

Northern Anchovy

History of the Fishery

Three separate fisheries in both California and Mexico exploit northern anchovy (*Engraulis mordax*). Anchovy landed by the reduction fishery are converted to meal, oil, and soluble protein. These products are sold mainly as protein supplements for poultry food, and also as feed for farmed fish and other animals. Meal obtained from anchovy is about 65 percent protein compared to about 50-55 percent for meal from other fishes.

Anchovy harvested by the live bait fishery are not landed but kept alive for sale to anglers as bait. Transactions between buyers and sellers of live bait take place at sea or at bait wells tied up at docks. Live bait dealers generally supply bait to commercial passenger fishing vessels (CPFVs) on a contract basis and receive a percentage of the fees paid by passengers. Bait is also sold by the "scoop" to anglers in private vessels. Anchovy landed by the non-reduction (other than live bait) fishery are used as dead frozen bait, fresh fish for human consumption, canned fish for human consumption, animal food, and anchovy paste.

Reliable records of California landings of northern anchovy date from 1916. Landings were small until the scarcity of Pacific sardines caused processors to begin canning anchovies in quantity during 1947, when landings increased to 9,464 tons in 1947 from 960 tons in 1946. To limit the quantity of anchovies being reduced to fishmeal, the California Fish and Game Commission required each processor to can a large proportion of the harvest (40-60 percent depending on can size). Anchovy landings declined with the temporary resurgence of sardine landings around 1951. Following the collapse of the sardine fishery in 1952, anchovy landings increased to nearly 43,000 tons in 1953, but subsequently declined due to low consumer demand for canned anchovy and increased sardine landings. Landings remained low through 1964. During the early years (1916 through 1964), anchovy were harvested almost exclusively by California fishermen. Mexico did not begin harvesting anchovy until 1962.

Beginning in 1965, the California Fish and Game Commission managed anchovy on the basis of a reduction quota. This quota had been taken by a fleet of approximately 40 small purse seine vessels operating off southern California known collectively as the "wetfish" fleet, which fishes for other species in addition to anchovy. In 1965, only 171 tons of anchovy were landed for reduction, which increased to an average of over 64,000 tons per year between 1965 and 1982. After 1982, reduction landings decreased dramatically to an average of only 923 tons per year from 1983 to 1991, and fell to zero in 1992 through 1994. During the period 1995 to 1999, only four tons were reported as reduction landings. Although Section 147 of Title 14, Cali-

fornia Code of Regulations, currently provides a process for the California Department of Fish and Game (DFG) to issue permits for reduction fishing, decreased prices of fishmeal and the low prices offered to fishermen have deterred any significant reduction fishing in recent years.

The non-reduction live-bait fleet in recent years has consisted of about 18 boats that are distributed mostly along the southern California coast to serve the principal sport fishing markets. Live bait boats fish for a variety of species, but anchovies comprised approximately 85 percent of the catch prior to 1991. Pacific sardines became available to the live bait fishery again in 1992, and the composition of live bait catches shifted from primarily anchovy to primarily sardine. From 1996 through 1999, sardines constituted approximately 72 percent of the live bait catch. Historically, the anchovy live bait catch ranged from 4,000 to 8,000 tons per year and averaged approximately 4,500 tons annually between 1974 and 1991. This average dropped to slightly over 2,500 tons between 1992 and 1994. Current estimates of the live bait catch are available from the DFG Pelagic Fisheries Assessment Unit in La Jolla, California. Non-reduction (other than for live bait) landings averaged slightly over 2,200 tons per year from 1965 to 1994, and increased to an average of about 4,122 tons per year between 1995 and 1999.

Anchovy landed in Mexico, other than a small amount used for bait, have been used primarily for reduction. Mexico's harvesting and processing capacity increased significantly in the late 1970s when several large seiners were added to the fishing fleet and a large reduction plant was constructed in Ensenada. Mexican anchovy landings averaged approximately 85,500 tons from 1962 to 1989, with a high of over 285,000 tons in 1981. Northern anchovy catch decreased sharply in 1990, and despite landing 19,600 tons in 1995, average annual Mexican landings from 1990 to 1999 were only 3,600 tons.

The U.S. northern anchovy central subpopulation fisheries have been managed by the Pacific Fishery Management Council since 1978, and the central and northern subpopu-

lations since 1998. The fishery management plan has been

Northern Anchovy, *Engraulis mordax*
Credit: DFG

amended to include all four species of finfish collectively known as coastal pelagic species (CPS); Pacific sardine, Pacific mackerel, jack mackerel, in addition to northern anchovy, and has been renamed as the Coastal Pelagic Species Fishery Management Plan. Regulations described in the fishery management plan designate the northern anchovy fishery as not actively managed due to low fishery demand and high stock size. If conditions change, and active management is required, then provisions in the fishery management plan require calculation of an Allowable Biological Catch (ABC) for northern anchovy fisheries in U.S. waters. As of May 31, 2000, there were 63 vessels licensed to fish CPS finfish under the NMFS limited entry program, which is in effect south of 39° N. latitude (Pt. Arena, California). North of this area, there is open access to the fishery.

Maximum Sustainable Yield (MSY) for northern anchovy in the central subpopulation is estimated to be 135,600 tons per year at a total biomass level of about 808,000 tons. At present, northern anchovy are not actively managed, but a recommended default MSY control rule gives an ABC for the entire stock equal to 25 percent of the MSY catch, or just over 34,000 tons. An estimated 82 percent of the stock is resident in U.S. waters. ABC in U.S. waters is, therefore, 82 percent of 34,000 tons or 27,600 tons. Under federal management, there is no longer a separate quota for reduction landings of anchovy. Although fisheries in Mexican as well as U.S. waters harvest the northern anchovy, there is no bilateral management agreement with Mexico. The Mexican fishery is managed independently and is not restricted by a quota.

Economics explain a great deal about the current dynamics of anchovy fisheries in California, because the fisheries are more limited by prices and markets than by biological constraints. The price paid to fisherman for anchovy landed as live bait in southern California was about \$440 per ton in 1999, slightly less than the \$480 per ton paid for sardines as live bait. Although prices and revenues for live bait tend to be surprisingly high, annual catches have been modest due to market limitations.

During 1981 to 1999, the price paid for anchovy landed for non-reduction purposes other than live bait averaged about \$330 per ton. As with live bait, market limitations have resulted in modest annual catches despite relatively high prices paid to fishermen.

The average price for anchovy landed by the U.S. reduction fishery during 1981 to 1999 was about \$80 per ton, but the price paid during 1997 was only \$40 per ton. Low prices, as well as market problems have prevented a significant U.S. reduction fishery in recent years.

Status of Biological Knowledge

Northern anchovy are distributed from the Queen Charlotte Islands, British Columbia to Magdalena Bay, Baja California. The population is divided into northern, central, and southern subpopulations or stocks. The central subpopulation ranges from approximately San Francisco, California to Punta Baja, Baja California, with the bulk being located in the Southern California Bight.

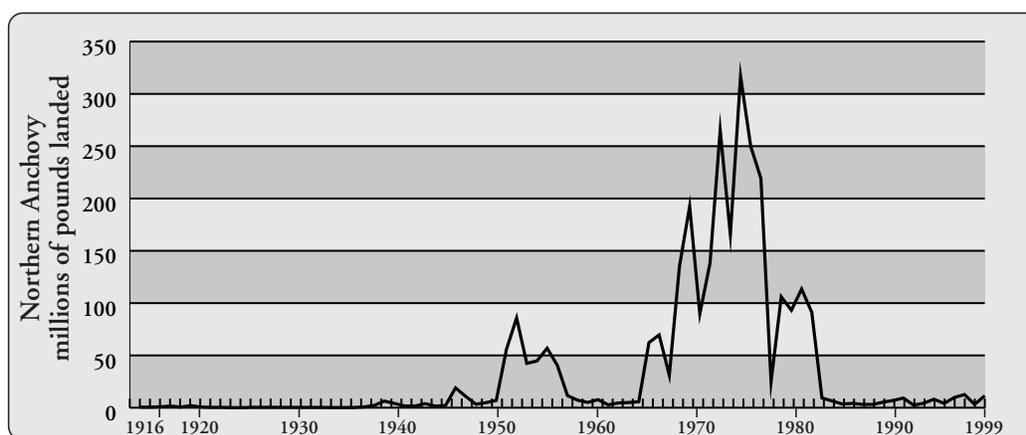
Northern anchovies are small, short-lived fish typically found in schools near the surface. They rarely exceed four years of age and seven inches total length, although individuals as old as seven years and nine inches have been recorded. There is a great deal of regional variation in age composition (number of fish in each age group) and size at age with older fish and larger fish found at relatively offshore and northerly locations. In warm years, relatively old and large fish are found farther north than during cool years. These patterns are probably due to northern and offshore migration of large fish, regional differences in growth rate, and water temperatures. Northern anchovies in the central subpopulation are typically found in waters that range from 54° to 71° F.

Information about changes in anchovy abundance during 1780 to 1970 is available from scales counted in sediment cores from the Santa Barbara basin. These data indicate significant anchovy populations existed throughout the time period and that biomass levels during the late 1960s were modest relative to those during most of the 19th and early 20th centuries.

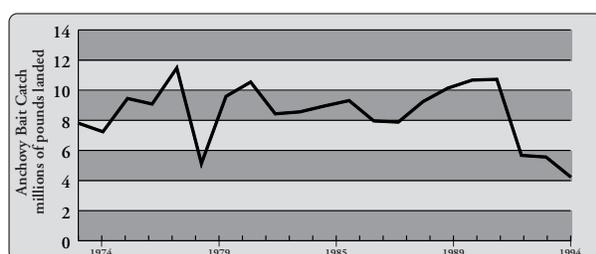
The age at which northern anchovy become vulnerable to California fisheries depends on the location of the fishery and type of fishery. Fish become vulnerable to the inshore live bait fishery at an earlier age than they become vulnerable to the reduction fishery. However, substantial numbers of zero and one-year-old fish are taken by both fisheries in most years.

Anchovy are all sexually mature at age two. The fraction of one-year-olds that is sexually mature in a given year depends on water temperature and has been observed to range from 47 to 100 percent. They spawn during every month of the year, but spawning increases during late winter and early spring and peaks during February to April. Spawning has been observed over a temperature range of 54° to 71° F. Individual females spawn batches of eggs throughout the spawning season at intervals as short as seven to 10 days. The eggs are found near the surface, and require two to four days to hatch, depending on water temperatures. Eggs and larvae are both found near the surface.

Northern anchovy are subject to intense predation throughout all life stages. Anchovy eggs and larvae fall prey to an assortment of invertebrate and vertebrate



**Commercial Landings
1916-1999,
Northern Anchovy**
Data Source: DFG Catch
Bulletins and commercial
landing receipts.



Live Bait landings of anchovy in CA, 1974-1994

Data source: DFG Database

planktivores. As juveniles in nearshore areas, anchovies are vulnerable to a variety of predators, including birds and some recreationally and commercially important species of fish. As adults offshore, anchovies are fed upon by numerous marine fishes (some of which have recreational and commercial value), mammals, and birds, including the state and federally listed California brown pelican. A link between brown pelican breeding success and anchovy abundance has been documented.

Northern anchovy eat plankton either by filter feeding or biting, depending on size of the food. Adult anchovy are known to filter anchovy eggs and it is possible that this type of cannibalism is an important factor in regulating population size.

Status of the Population

Estimates of the biomass of northern anchovy in the central subpopulation averaged 359,000 tons from 1963 through 1972, increased rapidly to over 1.7 million tons in 1974 and then declined to 359,000 tons in 1978. Since 1978, biomass levels have tended to decline slowly, falling to an average of 289,000 tons from 1986 through 1994. Anchovy biomass during 1994 was estimated to be 432,000 tons.

Total anchovy harvests and exploitation rates since 1983 have been below the theoretical levels for maximum sustained yield, and stock biomass estimates are unavailable for recent years but, based on abundance index data, the stock is thought to be stable at a modest biomass level. The size of the anchovy resource is now being determined mostly by natural influences, such as ocean temperature.

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References

- Conrad, J. M. 1991. In Pacific Fishery Management Council. 1998. Amendment 8 (To the Northern Anchovy Fishery Management Plan) incorporating a name change to: The Coastal Pelagic Species Fishery Management Plan.
- Jacobson, L.D., N.C.H. Lo, J.T. Barnes. 1994. A biomass based assessment model for northern anchovy, *Engraulis mordax*. Fish. Bull. 92:711-724.
- Methot, R.D. 1989. Synthetic estimates of historical abundance and mortality for northern anchovy. In: E. Vetter and B. Megrey (eds.). Mathematical analysis of fish stock dynamics: reviews, evaluations and current applications. Am. Fish. Soc. Symp. Series No. 6. Am. Fish. Soc., Bethesda, MD.
- Parrish, R.H., D.L. Mallicoate, and K.F. Mais. 1985. Regional variations in the growth and age composition of northern anchovy, *Engraulis mordax*. Fish. Bull. 83:483-495.