38 season to the 1944-45 season, landings fluctuated from 493,000 to 680,000 tons. The sardine fishery began a spectacular collapse during following seasons, and in spite of continued demand, catches have declined progressively with only short term reversals.

There was a southward shift in landings concurrently with a decreasing catch. Commercial landings in British Columbia, Washington, and Oregon ceased after the 1948-49 season. Through the 1945-46 season, most California sardine landings were at Monterey and San Francisco. San Pedro has accounted for most California landings since then. Mexican landings have exceeded those of California every season since 1962-63, and current landings are mainly from southern Baja California and the Gulf of California. The decline of the sardine has been characterized by a progressive decrease in range as well as numbers.

In past years, the principal uses for sardines were as canned food or for reduction to fish meal and oil. Most fish landed north of California were for reduction. California processors began as canners, and canning continued as an essential part of their operation, but they soon realized that reduction of whole fish to meal and oil could be a profitable

supplement to the canning operation. Reduction remained profitable for more than a decade, including the war years, and for many years tonnage reduced exceeded tonnage canned.

An extremely lucrative market for sardines for bait has developed in the San Francisco Bay area in recent years. Sardines landed in California for this market bring the fishermen $400 to $500 per ton. Fresh and frozen sardines are imported from Mexico and other countries to augment the California landings. In 1969 the California Legislature enacted a measure permitting an annual take of 250 tons of sardines for bait. At present, the San Francisco-Delta bait market appears to be the most significant economic factor responsible for continued fishing pressure on the California sardine resource.

Fishery Data

Sardine catch records for California have been compiled since 1916. Fish dealers are required to report quantities of fish landed and area of catch. When possible, catch records are supplemented by interviews of vessel captains (Blunt and Kimura, 1966).

Several studies of catch-per-unit-of-effort as a measure of relative abundance or availability of sardines were made during the large fishery years and led to forecasts of impending trouble based on declining catch-per-unit-of-effort (Clark, 1939; Silliman and Clark, 1945; Clark, 1956). However, recent studies by J. Radovich (pers. commun.) question the value of traditional use of catch-per-effort data as a measure of abundance in a searching type fishery.

BIOLOGICAL DATA

Geographic Range

The Pacific sardine has been recorded in the Pacific coastal waters of North America from southern Alaska to Cape San Lucas and the Gulf of California. In recent years the occurrence of sardines north of Point Conception has been increasingly rare.

Status of Populations and Subpopulations

Heterogeneity within the Pacific sardine population has been investigated through meristic and morphometric characteristics (Clark, 1947; McHugh, 1950; Wisner, 1961; Mais, 1972), differences in growth rates (Felin, 1954), and serologic characteristics (Sprague and Vrooman, 1962; Vrooman, 1964). These studies demonstrate: (1) a northern subpopulation with a center of abundance off southern California and northern Baja California, (2) a southern subpopulation centered off central and southern Baja California, and (3) a gulf subpopulation inhabiting the Gulf of California.

The line of demarcation between the northern and southern subpopulations is known to shift from time to time probably in response to changes in water temperature and perhaps to population pressures. Thus, fish of the southern subpopulation have been found off southern California on occasions in the past; however, all samples taken locally since 1960 have been of the northern subpopulation (A. M. Vrooman, pers. commun.).

It is primarily the northern subpopulation that has experienced the dramatic decline over the past 40 years. The northern stock biomass was estimated to have been around 3 million tons in the early 1930's (Murphy, 1966). Latest estimates (1971) place the biomass at probably not more than 5,000 tons and perhaps as low as 2,000 tons (P.E. Smith and W. Lenarz, pers. commun.).

The dramatic reduction in the size of the sardine population and the collapse of the once great fishery depending upon it generated considerable research into the dynamics of the population and the causes of its demise. There was debate over the relative importance of overexploitation and environmental factors, and little agreement over the relationship between strength of a year class and the size of the spawning stock that produced it (Clark and Man, 1955; Man, 1960; Murphy, 1961; Radovich, 1962; MacGregor, 1964). The question of species interaction, and in particular the importance of competition between sardines and a burgeoning anchovy population received attention from several authors (Ahlstrom, 1965, 1967; Isaacs, 1965; Murphy, 1966, 1967; Bogdanov, 1968). However, evidence from numbers of fish scales in ocean sediments (Soutar, 1967; Soutar and Isaacs, 1969) and from reexamination of early ichtyoplankton survey data (P.E. Smith and W. Lenarz, pers. commun.) indicate that sardines and anchovies have coexisted at high population levels in the past and that competition is probably not a major factor preventing the recovery of sardine stocks.

Migrations

Tagging experiments conducted between 1935 and 1942 showed extensive movements of sardines between fishing ports (Clark and Janssen, 1945). Northward movements took place during summer, and southward in late fall and winter. Older and larger fish tended to migrate furthest to the north.

Reproduction

The Pacific sardine is a pelagic marine spawning fish. Spawning occurs in the open ocean over deep water as well as in inshore areas, and is known to occur from Oregon to Cape San Lucas and throughout most of the Gulf of California. The chief spawning areas on the Pacific coast are (1) the southern California bight for the northern subpopulation, and (2) Baja

California waters centered on Punta Eugenia for the southern subpopulation (Ahlstrom, 1966; Kramer, 1970).

The majority of sardines spawn at age two. Under favorable environmental conditions a portion of the 1 year old fish also will spawn. Sardines of the southern subpopulation mature at a smaller size than those of the northern subpopulation.

The number of eggs produced per batch per female is almost directly proportional to the weight of the fish. However, the number of batches spawned per female per year has never been satisfactorally resolved (Clark, 1934; MacGregor, 1957).

Some spawning occurs throughout most of the year; however, in the southern California bight most spawning takes place during spring, while off central and southern Baja California there are spawning peaks in both winter and summer months (Farris, 1963).

Size, Age and Growth

Length frequency data have been collected systematically on sardine landings since 1919 (Felin and Phillips, 1948). Techniques of determining ages of sardines by means of scales and otoliths were developed by Walford and Mosher (1943a, b). Age compositions of the commercial catch from the 1932-33 through 1965-66 seasons have been published. However, Kimura (1970) has demonstrated formation of a false annulus on laboratory reared sardines and questions the reliability of previous age assignments.

Southern subpopulation sardines grow at a faster rate during their first year of life than those of the northern race. Nevertheless after age one, northern fish put on more gorwth per year and reach a greater size and age than southern fish. Samples from the commercial catch from San Pedro to British Columbia showed a definite north-south cline in size of

fish of the same age.(Phillips, 1948; Felin, 1954). The increased size of northern fish may be due to (1) more fish of the southern subpopulation in the landings at San Pedro, (2) larger fish of a year class performing the longer migrations northward, or (3) better growth in northern latitudes associated with more abundant food.

The effects of temperature on the development of sardine eggs and growth of larvae has been reported by Lasker (1964). He showed that at low temperatures (<15 C), larvae are more vulnerable to predation because development of jaws and of eye pigmentation is delayed.

REGULATION AND MANAGEMENT

Prior to 1967, management of the sardine resource in California almost entirely was limited to (1) control of tonnage of whole fish used for reduction, (2) case pack requirements, and (3) restriction of the fishing season to the time of year when fish were most available and in prime condition for processing (Ahlstrom and Radovich, 1970). A moratorium on sardine fishing in California was in effect during the 1967-68 and 1968-69 seasons. The moratorium limited the quantity of sardines which could be taken incidentally with other fish to 15% by weight of a mixed load.

DISCUSSION

Catch Statistics

Reliable catch statistics for sardines landed in California date from 1916 to 1967. Since the moratorium on sardine fishing went into effect, the high value of sardines for bait has encouraged a significant but undetermined portion of sardine landings to go unreported. This situation will probably continue as long as California caught sardines are permitted to be used as bait.

Reliable catch statistics for sardines landed in Mexico have not always been available to California biologists on a timely basis, largely due to difficulties in communications between workers in the two countries.

Biological Knowledge

The most immediate need is for a means of estimating the population size in the absence of a fishery and with the population so low that there are sampling problems with egg and larva surveys.

Fecundity studies in the past (Clark, 1934; MacGregor, 1957) have dealt only with the northern subpopulation. If population estimates for the southern subpopulation are to be made using the "egg number-fecundity-biomass" method, studies of fecundity of the southern stock will be needed. The question of the number of batches of eggs spawned per female per year has never been resolved.

Management

At this point in time, the only effective means of management of the sardine northern subpopulation would be a complete ban on sardine fishing in California and northern Baja California. Such a measure must specifically prohibit the use of northern subpopulation sardines in the San Francisco-Delta bait market. The absence of this high value market will remove the incentive for incidentally catching sardines.

A bill (SB 192) has been introduced into the Legislature that would prohibit the catch of sardines except for an incidental catch (limited to 15% of a load) that may be used only for canning or reduction. Under the terms of this bill the Department will make an annual determination of the spawning population of the northern stock and when this reaches 20,000 tons, a 1,000 tons quota will be allowed. The quota would increase as the population increased.

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