Monterey Sardine Story

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Monterey and the sardine fishery are linked by history and the stories of their close relationship often contain as much fiction as the novels of Steinbeck. In fact, the stories of the demise of the sardine are as varied as the people who fished, canned and studied them. Was overfishing, ocean currents, or the ocean disposal of nerve gas off of San Francisco following WW II that which caused the disappearance of sardine from Monterey Bay? Did the fish simply move to Peru or Chile or South Africa, to be followed a couple of years later by the machinery sold from the bankrupt processing plants along Cannery Row?

What really happened?

I arrived in Monterey in 1966 as the new California Department of Fish and Game marine biologist responsible for monitoring the wetfish fishery. Wetfish are the fish that are canned "wet" and then cooked in the can, i.e. sardine, anchovy, squid and mackerels. I was extremely lucky to share an office for my first few years with the only other marine fisheries biologist in the region, Julie Phillips. Julie had come to Monterey with a similar background to my own; however, he came about forty years earlier. Julie was just about the closest thing to a sardine text book that was available in 1966, or 2000 for that matter as he had been the wetfish biologist through the development, peak and collapse of the sardine fishery. By 1966 there were just two canneries still operating on Monterey Bay, the Hovden Cannery on Cannery Row and the Santa Cruz Cannery in Moss Landing. There were also just two purse-seiners left, the New Roma and the Vitina A, although there was still a fleet of lampara boats. At this time the only sardines being landed in Monterey Bay were at the Santa Cruz Cannery in Moss Landing. Almost all of them were 12-14 inch, 10-14 year-old female sardines taken as trace amounts in jack mackerel landings made by the New Roma. In the intervening 34 years I have studied sardines from most of the sub-tropical areas of the world in which they occur, and for the last 26 years I have worked with a team of physical oceanographers involved in research on interaction between climate variations and fisheries in the Pacific.

So what follows is my version of what happened, with a bit of help from Julie.

The short of it is that the collapse occurred in slow motion and a lot of things went wrong for sardines over an extended period. The primary ingredients were overfishing, a long term cooling in the California Current, WW II, El Nino and nobody home in the California Legislature. The seasoning included technological innovation in fishing gear and processing methods, a difference in opinion between the state and federal scientific communities, and the fishermen's fear of the precedent of closing a major commercial fishery.

Canning of sardines started in San Francisco in 1889 and in Monterey in 1902. After a slow start, the central California fishery increased rapidly during the 1920s reaching 120,000 tons by the 1928 season. From 1936 to 1945 the central California fishery averaged 332,000 tons with a peak of 460,000 tons in 1939. Landings fell sharply from 251,000 tons in 1945 to only 18,700 in 1947 and then rose to 148,000 tons when the last great year-class of sardines (1947) entered the fisher in 1949. The central California landings then fell to 33,000 tons in 1950, to 961 tons in 1951 and to 1 ton in 1953. Landings in central California over the next 30 years totaled only 28,191 tons with 23,335 of this landed during the first el Nino to be recognized in California. I will come back to this event later as it plays a major role in the sardine story. The southern California sardine fishery developed slower, going from 27,000 tons in the 1916 season to a peak of 204,000 tons in 1942. The only year it exceeded this level was in 1950 (306,000 tons), during the collapse of the central California fishery, when the bulk of the Monterey fleet moved to southern California to fish.

The people who developed the sardine fishery were a varied mix of immigrants mostly from fishing cultures elsewhere in the world. The fishermen were primarily from the Mediterranean, the Adriatic and the Sea of Japan. The processors were from New England, the North Sea, the Bay of Biscay and the Baltic Sea. This fertile mix of experience and backgrounds resulted in a rapid development of fishing and fish processing methodology that revolutionized the industry and allowed the industry to achieve the harvesting and

processing capacity that put the sardine at risk.

Contrary to many stories you will hear, overfishing was rampant in the sardine fishery, however this was not the case during the peak of the fishery. For example, during the peak of the fishery (1932-47) the average annual exploitation rate was 25% of the sardine biomass and the biological production rate (surplus production) was 20% of the biomass; a difference of only 5% per year. The real overfishing occurred during the period of the collapse of the fishery in Southern California (1958-64) when the average exploitation rate rose to 50% and the production rate fell to 7%; resulting in an average annual over harvest of 43% of the biomass. In contrast, during the period of the recovery (1983-97) the average harvest rate was just under 9%, the average production rate was huge (57% per year) and the biomass increased at an average rate of nearly 50% per year. However, the highest biological production rates occurred at the beginning of the recovery when the sardine biomass was less than 100,000 tons (101% per year). During this period when the biomass was between a tenth and a half million tons the production rate was 43%. In recent years when the biomass has been over a half million tons the rate has declined to 23%, not markedly larger than it was during the peak of the fishery.

Fishery	Biological Exploitation	Production	Difference Rate:
Fishery Peak 1932-47	25%	20%	-5
After Peak 1948-57	27%	19%	-8
Fishery Collapse 1958-64	50%	7%	-43
After Collapse 1965-82	NA	NA	NA
Fishery Recovery 1983-97	<9%	57%	+49
Early Recovery 1983-87	<9%	101%	+92
Mid Recovery 1988-93	<9%	43%	+32
Late Recovery 1984-97	<9%	23%	+14

What was the role of the ocean?

Large multi-decadal regime shifts in the Pacific Ocean Basin are now all the rage; however, there was little reason to suspect this type of climatic variation during the collapse of the sardine. In spite of this, Garth Murphy, a biologist that did the classic sardine population analysis, used increased mortality rates starting in 1949. In hindsight it is clear that the warm oceanic regime of the mid-1920s to mid-1940s was largely the cause of the bloom in the sardine population. The onset of generally cold sea surface temperatures, along with altered circulation patterns in the North Pacific, were working against the sardine.

So how does the temperature of the California Current Region affect sardines? First the abundance of the plankton on which sardine feed increased from south to north in the California Current. The temperature tolerance of sardines largely prevents them from occupying regions with sea surface temperatures below about 50 degrees Fahrenheit (10C). Sardine eggs and larvae are most common between 57-61 degrees (14-16C) and spawning concentrations are seldom found in areas with the sea surface temperature below about 55 degrees (12.5C). In the warmest years, the late winter critical 50-degree isotherm is near the center of Vancouver Island at about 49N; in the coldest years, it is near the California-Oregon border (42N). Therefore, sardine can winter in the Southern Canada to Oregon region during warm years, but not during cold years. In the warmest years, at the onset of spawning (February), the area of preferred temperatures is displaced far to the south, between the Mexican Border and Point Eugenia in Baja California. In the warmest years, sardines spawn in the productive waters of central California and the adults migrate to feeding grounds in the very productive waters of the Pacific Northwest. In the coldest years they spawn in the very unproductive waters of northern Baja California and they feed in the unproductive waters of southern California and, to a lesser extent, in the productive waters of central California.

The net effect of these temperature-dependent geographic dislocations in their spawning and feeding grounds is that during extensive warm periods sardines increase their population size by about 30% per year and during protracted cold periods their population size decreases even without a fishery. The rate at which this natural decline occurs is not as well known as the decline during the 1950s. However, it is well known from paleo-sediment analyses that the sardine population off California has been rising and falling for thousands of years with an average period of approximately 55-60 years.

Historical evidence also shows that the Japanese sardine (the same species as the California sardine) and the Baltic herring have been fluctuating throughout recorded history with similar length cycles.

What did World War II have to do with the Monterey Sardine?

In the late 1930s a small group of heroic fishery biologists from the California Department of Fish and Game was approaching the point where I believe they would have convinced the California Legislature that a 250,000 ton quota should be

adopted. I use the term heroic in the old fashion sense, denoting those who continue to fight even though they have lost every battle they have ever been in. During WW II the regulation of the sardine fishery, which had been the responsibility of the California Legislature, was taken over by the federal government with the overriding goal of maximizing the amount of canned fish for the war effort. After WW II was over it took a number of years before the fisheries research community was re-established and by the time they were ready to act, the sardine was already in extremely serious trouble.

Prior to WW II the sardine was essentially studied by biologists from the California Department of Fish and Game (CDF&G), with some input from biologists from Oregon, Washington and especially Canada. After WW II the US federal government entered the fray. An early decision split research into three major camps; oceanography went to the Scripps Institution of Oceanography and studies of the fishery and adult fishes was retained by the CDF&G. The federal government undertook studies of the eggs and larvae and in 1950 an extensive series of research cruises for eggs and larvae as well as oceanographic research was established. Note that this research effort started just when the sardine population had collapsed. Instead of closing the fishery the California Legislature decided to study it. The first years of the research survey were carried out during the extremely cold years of the early 1950s when there was virtually no sardine spawning north of Point Conception and the majority of spawning was off Baja California. By the mid-1950s when the southern California fishery had collapsed; California landings in the 1952-53 and 1953-54 seasons were only about 5,000 tons. And then along came the massive 1958-59 el Nino resulting in a northern displacement of the small surviving sardine population into southern California and a sharp increase in the numbers of eggs and larvae taken in the surveys. The biologists from the CDF&G were of the opinion that the increase in eggs and larvae in southern California showed that there was a strong recovery underway.

You will never guess what side the fishermen were on.

The California legislature did nothing. It should be noted that the collapse of a major marine fishery was outside of anyone's experience, and of course the fishermen and half of the scientists were on one side and only the biologists from the California Department of Fish and Game were on the other side. By the early 1960s it was all over. The cold ocean returned and Cannery Row in Monterey was well on its way to becoming a legend. In June of 1967, sixteen years after the collapse of the sardine fishery of Monterey Bay, the California Legislature closed the directed sardine fishery in California.

The ultimate reason that the sardine fishery collapsed is that the California Legislature failed to adequately protect the resource. Long after the collapse, when biologists from the California Department of Fish and Game finally persuaded the Legislature to do something, they passed a partial solution. When they "closed" the sardine fishery in1966 the Legislature included a provision that allowed 15 percent of any fish landing to be sardines. So to land 5 tons of sardines, that were valued at $500-$1,000 per ton, all a fisherman had to do was catch 30 tons of anchovy or jack mackerel that were valued at $32-60 per ton. Then in 1969 the legislature liberalized the regulations further; allowing a directed, 250 ton per year dead bait fishery. A moratorium on the sardine fishery was finally achieved in 1974, twenty-three years after the Monterey Bay sardine fishery collapsed.

In 1934 the biomass of the California sardine stock was over 4,000,000 tons (about 32 billion fish). In 1966 the biomass was about 4,000 tons, one tenth of one percent of its peak biomass. Population estimates are not available for the sardine from 1966-1982 and it is likely that we will never know how low the stock level was at the end of fishing in 1974. In 1975 sea surface temperatures in the California Current reached the coldest levels for which we have good records. Then in 1976-7 the oceanic climate changed again and an extended warm period began. The best guess is that the sardine biomass was between a couple of hundred tons and a couple of thousand tons when the warm water returned. The warm period continued through the 1980s and the 1990s and included several extensive el Nino events. The sardine fishery remained closed during the late 1970s and in the early 1980s small numbers of sardine were again seen in southern and central California. A minor and tightly regulated California fishery was allowed in the late 1980s and by 1990 the combined California and Mexican catch increased to 14,000 tons. By 1997 the estimated biomass exceeded 1 million tons and the combined total landings by the regulated California fishery and the unregulated Mexican fishery exceeded 110,000 tons.

It is now mid-February 2000, the 10C isotherm is once again just north of the California-Oregon border and the early signs of a return to a pattern of cold temperatures in California are evident.