DIVISION OF FISH AND GAME OF CALIFORNIA
FISH BULLETIN No. 19
Sardine Fishing Methods at Monterey, California

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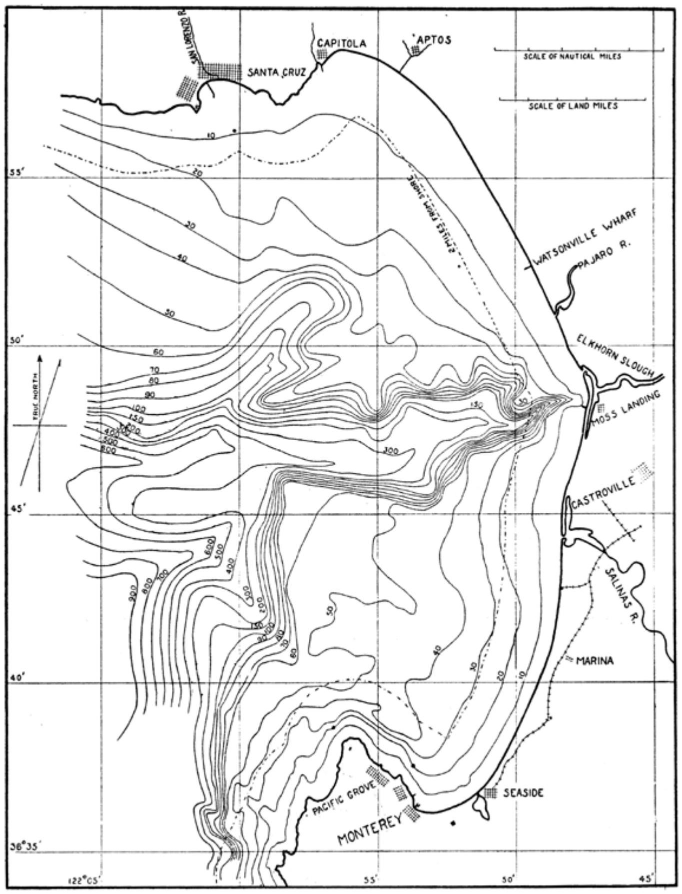

FIG. 1. Monterey Bay, showing depth contours plotted from soundings shown on the U. S. Coast and Geodetic Survey chart of the bay. Contour interval is 10 fathoms from shore out to 100 fathoms. Between 100 and 200 fathoms the interval is 50, and elsewhere it is 100 fathoms.

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1. Introduction

The object of this bulletin is to put on record a description of the Monterey sardine[1] fishery which can be used as a basis for judging future changes in the conduct of this industry. Detailed knowledge of changes is essential to an understanding of the significance of total catch figures, or of records of catch per boat or per seine haul. It is particularly necessary when applying any form of catch analysis to a fishery as a means of illustrating the presence or absence of depletion or of natural fluctuations in supply. Most of the detailed descriptions in the following pages are based on conditions as they existed during the two fishing seasons, 1920–1921 and 1921–1922. However, the many changes, chiefly general developments in the industry, have so profoundly affected the total catch and catch per boat that several revisions of the original account have been required. Dates of revision, in parentheses, accompany the notes of these changes. While this is somewhat awkward, it definitely fixes the year in which certain practices began or were discontinued, and thus aids in fulfilling the chief purpose of the record.

These notes include only a description of fishing methods, fishing gear, and some of the business conditions of the industry which directly affect the catch. No attempt is made in them to cover all of the complex economic conditions that may influence the catch.

The writer wishes to thank the cannery managers and employees who have given their time and assistance in this work, and he is especially indebted to the many fisherman, who in all cases cheerfully answered questions, explained their methods, and submitted to the annoyance of a landlubber aboard. Special thanks is due "the father of sardine fishing in California," Pietro Ferrante of Monterey, who devoted several days of his time to explaining and demonstrating the mysteries of the lampara. All the members of the Bureau of Commercial Fisheries, who have had the privilege of working at the Hopkins Marine Station, feel indebted to Dr. Walter K. Fisher, the director, who in the name of Stanford University has generously supplied us with a laboratory room and equipment at the station since 1919 when our sardine work began at Monterey.

CALIFORNIA STATE FISHERIES LABORATORY.
March, 1929.

2. Part 1. GENERAL

2.1. Locality and fishing grounds

The Monterey fishery is the northernmost sardine fishing center in the state. From 1 to 5 lampara crews (1922) fish out of San Francisco part of the year, catching small quantities of sardines and herring as bait for the crab fishermen, but sardine canning is limited to 3 localities, which are in order of their importance: (1) Monterey, including Santa Cruz; (2) San Pedro, including Wilmington and Long Beach; and (3) San Diego. (See Fig. 2.) During the fishing season

[1] Only one species (Sardina caerulea) is involved in this fishery. Other species, as mackerel, herring, anchovies, kingfish, squid, sharks, and jelly fish are accidentally caught in the net hauls but in relatively small quantities.

of 1925–26, one fish and fruit cannery began packing sardines on a small scale at Pittsburg, which is close to the junction of the Sacramento and San Joaquin rivers. This one cannery has continued packing sardines (1926–1929).

By rail it is 127 miles from the Monterey canning plants to San Francisco. By water San Francisco is 100 miles to the north, the trip requiring 12 hours. The freight steamer trip of 480 miles from Monterey to San Pedro (the port of Los Angeles) takes 36 hours. Monterey Bay is crescent-shaped, being 23 miles from tip to tip and making an indentation of about 15 miles in the general northwest to southeast coast line. Santa Cruz, at the northern end of the crescent,

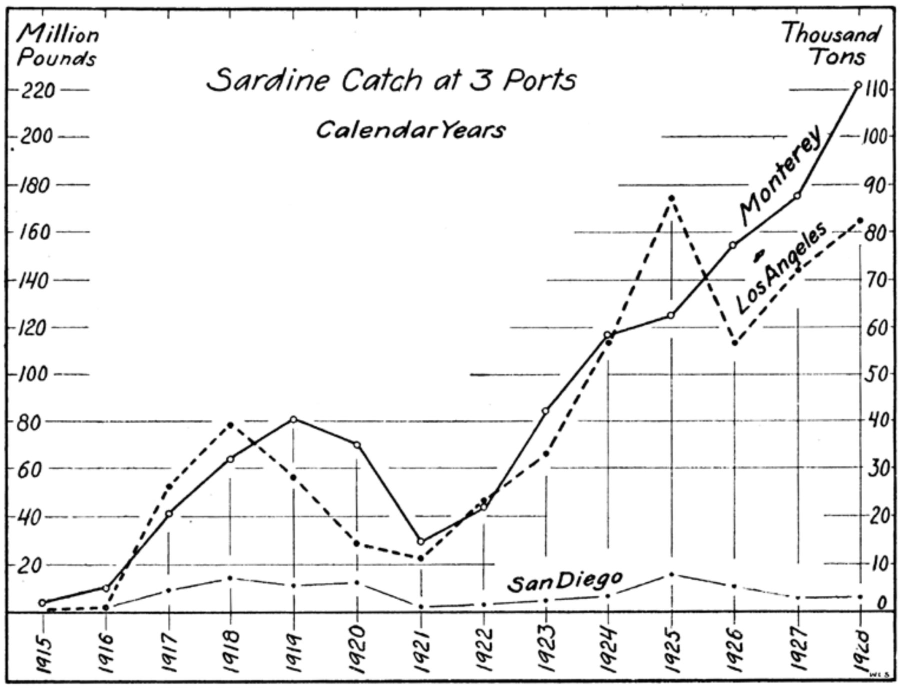

FIG. 2. Annual sardine catch at Monterey, Los Angeles Harbor and San Diego for the 14-year period 1915–1928.

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had in 1922, one sardine cannery fishing 4 crews, but these were not under direct observation and as the plant soon closed and has not operated since, this account will be limited to the Monterey fishery located at the southern end of the bay. Point Pinos, the southern tip of the crescent, is the termination of a peninsula extending 3 or 4 miles to the northwest, thus forming a protected cove. (See Fig. 1.) The town of Monterey is located at the most sheltered spot of this cove and it is here that the fishing fleet finds protection from all storms except those from the north-northwest. The canneries are located a mile from Monterey on the peninsula and clustered along a waterfront not over a mile in extent. The plants have spur railway tracks at their doors but most finished case goods are shipped by boat from the Monterey municipal wharf. The coast line of this peninsula is rocky with rocky bottom dropping off to 30 fathoms a mile off shore. The gently curving shore line of the crescent is sandy beach, dropping off to sandy bottom 15 or 20 fathoms deep a mile off shore. (See Fig. 1.)

The greater part of the sardine catches are made in or near the sheltered cove within 5 miles of the town of Monterey in 15 to 40

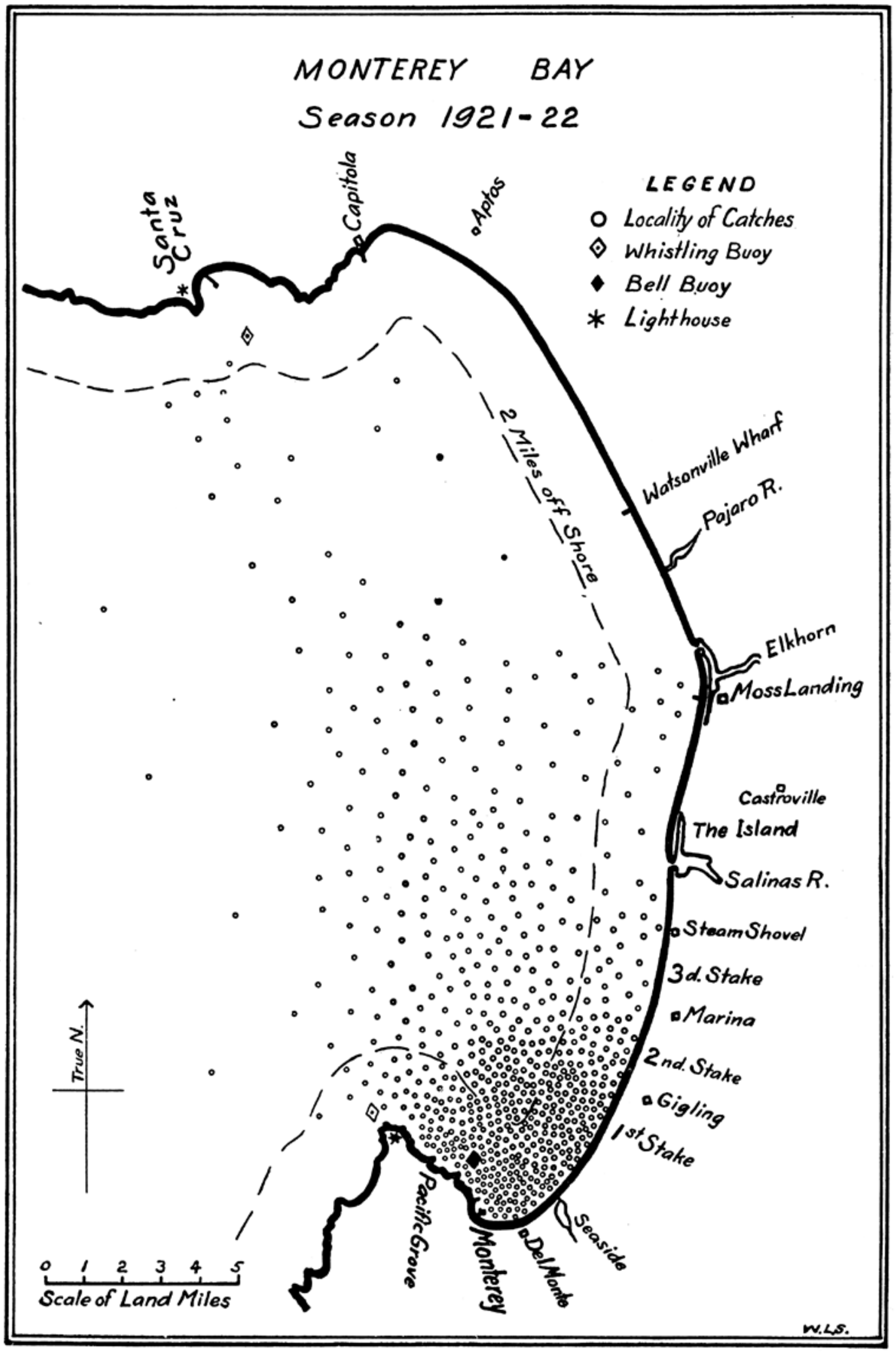

FIG. 3. Locality of the catches made by the boats from which samples were taken. The fishing season 1921–1922 is represented and illustrates the concentration of catches in the cove of the bay near the town of Monterey where the canneries are located. Locality names on this map are those used by fishermen

FIG. 3. Locality of the catches made by the boats from which samples were taken. The fishing season 1921–1922 is represented and illustrates the concentration of catches in the cove of the bay near the town of Monterey where the canneries are located. Locality names on this map are those used by fishermen

fathoms of water (1925). A large percentage of the catches are made within 2 miles of the canneries, and the location of many should be measured in yards rather than in miles.

The fishing season of 1921–1922 (July 23, 1921, to February 8, 1922) was fairly typical of the period 1919–1926. When the location of catches of the boats from which samples were taken[2] (about 600 catches) was plotted, it was found that of these catches, roughly 74 per cent, were made within 5 miles of the canneries. (See Fig. 3.) In other words three-quarters of the catches were made in the sheltered cove at the southern tip of the bay where the town of Monterey and the canneries are located.

The following table gives an idea of the distance off shore (not necessarily distance from the canneries) of these catches during the 1921–1922 fishing season:

Percentage of catches	Distance off shore
45	1 mile or less
64	2 miles or less
77	3 miles or less
87	4 miles or less
92	5 miles or less

In the accompanying table of distances and sea depths, the first 12 localities named are those at which most of the Monterey catches were made. The locality names are those commonly used by fishermen, the term "stake" applying to triangulation stations.

Distances From Monterey Canneries to Fishing Grounds in Land Miles (Water Route)
Also Sea Depths in Fathoms From U. S. C. and G. Survey Charts

Locality names used by fishermen	Miles from canneries	Miles to a point 2 miles off shore	Sea depth in fathoms				
			1 mile off shore	2 miles off shore	3 miles off shore	4 miles off shore	5 miles off shore
Bell Buoy	.7	2.0	30	35	34	34	32
Northwest from Whistle Buoy	3.5	4.5	35	48	58	70	180
North from Pt. Pinos Lighthouse	2.8	4.0	32	50	50	50	50
Seaside	2.0	1.3	20	30	40	40	45
First Stake	3.5	2.8	17	30	38	40	50
Gigling	4.5	4.0	20	30	36	42	50
Second Stake	5.5	5.0	18	30	40	45	47
Marina	6.5	5.8	17	30	40	45	50
Third or Last Stake	7.5	6.8	18	28	40	42	47
Steam Shovel	8.3	7.5	14	25	33	40	45
The Island (Salinas River)	10.0	9.0	10	20	30	40	50
Moss Landing	14.0	13.5	30	44	100	150	150
Watsonville Wharf	18.0	17.0	8	15	22	30	35
Aptos	24.0	22.0	6	9	12	15	16
Capitola	24.0	22.0	7	10	12	15	16
Soquel Point	23.0	21.0	10	15	18	22	28
Santa Cruz Whistle Buoy	23.0	22.5	7	12	17	19	23
Santa Cruz Lighthouse	24.0	22.0	1	18	22	28	35

Distances From Monterey Canneries to Fishing Grounds in Land Miles (Water Route) Also Sea Depths in Fathoms From U. S. C. and G. Survey Charts

[2] Throughout this bulletin, constant use has been made of the notes recorded at the time of taking samples of sardines for the study of sizes of fish taken in the commercial catch. As the boats chosen in sampling were representative of the fleet, deductions drawn from these records apply to the operation of the fleet as a whole and are as reliable as can be expected of fishermen's answers to questions. For a fuller account of the notes recorded, see page 197 of Fish Bulletin No. 11 of the California Fish and Game Commission, Part V, "The Sardine at Monterey: Dominant Size-classes and their Progression, 1919–1923," by W. L. Scofield.

Most of the more distant catches are made a mile or two off the sandy curving shore, 6 to 14 miles northeast of the canneries. A few catches are made 3 to 7 miles off shore north or northwest of the canning plants. As fish occasionally are found only at the northern end of the bay, it may happen that during a period of a few weeks the crews travel 20 to 25 miles to fish off Santa Cruz and Capitola. Such periods of scarcity of fish in the southern half of the bay, though of short duration, apparently recur nearly every season, usually in the fall months. Very few catches are made (1922) outside Monterey Bay, although it is said that before 1919 when methods of locating fish were poorly developed, lampara crews sometimes traveled up and down the coast, fishing in the open ocean. This limited fishing radius is (1922) due rather to the abundance of fish close at hand than to lack of seaworthy equipment.

During a short interval of the 1924–1925 fishing season, crews searched for sardines in the open sea north of Santa Cruz, occasionally traveling as far north as Pigeon Point, some 25 miles up the coast from Santa Cruz or 50 miles from Monterey.

Periods of scarcity of sardines in the bay have been repeated since 1925, and the intervals of failure are apparently increasing in duration. This has led to a belief among many fishermen that the greatly increased seasonal catch of the last four years (1926–1929) has been too great a drain upon the local supply of fish. However this may be, there is a tendency toward a failure of the nearby fishing grounds to supply the increasing demands made upon them, and a larger percentage of the catch has been brought in from more distant grounds during the period 1926–1929. Obviously distant grounds are explored only as a result of the partial failure of local areas to supply the cannery demand for fish.

2.2. Markets

The Monterey sardine catch goes to four local markets, in order of their importance: (1) canneries, (2) salting plants, (3) fresh fish markets, and (4) bait markets. During the active salmon fishing season more sardines are used (1924) for bait than are shipped to fresh fish markets. Mackerel and rock cod fishermen also use sardine bait, but the amounts used for bait and shipped as fresh fish are a very small fraction of the total catch. Small quantities of sardines are cleaned and salted down in casks, especially during the last two or three years (1924) but most of the fish salted is used in the preparation of "saalachini." This is a process in which the sardines "in the round" are heavily salted in large tanks, later packed tight in box frames the size of the intended shipping containers and given a heavy pressing till the result is a solid fish mass. The saalachini industry flourished during the war, slumped to almost nothing after the war and has been revived on a small scale (1924). In 1920 roughly 1½ per cent of the total catch was used for saalachini, but the following year less than half of one per cent was so used. During the 1923–1924 season a new and well-equipped saalachini plant used, at irregular intervals, the catch of one and sometimes of two fishing crews or, roughly, 250 tons per month while operating.

Over 98 per cent of the total sardine catch at Monterey is delivered to the canning plants (1924). Only a small fraction of the canned product is consumed in California, a somewhat larger percentage is sold in the United States, but the great bulk of the output goes to foreign countries including Mexico, Cuba, Central and South America, and Hawaii, but chiefly to the orient (1924).

2.3. Cannery pack

The cannery pack at Monterey is almost all in one-pound oval cans and is shipped in cases of 48 cans each. Some half-pound ovals are packed, but very few of the small quarter-pound squares or "quarter-oils" are put up. Recently (1922–1929) one plant has made a sideline specialty of quarter- and half-pound squares in a variety of styles, such as peeled, filleted, smoked, in olive oil, and spiced.

During the 1925–1926 season large amounts of sardines were used in the manufacture of edible "fish flour" and reduced for the oil, which was hydrogenated and used as a substitute for cottonseed oil in the preparation of certain food products. In spite of this recent development of fish flour and edible oil manufacture, the total amount of sardines used for purposes other than canning is as yet but a small fraction of the quantity delivered to canning plants. However, less than half the fish delivered to a canning plant is actually canned. The offal varies from one-third to one-half of the total weight "in the round" of fish sent over the cutting tables. In addition, a certain percentage of "overage" or additional whole fish is (1919–1929) allowed each canner. From the offal and "overage," are obtained fish meal and oil. Some of the oil from cannery by-product plants is hydrogenated. The demand for sardine oil is strong, and as the price is good the profit is comparatively large. There is accordingly a great inducement for the packer to send as much fish material as possible through the reduction plant.

Packing methods and quality of pack vary between plants. In all canneries the fish are cut (cleaned), washed, brined, and dried. In most Monterey plants the next step is frying (really boiling) in oil before packing in the can. At one plant (1927) the fish is steamed rather than fried, and at another plant a short steaming follows the frying in oil. Several plants have filled special orders for fish boiled in brine instead of in oil. No Monterey canner has as yet (1927) adopted the improved methods developed by the Technology Division of the U. S. Bureau of Fisheries.[3] After sealing, all cans are given a thorough second cooking or "retorting" for several hours under steam pressure and at high temperature.

2.4. Annual catch and importance of the industry

The total catch at Monterey increased steadily from about 5,000,000 pounds in 1915 to about 80,000,000 in 1919. (See Fig. 2.) It dropped off a little in 1920 and slumped to about 30,000,000 pounds in 1921, reflecting the business depression and poor markets of that year. Before this postwar slump the fishing season of 1919–1920 was the largest catch, totaling roughly 86,000,000 pounds or 43,000 tons. After 1921 the catch rapidly increased till in 1923 it surpassed the boom times during the war, and by 1927 it had reached 175,000,000 pounds.

As an index to the importance of the Monterey canning industry as it was in 1924, the following summary is given, in round numbers,

[3] Beard, Harry R. Preparation of fish for canning as sardines. U. S. Bureau of Fisheries Report, 1927, p. 67–223, (Doc. 1020).

of an estimate made in that year. The 10 canneries then in existence had an investment in plants of more than $1,500,000, and the 7 plants operating employed, in the plants, over 1900 people. Including the 300 fishermen, about 2200 people were employed locally. The cannery payroll was about $80,000 a week in the packing season, and the plant expenditures in general packing costs totaled about $500,000 per month. The sardine fishermen had about $200,000 invested in fishing equipment, or roughly $6,500 per crew. Since 1924, there has been a rapid expansion of the industry and the investments in plants and numbers of men employed have greatly increased.

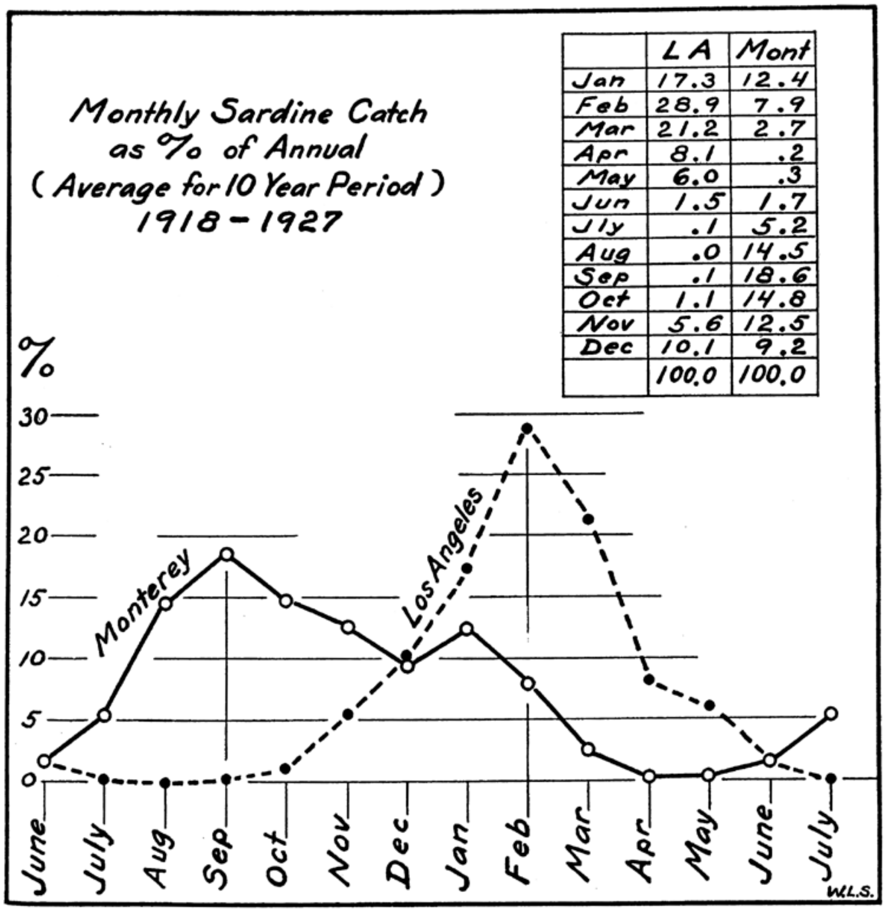

FIG. 4. Monthly sardine catches expressed as a percentage of the annual catch at each port. Percentages averaged for the 10-year period 1918-1927.

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2.5. Fishing season

The sardine fishing season at Monterey may be considered as 10 months of the year with April and May the off months.[4] (See Fig. 4.) While the catch of these 2 months combined is but half of one per cent of the total catch, some fish are taken the year round, the catch of May, 1923, being over 260 tons. During the war one plant is

[4] Scofield, W. L. Sardine seasons at Monterey and Los Angeles Harbor. California Fish and Game, Vol. 14, No. 3, p. 198, 1928.

reported as having run continuously for 18 months. The bulk of the catch (90 per cent) was made in the 7 months from the first of August to the end of February of the following calendar year. The 4 months of August, September, October, and November were the biggest months, during which over 60 per cent of the total catch was made, September being the biggest month.

The small catch of February may be due to the fact that very large fish make up most of this month's catch. These large fish of the "four to the can" size usually do not have a ready sale except as an occasional small special order (1920–1925). The fish caught in March tend toward mixed sizes, ranging from small to very large. This is very undesirable in packing as cans are segregated according to the number of fish per can. Aside from the two winter handicaps (rough weather and very large fish) the general business situation leads to a limitation of catch after October. The Monterey packers start (June or July) three or four months before the plants at San Pedro open, thus taking advantage of the early orders. By the end of October they have canned the bulk of the season's pack and the competition of the southern canned fish on the market begins to be seriously felt (1925). On the other hand the increase in the catch during the summer months is probably governed more by the condition of the fish than by business conditions. The April and May fish are usually too small and soft for the best pack. By July the fish are in good condition though still rather small for the popular demand of six to eight to the can. So many small fish are required to fill a can that they must be packed in two layers or "double row" in the can. The cutting and especially the packing of such sizes is much more expensive. By August the size and condition of fish is satisfactory for operating the plants full capacity.

From September through January the oil content of Monterey sardines is high, thus offering an added inducement to plants operating at capacity during these months because of the profit in fish oil from the by-products plants. This question of profit to be derived from oil and fish meal, involving the percentage of "overage" (whole fish diverted to the reduction plants) allowed by the changing laws and the application of regulations governing overage, is a very important factor in determining the sardine catch of California and must be taken into account when analyzing the trend of monthly or seasonal catches.

There is not a steady decline in the catch from October to April as January shows a marked increase over December. This increase is not due to one or two large January catches influencing the average, but is pronounced in every year except 1921 and 1922. (See Fig. 5.) The January catches of these two years were portions of the two poorest fishing seasons and were greatly influenced by the upset business conditions of the postwar slump. During these two seasons the limited orders were filled early in the season and few fish were packed after November.

It is not likely that the new year improvement in business conditions is sufficient to explain the large January catches. November and December are usually interrupted by rough seas that render fishing difficult and frequently make unloading at the cannery impossible for

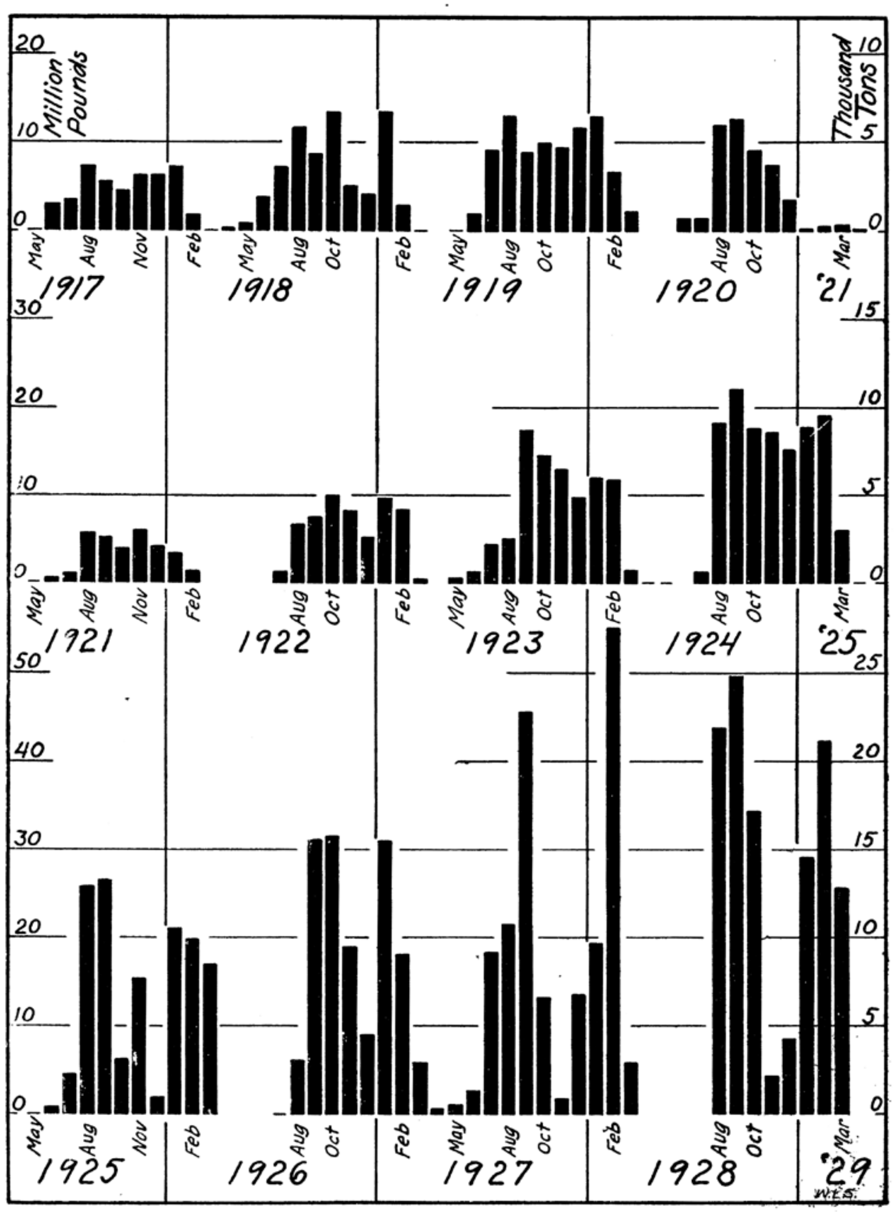

FIG. 5. The Monterey sardine catch for each month from May, 1917, through March, 1929.

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several days at a time. This is a limitation to the fishery but although it may be an important contributing factor, it alone seems scarcely sufficient to explain the decided increase of the January catches over those of December. It is possible that the change in fish sizes appearing in the catch may have a bearing on the question.[5] This change is

[5] Size changes are illustrated in Fish Bulletin No. 13 of the Division of Fish and Game of California, "Seasonal average length trends at Monterey of the California sardine (Sardina caerulea)," by Carroll B. Andrews, pages 4 to 7, For a discussion of samples taken during a transitional period, see Fish Bulletin No. 11, "The California sardine," Part IV, "Errors in the method of sampling used in the study of the California sardine," by W. F. Thompson.

from the medium sized fish of October and early November to the very large fish of January and February. The December catches are made in this transitional period just before the winter fish appear in the catch. This suggests the possibility that the intermediate sized fish are not readily available to the fishermen during December.

It is the belief of many canners that the early summer fish at Monterey and the late spring fish at San Pedro are in such poor condition that the resulting pack of these periods is inferior (1929). In an effort to better the pack, the association of canners met in the summer of 1928 and decided on a 5 months' closed season at Monterey and San Pedro. This season did not seriously interfere with cannery operations as the open season of 7 months at San Pedro (October to April, inclusive) and the 7 months (August to February, inclusive) at Monterey accounted for over 90 per cent of the normal season's pack. This agreement, however, did affect the opening dates of the fishing season 1928–1929. August 6 was the opening date adhered to at Monterey, and October 6 started the season at San Pedro. The dates set for the close of the season were not observed at either port.

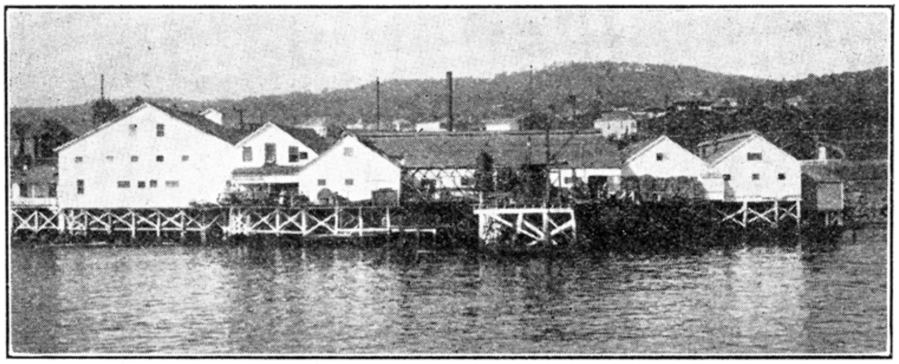

FIG. 6. A Monterey sardine cannery. Photograph by H. B. Nidever, April, 1914.

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2.6. Number of crews and plant capacity

The number of crews fishing for any one plant depends largely, but not entirely, on the cannery capacity. Each crew captain desires as large a limit as possible but may consent to fish for a small limit rather than risk having his equipment lie idle for the season. From the canners' standpoint it is desirable to have more crews than absolutely necessary and place each crew on a fairly small limit (1922). Two canneries of the same capacity may have a different number of crews and one plant may vary its number of crews during a season, so there is no definite rule for the number of crews employed per unit of capacity. However, an average for the 2 seasons, 1920–1921 and 1921–1922, shows 1 crew employed for each 12 tons' daily capacity, with a range of 10 to 18 tons. During these 2 seasons the number of canneries operating at any one time varied. of the 10 canneries at Monterey in 1922, 2 plants remained closed throughout the 2 seasons because of the general postwar business depression, some operated spasmodically, and a few ran continuously most of each season. Naturally the total number of crews fishing at any one time varied widely. At times only 3 crews were fishing and sometimes 15 to 20 crews were employed. During the 1920–1921 season, 7 canneries operated and employed 29 crews part of the time. The previous season there were 7 canneries with 28 crews fishing at some time during the season. As a result of the boom conditions during the war many lampara crews were equipped that could not find employment later. It was reported that in 1919 there were about 45 lampara crews and over 400 lampara fishermen in Monterey.

In 1922 the industry at Monterey was oversupplied with both canning plants and fishing crews. By 1924 the oversupply of fishermen had been remedied in that many sardine fishermen turned to some other type of fishing (especially salmon fishing in Alaska) or were forced into other occupations. As early as September, 1923, there was a temporary shortage of experienced lampara fishermen, a condition favorable to the success of the strike of that month. The number of plants equipped for canning was reduced from 10 to 8. In the following table plant capacities and usual number of crews are listed for 2 fishing seasons. The cannery capacity given is an estimate of normal daily capacity, not the maximum or the actual average. While a plant is (1922) capable of handling an excess of 10 per cent over normal capacity or even a greater excess for one or two days at a time, it is frequently obliged to accept a catch far below its capacity. Furthermore, comparatively slight changes in the plant may increase or decrease the capacity. The average normal daily capacity per plant was in 1922 about 47 tons of fish "in the round."

Monterey cannery	A	B	C	D	E	F	G	H	I	J
Normal daily capacity in tons	45	95	45	55	40	40	15	60	40	30
Number of crews 1920–1921	5	7	3	4	3	—	1	5	—	—
Number of crews, 1921–1922	5	7	4	5	3	4	1	—	—	—

1920–1921 : Seven plants of 355 tons normal daily capacity; 28 crews.

1921–1922 : Seven plants of 335 tons normal daily capacity; 29 crews.

Obviously, changes in the number of plants operating, alterations affecting plant capacity and change in the number of crews employed will have a direct effect on the total catch recorded each season. Although the tendency has been (1920–1929) to enlarge existing canneries rather than erect new plants, there have been frequent changes in the number of active plants. Soon after 1922 one canner purchased and operated another plant that had been idle for several seasons. Two canneries were dismantled but later refitted for canning. One plant failed in business and lay idle for two seasons. In the spring of 1924, there were 8 Monterey plants equipped for canning. In September, 1924, 2 plants burned, reducing the number of active canneries to 6, although a seventh plant was equipped for canning. Two new canneries were built in 1925, making 9 plants. In October of 1927 there were 10 plants and in March of 1929 there were 10 canneries, 1 fish flour plant and 1 edible oil plant.

The great increase in this fishery (1920–1929) took place in the individual plant capacity, accompanied by the employment of more fishing crews and increased fishing effort. During this interval the plants enlarged their floor space, added canning machines and other equipment necessary to greatly increase their possible daily capacity. In addition, larger reduction plants were installed to handle the increased amounts of offal and whole fish that were converted into meal and oil. During most of this period the canner was permitted to reduce one-fourth of his catch in addition to the offal, and this "overage" allowance led to catches far in excess of the actual canning capacity of the plants.

Although the output of a canning plant (exclusive of the reduction plant) is influenced by tank and cutting space, capacity of dryer, fry bath, retorts, basket or flake equipment and cooling space, the chief factor is the number of can-closing machines operated. The machines used at Monterey are of two types, the Gray closing machine with a maximum 8-hour capacity of 20 tons (round fish), and the Max Ams with a theoretical maximum of 20 tons per 8-hour day, but in practice, frequently operated at slower speed. The 7 plants operating during the 1923–1924 season were equipped with 18 Gray and 4 Max Ams, but 3 or 4 of these machines were not used. The Gray machine has a maximum capacity of 2,520 cans per hour (42 cans per minute). However, 80 per cent efficiency is all that is usually expected of a closing machine, although some plants claim greater efficiency from their machines.

It has been stated above that, although the number of plants operating has varied from year to year, the tendency during the 1920–1929 interval was to increase the capacity of individual plants rather than to build new canneries. The enlarged plant capacity as well as the addition of new crews is illustrated in the accompanying table.

Table of Plant Capacity and Number of Crews

	Number of plants operating	Number of crews	Normal daily capacity of all Monterey plants in tons
1920-1921 season	7	28	355
1921-1922 season	7	29	335
October, 1923	7 canneries	29	--------
	1 saalachini	1	350
1923-1924 season	7 canneries	29	370
August, 1924	10 canneries	33	--------
	1 saalachini	--------	--------
1924-1925 season	10 canneries	37	--------
	1 saalachini	--------	--------
August, 1925	9 canneries	41	--------
1926-1927 season	--------	55	--------
October, 1927	10	55 lampara	--------
	--------	2 purse	--------
January, 1928	11	--------	900
March, 1929	10 canneries	61	1,600
	1 fish flour	--------	--------
	1 edible oil	--------	--------

The normal daily capacity of all the Monterey plants for March, 1929, is given in the table as 1600 tons. This is for an ordinary eight-hour day, but by working overtime the 12 plants could readily handle 2000 tons. On February 2, 1929, there were 3065 tons of sardines delivered at the Monterey plants, but some of this fish had to be held over in the canneries till the following day.

The table illustrates a growth in the total daily capacity from 350 tons to 1600 tons and the daily average capacity per plant increased from 47 to 133 tons. The total daily capacity of the Monterey plants in 1929 was 4½ times greater than it was in 1921, but the number of crews employed was but little more than doubled. During the period 1920–1922 one crew, on the average, was employed for each 12 tons of plant capacity, but in the spring of 1929 there was one crew for 27 tons capacity. This means that the number of crews has not been increased proportionately with the enlargement of cannery capacity. Obviously the individual boat catch must more than double to supply the doubled demand on each crew, otherwise the supply of fish at the cannery would constantly fall short of the demand (based on capacity). This increased demand per crew has led to an increase in the fishing effort put forth by each crew, aside from all improvements in gear or changes in the number of crews.

2.7. Nationality of fishermen

During the two fishing seasons, 1920–1921 and 1921–1922, about 260 fishermen were employed in supplying the canneries. In addition 20 to 40 men were fishing sardines for other markets. These men were largely Italian or from Italian colonies; many, for example, are Sicilians. Three crews of Japanese and one Spanish crew fished during this time. There were a few American of Italian parentage, and an occasional Austrian, Danish, French or Portuguese fisherman. Roughly, 86 per cent of the men were Italian or of Italian parentage, 10 per cent were Japanese, and 3 per cent were Spanish. In other words, practically all the fishermen except the Japanese came from the shores of the Mediterranean. The great majority of sardine fishermen had neither become citizens nor made declarations of intention. Most of the older fishermen did not speak or understand English. Starting in 1924, there was a general movement among the fishermen to learn English and obtain citizenship by means of night schools conducted on the waterfront. By 1929 a number of sons of the early fishermen had engaged in fishing. These younger men are Americanized, but the Italian race still dominates sardine fishing at Monterey.

2.8. Price paid the fishermen

Fishermen are paid an agreed-upon price per ton (wet weight) for sardines delivered at the cannery. During the first years of the World War (1915–1917) while the sardine packing industry was developing, the price per ton to the fishermen is said to have been as low as $4 to $6. By the fall of 1918, the price had increased to $12. Through the summer and fall of 1919, the usual price was $12, although some deliveries were paid for at $10. The $12 price remained standard through the spring and summer of 1920, but in the fall of that year the prices varied from $12 to $9 per ton. In the fall of 1921 most plants paid $10 but some paid $8. The $10 price became accepted as the standard and continued up to August of 1926, although occasional payments were made at $8 and $7. These payments at less than the standard price were sometimes for small or mixed sizes, but frequently they were given for fish delivered in excess of the boat limit set by the cannery.

A short strike in August of 1926 resulted in changing the standard price from $10 to $11 per ton, and this increased price has held since (spring of 1929).

2.9. Shares

The average lampara crew is (1922) made up of 8 men and a captain.[6] The captain is usually the owner, manager and director of the work. He furnishes the equipment, pays the running expenses,

[6] In 1929, a captain and 12 men.

enters into the contract with the canner, and in most cases personally directs the fishing operations as well as doing his share of the crew work. He furnishes the launch, lighter, net, and incidental equipment, pays for the fuel and oil used, and for the boat and engine repair. The crew keeps the net, boats and incidental equipment in repair. The captain buys necessary replacements. The captain receives payment for the number of tons of fish "in the round" delivered to and accepted by the canner[7] (1922). This money is divided into shares for distribution among members of the crew. In most cases a division is made into 12 shares, 1 share to each member of the crew and the extra shares to the captain to cover his investment responsibility and risk. In past years it was customary for the captain to receive 5 shares, but at present (1922) he usually receives 4 and in some cases 3 shares. There is some variation in this arrangement as some crews total less or more than 9 men; also 2 or more men may be financially interested in the equipment. In 3 cases 1 man owns 2 boats and operates 2 crews. In 2 of these cases the owner has 2 captains under his direction who take charge of the actual fishing operations. In the other case the owner captains 1 crew and has an assistant in charge of the other. In other cases the captain is only partial owner of the equipment and must divide his shares with the parties putting up the capital. One crew is (1922) operated much like a stock company with the crew members as joint owners of the equipment. Although the canner sometimes advances money for the purchase of boats and other fishing gear, and occasionally retains a financial interest in a boat, such an arrangement is exceptional at Monterey.

2.10. Contracts and labor troubles

In the past all lampara fishing for sardines was done under written contract between the canner and crew captain. Most of the contracts covered but one fishing season although some were for three or five-year periods. The captain agreed to fish throughout the season (when fish could be caught) and to deliver all his catch to the specified canner for the specified price per ton. The limit allowed the captain was usually stated, but considerable leeway was necessary in this term of the contract. The form of contract used was found to be ineffectual and not binding on either party in the majority of cases, so contracts were discontinued and verbal agreements substituted (1922). In actual practice the verbal agreements could be terminated at any time by either the captain or canner and the price and limit clauses were, until recently, open to fluctuation. Price fixing disputes, dissatisfaction on both sides, and strikes were more frequent than in other more developed industries. The Italian and Japanese fishermen had separate unions but all the Monterey sardine fishermen were combined under one union that frequently dissolved and reformed. The canners, up to 1928, were not combined as a formal association but met when emergencies arose, in an attempt to act jointly. As a result of the looseness in these organizations, fishermen had to treat with individual employers and the canner was unable to deal with a permanent union

[7] In the fall of 1923 the fishermen's union required that the canner pay the treasurer of the union for fish received, and this money was later allotted among the crews according to the tons delivered by each crew. This practice has continued to the present (1929).

of fixed policy. This partially organized condition displayed most of the disadvantages and few of the benefits of more complete organization. There was no provision made for a common meeting ground where grievances might be stated and disputed points settled, the decision being left to economic warfare, so that the employer faced the danger of a strike at the most embarrassing time possible and the fisherman was in constant fear of unemployment. In the emergencies that arose one or the other side won quickly so that the industry did not suffer from the interruption of a protracted labor dispute, although costly strikes and lockouts of short duration occurred each season (1922).

The scarcity of experienced fishermen at the opening of the 1923–1924 season led to a stronger union of all Monterey lampara fishermen. This was followed by the customary annual strike (September, 1923), but in settling this particular dispute many of the long standing points at issue were cleared up, temporarily at least. Such major questions as weights of fish and allowance for water, boat limits, and price per ton were settled, as well as many minor causes of trouble, so that this clearing of the atmosphere permitted the remainder of the fishing season to run smoothly with better feeling on both sides than had existed during the previous six or eight years. One clause of this settlement provided for a board of arbitration of three members consisting of a representative of the canners, fishermen, and Monterey Chamber of Commerce, to hear and attempt to settle future disputes before a strike or lockout was called. Another clause in this September, 1923, agreement provided that payment for fish deliveries should be made by the canner to the fishermen's union rather than to the individual crew captains.

In December, 1925, another short strike occurred but this one was unique in that it was not directed at the canners. The dispute was between crew captains and crew members chiefly over the question of shares. As a result, the fishermen's union was split into two organizations by the withdrawal of the crew members and their affiliation with the American Federation of Labor.

Another strike, lasting but a few days, occurred in the fall of 1926. The fishermen asked for a $2.50 raise in the price paid per ton but compromised on a $1 increase.

In 1928 the Monterey canners joined with the San Pedro packers in forming two associations of cannerymen. One of these associations had as its chief object the fixing of the price of case goods sold for export but this price agreement, like its predecessors, was shortlived. However, the organization accomplished some good results in standardization of the pack and future benefits are to be expected if the association continues to function.

3. Part 2. FISHING GEAR

3.1. Launches

The launches are (1922) of quite uniform style of construction with clipper bow, wide flaring gunwales, compromise stern and good lines. This plan of small boat was developed for salmon trolling and became known along the California coast as the Monterey type. The clipper bow and flare made for a dry deck and the stern was a compromise between a pointed stern and a fan-tail, so that salmon lines over either side could be more readily hauled in by the one man at the tiller. Many of these salmon trollers were used in sardine fishing and were only slowly replaced (1918–1925) by larger boats built especially for sardine work. These newer launches followed closely the old lines with which the fishermen were familiar. Custom has largely determined the general type of boat used and utility has been responsible for the modifications adopted. As a matter of fact the Monterey troll boat itself with its small gas engine was merely a slightly modified lateen sailboat, which was used at Monterey (1902) principally for gill netting. As the advantages of power in a fishing boat became evident, the fishermen took out the mast and substituted a small engine. The

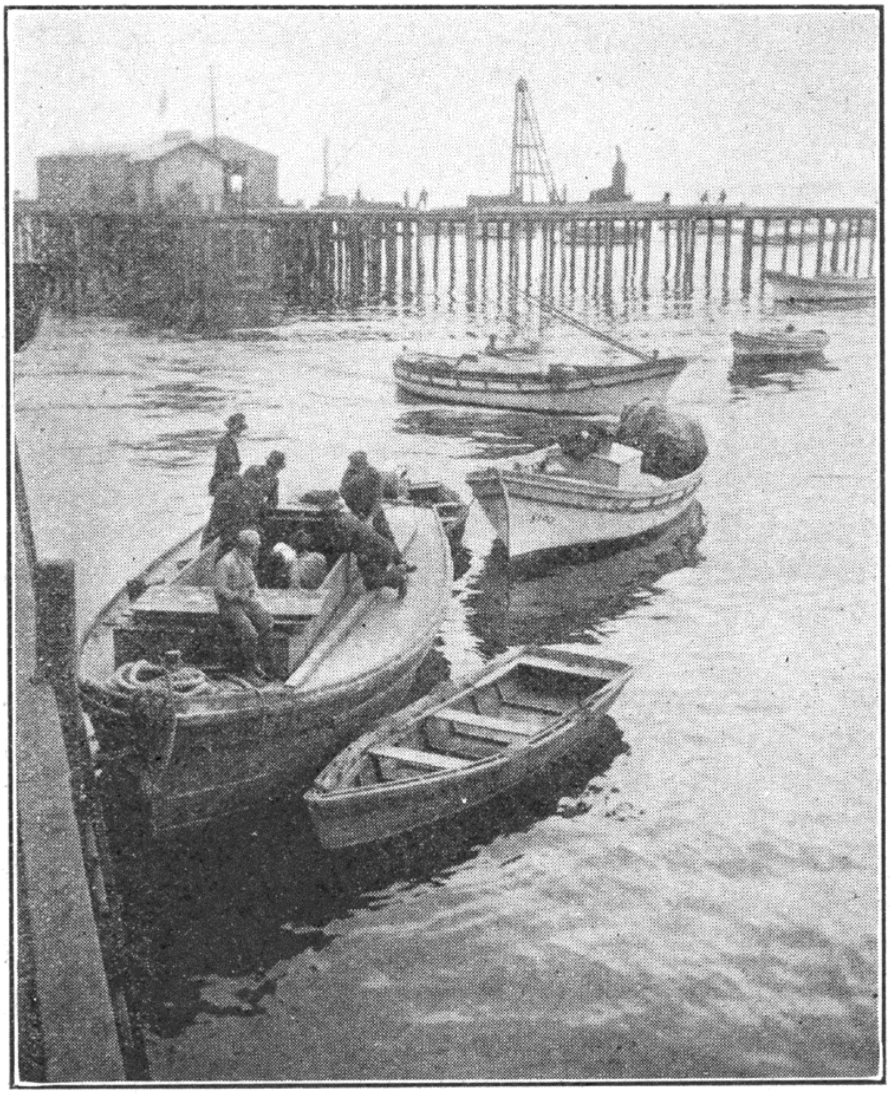

FIG. 7. Flat-bottomed lighter, skiff and launch with lampara piled in the stern. The second launch (center background) is a salmon troller with short mast and out-rigger "poles." Photograph by W. L. Scofield, Monterey, July, 1919

lateen sailboats of earlier days had a wide beam for sailing, flaring gunwales, a rather high pointed stern, and a straight bow with a removable bowsprit. When sails were displaced by engines a short and apparently useless bowsprit was retained. The high stern of sailing days was no longer necessary and the sharp point caught the salmon lines so it was lowered and "compromised." The writer is not informed as to when and how the clipper bow on these fishing boats developed, but his photographs of the lateen boats made at Monterey in 1902 show straight bows. For the origin of the lines used in these boats, we would probably have to go back many years and visit their original home in the ports of the Mediterranean Sea. The photograph of figure 7 illustrates the fact that the early sardine launch and the salmon troll boat were almost identical.

On the sardine launches (1922) there is a small house amidships but this is usually no more than a hood or shield for the man operating the engine and the wheel. Formerly the decks were very much rounded[8] but the tendency of recent construction is to flatten the deck (allowing a little slope for drainage) in order to reduce the danger of the men slipping. A small deck hatch forward gives entrance to the hold, but the space below deck is seldom used except for the engine and propellor shaft. There is no mast except a 4 to 6 foot pole to support an electric spot light which is used when loading the barge after a haul. A few of the boats are equipped with running lights but these are seldom used.

A typical launch (1922) is about 34 feet long, 9½-foot beam, and 3½ to 4 feet deep. (See Fig. 8.) Lengths vary from 27 to 40 feet but very few boats are under 30 feet long. The larger boats are equipped with more powerful engines. For convenience in considering size, launches are divided into three classes, the one-, two-, and three-cylinder engine types. The following table was compiled from the Monterey records of registration of lampara launches for the two calendar years 1920 and 1921. The value of boats as listed below are very rough approximations and are probably too low, as the fishermen were reluctant to give correct values for fear the information might be used by a tax collector. The values given are replacement values and not the original cost. A rough rule-of-thumb sometimes used for determining the value of such boats and engines is to multiply $100 by the number of horsepower and add $40 for each foot of boat length.

		Boat length in feet	Horsepower of engine	Replacement value of boat and engine in dollars
One-cylinder	Average	30	8 and 10	2,100
type	Range	27-32	8 and 10	1,800-2,600
Two-cylinder	Average	34	16	3,000
type	Range	31-38	12, 16, 20	2,000-5,000
Three-cylinder	Average	38	30 and 35	4,900
type	Range	35-40	30 and 35	4,000-6,000

TABLE

Four thousand dollars may be given as a rough estimate of the average purchase cost of launch and engine in 1922. Roughly 28 per cent of the launches have one-cylinder engines, 61 per cent have two-cylinders, and 11 per cent are of the three-cylinder type (1922). The one-cylinder engines are mostly Hicks make with a few Imperial. The two-cylinder engines are Enterprise, Hicks, Imperial, Atlas, and Standard, with some Union, Stewart, and Acme. The three-cylinder engines are largely Enterprise and Imperial. The life of a launch is about ten years, but frequent repairs are necessary. Although these lampara launches seldom leave Monterey Bay, most of them are of sufficient size and power to travel anywhere up and down our coast.

The tendency toward larger boats is shown by the fact that new launches added to the fleet are of the largest class as to both horsepower

[8] It is quite likely that the steeply rounded deck of the early sardine launches was merely a survival from the lateen sailing days when the little sailboats had to "shed water like a duck,"

and boat length (1923). During the 1924–1925 fishing season many of the crews purchased larger lighters because throughout that season the boat limits were either very high or removed entirely. This emphasized the advantage of larger launches with greater towing capacity and, as fishermen expected a repetition of high boat limits the next season, several crews purchased larger launches as well as larger lighters in preparation for the 1925–1926 fishing season. A

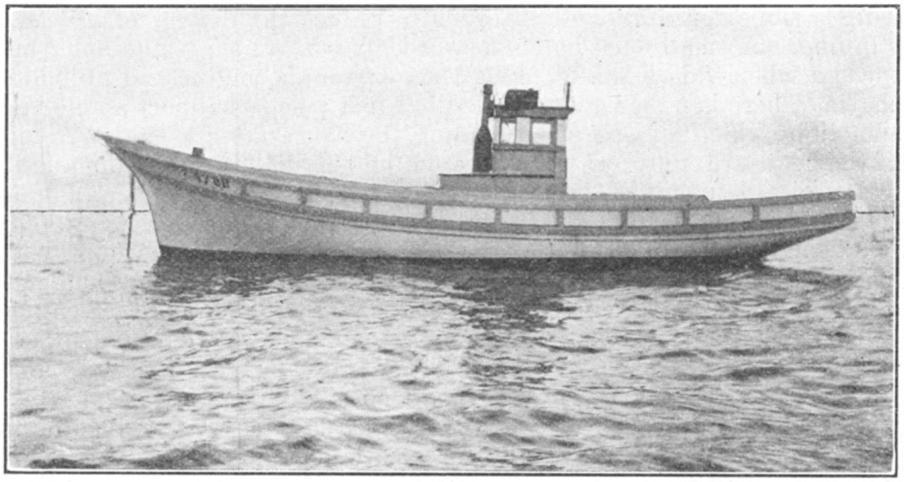

FIG. 8. Typical sardine launch at Monterey in 1922.

FIG. 8. Typical sardine launch at Monterey in 1922

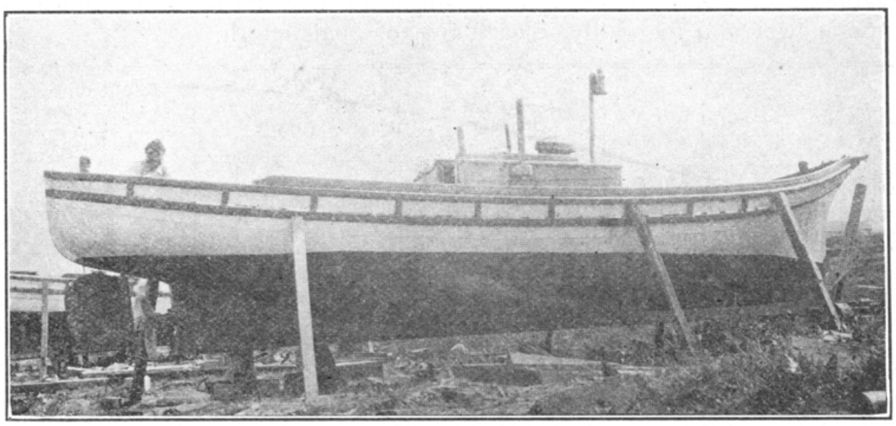

FIG. 9. Monterey sardine launch. Photograph by H. B. Holmes, 1922.

FIG. 9. Monterey sardine launch. Photograph by H. B. Holmes, 1922

launch added to the Monterey sardine fleet in March, 1925, illustrates this tendency toward larger boats. This launch was 53 feet long, 15-foot beam, and equipped with a 45-horsepower engine as contrasted with the typical launch of 1922 which was 34 feet long, 9½-foot beam, with a 16-horsepower engine.

The first Diesel engine to be used in a Monterey sardine lampara launch was installed in 1927 and during the fishing season 1927–1928 two more were added. Four Diesel engines were added in the 1928–1929 season, making a total of 7 in use in March, 1929. The 2 purse

Fig. 10. Round-bottomed lighters in foreground, sardine launches in background. Photograph by W. L. Scofield, Monterey, 1919.

FIG. 10. Round-bottomed lighters in foreground, sardine launches in background. Photograph by W. L. Scofield, Monterey, 1919

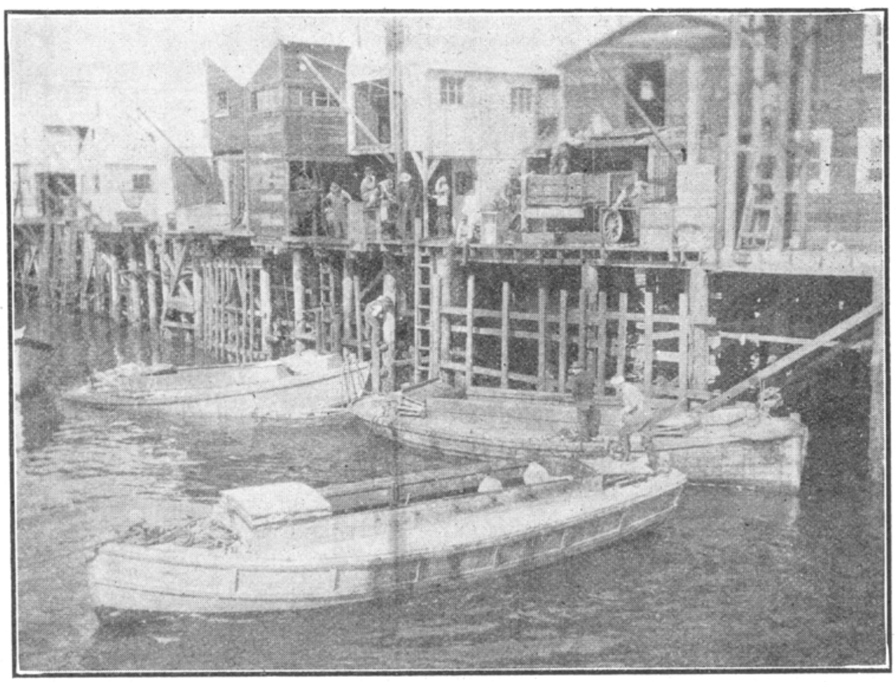

Fig. 11. Flat-bottomed lighters (foreground and with a stern load at left). At the right, a round-bottomed lighter. These sardine lighters are here being used to deliver squid to the Monterey markets before the opening of the sardine canning season. Photograph by W. L. Scofield, June, 1919.

FIG. 11. Flat-bottomed lighters (foreground and with a stern load at left). At the right, a round-bottomed lighter. These sardine lighters are here being used to deliver squid to the Monterey markets before the opening of the sardine canning season. Photograph by W. L. Scofield, June, 1919

seine boats sent to Monterey in 1926 were equipped with Diesel engines.[9]

As a result of the addition of larger boats, the average size of sardine launches in March, 1929, had increased to 45 feet, and the value of launch and gas engine was placed at $7,000 to $8,500. Launches with 40-horsepower Diesel engines were valued at $12,000.

3.2. Lighters

The lighters or barges are used merely for transporting the catch from the fishing grounds to the cannery, and as they are always towed by the launch they are not equipped with power. The lighters are from 25 to 35 feet long, 8 to 12-foot beam, and 3½ to 4½ feet deep. The capacity ranges from 12 to 30 tons of fish with 20 tons as about the average in 1922.[10] Most of deck space is (1922) taken up with

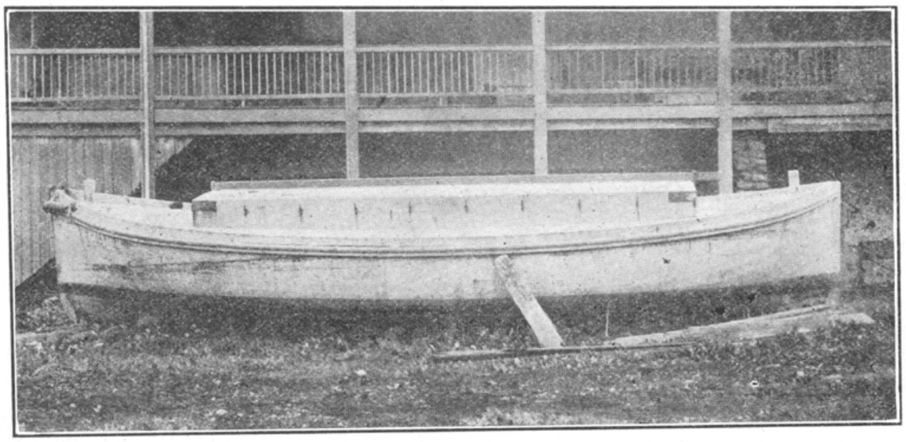

FIG. 12. Government barge converted into a sardine lighter. Photograph by H. B. Holmes, Monterey, 1922.

FIG. 12. Government barge converted into a sardine lighter. Photograph by H. B. Holmes, Monterey, 1922

a hatch 5 to 8 feet wide and 16 to 18 feet long leaving only a narrow deck on each side. The hatch is built up 1 to 2 feet above the deck and has 5 to 7 removable hatch covers. Some of the larger lighters have a partition amidships so that two sizes or species of fish may be kept separate, but the majority have only a removable brace in the center. Horizontal partitions or "double decking" is seldom if ever used. Nearly all of the lighters are square-sterned (see Fig. 13) and little care is given to construction lines (1922). The best lighters are converted government barges (see Fig. 12) which have been purchased at auctions of condemned navy goods. Most of the lighters are equipped with a simple hand pump for emptying water from the hull. The fish, as dipped from the net, are fairly free from water and may be loaded in till the decks of the lighter are submerged, but before unloading water is poured into the hold to facilitate shoveling the fish. Lighters are of two general types, flat and round-bottomed. The flat-bottomed

[9] These 2 boats were about 80 feet long, carried a crew of 9 men each and had a capacity of about 75 tons of sardines in the hold. With a deck load, each boat could carry 110 tons.

[10] The average barge capacity has increased since 1922 by the addition, especially in 1924, of larger lighters capable of holding 40 to 55 tons (1926). In the period 1927–1929 there were added to the fleet, lighters that would carry over 60 tons of sardines.

boats are cheaper ($500 to $800 original cost in 1922) but when towed empty they pound on the sea, requiring constant repairing, and may last only one or two seasons. Round-bottomed or "boat-shaped" lighters are considered much better and will last two or three seasons of rough use, but the original cost is from $700 to $1,000 (1922).

In March, 1929, the value of the newer and larger lighters was estimated to be from $2,000 to $3,000.

3.3. Incidental equipment

The chief items of the investment necessary to equip a lampara crew are the launch, engine, nets, and lighter, but the relatively small incidental equipment costs mount up to a considerable sum. Chief of these costs is the outlay necessary for lines used in mooring the lighter under the landing cable at the cannery. The lighter must be equipped with 4 to 6 lines of 3 to 4-inch rope, totaling 150 to 200 fathoms. These lines are constantly being broken by the surging of the boat in heavy seas and the replacement cost for rope alone often amounts

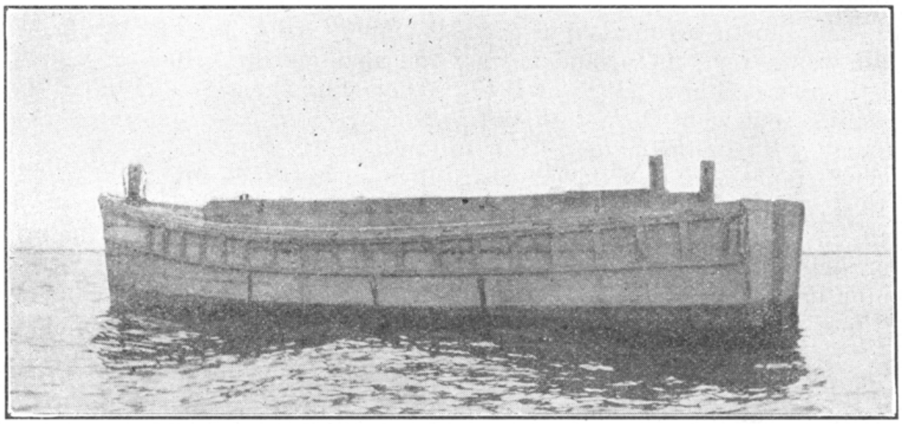

FIG. 13. Typical flat-bottomed, square-sterned sardine lighter at Monterey, 1922.

FIG. 13. Typical flat-bottomed, square-sterned sardine lighter at Monterey, 1922

to $150 a year (1922). An extra heavy towline is also required for the launch when towing the lighter. A skiff ($20 to $40) is necessary to transport the crew to and from the moored launch and also to assist in tying up the lighter under the landing cable. Two moorings or anchored floats for mooring the launch and lighter must be maintained. In addition the launch is equipped with an anchor and chain for use when away from the mooring. Other items such as dipnets, scoops, fish shovels, and scares are of small cost because they are usually made by members of the crew, and the fishermen do not figure labor time as a cost.

3.4. Nets

3.4.1. Kinds of nets used

The taking of sardines at Monterey in any large quantities began in 1903 with the establishment of a sardine packing plant. From 1903 to 1906 purse nets were used. The gill net has been used for years in obtaining bait but these catches of a few pounds are negligible. In 1905 the "lampara" net was introduced to the Pacific coast at Monterey from Tangeria and since 1906 it has been practically the only net used in sardine fishing in Monterey Bay, although one or two purse seines continued in use at Monterey until 1914 or 1915.[11]

At San Pedro also, the purse seine was replaced by the lampara (called "round haul" in southern California) for sardine fishing, and was used almost exclusively until January, 1925; at this time one crew captain revived the use of the purse seine, and by the end of that year 25 such seines were in use at San Pedro. In 1926, 2 purse seine boats were sent from San Pedro to Monterey and tried out with poor results. From 1927 to the present (1929) the use of the 2 purse seines at Monterey has been more successful, especially during periods of scarcity of fish in the bay. The purse seine boats being larger and equipped with black oil engines, can make the trip to distant fishing areas at less cost than the smaller lampara launches powered with gas engines. This illustrates the superior transportation facilities of the purse seine boats rather than demonstrating the relative merits of the two types of nets.[12] It is too soon to judge the success of this attempt to return to the use of purse seines at Monterey in competition with the lampara.

The Japanese round haul net was employed by a few crews, but its use was never general and it was soon abandoned, the last one having been operated about 1918 or 1919.[13] This Japanese net is credited with fishing somewhat deeper than the lampara and has a larger area of small mesh in the bunt. As it requires more men to operate it, this type of net was abandoned, the Japanese crews of Monterey (1920–1925) preferring the lampara. In the spring of 1929 one Japanese net called "shizuoka" was reported in use at Monterey, probably the same or similar to the earlier Japanese nets. In March, 1929, there were at Monterey 56 lampara crews, 2 crews using purse rings in the lampara, 2 purse seine crews, and 1 Japanese net or shizuoka crew.

3.4.2. Purse principle used in the lampara

In operation, the lampara employs the purse net principle in that the bottom of the net can be closed with the lead line after part of the wings have been hauled in, but there is no separate pursing line and the closing is not actually a "pursing." Unlike the purse net, the lampara has a "bag" or "sack" (bunt) so large that many tons of fish may be held there without crowding and undue excitement until the bottom of the net can be closed. This bag with its two long wings is laid out in a circle but as soon as the fishermen start to haul in the wings, the circle becomes distorted and the net operates very much like a huge scoop. The wings closing in frighten the fish toward the bag, the lead line in advance of the bunt's cork line further serves in the scooping process, until the two portions of the lead line close together like folding doors; the fish are then literally scooped into the bunt of the net.

[11] This corrects a statement (for which the writer was responsible) made in California Fish and Game, Vol. 7, No. 4, p. 197, to the effect that the lampara entirely replaced the purse seine at Monterey in 1906. We have since found notes recorded by H. B. Nidever showing that two purse seiners were operating at Monterey as late as 1914.

[12] Scofield, W. L. Purse seines for California sardines. California Fish and Game, Vol. 12, No. 1, p. 16–19, 1926.

[13] For a description of a very similar Japanese round haul net used at San Pedro, see "Methods of sardine fishing in southern California," by Elmer Higgins and H. B. Holmes, in California Fish and Game, Vol. 7, No. 4, p. 227, 1921.

3.4.3. Lampara modifications

When the lampara was introduced in southern California some modifications in construction were made, the most important being an increase in size of the whole net. Also the Japanese round haul net was (1922) very popular at San Pedro. At Monterey larger lamparas were tried experimentally as were also minor variations in construction, but during the last few years net construction has become more standardized, so that now (1922) there is great uniformity in both general plan and details of construction.

The plan of rigging purse rings and lines along the lead line of a lampara was not an uncommon practice at San Pedro in 1926. At Monterey this device was tried in earlier years[14] but was not used during the years 1919–1925. Pursing the lead line must sacrifice something of the scooping action of the lampara and would tend to permit fish to escape through the large mesh of the wings. In the spring of 1927 a significant reduction in the size of wing mesh was noted at San Pedro. By 1928 practically all the "round haul" nets of San Pedro were rigged with purse rings and lines. This abandoning of the scoop principle of the lampara led to reducing the mesh size in both wings and bottom of the bag. The San Pedro nets have also had the fullness of the bunt reduced so that they now more closely resemble the purse seine in their "hang" in the water and in the catching principle upon which they operate.

In January, 1928, one Japanese crew at Monterey rigged its lampara net with purse rings and in August of that year one Italian crew adopted this plan. A third crew tried this out in 1928 but soon abandoned the use of rings. Up to March, 1929, but two crews at Monterey were using the "purse-lampara." These two crews made the necessary modifications by deepening the wings, reducing fullness of the bunt, and reducing the mesh size in the wings and along the lead line of the bag.

3.4.4. Net sizes

In the nets used for supplying the Monterey packing plants there is some variation in the size, but even total size is becoming more standardized (1922). The chief factor in determining size of net is the number of men necessary to operate it. At Monterey larger nets have made somewhat larger catches but not enough larger to pay for the additional men required. Smaller nets, having the advantage of fewer men, are not so satisfactory in supplying the packing plants, because more hauls are usually necessary. This is a great disadvantage when the time available for fishing is short. Also on many nights when fish are "wild" and active the small net fails where larger nets, circling a larger area, are partially successful. Larger nets with larger crews were used during the boom times of the war but since then there has been reduction in size of nets and crews (1922). Smaller lamparas (discussed later) are used successfully in catching sardines for bait and for the fresh fish markets as well as in taking squid, mackerel, king fish, and smelt for the fresh fish markets.

[14] Evidently purse rings were being tried experimentally at Monterey about 1917 and 1918 since their use was noted in California Fish and Game, Vol. 5, No. 1, p. 41. This short article entitled "New fish net" describes the use of purse rings in a "purse-lampara" at Monterey.

The lamparas used in supplying the canneries in 1922 had a range of 150 to 240 fathoms in total length but nearly all of them were from 170 to 200 fathoms long, since this was the size best handled by a crew of 8 to 10 men. The net sizes as given in the Monterey registrations for 1920 and 1921 averaged 195 fathoms long (exclusive of the smaller bait nets). This standard length of 190 to 200 fathoms has continued through the period 1920 to 1929 in spite of the fact that the size of the crew has increased to 13 men (March, 1929).

3.4.5. Value and length of life

The value of a net is (1922) roughly $1,500 to $2,000[15] and its life is about two years, but the length of time a single net is in use is difficult to determine because of constant repairing, including the replacement of sections of damaged webbing. Furthermore a net is often rebuilt with substitutions of webbing of different mesh size and the elimination of sections that have been mended too much. The net frequently has great holes torn in it by sea lions and occasionally is badly torn in the propeller of a launch. To prevent quick rotting, the net must be carefully washed after each night's catch, the slime from anchovies being particularly detrimental. Salt is used when the net is piled wet for any length of time, but nets are usually carefully dried before coiling away for an extended period. Frequent dryings in the sun are necessary as well as an occasional tanning.

3.4.6. Details of lampara construction

Since the net is the most important part of the fishing equipment its construction is recorded in detail. For an account of fishing methods and nets used in southern California see the magazine, California Fish and Game, October, 1921, Vol. 7, No. 4, page 219, and especially pages 223–228, where diagrams and sketches of the nets used are given. For a brief history of the nets used, see page 196 of the same issue. The following detailed account of nets used at Monterey is based largely on data furnished by H. B. Holmes. Holmes, accompanied by the writer, spent several days in the spring of 1922 in the detailed examination of Monterey nets. As the construction of the lampara is somewhat complicated and involves a number of different parts, it will be convenient to refer to a diagrammatic sketch (see Fig 14) of a typical net in which the various parts are designed by letter. In the sketch and following description measurements are given in fathoms (6 feet). The net consists of a large bag or bunt of smaller mesh and two long wings of larger mesh. The wings are not detachable as they are in the nets at San Pedro. Following the practice of fishermen, throughout this description the wings are designated as right or left as viewed looking toward the open bunt or as viewing the wings of a stage set in a theater. Mesh size is measured from one corner of the opening to the diagonally opposite corner when the cords are pulled flat shut from these corners. Thus a one-inch mesh so measured will open up into a square half an inch on a side.

3.4.7. The Bag

Part A. The small mesh of the bag proper is in nearly all cases 40 fathoms along the cork line and 20 fathoms deep. Occasional variations

[15] In the spring of 1929 the value of lampara nets was from $900 to $1,200.

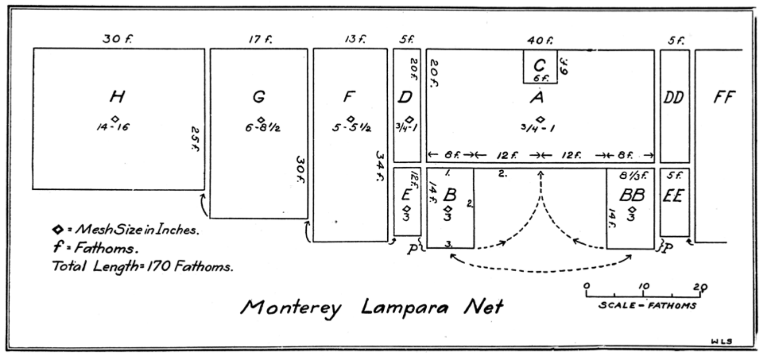

FIG. 14. Diagrammatic plan of a sardine lampara net. Monterey, 1922.

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FIG. 14. Diagrammatic plan of a sardine lampara net. Monterey, 1922

from this may be from 32 to 40 fathoms long by 18 to 24 fathoms deep. The size of mesh is in most cases either three-fourths of an inch or 1 inch, but in a few cases seven-eighths of an inch is used. The size of mesh in this portion of the bag varies somewhat with the season of the year, 1-inch mesh usually being preferred. When anchovies are abundant they gill readily in 1-inch mesh, so at such times the smaller three-fourth inch mesh is preferred.

Parts B and BB, commonly known as the bed or floor of the net, is the most important part of the whole net from the standpoint of construction, for it is the hanging of this portion that gives the proper bagging or cupping of the bunt and determines not only the action of the bunt in the water, but also the proper closing of the lead line to prevent the escape of fish. The standard size for each part of the floor (B or BB) is 14 fathoms by 8 1/3 fathoms. The size of mesh is nearly

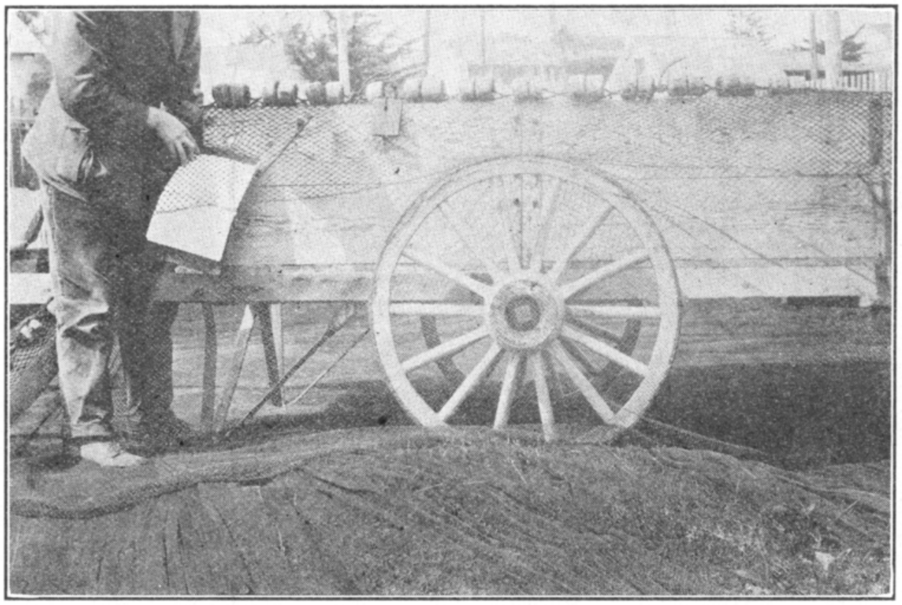

FIG. 15. Heavy webbing of the "landing bag" and the lighter three-fourth-inch mesh of the bunt is shown on the lower portion of the notebook background. The small wooden marker designates the center of the cork line. Photograph by H. B. Holmes, Monterey, 1922.

FIG. 15. Heavy webbing of the "landing bag" and the lighter three-fourth-inch mesh of the bunt is shown on the lower portion of the notebook background. The small wooden marker designates the center of the cork line. Photograph by H. B. Holmes, Monterey, 1922

always 3-inch, although 2½ or 3½-inch is sometimes used.Along side 1 (see diagram) the 8 1/3 fathoms are hung to 8 fathoms of part A. That is, occasional extra meshes of B are "taken up" so that in the 8 fathoms of A there is a take-up of one-third of a fathom (2 feet). Side 2 (14 fathoms) is hung along the next 12 fathoms of A so that there is an increased fullness of B accomplished by a take-up 4 times greater than along seam 1, that is, the take-up of the extra 2 fathoms of B in 12 fathoms of A. Side 3 of B then joins the corresponding side 3 of BB (bottom side as depicted in the sketch), and they are hung evenly without take-up. The upper 12 fathoms of side 4 of B are then hung evenly (without take-up) to the side of part E (12 fathoms), thus leaving an additional two fathoms of B projecting beyond E, and it is this projecting portion of B that is attached to the lead line (see point p in the diagram). The projecting 2 fathoms of B and the 2 fathoms of BB making 4 fathoms, are attached to about 2 feet of lead line by taking up the meshes into 6 large bunches before hanging to the 2 feet of lead line. This midpoint in the lead line is the pivotal point or hinge of the "folding doors" of the net when the lead lines close the bottom of the net.

Parts D and E by position might be considered as parts of the wings since they are beyond the center of the lead line which might be taken as the boundary of the bag, but as they correspond to the bag in mesh size the fishermen usually speak of them as part of the bag. They are in reality an extension of the bag mesh into the wings. Parts D and E are hung to A and B, respectively, and to each other without take-up. Part D corresponds to A in having either three-fourths or 1-inch mesh, while E corresponding to B usually has 3-inch mesh. Occasionally only

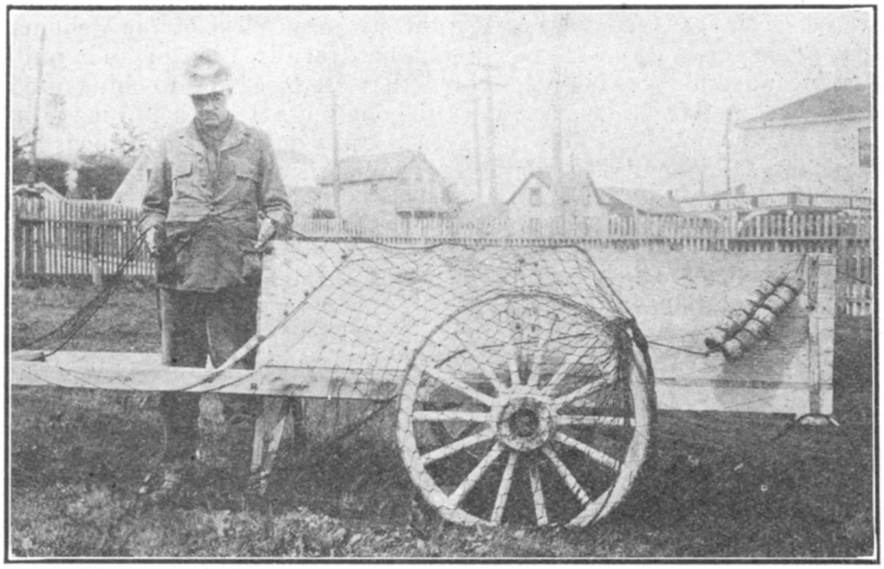

FIG. 16. Wing tip showing 14-inch mesh and bunched corks. The small mesh shown over the wheel of the cart is merely a small piece of webbing inserted at the brail end to take up the strain on the end of the 14-inch wing mesh. Each crew has (1922) such a cart for transporting the net to and from the dry grounds. Photograph by H. B. Holmes, Monterey, 1922.

FIG. 16. Wing tip showing 14-inch mesh and bunched corks. The small mesh shown over the wheel of the cart is merely a small piece of webbing inserted at the brail end to take up the strain on the end of the 14-inch wing mesh. Each crew has (1922) such a cart for transporting the net to and from the dry grounds. Photograph by H. B. Holmes, Monterey, 1922

the upper half of D is made of 1-inch webbing, while the lower half is, like E, of 3-inch mesh, but this is exceptional, not the rule. Almost without exception both D and E are 5 fathoms wide (along the cork line). The depth of D is that of A, usually 20 fathoms. E is 2 fathoms shorter than B, as explained above. The upper edge of D is hung to the cork line and the lower edge of E is hung to the lead line.

Part C, the "landing bag," is a piece of heavier webbing, usually 6 fathoms square, inserted without take-up at the center of part A along the cork line. (See Fig. 15.) It is in this portion of the net that the fish are closely packed while dipping the catch from the net to the lighter. When ready to empty the net, the cork line of the landing bag is attached temporarily to the lighter and the lower edge is held in the launch. The landing bag is thus subjected to the wear of the dip net as well as to the heavy strain of suspending the catch between the two boats. This strain while emptying the net, it will be noted, is at right angles to the cork line, whereas the heaviest strain on other portions of the net is parallel to the cork line while paying out and hauling in the net. For this reason the webbing of the landing bag is placed differently than in any other portion of the net. The standard knot for tying the cords into webbing will wear longer and resist strains better if the pull comes "with the knots," that is, in the direction into which the loose mesh cords naturally fall when relieved of all strain. A strain at right angles to this natural direction or pulling "against the knots" shortens the life of the webbing. The landing bag is hung so that the pull at right angles to the cork line is "with the knots" of the webbing. In all other portions of the net the webbing is hung so that the pull with the knots is parallel to the cork line, except of course in the case of part B, which has an end and a side hung parallel to the cork line, so that in this case the strain on most of the webbing comes at an angle of 45 degrees to the natural direction of knot pull. In this connection it should be noted that all pieces of webbing used in net construction are rectangular, diagonal cuts never being made in a piece of webbing for a new net. In a badly worn net cut down for bait fishing, diagonally cut patches are sometimes used, but it is considered bad practice.

3.4.8. Wings

In the wings (exclusive of parts D and E) there is more variation in construction than in the bag, but this is of no great importance since the wings serve primarily in frightening the fish back into the bunt rather than in holding the catch. In most cases the wing (exclusive of parts D and E) is made up of three parts, each differing from the others in depth and size of mesh. There is also some variation in length along the cork line of the different parts, but a total wing length of 60 fathoms is the general rule.

Part F, or the base of the wing proper, is usually about 13 fathoms along the cork line and the depth is about 2 fathoms greater than the combined depth of parts D and E, or in the typical net, 34 fathoms deep, thus necessitating a take-up of 2 fathoms when hanging to D and E, which total 32 fathoms deep. This extra depth is for the purpose of assisting the lead line to close more completely, the resulting fullness of F being a graduation from the bulging of the bunt to the more vertical wings. The mesh size is usually 5 inches but 5½-inch mesh is found in several of the nets. Since it is the tendency of fish to escape below the net before the two lengths of lead line can be completely closed, some fishermen have built lamparas in which the bottom 2 or 3 fathoms of this part F of the wing are of 3-inch mesh (like part E) instead of 5-inch, the idea being to prevent the escape of fish through the mesh just above the lead line. As this is not the usual practice among the best fishermen, it is likely that this smaller mesh delays the closing of the lead line more than enough to offset the escaping of fish through the mesh. It should be noted that the wings are subjected to considerable strain while the net is being hauled in, and the meshes as a result are pulled partly shut rather than hanging open as in a stationary gill net.

Part G. The length along the cork line for part G varies considerably but is usually 15 to 20 fathoms, and its depth is about 5 fathoms less than part F or 25 to 30 fathoms. The necessary take-up of part F is distributed evenly along the seam between G and F. The mesh size of part G varies between 6 and 8½ inches.

Part H. The usual length along the cork line for part H is 30 fathoms. The depth of this part is about 5 fathoms less than part G or 25 fathoms in most cases. Mesh size of this part varies between 10 and 17 inches but 14 and 16 inches are the most used.

In brief summary, the wing of practically all the large nets is made up of three parts, which are, from the bag toward the end, successively longer along the cork line, larger meshed and of less depth. In an

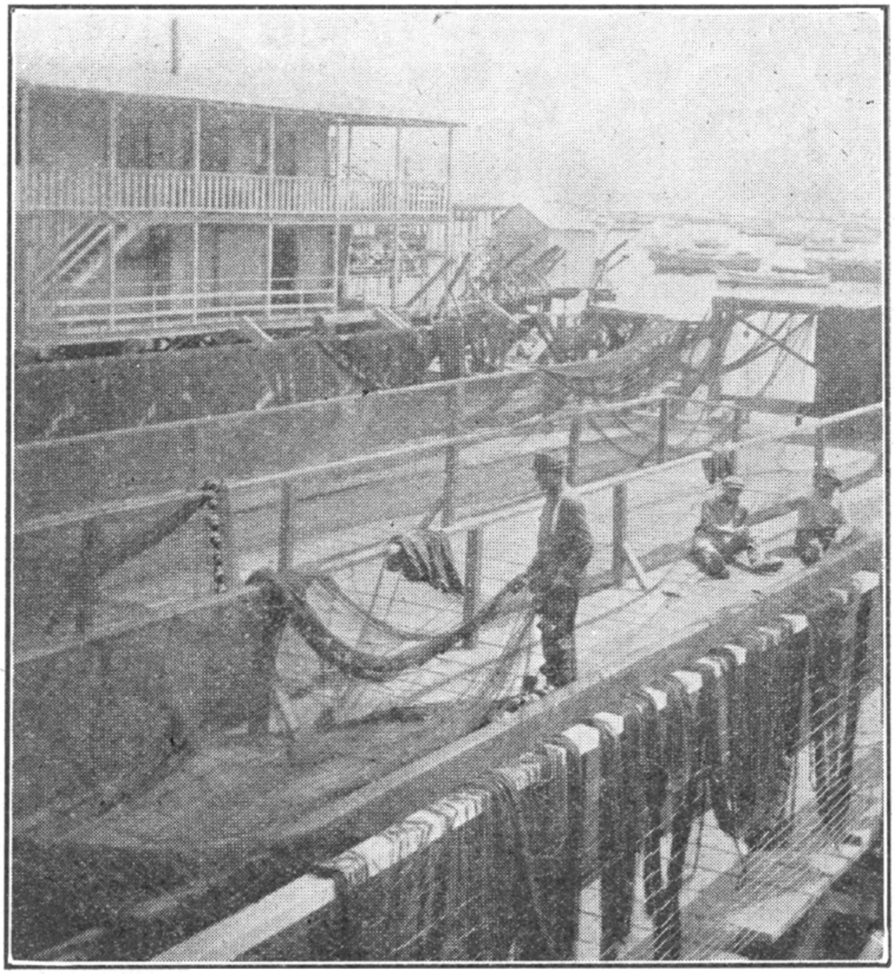

FIG. 17. A "lampara" on the net racks. Photograph by W. L. Scofield, Monterey, July, 1919.

FIG. 17. A "lampara" on the net racks. Photograph by W. L. Scofield, Monterey, July, 1919

occasional large net in the past few years (1919–1922) a fourth part was introduced between parts H and G, in which case the length, depth and mesh size was graduated in four steps instead of three, but such nets are now (1922) very exceptional if used at all. There is, however, a more important variation in depth of the wing parts. Some of the nets constructed during the period 1919 to 1922 by the leading netmaker of Monterey have the wing parts an equal depth throughout. The three parts instead of being graduated in depth toward the end, maintain the original depth of 30 to 35 fathoms to the end of the wing. The possible advantage of this deeper wing-end would lie chiefly in more effectually frightening the fish toward the bag. An argument sometimes given for this greater depth of wing is that the increase relieves some of the strain on the webbing of the wing while hauling it in, but in reality the strain of pulling the wing falls chiefly on the lead and cork lines rather than on the webbing itself and an increased bulk of the webbing, being more difficult to handle and offering more resistance in the water, may delay the haul somewhat. The success of a haul frequently depends on the speed of bringing in the wings. This uniform depth of wing construction is employed at present (1922) in less than 10 per cent of the nets in use at Monterey.

3.4.9. Cordage

The fine or 1-inch mesh of the bag is of No. 26 twine. Sometimes the lower portion next the bed is No. 26 with larger twine above. The 3-inch mesh and larger is of No. 3 twine. In the heavy twine of the landing bag No. 6 or 9 is used—frequently No. 9 is used in the upper half next the cork line and No. 6 below.

3.4.10. Lines and attachments

The lead line, running around the lower edge of the net, is a three-eighth-inch hemp rope with No. 1 leads hammered around it, the leads being placed a foot apart at the bag. Toward the end of the wings, the spacing between leads is gradually increased to 2 feet or more. The lead line is hung a little loose to the net, the slack in the line in many cases at least being 1½ inches to 18 inches of net. Along the entire length of the upper edge of the fine mesh (1 inch) of the bag, there is a selvage webbing about 2 feet wide of three-fourth or 1-inch mesh of heavy twine. Usually No. 12 cordage is used in the selvage edge over the landing bag, and No. 6 twine selvage along other portions of the bag. The selvage seldom if ever extends along the wings.

3.4.11. Corks

A one-fourth-inch (or three-sixteenth-inch) rope is looped over and through the upper meshes of the selvage of the bag. The corks are strung on another similar rope and the two ropes are lashed together on each side of the cork, the double rope preventing twisting or rolling of the cork line. (See Fig. 15.) Along the wings a single one-fourth-inch cotton rope is used, the webbing being attached by loops of twine tied to the cork line. Along the bag and extending along the 5-inch webbing of the wings, 3-inch or 4-inch cylindrical corks are placed in pairs less than a foot apart at the landing bag and the distance apart increasing to about 2 feet along the 5-inch mesh of the wing base. Along the middle section of the wings (part G with 6 to 8½-inch mesh) are spaced larger corks 6 inches square cut from slab cork 1-inch thick. Along the largest mesh or end section of the wings the cylindrical 3-inch corks are used but they are bunched, a dozen in a cluster and the bunches spaced about every 6 fathoms along the cork line. (See Fig. 16.) The object of the larger square corks and the bunches of corks is, of course, to prevent them passing through and entangling the larger meshes of the wings.

3.4.12. Brail

The end of the wing is fastened to a short heavy stick or brail about 18 inches long. The meshes of the wing-end are often gathered into from 6 to 10 bunches and hung to the stick by means of a short rope, or the meshes of the wing may be hung to a short piece of heavy webbing (see Fig 16) of about 6-inch mesh, which is, in turn, hung to the brail. A long heavy line for use in laying out the net and pulling the wing-ends up to the boat is attached to the brail of each wing.

3.4.13. Bait nets

Smaller lamparas are used (1922) at Monterey for catching sardines for the bait and fresh fish markets and in the fishing of other species than sardines for the markets. These nets are built on practically the same plan as the nets used in supplying the canneries, the difference being in reduced dimensions. These smaller nets are in most cases owned by the captain of a regular cannery crew and are fished at odd times when the canneries are not operating. Occasionally such a net is owned by fishermen not connected with a cannery and is used during the salmon season for catching bait, and at other seasons is employed intermittently in fishing other species for the fresh fish markets. The bait nets are frequently as large as 130 to 140 fathoms long, and some are as small as 75 fathoms long, the average length being about 115 fathoms. They are not so deep as the larger nets but reduction in depth is proportionately not as great as the reduction in length. The measurements of the bag are reduced somewhat and the wings are much shortened. In some of the smaller bait nets the wings have but two sizes of mesh instead of three, such as 5½ and 10 or 14-inch. The mesh sizes of the bag are the same as in the large nets. The advantage of the small net is that a crew of from 4 to 7 men can operate for the restricted bait and fresh fish markets at a profit, whereas a crew of 8 to 10 men with a large net could not make wages on such small catches.

3.5. Strainer

The "strainer" or "second sack" is an attachment used with the lampara net only when anchovies are abundant and mixed with sardines, its object being to strain out the sardines by allowing the anchovies to escape. As a rule anchovies are found mixed with sardines in quantities sufficient to justify the use of the strainer, only during a few weeks in the spring of the year. The mesh size of the lampara's landing bag is three-fourths or 1 inch. Since the strainer was first used its mesh size has been uniformly 1½ inches up to the present time (summer of 1925). The mesh of the strainer being larger than that of the lampara bag, allows the anchovies to escape but holds the sardines of canning size. Fishermen claim that the slime of anchovies rots the nets very much more rapidly than sardine slime, and as a result they carefully avoid, whenever possible, fouling the net with anchovies. The chief reason given for the use of a strainer is that it saves the lampara from much of the anchovy slime incident to the close crowding of the fish while loading into the lighter. One fisherman gave as his opinion that the use of the strainer at all times when anchovies were abundant, would prolong the life of a lampara net almost a year. A secondary reason given for the use of such an attachment is that the percentage of small and mixed sized fish is thereby cut down, making the catch more acceptable to the canner, and that fish so strained may be kept firmer and in better condition for canning when anchovies have been eliminated.

As first used, the strainer consisted of a piece of 1½-inch mesh webbing about 9 by 11 fathoms square provided with a 9-fathom cork line along one of the 11-fathom sides. There was a 2-fathom take-up, so that the resulting strainer was about 9 fathoms square. The side opposite the cork line was not provided with a lead line, but had short cords for tying to the cork line of the lampara. The strainer was not attached until the lampara had been hauled well into the boat and the fish impounded in the bag. The cords of the strainer were then tied to the lampara cork line and the fish further crowded by hauling in the lampara, till the cork line of the big sack was submerged. The catch then poured over the sunken cork line into the "second sack" buoyed up by the strainer's cork line. Evidently this arrangement was not satisfactory, and probably allowed too many fish to escape over the sides of the second sack. The strainers used in the spring of 1925 were about 7 fathoms square with 2 cork lines, along 2 opposite sides, and cords along the other 2 edges. The edge corresponding to lead line was, as before, tied to the lampara cork line and the opposite edge was attached to the lighter when brought opposite the launch, the 2 cork lines thus serving to buoy the sides of the second sack. Fish are dipped from the strainer to fill the lighter.

It is probable that a strainer was tried in the spring of 1920, but it was not given a real experimental try-out till the spring of 1921 by 2 crews. The following spring it was used for short periods by 3 crews and in 1923 by 5 or 6 crews. Many other crews adopted the device in 1924, and by the spring of 1925, the strainer was used by all Monterey crews during the intervals when anchovies were found mixed with the sardines.

It is claimed that the effect of using the strainer in the spring has been to insure deliveries of fish more uniform in size and in better condition, since anchovies are thought to hasten softening of the sardines. It is also claimed that in years past, fishermen made hauls before they discovered that the catch was of small sized and mixed fish. Such catches were frequently turned loose, but not without killing many small sardines. From the writer's experience in watching crews make their hauls, it would seem that in most cases the captain is able to determine the species of fish and the approximate size of fish (also size of the school) before laying out the net. It is a rather exceptional case when a water haul results from having circled a mixed school or fish of a size too small for acceptance by the cannery. The use of a strainer has undoubtedly reduced the number of anchovies in the spring catches, but more important still, for short periods (beginning with the spring of 1925), it reduced the percentage of very small sardines in the catch of certain months. This is of particular significance as we are analyzing the commercial catch to determine the normal proportion of size and age classes represented from year to year as one means of indicating the presence or absence of depletion.

4. Part 3. FISHING METHODS

4.1. Brief account of the netting

In order that a more consecutive idea may be had, a brief summary of the netting methods in general will be helpful before the separate steps are considered in more detail. The cannery supply of sardines is caught entirely in lampara nets. The quantity caught for bait in gill nets is negligible, and purse nets are no longer used at Monterey (1922). The launch and lighter are moored near the Monterey wharf. In traveling to and from the fishing grounds the launch carries the crew and piled net, with the lighter in tow. When fish are found the lighter is pulled alongside and the first or right wing of the net is made fast to it. The launch then circles the school of fish while the crew pays out the net. The launch picks up the lighter to regain the first wing, and the crew from the deck of the launch begins pulling in the wings thus slowly reducing the diameter of the circle. This is continued till the fish are concentrated in the center of the bag near the cork line. The lighter is then brought alongside the launch with the bag of fish between the two boats. The fish are then ladled[16] with a dip net into the lighter. After one or more such hauls the launch tows the lighter of fish to the cannery for delivery.

4.2. Available fishing time

Unlike the San Pedro fishery, the Monterey fishing is done entirely at night. There are one or two exceptions each season when small catches are made in daylight, an hour or two after sunrise, or a partially successful haul is made a half hour before sunset. In any one month only about half of the night time is available for fishing as over nine-tenths of the catches are made when the moon is not shining, that is, between moonset and moonrise. In most cases, especially during the winter months, no fishing is done on the 5 or 6 nights of the full moon, that is on the 1 or 2 nights preceding and the 2 or 3 nights following the night of the full moon. In the summer months fishing may continue up to the night of the full moon, and in a few cases partially successful fishing is carried on right through the full moon with no lost time between lunar periods. This is true of the summer months only. The nights between the first and last quarters (which include the full of the moon) have a few moonless hours (a rough average of 2 hours per night), but the sky even at such times is too bright for very successful fishing. The good catches are made on the 16 to 20 nights around the dark of the moon, especially between the third and first quarters, when there are but a few hours of dim moonlight during the night. The available fishing time is further limited by the fact that few catches are made till an hour and a half after sunset (during the after-glow) or in the dawning light of 1 to 2 hours before sunrise. This limitation is somewhat offset by the fact that catches are frequently made 1 or 2 hours before moonset and occasionally an hour or two after moonrise, but in such cases the moon is usually hidden by clouds or fog. The crews seldom fish Saturday nights so that the cannery force will not have to work Sundays. Fishing is done Sunday night for Monday packing. Another important limitation is stormy weather (either rough water or high winds) which frequently prevents fishing for days at a time. Throughout the year the variation in the time between sunset and sunrise is an important factor; fortunately during the height of the season when fish are abundant and in good condition for canning, the nights are long. For instance, the middle of December has over 14 hours of night, while the

[16] The term "brailing," common to most English speaking fishermen, is seldom heard among sardine men of California. The terms "dipping" or "scooping" are used.

middle of June has but little over 9 hours. The interval between moonset and moonrise is fairly regular during the height of the sardine season but irregular during the summer time. This has the effect of further limiting the available fishing time of the summer months.

The fishermen refer to the available fishing time of a lunar month as a "moon" but they mean the moonless portion of a lunar period, and for convenience we adopt this meaning of the term "lunar period," which is reckoned from full moon to full moon, not from new moon to new moon. Theoretically, a year has 12 1/3 such lunar periods, each period having an average of 29 nights (portions of which are moonless) or an average of 180 moonless hours with a range of 140 to over

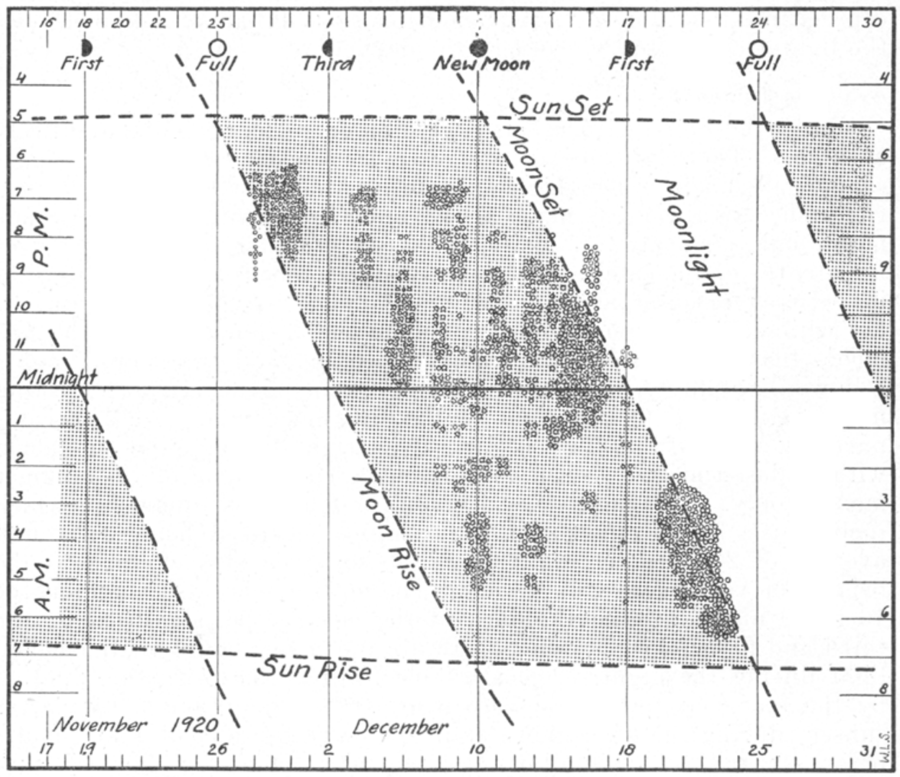

FIG. 18. The lunar period, November 26 to December 25, 1920, to show available fishing time while the moon is not shining. Small circles represent tons of sardines caught each night by the five boats from which we took samples. The vertical scale represents hours of the night, and the horizontal scale shows nights of the month (from noon of one day to noon of the next). Phases of the moon are based on calendar days (midnight to midnight) which accounts for their slightly unequal spacing on this chart of "nights."

FIG. 18. The lunar period, November 26 to December 25, 1920, to show available fishing time while the moon is not shining. Small circles represent tons of sardines caught each night by the five boats from which we took samples. The vertical scale represents hours of the night, and the horizontal scale shows nights of the month (from noon of one day to noon of the next). Phases of the moon are based on calendar days (midnight to midnight) which accounts for their slightly unequal spacing on this chart of "nights."

200 hours each period. Each of the 29 nights has on the average less than 6½ moonless hours. In reality the number of nights actually fished each lunar period ranges between 15 and 24, with 19 nights as the average during the sardine season, due to limitations already mentioned.

The consideration of a single typical lunar period may be of interest as an illustration. The period falling between the two full moons of November 25 and December 24, 1920, has a total of 218 moonless hours theoretically and 29 nights, some portions of which are moonless, or an average of less than 8 moonless hours per night. Assuming the 5 boats observed each night to be representative of the fleet, fishing was conducted 18 nights during the period. Actual catches were made within a total of 80 hours or within an average of about 4½ hours per night. This illustration (see Fig. 18) shows graphically the fact that most of the catches are made in the dark while the moon is below the horizon. of the total tons of catch here represented 92 per cent were taken between moonset and moonrise, while 8 per cent were caught while the moon was above the horizon but not necessarily shining. On 6 different nights during this period a few tons were caught during hours when the moon was up, but weather notes kept at the time show that 4 of these nights were cloudy with drizzling rain. The other 2 nights, though listed as clear in general, may have had drifting clouds sufficient to obliterate the moon for short periods. of these catches made while the moon was up, 75 per cent of the tonnage was taken during dark rainy hours and 25 per cent was caught on the 2 nights listed as clear. In other words, at least 98 per cent of the catch was made while the moon was not shining.

4.3. Locating fish

In practically all cases sardine schools in Monterey Bay are located by the luminescence their movements produce. The "fire" or the "lights" can be seen readily only on dark nights, and for this reason the fishing is almost entirely confined to the night hours when the moon is not shining. Different species of fish have characteristic movements in the water, so that the kind of fish and to a less extent the size of the fish can be distinguished on dark nights by the luminescence. The chief exception to this method of locating fish is that occasionally for two or three nights at a time, sardine schools are located by seeing the fish "jump" at the surface, or more properly speaking, seeing their fins cut the surface of the water. Such cases are to be expected only when the bay is very calm on nights near the full moon when it is impossible to see the "lights." Small catches are sometimes made at such times by making the haul close to shore in shallow water over sandy bottom, where the lead line can be allowed to scrape the sand to prevent the escape of the fish. A still more rare exception is the case where fish are located in the day time by actually seeing a school in the water near the surface when the crew happens to be out washing the net or is attracted by birds feeding on the school.

4.4. Scouting

Upon arriving at the fishing grounds the launch, towing the lighter, cruises about under command of the captain, who stands at the bow and signals with his hand the desired speed and course to the man operating the engine and wheel. No lights of any kind are used on the boat during any stage of the fishing operations, except a spotlight after the haul has been made and the fish are being dipped from the net into the lighter or when repiling the net after a haul. When fish are sighted, it is desirable to circle about them to find out the kind of fish, the size of the school, the size of the fish, if possible, and to learn whether the fish are quiet or lively, as well as to determine whether they are drifting in a definite direction or merely circling about idly. Furthermore, it is necessary to maneuver for position, considering wind, water currents, and direction of school movement, before the layout of the net is started. During much of the season when fish are quiet the school is often "split," the launch being steered through the school at slower speed. Splitting quiet fish seems to have little effect, as they dart away from the launch but a short distance, and the "split" soon closes again astern of the lighter, or the fish may sink a short distance to come up again soon. "Scary" fish may move rapidly off or are more apt to "dive," that is, drop so deep in the water that they can not be seen by the fishermen. If fish are very quiet, the captain stamps on the deck to frighten them so as to assure himself that they are sardines rather than anchovies, small mackerel or kingfish.

4.5. Size selection by fishermen

The one-inch mesh of the lampara probably allows many of the smallest sized sardines to escape, although a few extremely small fish are caught in these nets. It is possible that this net selection is not constant for one particular net and that "wild" or active fish are more apt to escape through the larger mesh of the wings and bed than are quiet fish, so that on two different nights the same net might average different sized fish on this account. To carry the speculation further, if small fish were more active than larger fish, they would be more apt to escape through the wing mesh before being impounded in the small meshed bag. We have no definite information on the above points, nor have we as yet determined the exact effect of the use of the "strainer."

Aside from net selection, there is (1919–1926) decidedly a conscious selection on the part of the fishermen against the very small fish. Even when the "quarter-oil" sizes are plentiful in the bay, the fishermen avoid them because they are not packed by Monterey canners and therefore not accepted at the plants. The captain, while scouting the school, is able in most cases to distinguish between the very small and medium sized sardines, and if the school is found to be of small fish, he passes on without laying out the net. On light nights (when visibility is poor for luminescence) a haul may be made in small fish, and in such cases the catch is usually turned loose without loading any of it into the lighter. On nights when fishing is poor the fisherman naturally is less particular in his selection against very small fish. He sometimes even brings in a few tons of a size smaller than desired by the packer rather than return empty or "skunked."

Although quarter-oils are seldom packed at Monterey, there is a certain amount of moderately small fish packed in the pound-oval cans, especially during the summer months when medium and larger fish are not available. Such sizes (more than eight to the can) are packed "two row" or "double layer" in the can, a pack which is much more expensive than "single layer" and is in less demand among canners and brokers. It is probable that on nights when fishing conditions are good the fisherman selects against these "double layer" sizes but on bad nights he brings them in. Although the degree of selection against very small and moderately small or "double layer" fish may vary within a season, we have not determined as yet that this selection varies from one season, as a whole, to another.

Medium sized fish might be designated as those sizes requiring six to eight fish to fill the pound-oval can. These are the sizes appearing most abundantly in the Monterey catch throughout the greater part of the fishing season. The six-eight pack is the one most desired by the trade. The pack of large fish (four-five to the can) does not move so readily, except for smaller special orders, and fish of these sizes are usually not desired by the canner. When possible, large fish are cut farther back on the body so that they will go six to the can.

There may be some selection by fishermen between medium and large fish, but it is doubtful if this is a very important factor in determining size of fish delivered. When fishing conditions are particularly favorable, a crew may reject hauls unless of just the size of fish desired, but certainly throughout most of the season, fishermen deliver the size readily available. When a special order for large fish (four to the can) is received, there is usually difficulty in filling it unless it comes during the midwinter months, and special instructions to fishermen as to sizes desired are usually not effective. It is more difficult for the fishermen to distinguish between medium and large fish in the water than between medium and small.

To summarize, there is certainly conscious selection to exclude the "quarter-oil" sizes. There is no doubt some selection against fish smaller than the "eight to the can" size on nights of "good" fishing, but on "bad" nights such selection by fishermen is not a very important factor in determining the relative numbers of medium and large fish. Selection for certain sizes to fill special orders is not very successful and probably affects such a small percentage of the total catch that it may be disregarded. The degree of selection, when it exists at all, may vary from day to day, but it very likely remains about the same for one season as contrasted with another. The size of fish readily available to the fisherman is the chief factor in determining the size caught.

The above paragraphs on size selection were written in May, 1926. Since that time (1927–1929) there has developed at Monterey another kind of selection which has affected the catch per boat and per haul. This is the avoidance of small sized schools, brought about by the increase in boat limits and the desire of the fishermen to load up in a short time. If there is a tendency for small schools to be composed of small fish, this selection against small schools is also a selection against small sardines. The facts are not as yet known (1929).

4.6. Considerations governing layout

The catch of any one haul depends very largely upon the skill of the captain, and considerable knowledge and experience are necessary for success. There are three important factors to be considered: wind, water current, and movement of the fish. Many times the fish are quiet or "dead" or merely idly circling about so that school movement can be disregarded. Sometimes the school is drifting or traveling in a definite direction and in such cases the net is pulled against this drift, wind and tidal currents permitting. For example, assume a strong tidal current running to the south and a school of fish moving to the southeast. The haul may be made against the tide, but most of the fish meanwhile escape through the left wing mesh, so that in this case the cast is better made against the drift of the fish. The tide then tends to close the left wing and open the right wing, thus causing a poor haul and the escape of most of the fish, yet the fine mesh of the bag stops some of them, and such hauls are (1922) frequently made for the sake of the two or three tons that may be caught out of a large school. The wind is to be considered as it drifts the cork line of the net as well as the launch and lighter when they are not anchored.

Tidal current is of particular importance as it drifts the whole net and decidedly affects its shape after the layout, so that sets are usually made against this current. The tidal current is usually less noticeable at the surface but much stronger deeper down, which tends to drift the lead line out beyond the cork line. The surface and deeper currents are often in opposite directions, especially near the turn of the tide and cross currents or even whirlpool currents may so distort the net circle after the layout that the net can not be pulled evenly. A test, sometimes used to determine the strength and direction of cross currents at different depths, is to lower a weighted cord as a plumb line over the side of the stationary launch and then pour a stream of sand down along the cord. Such a test is desirable when there are but one or two hours of darkness available and a water haul resulting from unsuspected deeper currents might mean a failure for the night's fishing. Naturally the direction of the pull depends on the comparative strength of current and wind, but in general the hauls are made against the tidal currents. If the wind is very strong, it interferes with the set no matter what the direction of the pull, and in the winter time wind frequently prevents the crews from fishing for several days at a time. High winds are often (not always) accompanied by choppy seas that make loading into the lighter very difficult and may prevent unloading at the cannery. Heavy rolling swells are only a minor inconvenience to fishing, but are the chief cause in preventing unloading at the cannery, as such swells when they reach shallow water under the cables break loose the lighter from its moorings. In general, a haul is difficult and only partially successful if a fairly strong wind and current are in *opposite* directions. In such cases the wings and bag are drifted together or "flattened out" before the net can be pulled and the fish escape through the wing mesh or under the lead line. Such a haul may be partially successful when started at right angles to or quartering against the "tide," but the net is skewed out of shape badly and comes in unevenly at best. When wind and tide are at *right angles*, the haul is usually made against or quartering to the "tide," as the current drifting the webbing has more effect on the shape of the net than the drifting of the cork lines.

When one considers the many and varied conditions to be met, it is not hard to understand why a skillful captain is able to bring in good catches when other crews fail. Failures are common, even on nights when fish are seen abundantly in the bay. The ideal conditions are the calm nights with quiet fish several miles off shore, so that the mild tidal drift is the only consideration. Such nights are met with most frequently in the late summer and early fall or from the middle of August to the middle of October. In the winter time much high wind and rough sea are to be expected.

4.7. Laying out the net

When the captain has maneuvered the launch to the desired position in relation to the school of fish, he gives the command to start the layout, the tow rope of the lighter meanwhile having been shortened so that the barge is but a few feet behind the launch. The brail of the net's right wing is made fast to the bow of the lighter and the tow rope cast off. The launch then begins circling the fish, under directions from the captain, at moderate speed, so that the crew can pay out the net by casting out the first wing a coil or two at a time. When the bag is reached the first five or six fathoms of cork line are payed out rapidly while the shorter lead line is handled slowly. The great mass of finemeshed bag is then heaved overboard at one time; the launch, meanwhile, having completed half the circle, is turned back toward the lighter. The cork line with fine mesh of the left wing is payed out rapidly and the lead line more slowly till the separate pile of lead line is all out. The coiled last wing is really dragged out of the boat by the weight of the bag in the water, while the launch, at increased speed, steers for the lighter. The effort is made to complete the circle just as the last brail goes overboard, so as to save time in recovering both brails and starting the haul, but the left wing brail has a line attached to allow leeway for miscalculations. One of the crew in the bow with a boat hook catches the lighter, recovers the first brail, and makes fast the lighter at the starboard bow of the launch, while the pulling of the net is started with all possible speed and energy.

4.8. Scares

When a net has been laid out, the circle of webbing surrounds the fish on all sides except the opening in the circle at the boat caused by the wings being pulled aboard. The mesh of the net going through the water excites sufficient luminescence to frighten the fish away from it. They see the opening in the circle of "fire" and rush toward it, hoping to escape under the launch, so it is necessary to frighten them back. This is done by lowering some object over the side of the boat and jerking it up and down violently to disturb the water under the boat as much as possible. The common form of scare or plunger is a 10 or 15-fathom rope with a rock or chunk of iron as a weight attached to one end, and small wooden paddles at 1 or 2-fathom intervals, hung loosely to the rope so that they may bob about or flutter in the water. After the fish find this avenue of escape cut off, they usually return to the center of the circle as far from the "fire" as possible. But on nights when they are rather "wild," this is the most critical time during the haul till the lead line is in, because the fish are apt to dive straight down till they are below the lead line and out of danger. The success of the haul depends largely on the fish remaining in the center of the circle until the lead line is in, or at least "closed." One sea lion inside the circle may so frighten the fish that they all "go down" (dive) and a water haul results, not to mention the hole left in the net where the sea lion escaped. A net is sometimes so riddled with holes torn by sea lions that fishing has to be abandoned until the net can be spread out on the ground and mended.

4.9. Hauling the net

The net is pulled by hand from the port side of the launch, the right wing from near the bow, and the left wing from near the stern, with roughly half the crew (three to five men) at each wing, with one man in the center working the scare (1922). Each wing is hauled with cork line, lead line, and the intervening webbing bunched in the hands and pulled like a rope. It is necessary at all stages of the hauling to pull the two sides of the net in evenly to prevent the escape of fish, and for this reason the men call back and forth to each other how much of each wing is in. If half of the crew has been a little slower than the other half, it is necessary for them to pull in faster in order to even up the net. The necessity for speed and rivalry between the two parts of the crew result in fast, heavy work. When about three-quarters of each wing is in, the lead line is pulled separately from the cork line because, as the circle closes in, the fish become more crowded and are apt to dive under the lead line. Pulling the lead line separately has the effect of closing the net on the bottom, with the two lengths of lead line nearly parallel, while the cork line is still circled so that the net becomes more like a scoop than a purse net. Closing the net on the bottom often is called "cutting the fish." The point at which the lead and cork lines are pulled separately varies somewhat. When the net is quite full of fish, the lead line is pulled sooner (when half of the wings are in) because of the extra crowding of the fish; also on nights when the fish are "wild" the lead line is pulled sooner to prevent their diving under it, but normally the lead line is pulled when three-quarters of the wings are in, or at a point 12 to 20 fathoms before the small mesh of the bag is reached. The crew knows about how much of the wing is in by the change in the size of mesh. Occasionally markers are used along the cork line. For example, the change from 8 to 5-inch mesh (often 18 fathoms from the small mesh of the bag proper, or about 13 fathoms from the 1-inch mesh) may be the signal for pulling the lead line separately. At this point the man working the scare pulls it out on deck and takes one lead line (usually that of the left wing), while one of the men at the other wing pulls the other lead line. The lead line is pulled rapidly till the center of the line is aboard. Then a man is assigned to pull each cork line and all other members of the crew pull in the large mesh (3-inch) of the bag till the small mesh (three-fourths or 1-inch) is reached, because the larger mesh would allow fish to escape through it if they became too wild from crowding and started to dive. After the fish are secured in the fine webbing of the bag, the crew takes time off for a short rest. This lull is (1922) considered advantageous, as the frightened fish are given time to mill about, which seems to exhaust many of them so that they are not so difficult to dip into the lighter, and, incidentally, the milling process scrapes off many of the scales. After the fish have quieted down somewhat, the small mesh is pulled slowly into the launch till the catch is concentrated in the landing bag.

4.10. Filling the lighter

After the catch has been concentrated in the landing bag, the lighter is pulled along side so that the bag hangs between the launch and the lighter. Rope loops on the cork line of the landing bag are attached to hooks on the hatch of the lighter. As the weight of the bag full of fish tends to draw the two boats together, it is necessary for two men to hold the lighter off a distance of 6 or 8 feet with boat hooks. Other members of the crew are holding the webbing of the bag, while three men do the dipping or brailing from the net into the lighter (1922). One man on the launch operates the handle of the dip net while two men on the narrow deck of the lighter handle the ropes attached to each side of the dip net. The man with the handle shoves the dip net into the fish while the men at the ropes lift it and empty it into the lighter. Since handling these ropes is heavy work, the two men in the lighter are frequently relieved when a large catch is made (1922).

Since the above was written, there has been (from 1925 to 1929) a decided enlargement of the scale upon which fishing operations are conducted. Increased boat limits with larger boat catches have led fishermen to speed up the brailing of fish from the net to the lighter. At present (1929) two or three and sometimes four dip nets are operated simultaneously.

4.11. Unloading

When the catch is made, the lighter of fish is towed by the launch to the cannery where it is moored to await its turn at unloading. Hatches on the lighter are not battened down unless the sea is choppy. Unloading is begun whenever the first boat comes in, at any hour of

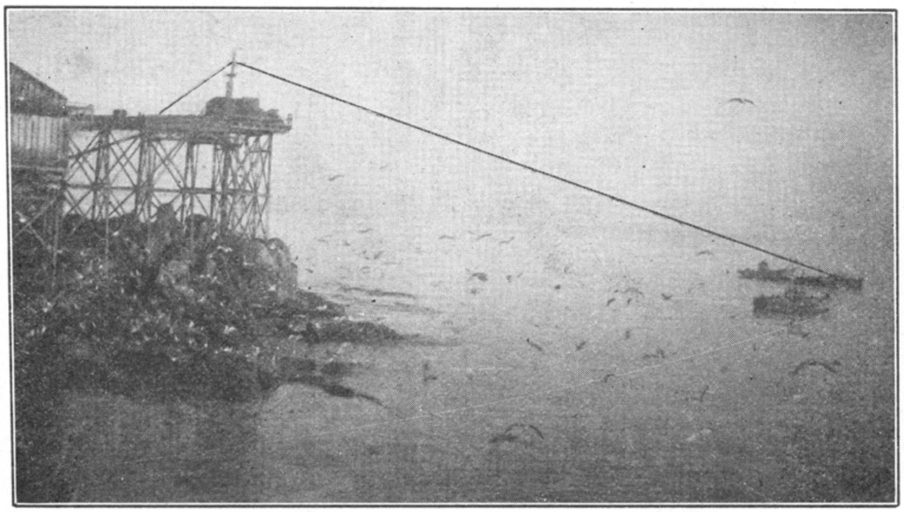

FIG. 19. Elevated winch-house at the cannery with unloading cable. Lighter "tied under the cable" and a launch with lighter waiting to unload. Photograph by W. L. Scofield, Monterey, October, 1921.

FIG. 19. Elevated winch-house at the cannery with unloading cable. Lighter "tied under the cable" and a launch with lighter waiting to unload. Photograph by W. L. Scofield, Monterey, October, 1921

the day or night. When a lighter is moored at the cannery the night-watchman telephones for the floor boss and the winchman. The fish cutters are called by blowing a signal on the cannery whistle, each cannery having a different signal so that cutters may distinguish between calls. At nine of the ten Monterey canneries (1922) unloading is accomplished by means of a heavy steel cable, one end of which is anchored in deep water far out from the cannery and the other end attached to the elevated hoising platform of the building. (See Fig. 19.) The lighter is "tied up" under the cable with two bow and two stern lines to four different floats, so that the boat may be held in position as nearly as possible in rough water. At one cannery, a wharf (see Fig. 20) is built out so that boats may tie up alongside, but even in this case no automatic hoist or endless chain conveyor is used. The situation of the other plants is too exposed to permit unloading at a wharf without breakwater protection. A trolley runs on the supporting cable from which a metal bucket is suspended and lowered into the lighter, shoveled full of fish, and hoisted to the cannery by means of an electrically operated winch and light hoisting cable. The bucket is provided with a trapdoor bottom for ease in emptying, and small holes for the escape of water while hoisting. The fishermen add quantities of water to the fish in the lighter to facilitate shoveling. Men standing in the hold of the lighter shovel the fish with hand scoops (1922), but sometimes the three-man dip net (the same as is used in filling the lighter from the lampara net) is used. Spotlights from the cannery illuminate the barge for night work. At best this is a slow process and the most dangerous of all the fishing operations. With a sea running

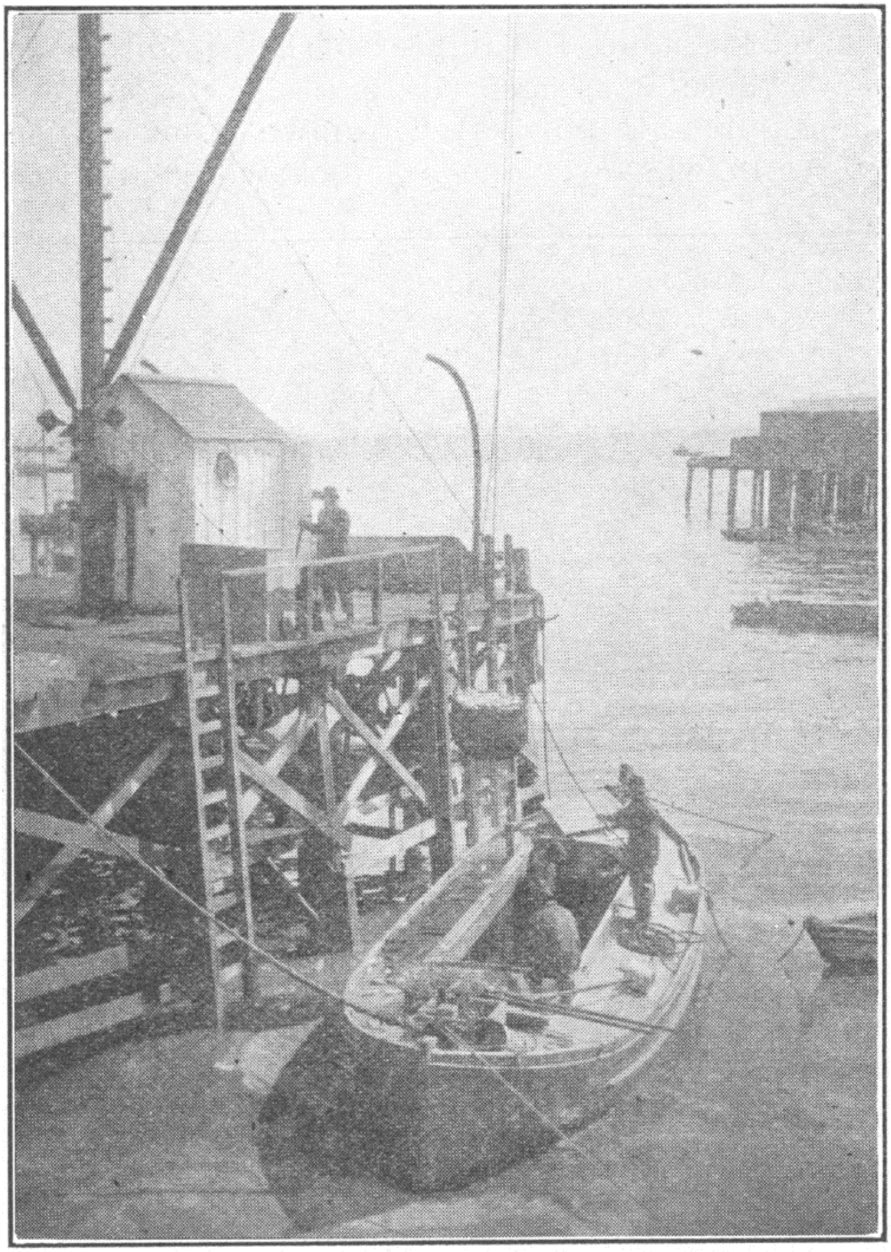

FIG. 20. Unloading sardines with "basket" hoist before the adoption of a standard metal bucket. This is not typical of Monterey in that the lighter is shown along side a wharf instead of "under the cable." Photograph by W. L. Scofield, Monterey, 1919

and the lighter plunging and often breaking the lines, there are frequent and thrilling narrow escapes. In calm weather, it takes from 1½ to 3 hours to unload a lighter of 12 to 15 tons. Unloading therefore consumes from 5 to 9 hours (1922). Occasionally a high surf develops and prevents "hoisting." After unloading, the crew washes down the decks and the hold of the lighter while putting to sea a mile or two. Here the net is carefully washed. Unloading at night is preferred by the canners, as it allows a large part of the night's catch to be fried (1922) and cooled in readiness for the next day's pack. Night delivery certainly makes for the fish being delivered in better condition. Fish left too long piled deep in the lighter under pressure from the fish above, become soft. Ordinarily, fish are delivered in excellent condition because of the short time elapsing between catching and delivery. The cold water of the bay and the cool weather prevailing in this region are also factors favorable to the good condition of the fish. Usually, the boats are moored at the cannery within an hour after the last haul of the net. Delays are due to the fact that boats have to wait their turn to be unloaded.

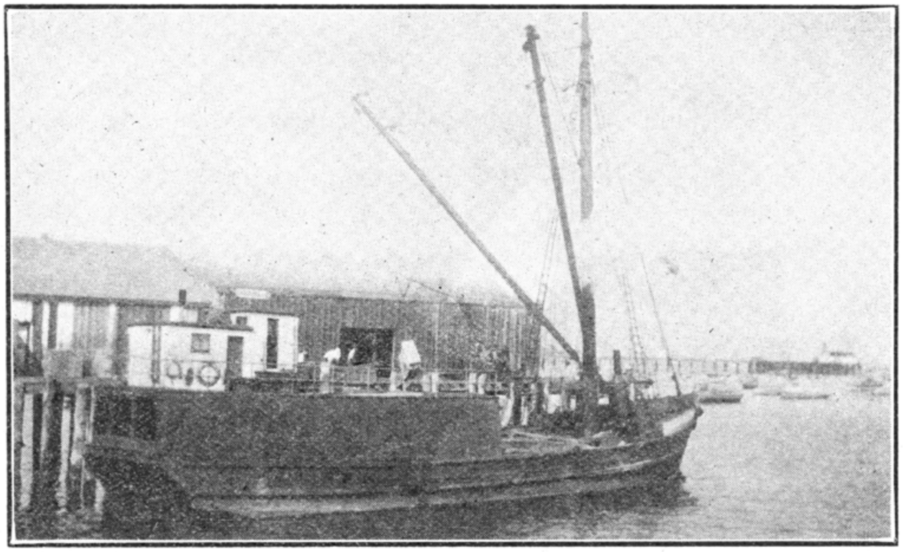

FIG. 21. The *"Coquelle"* loading cased sardines at Monterey wharf for San Francisco. Photograph by W. L. Scofield, October, 1921.

FIG. 21. The "Coquelle" loading cased sardines at Monterey wharf for San Francisco. Photograph by W. L. Scofield, October, 1921

Up to 1922, it was customary for the cannery to be provided with but one unloading cable. This was sufficient for the few boats and low boat limits at that time, but fishing operations grew in magnitude and the amounts of fish delivered at the canneries increased greatly through adding more boats and raising the boat limits. This led to such delay in unloading that each cannery plant was equipped with a second unloading cable during the period 1923 to 1928. In addition to the two cables, one plant installed in the summer of 1927 a suction pipe for automatic delivery of fish to the cannery from a receiver anchored in the water. This device was installed for the benefit of the two purse seine boats operated by that cannery. These boats drew too much water to allow of their mooring under the cables, and it was not considered feasible to extend the cables to deeper water. A second cannery installed in December, 1928, a suction device for unloading, and it is possible that this principle will supplant the slow method of "cable hoisting."

4.12. Weighing the catch

Receiving the correct weight of fish delivered is of great importance in comparing the catch records from year to year and in tracing the catch per unit of gear through a series of years. California has been the pioneer in requiring all fish transactions to be recorded in triplicate so that the state, receiving one carbon copy, may have an exact record of individual boat deliveries. This simple plan has worked remarkably well, but in the case of sardine deliveries in the past the correct weight was in most cases not recorded in the triplicate receipt book. This failure to record correct weights was not only an attempt to defraud the state and take advantage of the fishermen and competitors in business, but was largely due to the very unsatisfactory system of weighing at the canneries. This condition, so far as the mechanics of weighing are concerned, has been remedied, fortunately for everyone concerned, since it led to constant trouble, particularly between plant managers and fishermen. In past years there was no uniformity as to weighing at the different plants. Half the plants were equipped with scales for weighing each box load of fish delivered, but at the other plants the box content had been estimated, one operator going so far as to judge the amount of fish received by what he considered to be a sufficient case pack per ton without reference to box content. There was no uniformity as to boxes used, the average size being 4 by 4 by 4 feet, and the contents variously estimated at from 400 to 700 pounds of fish. At one plant the allowed weight of the same box was changed three different times in as many seasons. In one or two cases, baskets of heavy webbing hung on a metal ring were used, a very inaccurate container because subject to stretching and fraudulent alteration of the webbing. In either case, whether weighed or measured, there was difficulty as to the allowance made for water, since some water remained in the box in spite of auger holes provided for its escape. The deductions for water were figured as a percentage of the total weight and varied at different plants from 2 to 15 per cent.

The troublesome lack of uniformity in the system of weighing was settled by the strike of September, 1923, at which time all plants at Monterey installed a uniform metal bucket of identical pattern for measuring rather than weighing sardines. A number of buckets of fish were allowed to drain and the dry weights averaged. A uniform weight allowance for the fishing season 1923-1924 was established at 615 pounds per bucket with no deductions for water. Although the average weights exceeded 615 pounds, this weight was accepted as an average to apply throughout the season, thus allowing for the rough winter months when it is difficult to fill the buckets, and providing also for the occasional presence in the catch of anchovies, sharks and jelly fish. The adoption of a uniform measure, however, does not provide against small donations of fish on the part of the fishermen, nor prevent unrecorded deliveries.

4.13. Time required for hauls

Most of the total cruising time is spent in searching for fish within a limited fishing radius rather than in travel to and from the fishing grounds (1922). During the fall and early winter, schools are usually located readily so that the time spent searching is not great, and hauls may be made every half hour. Sometimes small schools of active fish are found abundantly, and since few fish are caught at each trial, the hauls may be only 20 minutes apart. In most cases, however, not more than one cast of the net is made per hour. Circling a school while paying out the net requires about 8 to 10 minutes for a large net. Pulling in the wings up to the center of the lead line takes about 6 to 8 minutes, and hauling the remainder of the net requires about an equal time. The crew works with great energy till the fine mesh of the bag is brought up to the boat, and the men ease up for a breathing spell. The time spent dipping the fish from the net into the lighter varies from 5 to 40 minutes, depending upon the size of the catch (1922). The elapsed time between catching and delivering the fish to the cannery is usually not more than an hour.

Crews may be out from 2 to 10 hours, but more frequently 2 to 4 hours are sufficient. One crew in 1919 claimed the record of 48 minutes total elapsed time from leaving the mooring to return to the cannery with a lighter full of fish, the haul being made just in front of the cannery. It may be well to point out here that the 2 to 4 hours' fishing time mentioned above is only part of the night's work for the crew. There are usually long delays, waiting in turn to unload, aside from the unloading operation itself, cleaning boats and washing the net. Much extra daylight time is spent in drying the net, tanning, and the almost interminable mending and replacement of webbing.

With the increase in size of catches since 1922, the time spent in fishing has increased considerably. Also the time per haul and the interval between hauls have lengthened because of larger catches being made and the avoidance of the small hauls for 2 or 3 tons of fish.

4.14. Anchoring

In most cases the anchor is not used while making a haul. Frequently the fish are found in water too deep for anchoring, but even in shallow water when there is little wind, the crews prefer not to "drop the hook." With a moderate wind, the anchor is sometimes dropped to prevent the boats drifting too rapidly, especially when there is danger of going ashore. The slower drift from tidal currents does not call for the use of an anchor because the net also drifts with the current. When the anchor is used the lighter is made fast while the net is laid out, and afterward the anchor rope is transferred to the launch, where it is made fast amidships to keep the launch broadside to the net while the haul is being made. A short anchor rope is used so that the anchor will not hold firm, but drag somewhat under the strain of the net pulling. Some fishermen claim that when the launch is anchored firmly the net does not come in properly, the difficulty being that the lead line is pulled up toward the surface too rapidly, thus allowing fish to escape. Probably the chief reason for dispensing with the anchor is that it delays the haul. The net is not actually dragged through the water, but itself acts as a drag anchor and the launch is pulled toward it. Older fishermen say that in past years the use of the anchor was much more prevalent than it is at present (1922).

4.15. Piling the net

All the Monterey crews (1922) pile the lampara net on the port deck of the launch as they all circle the school of fish from right to left (counter clockwise). This direction of circling is more the result of habit than of reason and experience. In most cases the direction of circling makes no difference, but in deep water where the lighter can not be anchored, and on nights when there is wind with strong tidal currents, the direction of circling may be very important. It is possible that the counter clockwise direction meets conditions in Monterey Bay oftener than the reverse direction, but there are many times when the clockwise direction would be better. For example, assume a wind from the west, a strong north running "tide" and water too deep for anchoring. The haul will be made against the current. In a counter clockwise haul the wind will drift the lighter and first wing of the net to the east, thus constantly widening the opening and requiring the launch to travel farther and spend more time before the pulling of the net. In a clockwise haul, which would start on the west side, the drift of the lighter would tend to close the opening and time would be saved. This is recognized by the better fishermen, but the crews are in the habit of pulling on one side and to reverse the haul seems awkward to them. It is said that the lampara crews in San Francisco Bay (1922) circle in a clockwise direction. The San Pedro fishermen usually circle clockwise, but sometimes circle in the reverse direction. (See California Fish and Game for October, 1921, Vol. 7, No. 4, p. 235.)

Nearly all the Monterey crews pile the net in the same manner. Three or four crews (Japanese) pile in a different way which will be mentioned later. In the typical (Italian) method, the net is piled on the port deck aft of the house. The wings as they come in are coiled in a circular pile 3 or 4 feet in diameter. The left wing, which is pulled from the stern, is coiled in the stern. The right wing, which is pulled from the port side near the bow, is passed back as it comes in and is coiled temporarily just aft of the house in the center of the deck or even on the starboard side to be out of the way. The bag as it comes in is not coiled. Two sizes of mesh make up the bag, a fine webbing three-fourths, seven-eighths or 1-inch around the top and 3-inch mesh at the bottom, forming the bed or floor. The fine webbing is piled along the port gunwale just forward of the coiled left wing with the cork line toward the center of the boat. (See Fig. 22.) The 3-inch webbing is stretched out forward along the port gunwale with the lead line toward the bow. Up to this point all the piling has been done as the net was pulled in. All that remains to be done to make the net ready for the next haul is to repile the first or right wing. As pulled in, the end or brail came in first and is at the bottom of the pile, but as this brail has to go out first, the right wing is repiled and reversed. It is coiled on top of the 3-inch mesh of the bag at the port gunwale with the smaller wing mesh at the bottom and the brail at the top. The brail of this wing is frequently passed back to the stern in readiness for attaching to the lighter at the next haul. On some of the larger boats a small platform about 2½ feet wide and 4 feet long is built up on the port deck near the stern. This platform has a level top (offsetting the deck slope) which extends from about 2 inches below the top of the gunwale to about the center of the deck. On this is piled the fine webbing of the lampara bag, the purpose being to facilitate paying out the bag, especially when it is dumped at one time.

The Japanese method (1922) of piling the lampara differs from the Italian, the idea being to arrange the net so that it will pay out very rapidly. In order to gain speed in the layout, the Japanese do not coil the wings in the Italian fashion but separate the cork line from the lead line, piling each separately. The left or last wing is piled on the starboard side near the stern as the net is being pulled in. The cork line of this wing is arranged in a zigzag pile at the starboard gunwale. The lead line and webbing of this wing are coiled toward the

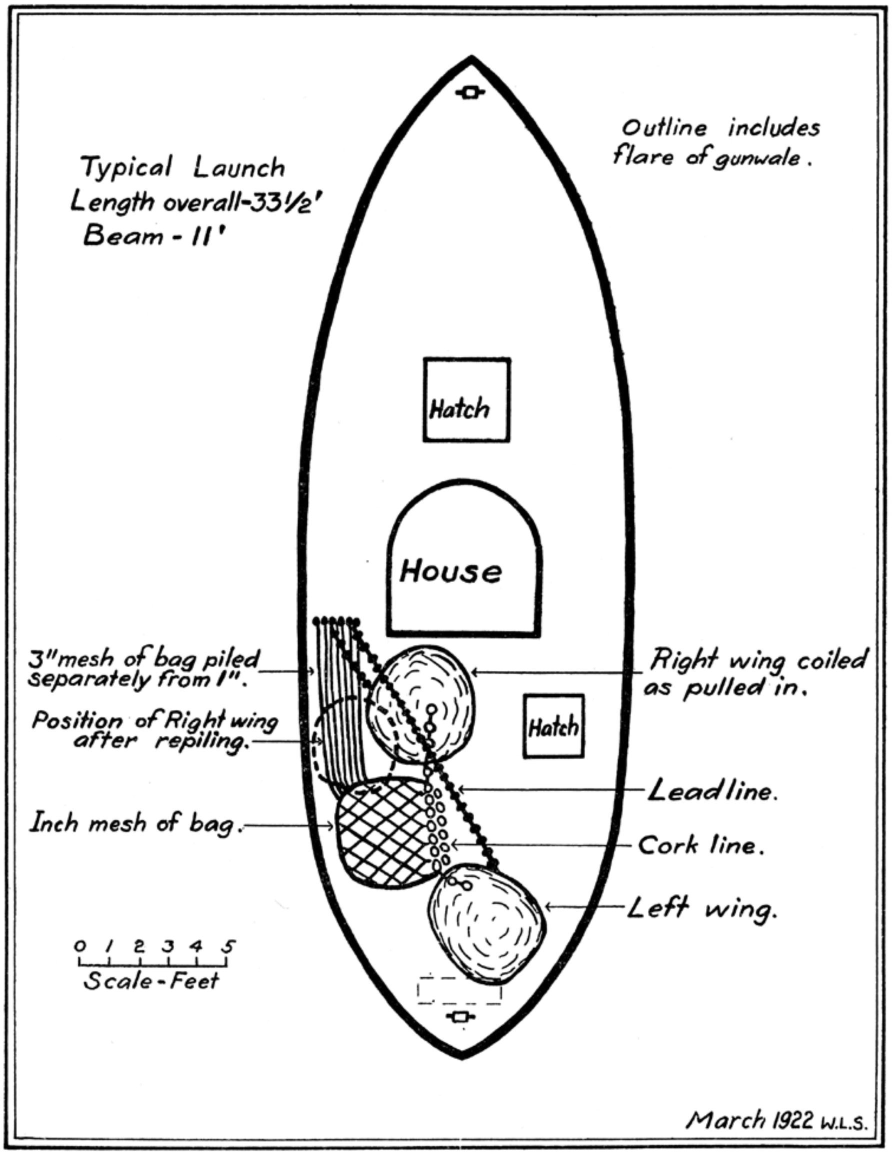

FIG. 22. Outline of typical Monterey sardine launch of 1922, and diagrammatic sketch of lampara net piled on deck, Italian style, for a counter clockwise layout.

FIG. 22. Outline of typical Monterey sardine launch of 1922, and diagrammatic sketch of lampara net piled on deck, Italian style, for a counter clockwise layout

center of the deck from the cork line. The cork and lead lines of the bag, each with its different sized webbing, are piled separately practically the same as in the Italian method. The right or first wing as it is pulled in, is piled temporarily and requires repiling before the next haul. In repiling, the cork line of the right wing is arranged in a zigzag pile on top of the heap of fine webbing of the bag, the corks being toward the stern. The lead line and webbing of the wing are coiled on the 3-inch mesh of the bag. This method of piling allows greater speed of the launch when circling for the layout, and the drag of the webbing already in the water literally pulls the net out of the boat with but little assistance from the crew. However, more time and care are required in piling. The Italians claim that this method is more apt to tear the net during the layout and that the noise of the leads and corks rumbling over the gunwale frightens the fish. The Japanese claim that nets seldom snag enough to tear and that the quick layout catches more fish than a slow and careful circling. The Italian fishermen are credited with being more successful than the Japanese, but skill and experience in planning the layout are much more important than the actual method of casting the net.

4.16. Number of men per crew

For the two Monterey seasons (1920–1921 and 1921–1922) the lampara crews delivering to the canneries averaged 9 men per crew. This is based on 60 observations on 26 crews, giving a total of 544 men or an average of 9 men per observation distributed as follows:

Number of men in crew	7	8	9	10	11
Number of observations	3	17	20	13	7—total 60

The above gives an idea of the variation between 7 and 11 men per crew. Some of the variation is accounted for by the difference in size of nets used, but the same captain using the same or similar net may vary the number of men in his crew during a season. One of the most successful of the crews varied from 7 to 10 men, and another of the better known crews varied between 8 and 11 men. One crew always fished 8 men, another 9, and another 10, but the majority of the crews fluctuate from 8 to 10 men. The Japanese are credited with fishing fewer men per crew, but the difference is slight. During the 2 seasons but 3 Japanese crews fished at Monterey, and 7 observations on these 3 crews gave an average of 8.6 men per observation, whereas 53 observations on the 23 crews of all other nationalities (mostly Italian) gave an average of 9.1 men per observation. When smaller nets are used the size of the crew is cut down. When fishing for the bait and fresh fish markets with the smaller lamparas, the crew is usually 5 to 7 men, and in exceptional cases 4 men pull a small net for the bait market.

From 1924 to 1929, the increasing cannery demand for fish led to a general enlargement of the scale of fishing operations. Although there was little addition to net dimensions, the size of launch and lighter increased and more men were added to the crew to aid in handling the larger catches. During the fishing season 1928–1929, the crews averaged about 13 men. The range in number of men per crew was from 10 to 15.

4.17. Number of hauls per crew each night

A crew usually makes from 1 to 5 hauls in order to get its catch for the night (1921). When conditions are favorable 1 to 3 hauls are sufficient, but under adverse conditions 4 to 7 hauls may be necessary. On rare occasions as high as 14 hauls are made in 1 night. Very frequently 1 haul will catch more than the limit set by the cannery and occasionally 2 or more crews that happen to be close by will fill their lighters from a net that has made a big catch. Sometimes for a week or two at a time all crews will get the limit in 1 or 2 hauls. The average number of hauls throughout the season would be from 2 to 4. For example, assume the period November 8 to December 31, 1920, to be a fairly representative portion of a season. Observations on 5 boats each night that catches were made during this period gave the following results: One hundred and fifty crews made 498 hauls or an average of 3.3 hauls per crew each night.

Number of hauls for the night	1	2	3	4	5	6	7	8	9	10	11	12	Totals
Crews	24	35	30	31	16	4	5	0	3	0	0	2	150
Total hauls	24	70	90	124	80	24	35	0	27	0	0	24	498

TABLE

These figures include water hauls that failed to catch fish, but do not include the cases where a crew caught nothing all night and returned

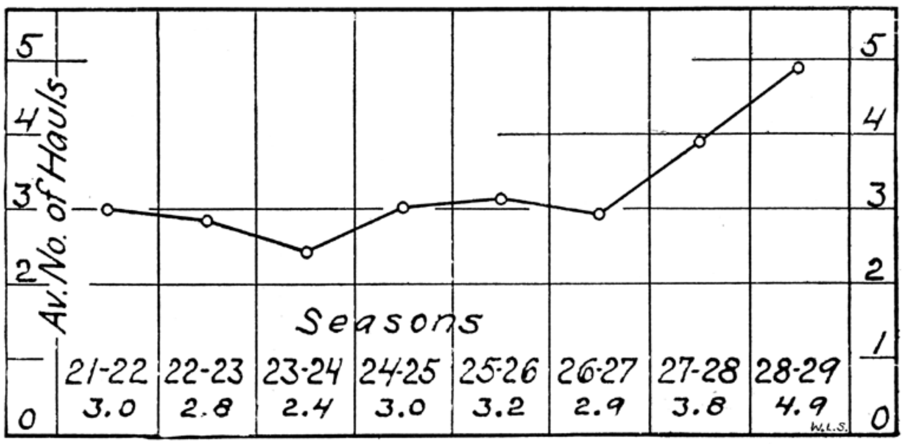

FIG. 23. Number of hauls per night. Season averages for the 8 fishing seasons, 1921–1922 to 1928–1929.

FIG. 23. Number of hauls per night. Season averages for the 8 fishing seasons, 1921–1922 to 1928–1929

without reporting to the cannery. Such cases are rare when the fishing is good, but are quite common during portions of the season when conditions are adverse and the fishing poor.

During the period (November 8 to December 31, 1920) already cited, the boats observed caught an average of 4.2 tons of fish per haul. The 150 boats making 498 hauls caught a total of 2067 tons during the period, or an average catch per boat of 13.8 tons each night. This was higher than the average for the total season 1920–1921, which was 11 tons per boat each night that catches were made.

It was stated above that in the fall of 1920, the crews on the average made from 2 to 4 hauls each night they fished. The accompanying graph (Fig. 23) presents the seasonal average number of hauls per night for 8 seasons since 1920. These figures are based on an average of 294 observations each fishing season.

During the first 6 of these 8 seasons, there was no very significant change in the average number of hauls, each of the 6 seasons showing an average of close to 3 hauls per night. The averages for the last 2 seasons (1927–1928 and 1928–1929) do show a marked upward trend.

For the sake of contrast the first season and the last season of this series are presented as frequency curves, in which the frequency of boat catches was plotted at each number of hauls. Since an unequal number of observations were made for these 2 seasons, the frequency has been converted into percentage so that the 2 curves will be directly comparable. (See Fig. 24.)

During the interval 1920 to 1929, the catch per boat increased greatly, but the number of hauls per boat catch did not increase at the same rate. This indicates that the catch per haul has grown and a catch analysis on the basis of tons per haul has shown this increase.[17] It would seem that fishing crews have met the demand for larger boat catches by increasing the catch per haul rather than quadrupling the number of hauls made. It is stated by many crew captains (and confirmed by superficial observation) that they no longer can afford to

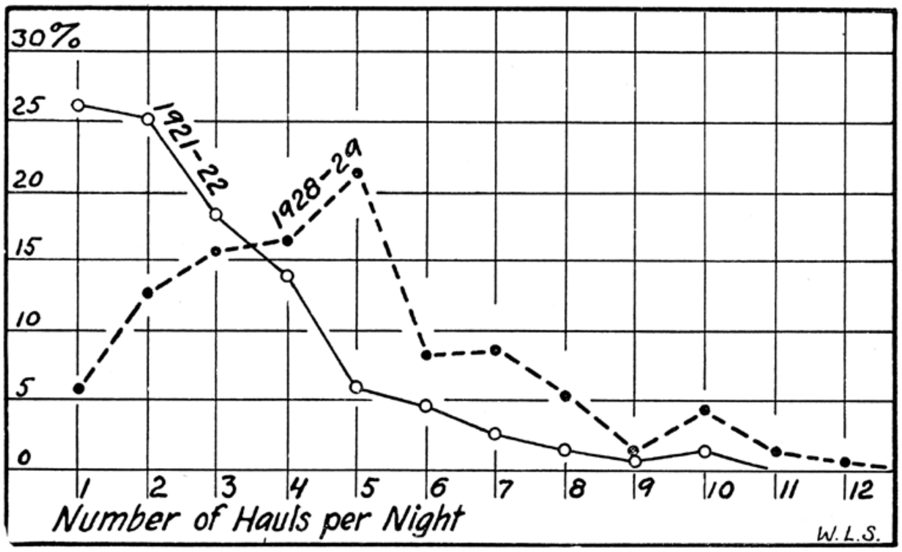

FIG. 24. Frequency of the number of boat catches plotted at each number of hauls necessary to make the boat catch. Two seasons, 1921–1922 and 1928–1929, are presented for the sake of contrast.

FIG. 24. Frequency of the number of boat catches plotted at each number of hauls necessary to make the boat catch. Two seasons, 1921–1922 and 1928–1929, are presented for the sake of contrast

cast the net for a 2 or 3-ton haul while fishing on a 35-ton limit. They state that they now habitually pass by small schools. This, in large measure, would account for the increase in catch per haul (1929).

Average number of hauls per night for each month of the 6 seasons 1923-1924 to 1928-1929

	1923–24	1924–25	1925–26	1926–27	1927–28	1928–29	Average for 6 seasons
August	3.6	2.7	4.2	2.2	4.1	3.8	3.8
September	3.1	2.8	3.9	3.1	4.4	6.1	3.9
October	3.1	4.4	4.0	4.0	3.8	4.8	4.0
November	2.0	3.8	3.7	3.7	2.0	4.5	3.4
December	1.7	2.7	1.4	2.7	2.2	4.0	2.3
January	1.2	2.2	1.7	2.5	3.7	4.5	2.4
February	1.7	2.0	2.3	1.9	2.8	3.3	2.4

[17] Such an analysis has been the subject of a special study by S. S. Whitehead of the staff of the California State Fisheries Laboratory. His results are summarized in an unpublished manuscript.

[17] Such an analysis has been the subject of a special study by S. S. Whitehead of the staff of the California State Fisheries Laboratory. His results are summarized in an unpublished manuscript.

The average number of hauls per night has remained more constant from season to season than we would expect. (See Fig. 23.) The averages from month to month have shown greater variation, as illustrated in the accompanying table and graph. (See Fig. 25.)

The right hand column of the table shows the average hauls per night for each significant month of the fishing season[18] and these results were plotted as a curve in figure 25. This curve indicates that more hauls are necessary through the summer months and that the desired catch is obtainable with fewer hauls during the winter. This curve is similar in shape (but inverted) to the curve of fish sizes appearing in the catch during the season.[19] In both cases, November is the transitional period. The fact of fewer hauls per boat catch in the winter months is not proof of easier fishing conditions. On the contrary, observation indicates that winter fishing is interrupted by rough weather but that, when successful hauls are made, the catches are larger. As evidence of the success of winter fishing, the accompanying

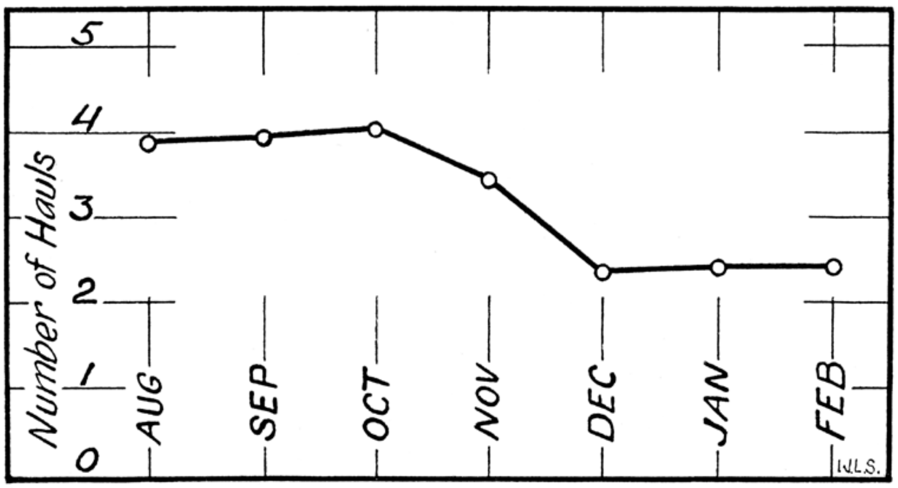

FIG. 25. Average number of hauls per night for each month of the 6 seasons 1923–1924 to 1928–1929.

FIG. 25. Average number of hauls per night for each month of the 6 seasons 1923–1924 to 1928–1929

graph (Fig. 26) is presented. This is taken from the manuscript report of S. S. Whitehead. In preparing this graph, Whitehead averaged the tons per haul for each month of the seven fishing seasons 1921–1927.

The greater success of winter hauls suggests a number of interesting speculations upon which definite information is lacking. Possibly the large winter fish congregate in larger schools. Possibly small scattered schools are more abundant during the late summer. If so, the avoidance of small schools by the fishing crews may materially affect our records of sizes of fish caught each month and each season. The frequency and duration of periods of scarcity of fish "in the bay" may have a bearing here. During periods of scarcity, the effort to make a catch probably increases, resulting in a larger number of hauls per

[18] These monthly figures are not an average of averages but were derived from the total hauls and total number of boat catches of the six seasons.

[19] See California Division of Fish and Game, Fish Bulletin No. 13, "Seasonal average length trends at Monterey of the California sardine (Sardina caerulea)," by Carroll B. Andrews, 1928.

boat catch. It is not known whether or not hydrographic conditions affect "wild" fish, involving increased fishing effort on the part of the crews (1929).

4.18. Boat limits

The amount of fish received by any one Monterey sardine cannery during a normal season is dependent on a host of economic factors. It is only during an exceptional season that the supply of fish, or rather, the availability of fish to the fishermen, is a very serious factor in the total season's deliveries to a packing plant (1922). In addition to the more obvious economic conditions such as operating capital, equipment, sale price of case goods and by-products, state regulations

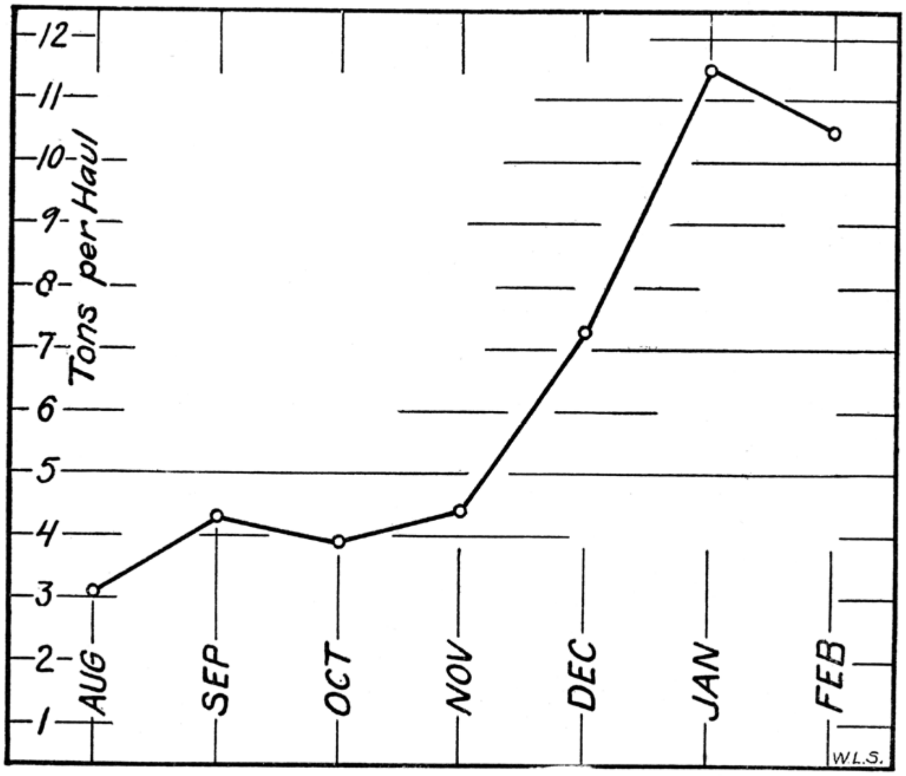

FIG. 26. Average tons per haul for each month through the average season 1921–1927.

FIG. 26. Average tons per haul for each month through the average season 1921–1927

as to fish reduction, price of materials and labor, transportation rates, etc., there are many minor factors such as rates of foreign exchange, brokerage connections, bank credit and labor agreements. This complex of conditions affects the season's catch and is reflected in the boat catch limit set by the cannery for its individual boats from night to night. Because of labor agreements, a cannery seldom reduces the number of crews employed in the midst of a season. The desired increase or decrease in amounts of fish received is usually accomplished through boat limits. It will be seen that a consideration of boat limits is essential before discussing boat catches.

For economy in operating, the canner desires a steady continuous supply of fish, the amount received each night equalling the estimated normal daily capacity of his plant (1922). If fish were available at all times, this would be simple, but there is great fluctuation from day to day in the amount of fish delivered to the canner. During some periods of the canning season, the combined catch of all his crews does not equal the capacity of the plant, while at other seasons one crew could swamp the cannery with fish. The canner therefore employs several crews so that during periods of relative scarcity he may receive as many fish as possible, and under normal conditions insure himself against an insufficient supply when one or two crews fail to make a catch. This necessitates limiting the amount that any one crew is allowed to deliver during the time that fish are readily available in great quantities. For example, consider a cannery with a daily capacity of 50 tons of raw material and employing 5 fishing crews. The theoretical limit would be 10 tons for each crew in order to total 50 tons. Then if one crew fails to make a catch the canner suffers a financial loss in not operating his plant at normal capacity. If one or another of his crews fails several nights in succession, the canner is apt to raise the limit per boat temporarily to 12 tons in order to insure a catch of 50 tons. Under such circumstances it frequently happens that each crew then brings in 12 tons, an oversupply requiring the cannery force to work overtime. The canner may then drop the limit back to 10 or even 8 tons for the following night, or in case of a decided oversupply may even order his crews to stop fishing for a day or two till the canning operations catch up (1922). When a period of poor fishing or so called "scarcity" occurs, the canner may remove the limit entirely and take all the fish each crew is able to deliver. At such times one crew may deliver 15 or 20 tons, but this is apt to be averaged up by the failure or partial failure of the other crews. Even when definite limits are set they are not always observed. One crew may know or assume that others have made poor catches and take a chance on bringing in over the limit. This overcatch may or may not be accepted, depending on conditions at the cannery, but acceptance of catches over the set limit is by no means rare (1922). This example is intended to illustrate the fact that the limit set by the canner, although operative most of the time, necessarily fluctuates, and the catch per boat varies from day to day depending largely on the cannery limit and indirectly on the availability of the fish. Two canneries of different capacity and the same number of crews or two plants with the same capacity and a different number of crews would be apt to set different limits. The crews fishing for the same cannery are frequently assigned unequal limits due to their fishing skill, type of equipment, dependability, or seniority of employment.

During the 2 Monterey seasons of 1920–1921 and 1921–1922, the limits, when limits were set, ranged from 6 to 16 tons per boat each night, with a rough average of something like 10 tons. The fluctuation in catch and limits and their relationship may be illustrated by the following table which shows the catch and the limit in tons that was set for the crew that night. The period covered is from August 1 to November 30, 1921. The nights were chosen at random and arranged in chronological order (not consecutive). One crew was chosen from each of two canneries.

Catch	7	8	21	14	9	12	13	13	13	2	19	7	9
Limit	0	0	0	0	0	12	12	12	12	8	12	8	8

Crew No. 1, total catch for 13 nights, 147 tons; average catch per night 11.3 tons.

Catch	9	3	16	5	3	14	18	18	7	7	18
Limit	0	0	16	15	0	14	0	0	0	0	15

Crew No. 2, total catch for 11 nights, 118 tons; average catch per night 10.7 tons.

In September, 1923, the Monterey Sardine Fishermen's Organization ruled that no boat should fish for a limit of less than 12 tons. Therefore, during times of uncertain supply the canner may no longer reduce limits to 10 or 8 tons, but may send his crews out under 12 ton limits or under no limits, depending on keeping his crews in for a night occasionally to offset a possible oversupply. This minimum 12-ton limit alone will have little effect on the season's catch, but will tend to increase the average nightly catch per boat (1926). A larger seasonal catch is the result of a general raising of maximum boat limits and the addition of more crews.

Throughout the period of 1921 to 1929, there was a steady enlargement of the industry, and this is reflected in the constant increase in the boat limits set for the crews. In the 1921–1922 fishing season no limits of more than 19 tons were set, whereas during the 1928–1929 season the limits ranged from 25 to 40 tons. The accompanying table well illustrates this growth in the size of maximum limits. The observations

LIMITS SET BY MONTEREY SARDINE CANNERS BY SEASONS

Number of Observations at Each Ton Expressed as Percentage of the Total for Each Season

Limit in tons	1921-22	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28	1928-29
5	1							
6	2							
7	1							
8	15							
9	1							
10	21	15	1	1				
11	3							
12	11	6	29	5				
13								
14	2		3					
15	11	30	33	12	2			
16	1	1	4	1				
17				1	1			
18	1	1	6	4	2			
19	1							
20		1	7	8	48	13	5	
21								
22				2				
23								
24								
25			1	5	33	8	6	12
26								
27								
28								
29								
30						5	5	10
31								
32								
33								
34								
35						2	1	20
36								
37								
38								
39								
40								7
No limit	29	46	16	61	14	72	83	51

LIMITS SET BY MONTEREY SARDINE CANNERS BY SEASONS
Number of Observations at Each Ton Expressed as Percentage of the Total for Each Season

of limits were made on those boats from which samples of fish were taken, and they were arrayed for each season to show the number of observations at each ton of limit. These numbers at each ton of limit were then converted to a percentage of total observations for the season in order that the figures for each season should be comparable with any other season. The table is based on 2181 observations distributed through the 8 fishing seasons 1921–1922 to 1928–1929, as follows: 542, 572, 180, 215, 183, 164, 203, 122.

The number of nights that boats were allowed to fish with no limit being set varied from year to year, but the trend is upward (shown by the "no limit" percentages at the bottom of the table). This upward trend would indicate either a willingness on the part of the cannery to accept all fish delivered, however great the quantity or difficulty on the part of fishermen in supplying the cannery demand for fish. There is certainly a maximum capacity for even the enlarged reduction and cannery plants, so it would seem that fish are not available to the fishermen in unlimited quantities. Fishing crews would quickly respond to "no limit" fishing with sufficient lighter capacity to flood the canneries if sardines (at $11 per ton) could be caught in indefinite quantities. During the 1926–1927 season the limits were removed over 70 per cent of the time because fish were not being delivered in sufficient quantity to fill the cannery demand. Throughout the next fishing season (1927–1928) limits were practically abandoned except for a few weeks in the early spring of 1928. Limits were not set during half the 1928–1929 season, and when they were imposed (35 tons 40 per cent of this time), the catches usually fell short.

It is recognized that this line of reasoning is not conclusive evidence and involves availability rather than actual abundance of sardines in the fishing area. It suggests, however, that the sardine fishery at Monterey is not capable of indefinite expansion under the fishing conditions now (1929) prevailing.

4.19. Catch per boat

When the fishing is poor, the boat catch depends on fishing conditions, but throughout the greater part of the season conditions are favorable and fish are abundant and easily caught (1924). During the height of the season, fishermen would bring in far greater catches than they now (1924) do if the canneries would handle the catch. Although much of the time the boat catch is determined by the boat limit set by the cannery, this does not mean that the *average* catch for a boat throughout a season equals the cannery limit. The average catch falls below the limit, because there are periods during any season when poor catches are made that pull down the average and are not offset by the deliveries in excess of the limit.

The availability of fish is (1924) fairly constant from season to season but varies greatly from week to week. Each season there are periods of poor fishing and the frequency or duration of these periods has some effect on the total catch (as was the case during the poor season 1925–1926). The variation (sometimes extreme) in availability from week to week shows itself as a drop in boat catch for poor periods but not as an increase during periods of good fishing. In general, the maximum for boat catches is (1926) set by cannery limits and the lower range is determined by fishing conditions.

Within each season there is a somewhat regular variation in average daily boat catch from low in the early season to high through the winter months, followed by a drop in March and April. As fish sizes follow roughly this same variation it suggests that certain sizes, being in greater demand, might cause an increase in catch at certain periods, but there is some evidence to show that the variation in average daily boat catch through a season may be due to fluctuation in oil content of sardines. Whatever the causes, this change in boat catch within a season is something that must be considered when boat catches are analyzed as a method of indicating depletion or its absence. (See Fig. 27.)

Although availability of fish apparently has not changed greatly from year to year (1926), the average daily catch per boat has increased decidedly during the period 1919 to 1925. The various causes are quite independent of "sup-ply" or availability of fish. For one thing, this

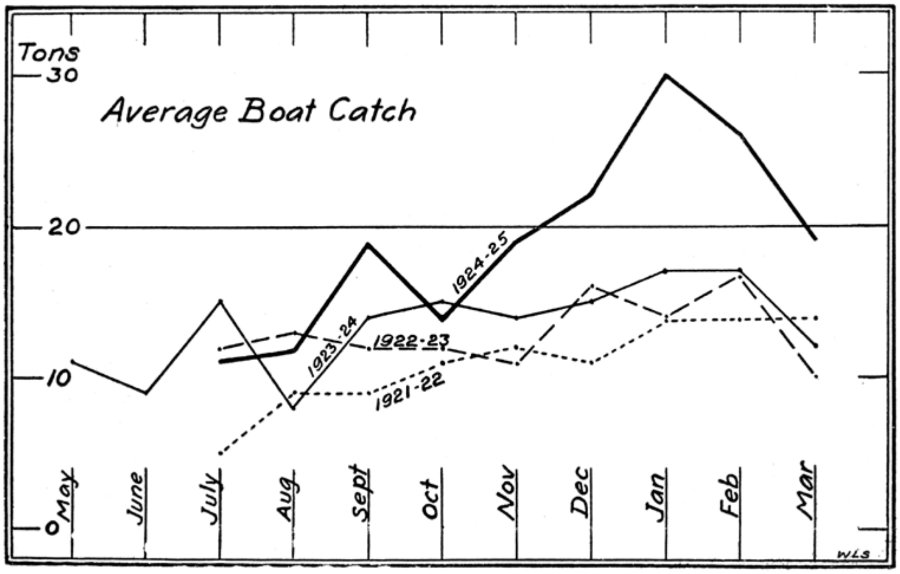

FIG. 27. Monthly averages of boat catches per night for four fishing seasons.

FIG. 27. Monthly averages of boat catches per night for four fishing seasons

period is characterized by the installation of reduction plants at each of the Monterey canneries. The low price for case goods and the large profit to be made from fish oil and meal have encouraged the taking of larger quantities of fish in order to secure the offal and "overage" to be used in the reduction plants. The price of canned sardines has been low during this period because many canners have been willing to sell at less than the cost of production and have depended, for their profit, on the oil yield of the reduction plant. The by-products plant has been the tail that wagged the dog. The canning capacity of individual plants has been steadily increasing and the sales of case goods have grown. These enlargements of canning and by-products plants have led to increases in the total catch without a corresponding increase in the number of crews fishing for each plant (1926). Economic conditions in the industry rather than fish supply have caused the increase in the total catch and in average daily boat catch.

The following table illustrates the fact that the average boat catch is greater during the fall and winter months than during the summer months when sardines have a low oil content. The catches of the boats from which samples were taken have been averaged for the period from the opening of the season up to November first, as contrasted with a similar average from November first to the close of each fishing season. It should be noted that these averages represent the successful boats, since there is no record of boats that failed to make catches and returned without reporting at the canneries. The table also illustrates the increase in average daily boat catch from season to season during the period. For each of the 2 preceding seasons (1919–1920 and 1920–1921) the average boat catch was between 10 and 11 tons.

Fishing season	Total season	Before November first	After November first
1921–1922	10.9	9.6	12.8
1922–1923	13.0	12.2	14.0
1923–1924	13.0	11.6	15.0
1924–1925	19.1	14.0	23.2

The accompanying figure 27 shows the average catch of these same boats each month. Although there is considerable fluctuation from month to month, it will be noticed that the catches through each season are smaller in summer, increase in the fall months, are highest in December, January and February, and drop off in March. The stormy weather and rough water of the winter months has the tendency to cut down the total monthly catch rather than the average daily boat catch, since complete failures do not enter into boat catch averages. The pronounced increase in the winter months of the 1924–1925 season is to be explained by the administration of the laws governing "overage" and by-products rather than by demand for or price of case goods. During most of this 1924–1925 season, the laws affecting overage and reduction of whole fish were not operative, due to cases pending in the courts.

During the period 1925–1929, the average boat catch continued increasing due to the enlargement of canning and reduction plants which resulted in raising the boat limits set by the canneries. For example, the average catch of the boats from which we took samples, for the season 1927–1928, was 27.1 tons. For the following season (1928–1929) the average was 26.4 tons.

This question of boat catches will not be considered here in any detail, as it has been the subject of a special study by S. S. Whitehead, who analyzed the boat catches, tons per haul, and tons caught per hour of actual fishing. Such analyses of boat catches are being made for other fisheries of California in an effort to determine fluctuations in the availability of fish to the fishermen, and if possible to determine the presence or absence of overfishing. In the case of the sardine fishery at Monterey, the problem of analyzing boat catches proved to be very difficult because of the rapid growth of the industry involving changing fishing conditions, and because of the falsification of catch records for past years. However, the method of studying individual boat catch records as an indication of fish supply, is proving of considerable worth when applied to other of our fisheries, and as improved methods of analysis are perfected we hope for increasingly valuable results.

CALIFORNIA DIVISION OF FISH AND GAME FISH BULLETINS

*No. 1. Report on Fish Conditions. 1913; 48 pp., 3 figs. Contains:

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Trout and Black Bass Planting and Transplanting in the San Joaquin and Southern Sierra Districts. By A. D. Ferguson.

*No. 2. The Scientific Investigation of Marine Fisheries as Related to the Work of the Fish and Game Commission in Southern California. By Will F. Thompson. 1919; 27 pp., 4 figs.

*No. 3. The Spawning of the Grunion (Leuresthes tenuis). By Will F. Thompson, assisted by Julia Bell Thompson. July 15, 1919; 29 pp., 9 figs.

No. 4. The Edible Clams, Mussels and Scallops of California. By Frank W. Weymouth. Jan. 10, 1921; 74 pp., 19 pls., 26 figs.

*No. 5. A Key to the Families of Marine Fishes of the West Coast. By Edwin C. Starks. March 3, 1921; 16 pp., 4 figs.

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