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CULTURE, HANDLING, AND PROCESSING OF PACIFIC COAST OYSTERS

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ABSTRACT

This report gives historical background; method of growing native and Pacific oysters; method of transporting, opening, washing, grading, and packing fresh oysters; method of processing frozen oysters; method of processing canned oysters and oyster products; and general state regulations governing the Pacific oyster industry.

INTRODUCTION

The oyster industry of the Pacific Coast of North America is primarily based upon the cultivation of Crassostrea gigas from seed brought each year from Japan. The native oyster, Ostrea lurida, which was the basis of a thriving industry, now has declined from its early importance. This part of the industry is being kept alive only in a few areas of Puget Sound.

The purpose of this article is to present the background of the present Pacific Coast oyster industry and to outline the practices involved in the cultivation, handling, and processing of its oysters. The article is not intended to be an exhaustive treatise but rather to be a source of general information. For specific details, the reader may wish to consult the references given.

HISTORICAL

Early settlers on the Washington coast found many tidal areas covered with a small round oyster, which later was classified as O. lurida (Carpenter 1864). These small bivalves inhabited many areas on upper and lower Puget Sound as well as on Grays Harbor and the next harbor south, then known as Shoalwater Bay. The latter bay, now Willapa Bay, contained the largest concentration of oysters on the West Coast. The huge quantity of oysters found in this area by the first white men, however, was only a fraction of the oysters that existed in ancient times in this region. Fossil shell beds, several feet in thickness, have been found by well drillers at depths of 200 feet or more beneath the present surface of the ground and many miles inland from the present shore line.

With the coming of white settlers, these native oyster beds became important commercially, and a lively trade developed with

San Francisco in the gold rush days. This trade arose through the fact that sailing ships arriving in San Francisco with gold-seeking passengers would be abandoned by their crews in the mad rush for the gold fields. Ships thus abandoned often remained unmanned until no longer seaworthy. Some of the smaller schooners were owned by the captain, and such a fate meant financial ruin to him. An early skipper, learning of the northern oyster beds on Shoalwater Bay, conceived the idea of freighting oysters from that area to San Francisco and selling them to the oyster-hungry and free-spending citizens. A plate of oysters on the half shell with all the fixings sold, in the better restaurants, for one Mexican "slug" per serving. A "slug" was a gold coin two and one-half times the size and weight of a 20-dollar gold piece.

No thought was given by the early-day oystermen to conservation. Oysters were picked or tonged onto bateaus or onto small sail-driven oyster luggers. They were taken ashore and sorted, marketable sizes were sold, and small oysters were tossed overboard onto the beach along with empty shells. Owing to the practice of not returning the small oysters to the beds to grow and of not returning the empty shells to the beds to supply cultch for future seeding, production gradually declined.

The native oyster was the basis of the Pacific Coast oyster industry from 1851 to 1890. In 1854, 50,000 bushels were sent to San Francisco. By 1870, this trade had grown to 200,000 bushels a year (Hazeltine 1956). The apparently inexhaustible supply gradually gave way to a growing scarcity, and the industry all but died out. Total destruction was averted because certain growers planted and cultivated individual beds of native oysters.

The native oyster industry in Washington struggled along until 1895, when the eastern oyster Crassostrea virginica, was introduced. This species, planted in San Francisco Bay in the 1860's, had been profitable because of the high price oysters commanded in that area. By 1895, eastern oysters were introduced to Willapa Bay, and their cultivation continued until about 1919, when they were wiped out within a few months by an unidentified cause.

The oyster industry languished until about 1928, when an experimental planting of the Japanese oyster, C. gigas, on Willapa Bay pointed the way to a revival of the industry. By 1948, production had reached 6,835,921 pounds of oyster meats (Hazeltine 1956) and by 1955, the production climbed to 10,072,871 pounds of meats in the State of Washington (Washington State Department of Fisheries 1955). The Pacific oyster, as C. gigas is now known on the West Coast, is the basis of the present oyster industry from Alaska to California.

OYSTER CULTURE

Native Oysters

During the time that the native oyster industry was on the decline in Willapa Bay, the growers of native oysters on lower Puget Sound built an intensive system of oyster culture by diking favorable areas. The enclosed ground was carefully cared for, and shells for cultch were returned to the beds as needed. These practices kept the native industry alive in Puget Sound after it had ceased to be of importance in bays along the seacoast. This culture is expensive in labor and investment. Nevertheless, the production of Olympias, as the cultivated native is known, reached 319,900 pounds of meats in 1935 (Washington State Department of Fisheries 1955). Owing to the high quality of this oyster, the market value in dollars was much higher than the production figures would indicate. In later years, the cultivation of Olympia oysters was hampered by predators, water polution from municipal and industrial waste, and by increasing costs of production. The yield of this species consequently has declined. In 1955, less than 55,759 pounds was produced. The present price, caused by scarcity, is about $30 per gallon. The cultivated native oyster industry can be rehabilitated and helped to its former importance on Puget Sound only by the control of these adverse factors.

Pacific Oysters

The Pacific oyster industry largely depends upon the importation of oyster seed from Japan, as local spawning is not dependable. The supply of imported seed is fairly constant, although the quality may vary. Cultivation of Pacific oysters on the West Coast has reached a firm basis that will assure a constant and growing industry of great importance to the economy of all states bordering the Pacific Ocean from Alaska to California. Hand methods of cultivation and harvesting have in general given way to mechanical methods. New oyster products are providing new markets.

Early steps in culture.-- The first step in the culture of Pacific oysters is the acquisition of proper growing ground through lease or purchase from present owners or lease from state reserves if available. The suitability of the ground is determined by firmness, water temperature, salinity, water currents, availability of food, absence of enemies of the oyster, protection from storms, accessibility, sloughs, and height of ground with relation to tidal range.

The second step is the acquisition of seed. The seed may be of local origin or, more likely, may be obtained from Japan. In either case, seed oyster production is based on extensive knowledge of the biology of the oyster.

To collect spat, as the young oysters are called, the Japanese oystermen prepare cultch of oyster shells in advance. Clean shells are perforated and strung upon wire. These strings, approximately 6 feet in length, are stacked ashore until needed. As spawning time approaches and the temperature of the water increases, the oysters are carefully watched by biologists, and samples of water are taken to determine if larval oysters are present. The Pacific oyster is oviparous. Oyster larvae are hatched from eggs that are fertilized outside the parent oyster, and development of larvae takes place in the water. The female may discharge 200 million eggs in a season (Washington State Department of Fisheries 1957). Mortality, however, is high.

When larvae are found in the water, the cultch is hung over racks placed at favorable locations on the beds. The tidal currents, sweeping to and fro through the shell racks, afford ample opportunity for the free-swimming larvae to attach themselves to the cultch. Larval oysters which are ready to set will stick to any clean surface they may contact, such as shell, rocks, or sticks. The shell of the larval oysters begins to form as a small glue-like spot that gradually grows in area. If the cultch is hung out too soon and becomes slimy with marine growth, fewer larvae will become attached.

In the United States similar methods of placing shells in the water may be used. In other cases the shells may be broadcast upon the beds and retrieved by dredges after setting has occurred.

The attachment of larvae to a clean surface at the proper time is vital to the oyster's future. Unless the larvae attain the proper base on which to develop, they will sink to the bottom, where they may be smothered in mud. After the larvae are attached to the cultch, they are known as "spat" and soon may be seen with the naked eye. A seed shell may have a single spat set on it, or the shell may be covered with hundreds of spat.

Source of seed, shipment, and planting.-- The American grower may order his seed, attached to "broken" or "unbroken" shell, from Japan. If unbroken seed is ordered, the shells are merely removed from the wires and are packed into shipping cases, which are wooden boxes holding between 2 and 3 bushels. Each case contains at least 12,000 young oysters. If broken seed is required, the shells are passed by hand under a hinged knife, and the shells cut into two or more pieces. This cutting results in some mortality of spat, but the advantages of broken seed in later saving of labor more than justify the loss.

Seed, before being cased in Japan, is carefully inspected by deft women workers to ensure an adequate number of spat per shell and to eliminate oyster enemies. American oystermen purchase seed through the oyster growers' association which sends inspectors and biologists to Japan to inspect the quality of the seed and freedom from pests prior to shipment. The cased seed is shipped in February, March or April on the decks of ocean steamers, where it remains cool and can be wet down frequently with sea water.

Prior to the arrival of the vessel, the seed purchasers are notified so they can have their trucks or barges at the dock to take delivery when the vessel arrives. Seed must be transported to the beds and planted as soon as possible. If there is delay in having the planting ground ready, the cases of seed must be submerged in sea water until needed.

The oysterman will consider several factors in choosing a seeding bed. Seeding ground should be protected from storms that might picked up the light seed and toss it into windrows to smother or that might roll the seed into deep sloughs, where it would be lost. Seeding ground should be free both of deep soft mud, which would allow the seed to sink and to be smothered, and of hard sand, which might cover seed shells or might subject the oysters to displacement by waves.

Prior to distribution of seed, the planting ground is marked out with stakes designating the limits of the bed and is cross staked into planting lanes. Stakes are limber wood poles fixed in place on the bed by merely pushing them into the mud. The poles must be limber in order to bend before the tidal currents or when touched by a passing boat. Seed cases are opened (fig. 1), and the seed is deposited on the deck of a bateau (fig. 2).

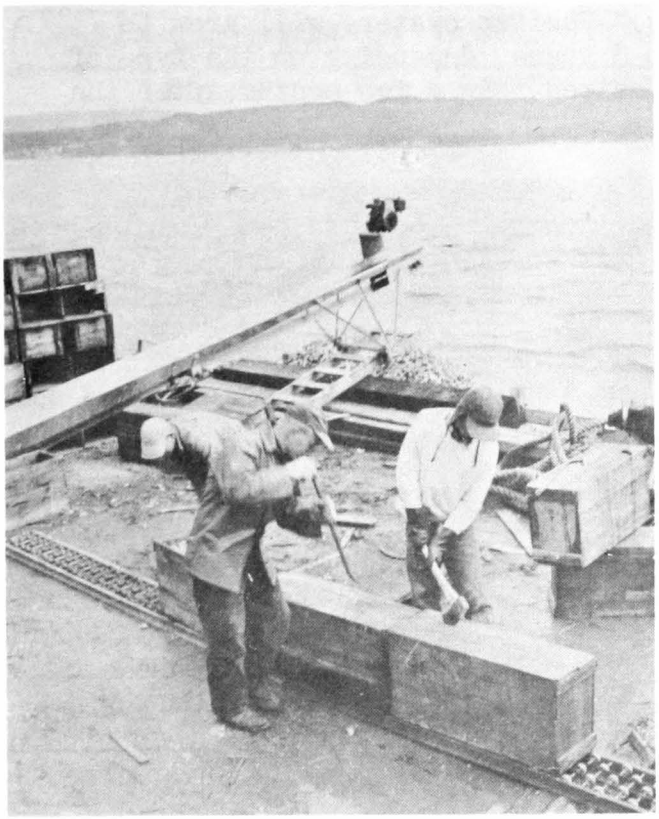

Figure 1.--Opening oyster-seed shipping cases, as received from Japan.

The bateau is towed through the planting lanes outlined by the stakes. Men with scoop shovels broadcast the seed from side to side, endeavoring to spread it as evenly as possible.

Figure 2.--Oyster seed from shipping cases loaded on bateaus and ready for planting in beds.

Care of growing oysters.--Pacific oysters will grow to marketable size in 2 (fig. 3) to 3 years, depending on the type of ground and the size of oysters desired. In a few months after the

Figure 3.--Inspecting young oysters for growth, about 2 years after planting.

oysters have been planted they grow into large clusters or clumps. To give the growing oysters room, the oyster farmer breaks up the clumps and spreads the oysters over the less-crowded areas in the immediate vicinity (fig. 4).

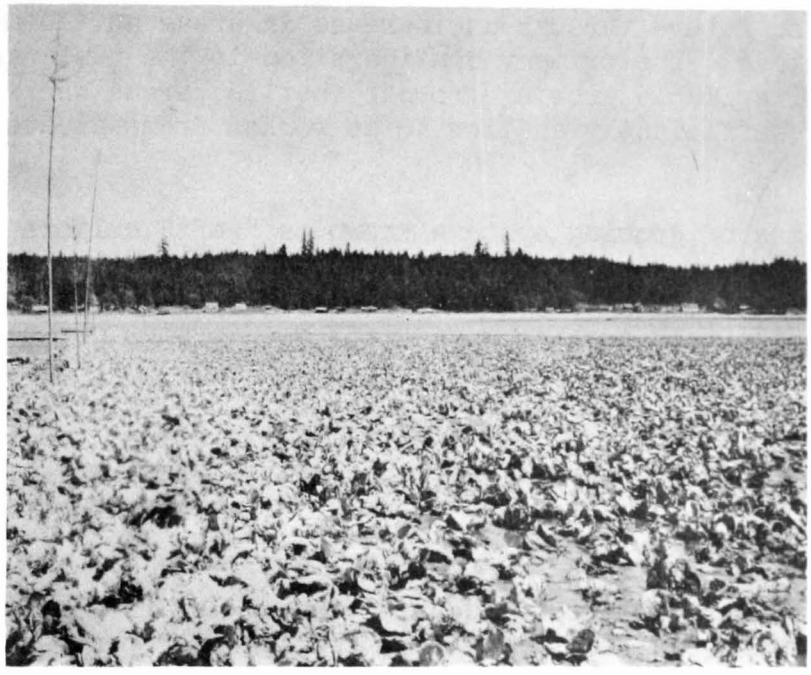

Figure 4.--Young growing oysters about 2 years old.

Oysters may need to be moved to better growing areas, as good seed-holding ground is not necessarily best suited for rapid growth. When oysters are being moved to other beds, large clusters of oysters may be broken into smaller groups. Crowded oysters will grow long and narrow and will not fatten well. Single oysters and clumps containing two or three oysters produce the best-shaped individuals, and the best quality of oyster meats, other factors being equal.

Separation of clusters, or "breaking," is done with a special hammer having a sharp point. The original seed shell is shattered by a blow, thus separating the oysters in the cluster. This process is expensive, and the mortality of the growing oysters may be considerable. For these reasons, "broken seed" from Japan is preferred, since it largely eliminates the expensive hand labor of breaking clusters.

In Japan, seed shell sometimes is slightly burned before stringing. Burning of the shell reduces its strength, and growing oysters pushing against each other fracture the weakened shell and cause it to fall apart. Even hand pressure easily will break such clusters.

New developments in oyster culture.--Oyster culture may be expanded in the future through an increase in areas suitable for the growth of oysters. The primary consideration in the past was the acquisition of suitable growing ground; that is, areas where the ground is exposed or sufficiently shallow to be worked from bateaus and barges at low tide.

A means of growing oysters known as "raft" culture was investigated by one grower in Alaska. Although this method has been used in Japan for many years, this culture aroused little interest in America in the past because sufficient good oyster ground was available, and supplies of oysters were adequate. The combination of rapidly increasing population and full utilization of available good oyster ground, however, may encourage this form of culture. If raft culture proves successful, many deep-water areas may be utilized that formerly would not have been considered for oyster production by conventional methods.

In the raft culture procedure, the oyster farmer suspends the oysters from rafts or floats made from two logs, or pontoons, or rows of barrels that are bridged with cross members. Strings of spat-bearing shells, spaced 8 to 10 inches apart, are suspended from these rafts so that all the seed shells remain beneath the surface of the water. The length of the strings, or wires, depends on the low-tide depth of the water, since the lowest shells must not touch bottom.

Some advantages claimed for raft culture are: (1) Oysters are free from crawling enemies, since seed does not touch bottom. (2) Oysters, being near the surface in the plankton zone, may get more feed. (3) They feed longer, as they are always submerged. (4) They are not smothered by mud. (5) Harvesting is not hindered by bottom vegetation. (6) Greater production may be obtained in a given area than would be possible if oysters were placed on the bottom. (7) Floats may be towed to better growing or feeding areas. (8) Better growth is obtained. (9) Decomposition products, including hydrogen sulfide, inhibit growth and fattening on some bottoms; raft culture reduces this effect.

There are disadvantages, however, such as (1) decay of floats, (2) damage to floats by storms, and (3) loss of strings in deep water caused by breakage of wires. Comparable labor costs of the two methods are not, as yet, available.

On the northwest coast from Washington to Alaska there are many hundreds of deep-water bays and coves with little or no beach area. Should raft culture prove to be successful and be found adaptable to northern waters, many areas would be opened for production.

MARKETING FRESH OYSTERS

Native oysters.--The small native oysters, Olympias, are grown on smaller areas than are the larger Pacific oysters. The beds usually are diked to retain a covering of water at all stages of the tide. Since these diked areas are of small extent, harvesting has not been mechanized, and shell stock, as unopened oysters are called, is gathered by hand labor.

Opening, or shucking, of native oysters also is a hand process requiring skill and practice. A gallon of the small oysters may contain from 1700 to 3000 meats. The oysters are not graded for size. High price and limited production confine the Olympia oyster to the fresh market. They are in demand by hotels and restaurants for use in cocktails and special epicurean dishes.

Pacific oysters.--When Pacific oysters reach marketable size, they are harvested from the beds by dredging. (Oysters missed by the dredge are picked up individually by hand at low tide in order to clean the bed for reseeding.) The oysters (fig. 5) are transported on the

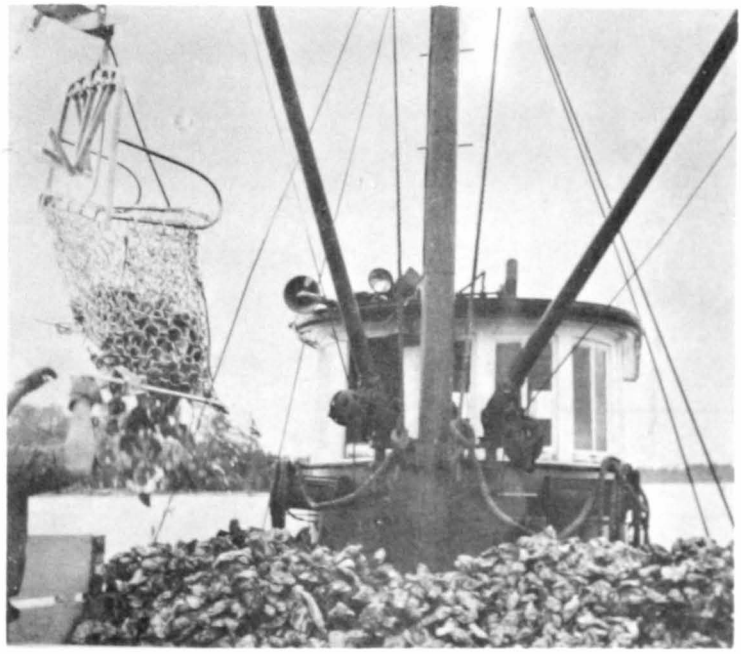

Figure 5.--Oyster drag being dumped on deck of dredging vessel.

deck of the dredge boat to the opening house. At the dock (figs. 6 and 7), conveyors elevate the oysters to storage bins located over opening tables.

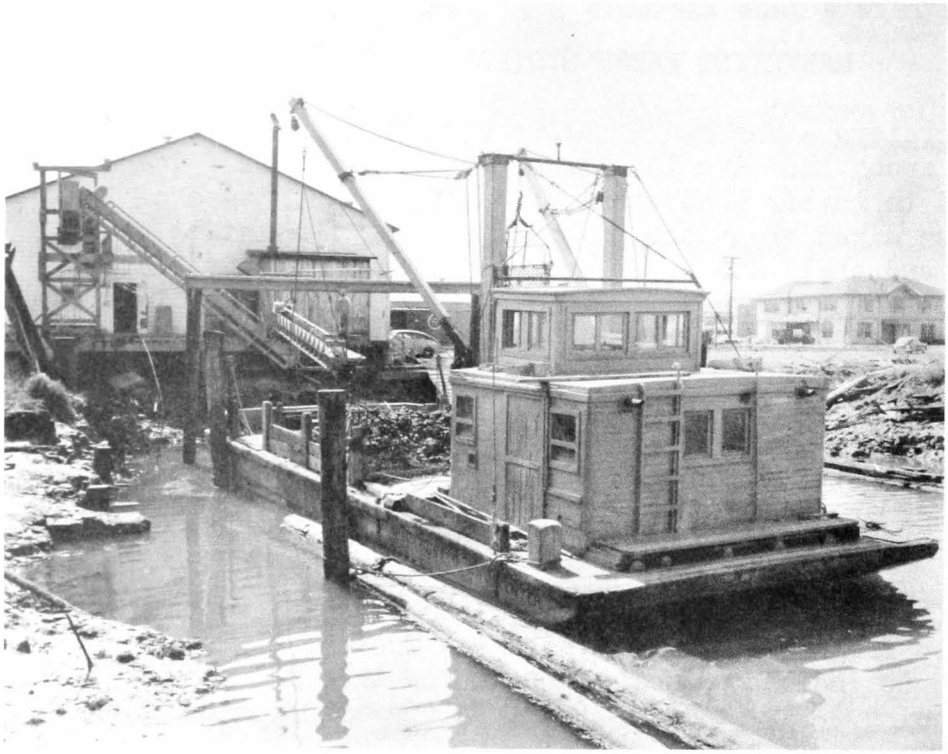

Figure 6.-- Oyster dredge with oysters on deck.

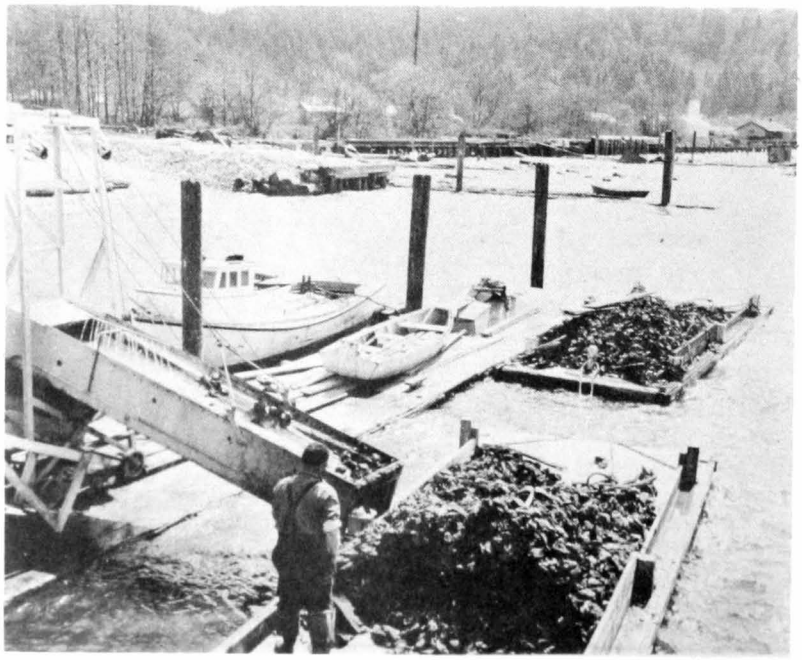

Figure 7.-- Unloading hand-gathered oysters at plant.

Oysters are washed by jets of water while passing up the conveyor and through a rotating screen washer to the storage bins. Stock from these bins may be opened either by steam or by hand.

Oysters to be sold fresh or fresh-frozen go to the opening table, where the meats are removed from the shells by hand (fig. 8) and are placed in containers.

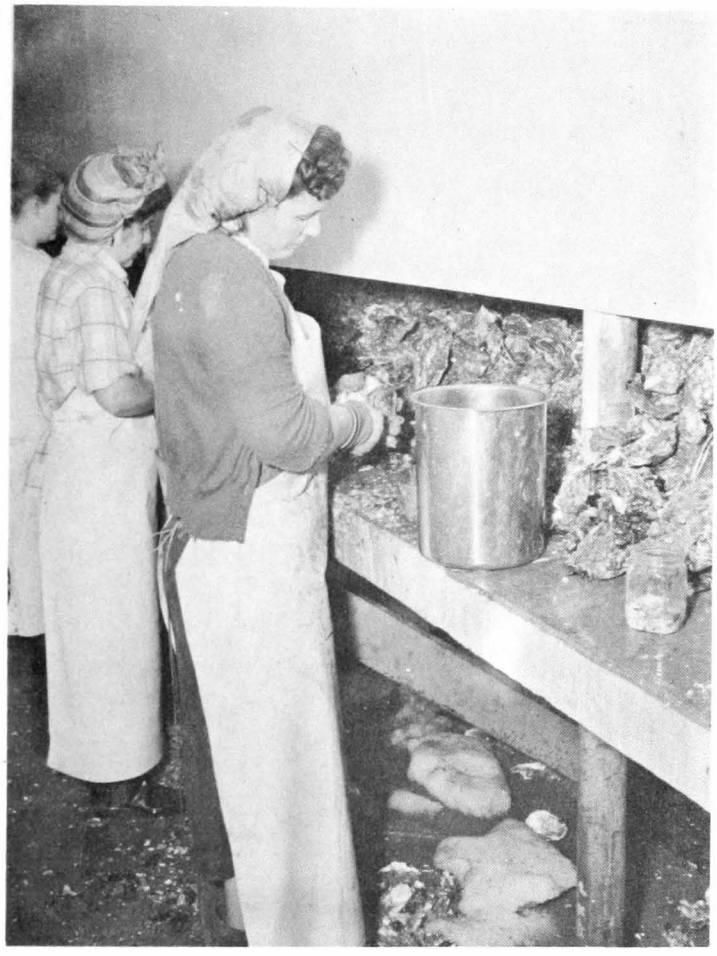

Figure 8.--Opening fresh oysters.

Meats then are carried to the blower or washer, a vat of potable fresh water, where they are agitated by injected compressed air to release any sand or silt trapped by the oyster mantles (fig. 9).

Figure 9.--Oyster meat washer or bubbler used to wash sand from opened meats.

Meats absorb water and increase in size and weight while in the blower, hence time of blowing should be as short as possible consistent with proper washing of the meats. Empty shell is conveyed from the opening

table to an elevated storage bin and thence to a storage pile, if to be used as cultch, or to a shell-grinding plant (fig. 10). Ground shell is used by poultry raisers as a lime supplement in poultry diets.

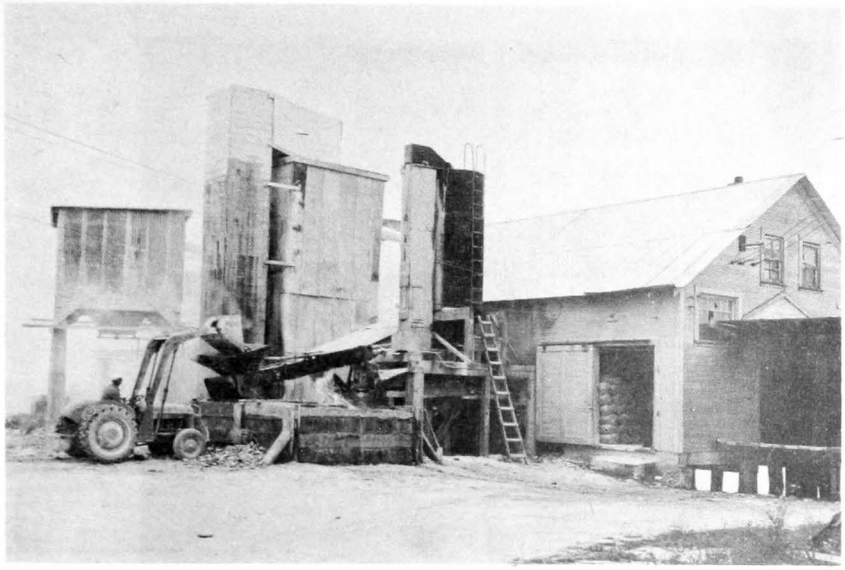

Figure 10.-- An oyster-shell grinding plant.

Grading and packing.--Grading and packing follow the washing operation. The gate of the blower is opened, and the meats are flooded onto the grading table (fig. 11). Here they are sprayed with fresh water to wash off the foam remaining after the blowing operation.

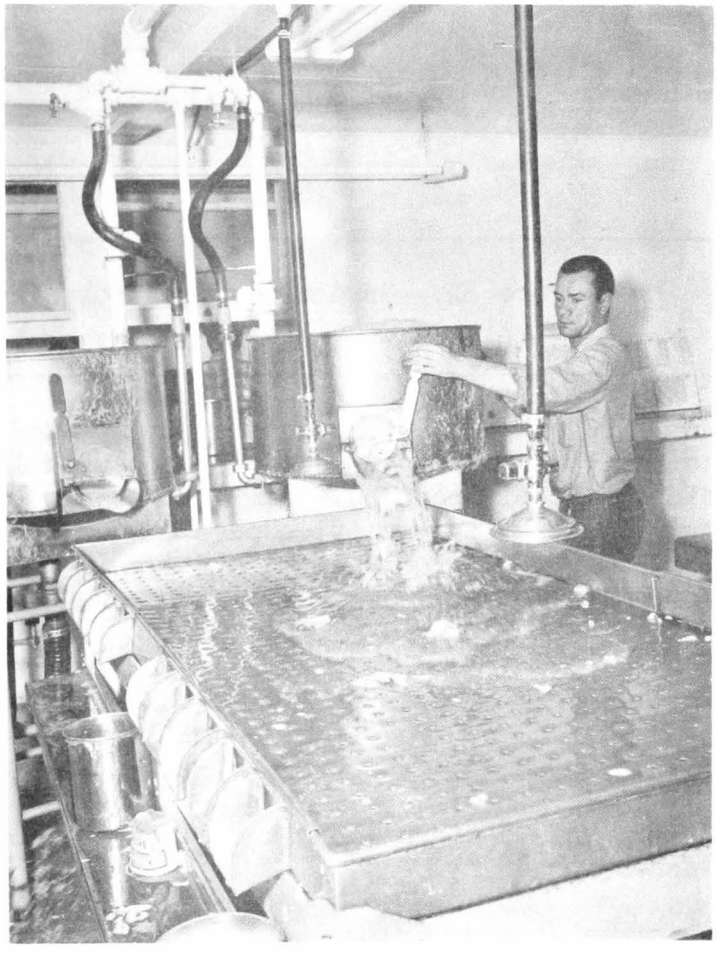

Figure 11.--Dumping oyster meats from washer onto grading table.

The meats are then graded for size and are packed into containers (fig. 12).

Figure 12.--Grading oysters for size--large, medium, and small--at grading table.

Oysters to be sold fresh are packed in containers ranging in size from the #10 can (603 x 700) 1/ used for military and institution packs to the pint and half-pint glass jars used for retail packs. Grading requirements by the Pacific Coast Oyster Growers' Association (Bulletin No. 67, May 1954) for Pacific oysters in the pint-size glass jars are:

Large meats	8 or less per pint
Medium meats	9 to 12 per pint
Small meats	13 to 18 per pint
Extra-small meats	19 and over per pint

1/ This designation means a can 6-3/16 inches in diameter and 7 inches in height.

The containers must be hermetically sealed with a crimped cover that bears the grade and the weight of oysters and the name and the certificate number of the packing house (fig. 13). Fresh oysters should be stored at 33° to 36° F. at all times until consumed, with the preference being for lower temperature.

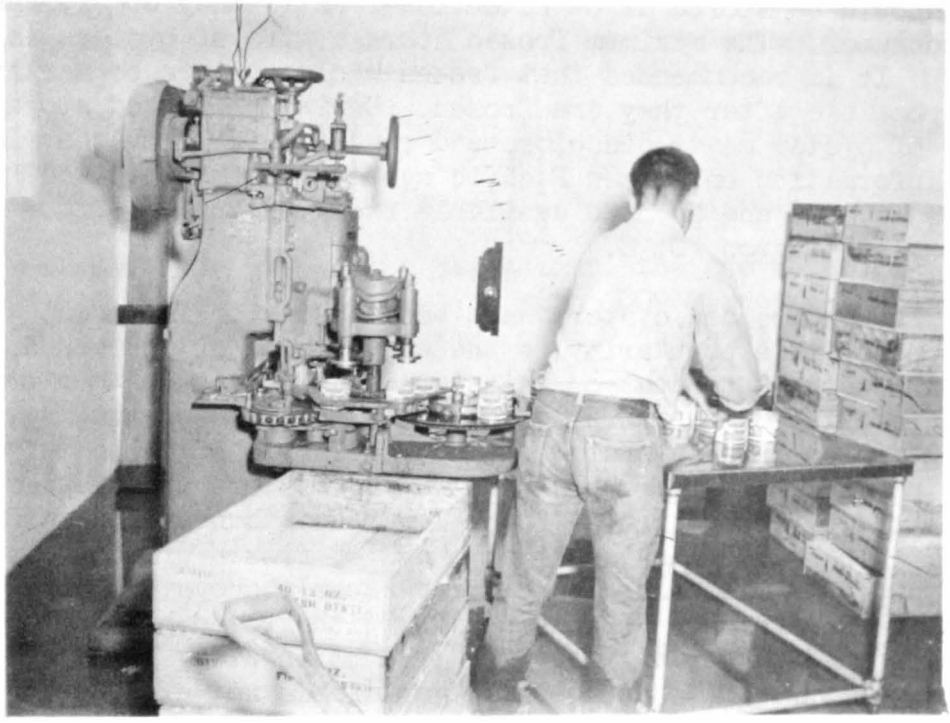

Figure 13.--Hermetically sealing containers.

PROCESSING PACIFIC OYSTERS

Fresh oysters held under refrigeration but at above freezing temperatures have a short shelf life. After approximately one week of storage at 33° to 36° F., the oyster meats have lost some of their original good flavor (Liebman, Kudo, Chappel, and Stern 1957). If oysters are to be supplied to a wider market and on a year-round basis, they must be preserved in some manner. Freezing and canning are the two methods of preservation most used.

Freezing Oysters

Fresh oysters for freezing are packed in cans, which are then sealed hermetically and placed in a sharp freezer at -20° F. or lower. Fresh Pacific oysters usually are frozen in the 10-ounce can (211 x 400). Lithographed cans with prominent labeling as to perishability of the product are recommended. These cans of oysters should be stored at 0° F. or lower until they are purchased by the consumer. The maximum frozen storage life of oysters is about 8 months. It is recommended that frozen whole oysters be marketed as soon as possible after they are frozen. During prolonged storage, surfaces of oyster meats discolor, and rancid off-flavors develop. Further information on frozen Pacific oysters may be obtained from Separates No. 423 and No. 480 available from the Bureau of Commercial Fisheries, Washington, D. C.

Frozen breaded oysters have become popular in recent years. One reason for this popularity is the convenience of a breaded, ready-to-cook product. A product of this type requires no further preparation than cooking, which usually is done without prior thawing. In preparing frozen breaded oysters, the processor should use only fresh oysters in prime condition. As soon as the oysters are breaded, they should be sharp frozen at -20° F. or lower and then stored at 0° F. or lower. Because of the irregular shape of frozen breaded oysters, air is trapped in the package; this may cause the oysters to become rancid in a few months. Persons dealing with frozen breaded oysters therefore should be certain that the product is always kept at the proper temperature and that the storage life is not exceeded.

Two methods of preparing breaded Pacific oysters for freezing are currently in use by processors. The usual method is to bread fresh, whole oysters, pack them in waxed fiber cartons, and place them in a sharp freezer. A new method has been introduced in which oyster meats are frozen in a polyethylene tube approximately 1-5/8 inches by 24 inches. The frozen cylinders of oyster meats are removed from the plastic tube and cut into small discs approximately 3/8 inch in thickness by 1-5/8 inches in diameter. These discs are dipped in batter, breaded, and packed in fiber cartons. The frozen breaded discs have the advantage of uniformity, which is an aid in cooking and serving. They are susceptible to rancidity, however, and should be stored at 0° F. or lower and marketed within approximately 4 months.

Canned Oysters and Oyster Products

Oysters are canned in five styles:

(1) Whole oysters, fresh opened and blanched.
(2) Whole oysters, steam opened.
(3) Stew oysters, sliced, with added milk and butter.
(4) Oyster stew base consisting of sliced oysters and nectar.
(5) Smoked oysters.

Whole oysters, fresh opened and blanched.--Fresh opening has the advantage that all seed attached to the shells may be saved. The meats are subjected to blanching in a bath of boiling water for 30 seconds. The can filled with oyster meats then passes onto the seamer conveyor. On its way to the seamer, the can may be filled with 200° F., 20° salometer brine or with 200° F. water and a salt tablet. The can then is vacuumized, seamed and heat processed.

Whole oysters, steam canned.--Steam-opened oysters were formerly used exclusively for the canned product known as "cove oysters." Shell stock was placed in retorts and steamed for various periods of time and temperature, depending upon the experience of the individual packer, 7 to 10 minutes at 212° being the average. Steam opening has the advantage of freeing the meats from the shell, and the shape of the oyster, as in the shell, is preserved, thus giving the canned product a desirable appearance. The meats from the opening table are sent to a meat washer, where they are agitated with air in a flowing water bath to remove sand and silt. The washed meats then are taken to a grading table, where they are sorted for size and then either are passed to a mechanical filler or are filled into the cans by hand. The cans pass onto a conveyor belt, where they receive the brine or salt tablets, and are seamed and processed. Whole canned oysters usually are marketed in two sizes: the 8-ounce (211 x 304) and the 7-3/4-ounce (211 x 300) can.

Oyster stew.--Oyster stew may be prepared from the steam-opened oysters. The meats are chilled to firm the flesh, are passed through a slicer, and then are sent to a can-filling machine. The fill-in weight of the 10-ounce oyster stew can is 1½ to 1-3/4 ounces of oyster meats. As the cans leave the filler and are conveyed to the seamer, a liquid mixture consisting of milk, salt, monosodium glutamate, and disodium phosphate is added to the cans. (The disodium phosphate serves to control the tendency of the milk to curdle.) Nectar, prepared by boiling oyster meats, is also added by some packers. A portion of butter is added to each can by hand or by means of a butter dispenser. The cans are then seamed and processed.

Oyster stew base.--Oyster stew base contains only sliced oysters, and oyster nectar prepared by boiling whole oysters. The user adds milk and butter to suit his individual taste. Stew base is marketed in 46-ounce cans (No. 3 cylinder - 404 x 700) for restaurant use.

Smoked oysters.--Oysters intended for smoking are opened by steam to remove excess moisture and to fix the oysters in their natural shape. Small meats are smoked and packed whole. Large meats are sliced before being smoked. The oysters or slices are placed in 20° salometer brine for 3 or 4 minutes and then are spread on wire-mesh trays to drain. Meats must not touch each other and must have ample space between them to allow for free circulation of smoke. The trays containing the meats are placed in the smokehouse, and the oysters are given a comparatively hot smoke for 2 to 3 hours until the meats are well colored. Smoked oysters usually are packed into quarter-pound cans (301 x 106) or into glass jars of the same capacity. A salad oil is added, and the filled containers are heat processed.

REGULATIONS

The U. S. Public Health Service exercises control over the oyster industry through supervision of oysters and other shellfish shipped in interstate commerce. A cooperative procedure worked out with the health departments of the interested states insures that proper sanitary methods are observed in the growing and processing of shellfish products (U. S. Public Health Service 1957 and 1959).

ACKNOWLEDGMENT

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