

**THE STATUS OF
THE NORTHERN ANCHOVY RESOURCE
AND ITS MANAGEMENT**



by

David Ganssle

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ABSTRACT

The northern anchovy, *Engraulis mordax*, has been the subject of increasing exploitation during the last 60 years. Concentrated study of its biology and population dynamics has yielded population estimates of 5 to 8 million metric tons or about 5 to 10 times that existing during 1950-51. Continuing cooperative study programs between the State of California, the Federal Government and the government of Mexico are recommended.

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Engraulis mordax
northern anchovy

U.S. DEPARTMENT OF COMMERCE
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HISTORY OF THE FISHERY

The northern anchovy, *Engraulis mordax*, the most abundant readily exploitable fish resource off California, has been used for human consumption, fresh, salted and canned; for pet food; for live and dead bait including large quantities of mackerel "chum"; fish hatchery food; and for reduction to meal and oil.

From 1916 to 1947 there was only a minor, incidental commercial anchovy fishery. During this period the average annual catch was 561 tons.

The catch increased somewhat from 1947 to 1951 to an annual average of 4,493 tons. Starting in 1952 with the collapse of the sardine fishery, anchovy landings rose and averaged 27,182 tons through 1957. The largest catch during this period was 43,000 tons.

In 1958 because of a one shot upsurge in the sardine catch and a decline in demand for anchovy products, the catch again dropped and until 1966 the annual average was 3,099 tons.

The catch again increased following a decision by the California Fish and Game Commission to allow the reduction of whole anchovies to meal and oil. From 1966 through 1971, annual landings averaged 48,370 tons. The highest annual total during this period was 96,243 tons (1970), and the lowest was 15,538 tons (1968).

Anchovy has been the principle species utilized by the southern California live bait industry since 1939. The catch by this fleet is not adequately documented since records are submitted voluntarily, but minimal estimates indicate an annual total of about 1,000 tons before World War II

and between 4,000 and 7,000 tons in recent years.

Anchovies are caught exclusively by round haul nets. In the early days lampara nets were used but today (with the exception of the live bait fleet) most catches are made with purse seines.

During the 1916-1951 period of minimal landings, catches were distributed more or less evenly in northern and southern California. In 1952 (the first year of significant increase), most of the landings were at Monterey; however, since 1953 Los Angeles and Port Hueneme received the bulk of the catch.

From 1966 to present (during the era of the authorized reduction fishery) over 90% of the catch has been made by southern California boats operating from San Pedro and Port Hueneme.

The anchovy fishery is essentially a "day" fishery and most catches are made close to port. At Monterey, most catches are made within the confines of the bay, but during the early 1950's some were made as far north as the Farallon Islands.

Most of the southern California catch comes from within 5 to 30 miles of port, but at times trips of up to 100 miles are made.

The live bait fleet (using lampara nets) operates in inshore waters, and in sheltered bays and harbors.

During periods of heavy exploitation, the California Department of Fish and Game has maintained close surveillance of the fishery. Total landings and individual boat catches have been carefully documented and a continuing program of cannery sampling has provided us with good age and size composition data (Collins, 1969, 1971; Spratt, 1972).

Since the start of the reduction fishery a mandatory log book system provides a considerable amount of catch-effort data. Because of the

present multi-species nature of the southern California purse seine fleet and consequently the inherent difficulty in separating "anchovy effort", little has been done with these data.

BIOLOGICAL KNOWLEDGE

Range

The anchovy is found from Queen Charlotte Islands, British Columbia, to Cape San Lucas, Baja California, but is most common from San Francisco to Magdalena Bay.

Population

McHugh (1951), using meristic counts and measurements, Vrooman and Paloma (pers. commun.) using serum transferrins and Spratt (1972) using otoliths have described three subpopulations. The "northern" subpopulation is found from British Columbia to central California, the "central" off southern California and northern Baja California, and the "southern" subpopulation off central and southern Baja California.

Tagging studies (Haugen, Messersmith and Wickwire, 1969) indicated some migration and intermixing between southern and central California and northern Baja California.

Migration

Anchovies are pelagic schooling fish, generally found in coastal waters and exhibiting seasonal as well as diurnal movements. During fall and winter they apparently move offshore and return inshore in spring. Fall surveys (Calif. Dept. Fish and Game, R/V ALASKA Cruise Repts.) show that anchovies occur well below the surface during the day and move into the upper layers at night.

During periods of warming, adult anchovies are less available in inshore waters. Fish-of-the-year seem to tolerate higher temperatures than adults. Zero and 1 year old fish dominate the inshore live bait catch and 1, 2 and 3 year old and older fish are found offshore and in the commercial catch (Baxter, 1967).

Anchovies have been found in water temperatures of from 8.5° C to 25.0° C but most are taken in water between 15° C and 20° C.

Over 90% of the larvae collected were found in water from 14.0° C to 17.4° C and most eggs found between 13.0° C and 17.5° C (Ahlstrom, 1959).

Maturity

A few anchovies reach sexual maturity at the end of their first year, about 50% are mature at 2 and 3 and all are mature at 4 years.

MacGregor (1968) has estimated that each female anchovy spawns 574 eggs per gram of total weight, probably more than once a year. Preliminary findings from recent and continuing studies by the California Department of Fish and Game indicate that mature females spawn 10,000 to 20,000 eggs 2 or 3 times a year (Ralph Norberg, pers. commun.).

Spawning although recorded from British Columbia to Magdalena Bay, Baja California, is heaviest between Point Conception, California and Punta San Juanico, Baja California. Most spawning occurs within 60 miles of shore, but eggs and larvae have been found 300 miles to sea. Ahlstrom (1956) found that south of Point Conception there are two major spawning areas, one off southern California and northern Baja California and the other off central and southern Baja California.

Spawning occurs in all months but is heaviest during late winter and spring. Eggs and larvae are pelagic in the upper layers and eggs hatch 2 to 4 days after being extruded (Bolin, 1936).

Size, Age and Growth

Clark and Phillips (1952) first determined the age and rate of growth for the northern anchovy and Miller (1955) established the validity of aging by scales. Collins and Spratt (1969) compared age results using scales with those obtained using otoliths and found no differences. At the present time otoliths are used in all age and growth studies.

The anchovy is short lived and individuals over 4 years of age are rare but 7 year old fish have been taken.

Food Habits

Berner (1959), found that anchovy larvae ate various developmental stages of copepods. Loukashkin (1970), found that adults are primarily indiscriminate filter feeders utilizing mostly all stages of copepods and euphausiids. Although he found phytoplankton in some stomachs (sometimes the dominant food item), he feels its role in the northern anchovy diet (unlike the Peruvian anchovy) is on the whole negligible.

Predators

Anchovies are preyed upon by a great many species of fish, birds and mammals including many important sports species.

Studies indicate anchovies constitute 13% (by volume) of the diet of California yellowtail (Craig, 1960), 29% of the diet of king salmon (Merkel, 1957), 76% of the diet of Pacific bonito, 80% of the bluefin tuna diet, and 44% of the albacore diet (Pinkas, Oliphant and Iverson, 1971).

It is interesting to note that the Pacific bonito population has blossomed concurrent with the tremendous growth of the anchovy population. Between 1951 and 1963, the bonito catch reported by party boats increased from 6,300 fish in 1953 to a high of 1.2 million fish in 1960. From 1961 to 1970 the bonito catch fluctuated between 1.3 million and 350,000, but

fell to 153,000 in 1971. Despite this large forage demand, the anchovy population has continued to grow (Ahlstrom, 1965; Smith, 1972).

DISCUSSION

Status of the Resource

The anchovy biomass in the California Current area has increased markedly over the past two decades. The total spawning biomass is estimated to be from 5 to 8 million metric tons which may be from 2 to 3 times the size of the population of 1940-41 and 5 to 10 times that of 1950-51. Based on California Cooperative Oceanic Fisheries Investigations egg and larvae surveys, it is estimated that perhaps one-half of the total biomass occupies California and northern Baja California waters (Smith, 1972).

The anchovy is a relatively short lived species subject to high annual mortality. Using data obtained from California Department of Fish and Game sea surveys and southern California commercial landings, MacCall (1973) estimated the total annual mortality to be 66.5% with about 3% attributed to fishing. He also found that as fish grew older the mortality rate increased.

Since the northern anchovy has exhibited large fluctuations in abundance it is imperative that cooperative programs leading to a more complete and up to date understanding of stock size and status be continued. Among these programs are: the California Department of Fish and Game commercial and live bait monitoring and sampling programs, acoustical, trawl and night light surveys and catch-effort studies; the National Marine Fisheries Service egg and larvae surveys and relevant Scripps Institution of Oceanography California Current system ecological contributions.

In addition to these continuing studies we must obtain more information from Mexican sources regarding this commonly shared resource.

Properly coordinated programs of this nature will result in an up to date continuing understanding of the status of the anchovy resource and will give the appropriate agencies the ability to initiate and modify realistic management programs regardless of what pressures may be applied to the resource in the future.

REFERENCES

- Ahlstrom, E. H. 1956. Eggs and larvae of anchovy, jack mackerel and Pacific mackerel. Calif. Coop. Oceanic Fish. Invest., Prog. Rept. 1 April 1955 to 30 June 1956:33-42.
- Ahlstrom, E. H. 1959. Vertical distribution of pelagic fish eggs and larvae off California and Baja California. U.S. Fish and Wild. Serv., Fish Bull. 60 (161):107-146.
- Ahlstrom, E. H. 1965. Kinds and abundance of fishes in the California current region based on egg and larval surveys. Calif. Coop. Oceanic Fish. Invest., Rept. (10):31-52.
- Baxter, John L. 1967. Summary of biological information on the northern anchovy, *Engraulis mordax* Girard. Calif. Coop. Oceanic Fish. Invest. Rept. 11:110-116.
- Berner, L., Jr. 1959. The food of the larvae of the northern anchovy, *Engraulis mordax*. Inter-Amer. Trop. Tuna Comm. Bull. 4(1):22.
- Bolin, R. L. 1936. Embryonic and early larval stages of the California anchovy. Calif. Fish Game 22(4):314-321.
- Clark, F. N., and J. B. Phillips. 1952. The northern anchovy (*Engraulis mordax*) in the California fishery. Calif. Fish Game 38(2):189-207.

- Collins, Robson A. 1969. Size and age composition of northern anchovies (*Engraulis mordax*) in the California anchovy reduction fishery for the 1965-66, 1966-67, and 1967-68 seasons. In Calif. Dep. Fish and Game, Fish. Bull. (147):56-74.
- Collins, Robson A. and Jerome D. Spratt. 1969. Age determination of northern anchovies, *Engraulis mordax*, from otoliths. In Calif. Dep. Fish and Game, Fish. Bull. (147):39-55.
- Collins, Robson A. 1971. Size and age composition of northern anchovies (*Engraulis mordax*) in the California reduction and canning fisheries, 1968-69 season. Calif. Fish Game 57(4):283-289.
- Craig, W. L. 1960. Food and feeding. In A study of the yellowtail, *Seriola dorsalis* (Gill) by John L. Baxter and a staff of associates. Calif. Dep. Fish and Game, Fish. Bull. (110):35-46.
- Haugen, Charles W., J. D. Messersmith, and R. H. Wickwire. 1969. Progress report on anchovy tagging off California and Baja California, March 1966 through May 1969. In Calif. Dep. Fish and Game, Fish Bull. (147):75-89.
- Loukashkin, Anatole S. 1970. On the diet and feeding behavior of the northern anchovy, *Engraulis mordax* (Girard). Calif. Acad. Sci., Proc. 37(13):419-458.
- MacCall, Alec D. 1973. The mortality rate of *Engraulis mordax* in southern California. Calif. Dep. Fish and Game, Mar. Res. Tech. Rep. (4).
- MacGregor, John S. 1968. Fecundity of the northern anchovy, *Engraulis mordax* Girard. Calif. Fish Game 54(4):281-288.
- McHugh, J. L. 1951. Meristic variations and populations of northern anchovy (*Engraulis mordax*). Scripps Inst. Oceanogr. Bull. 6(3):123-160.
- Merkel, T. J. 1957. Food habits of the king salmon, *Oncorhynchus tshawytscha* (Walbaum), in the vicinity of San Francisco, California. Calif. Fish Game 43(4):249-270.

- Messersmith, James D. 1969. The northern anchovy (*Engraulis mordax*) and its fishery 1965-1968. Calif. Dep. Fish and Game, Fish Bull. (147).
- Miller, D. J. 1955. Studies relating to the validity of the scale method for age determination of the northern anchovy (*Engraulis mordax*). In Age determination of the northern anchovy. Calif. Dep. Fish and Game, Fish Bull. (101):7-34.
- Miller, D. J. 1956. Anchovy. Calif. Coop. Oceanic Fish. Invest., Prog. Rept. 1 April 1955 to 30 June 1956:20-26.
- Miller, D. J., A. E. Daugherty, F. E. Felin, and J. MacGregor. 1955. Age and length composition of the northern anchovy catch off the coast of California in 1952-53 and 1953-54. In Age and length determination of the northern anchovy. Calif. Dep. Fish and Game, Fish. Bull. (101):36-66.
- Miller, D. J. and R. S. Wolf. 1958. Age and length composition of the northern anchovy catch off the coast of California in 1954-55, 1955-56 and 1956-57. Calif. Dep. Fish and Game, Fish Bull. (106):27-72.
- Pinkas, Leo, Malcolm S. Oliphant and Ingrid L. K. Iverson. 1971. Food habits of albacore, bluefin tuna, and bonito in California waters. Calif. Dep. Fish and Game, Fish Bull. (152):1-105.
- Smith, Paul E. 1972. The increase in spawning biomass of northern anchovy, *Engraulis mordax*. NMFS Fish. Bull. 70(3):849-874.
- Spratt, Jerome D. 1972. The use of otoliths to separate groups of northern anchovies. Calif. Dep. Fish and Game, Mar. Res. Tech. Rept. 1:1-25.
- Spratt, Jerome D. 1972. Age and length composition of northern anchovies, *Engraulis mordax*, in the California anchovy reduction fishery for the 1969-70 season. Calif. Fish Game 58(2):121-126.

Vrooman, Andrew A. and Paul E. Smith. 1971. Biomass of the subpopulations of northern anchovy, *Engraulis mordax* Girard. Calif. Coop. Oceanic Fish. Invest. Rept. 15:49-51.