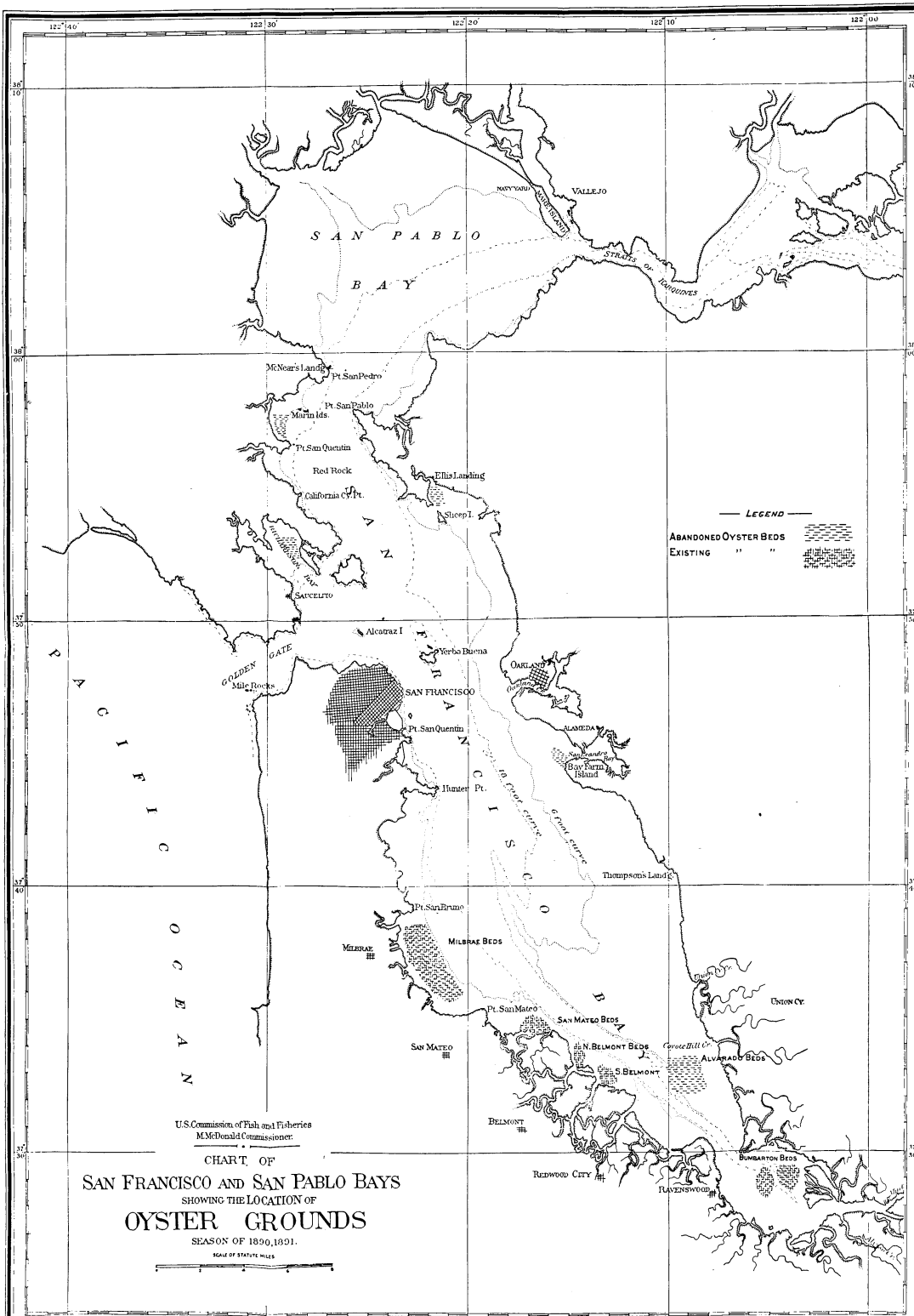


U.S. Commission of Fish and Fisheries
M. McDonald Commissioner.

CHART OF

SAN FRANCISCO AND SAN PABLO BAYS

SHOWING THE LOCATION OF

OYSTER GROUNDS

SEASON OF 1890,1891.

SCALE OF STATUTE MILES

2.—REPORT OF OBSERVATIONS RESPECTING THE OYSTER RESOURCES AND OYSTER FISHERY OF THE PACIFIC COAST OF THE UNITED STATES.

By CHARLES H. TOWNSEND.

CALIFORNIA.

SAN FRANCISCO BAY.

The oyster industry of the Pacific coast, exclusive of the trade in the small indigenous species, has never extended beyond the limits of the bay of San Francisco, where it has been restricted to the growing or fattening of seed or yearling oysters, brought annually in large quantities from the Atlantic coast and kept in the waters of the bay until they attain a marketable size. Although this method of supplying the market has been practiced by the oyster-dealers of San Francisco for many years, so that since the completion of the first overland railroad there has constantly been a supply of eastern oysters in the bay, it has generally been understood that there was no natural increase of the species, its alleged failure to propagate being usually attributed to the low temperature of the water. Some recent studies of the oyster beds and of the physical conditions of the bay of San Francisco by myself, under the direction of the United States Commissioner of Fish and Fisheries, have yielded data sufficient to warrant a review of the entire subject in a new light.

The interesting fact that oysters do propagate in San Francisco Bay, in certain favorable localities at least, calls for some explanation as to the long acceptance by the public of the statement that there has been no natural increase. This state of things may have resulted from one or more of the following conditions, perhaps in part from all of them, namely: The popular knowledge of the low temperature of the water as compared with the same latitude on the Atlantic coast; the peculiar situation of the localities where the imported oysters were laid out; the enemies they were known to have in Pacific waters; and the lack of sufficient public interest to demand the study and outlay necessary to discover the real truth respecting the life of the eastern oyster in

California waters. Doubtless one reason for the lack of information necessary to effect a change in the method of handling oysters is the fact that all the minor firms engaged in the business were early merged into one or more important companies, which, having practically the control of the entire oyster industry of the Pacific coast, had no need to change the methods of a business already profitable. Importations of seed oysters from Atlantic waters have therefore been made annually almost to the present time, while it is by no means proven that seed oysters can not be raised in that region. The methods of nearly twenty years ago are still in vogue, the only advancement made being the larger scale on which the business is now conducted.

The subject of oyster-culture does not appear to have engaged the attention of the State fish commission at any time, or at least it is not mentioned in such of the published reports as are accessible, and nothing has ever been done in California in this direction beyond the enactment of the usual laws relating to such fisheries.

During occasional visits to the oyster beds in 1889 I found proof of considerable natural propagation of the eastern oyster in the southern part of San Francisco Bay, and transmitted evidence of the same to the United States Commissioner of Fish and Fisheries, who directed that an examination be made in order to determine to what extent this had taken place.

My studies on this subject were limited to such times as the U. S. Fish Commission steamer *Albatross* was detained at the port of San Francisco, and even then they were secondary to my regular duties as naturalist of the vessel.

The investigations were, therefore, made very irregularly, and at different seasons of the year, as follows: February and October, 1890, and May, June, September, and October, 1891. A few days in June, 1891, were devoted to an examination of Tomales Bay, and two weeks in September, 1891, were spent in visiting the native oyster beds of Olympia and Willapa Bay. In this work I frequently had the use of one of the steam launches belonging to the steamer *Albatross*, which enabled me to examine every portion of San Francisco Bay, employing baymen as pilots for the narrower channels when necessary.

In view of the great success that attended the introduction of certain Atlantic species of mollusks and fishes into the waters of California, such as the soft-shelled clam, shad, striped bass, carp, catfish, etc., there was reason for expecting similar results from the introduction of the oyster. The investigations of this subject have simply disclosed the facts that the oyster has to some extent adapted itself to the new habitat in common with the other introduced species and that in spite of many unfavorable conditions it is slowly increasing. Future study with reference to oyster-culture on the Pacific coast should be made in the light of these facts.

Temperature.—The popular belief that the low temperature of the water of San Francisco Bay has prevented the increase of the oyster is not based on any exact information on the subject. The temperature of the bay in the vicinity of the city of San Francisco, usually not much higher in summer than in winter, was early assumed to be too low for oyster propagation; and, from the lack of special evidence of oyster increase, this gradually became the common explanation to casual inquirers about the matter, no one making any attempt to disprove it, although the spat from imported oysters has, it seems, been developing and growing in secluded places, doubtless from the very start. The oyster-growers apparently keep no record of temperatures, or of other observations that would throw light upon the physical conditions of the bay during the different seasons of the year.

Mr. M. B. Moraghan, an oyster-dealer of San Francisco, says that the temperature at his oyster beds at Millbrae ranges from 58° to 65° F. At the extreme southern end of the bay the summer temperature has recently been found to be much higher, ranging from 67° to 74° F. for July and August. My personal observations on the temperature were of course limited to times when the *Albatross* happened to be in port, and as this never occurred in summer the most important season is as yet but little understood. The importance of studying this subject is evident when the influence of the marked rainy and dry seasons of California upon the waters of the bay is considered. Although the water never reaches the summer warmth of corresponding latitudes on the Atlantic coast, the temperature is more equable than that of most places upon the Atlantic coast where oysters grow, and the extremes of temperature are within those of such regions. It may be that the temperature during the spawning season of the oyster, which is, of course the critical period, is low enough to seriously limit the quantity of spat developed, but this can readily be determined by a careful study of the beds at the proper season, which has not yet been done.

Experiments in the artificial propagation of the oyster indicate that the nearer the temperature to 70° the more likely is success. During the latter part of October, 1890, I found the temperature of the southern part of the bay, near Belmont, to be usually 61° F. On the same dates, in the region of San Mateo, a few miles nearer the sea, it was 1° lower; while at California City, still nearer, it was 57°. Recent observations have shown, however, that the water temperature is much lower in October than in the midsummer season. It is altogether probable that the extreme southern portions of the bay, 20 or 30 miles back from the sea, are several degrees warmer at all seasons than those farther north, since the region is more sheltered from sea winds and the strong breezes of San Francisco are less noticeable there. The French system of *claires* would furnish still warmer water than any of the bays of California.

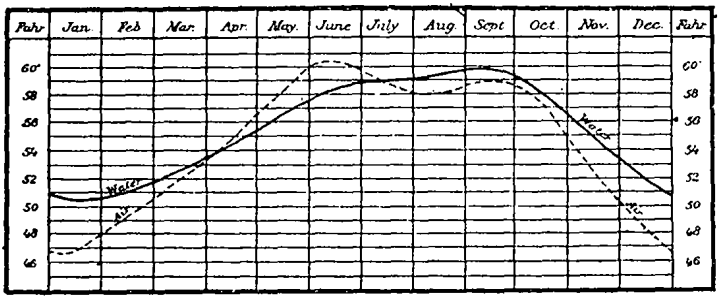
The following table and diagram of observations upon the temperatures of water and air in the Golden Gate, at 7 a. m.; for ten years, 1874 to 1883, are taken from Davidson's "Pacific Coast Pilot."

Table showing the temperature of the water and air in the Golden Gate for 10 years, from 1874 to 1883, inclusive.

[Observations taken daily at 7 a. m., and reduced to monthly means.]

Months.	Water.	Air.	Water—Air.
January	50.49	46.89	+3.60
February	50.99	49.21	+1.78
March	52.49	51.98	+0.51
April	54.28	54.72	—0.44
May	56.46	58.33	—1.87
June	58.35	60.27	—1.92
July	58.88	58.78	+0.10
August	59.23	58.00	+1.23
September	59.68	58.86	+0.82
October	57.83	57.30	+0.53
November	54.66	52.40	+2.26
December	51.94	48.58	+3.35

The data contained in the above table are represented graphically in the following diagram:



Prof. Davidson says: "The lowest temperature of the water is for the month of January, 50.49°; and the highest for the month of September, 59.68° F.," and he adds that "the temperature of the air follows very closely that of the water."

Hourly water temperatures taken by the *Albatross* at the foot of Market street and at the Union Iron Works, San Francisco, for limited periods, indicate a slightly higher temperature than in the Golden Gate, as may be seen from a study of the accompanying table. Temperatures taken by the same vessel at Mare Island, where the water is more subject to the influence of the Sacramento River, show a much lower temperature.

Table of hourly changes of surface-water temperature in parts of San Francisco Bay.

[Reduced to monthly means.]

Time of day.	Off Market street and Union Iron Works, San Francisco.									Mare Island navy-yard.				
	May 11 to 31, 1888.	June 1 to 25, 28 to 30, 1888.	July 1 to 4, 1888.	Oct. 22 to 31, 1888.	Nov. 1 to 30, 1888.	Dec. 1 to 25, 29 to 31, 1888.	Jan. 1 and 2, 1889.	Oct. 15 to 24, 1889.	Mar. 29 to Apr. 2, 1890.	Oct. 27 to 31, 1889.	Nov. 1 to 30, 1889.	Dec. 1 to 31, 1889.	Jan. 1 to 31, 1890.	Feb. 1 to 28, 1890.
	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.
1 a. m.	56.3	58.8	59.2	58.5	56.1	53.5	52.5	59.1	53.5	57.0	54.3	48.9	42.5	47.3
2 a. m.	56.2	58.5	59.0	58.4	55.9	53.5	52.5	59.2	53.5	56.8	54.0	48.9	42.5	47.3
3 a. m.	56.0	58.5	58.7	58.6	55.8	53.3	52.0	59.1	53.5	56.6	53.9	48.9	42.6	74.1
4 a. m.	56.0	58.7	58.5	58.6	55.7	53.3	51.5	59.2	53.5	56.6	53.9	48.8	42.5	46.9
5 a. m.	56.1	59.0	60.7	58.7	55.7	53.4	50.5	59.7	53.2	56.6	53.8	48.6	42.3	47.1
6 a. m.	56.3	59.5	60.2	58.4	55.4	53.5	50.5	59.9	53.7	56.4	53.9	48.4	42.2	47.0
7 a. m.	56.6	59.9	61.0	58.5	55.7	53.5	50.0	60.2	53.5	57.4	54.3	48.5	42.2	46.9
8 a. m.	56.9	60.3	61.2	59.0	55.9	53.8	52.0	59.9	53.7	59.2	54.9	48.9	42.8	47.3
9 a. m.	57.3	61.2	61.2	59.4	56.6	54.0	53.0	60.1	53.7	59.4	55.3	49.1	43.1	47.9
10 a. m.	57.8	61.4	61.5	59.3	56.1	54.0	53.5	60.3	53.7	59.4	55.7	49.6	43.4	48.0
11 a. m.	58.5	61.6	61.5	59.4	56.5	54.2	53.5	60.1	54.0	59.6	56.5	49.8	43.7	48.2
M.....	58.6	61.8	61.0	59.6	56.6	54.4	53.5	60.0	54.2	60.6	56.8	50.2	44.2	48.5
1 p. m.	58.9	61.9	62.0	59.6	57.1	54.7	55.0	60.3	55.2	60.4	57.5	50.3	44.8	48.7
2 p. m.	59.3	62.3	63.0	59.8	57.2	54.8	55.0	60.4	55.5	60.8	57.6	50.3	45.2	48.8
3 p. m.	59.4	62.2	62.7	59.7	57.2	54.8	54.5	60.3	55.2	60.6	57.7	50.2	45.4	49.1
4 p. m.	59.3	62.1	63.0	59.7	57.2	54.9	54.0	60.4	55.5	60.6	57.6	50.1	45.1	49.3
5 p. m.	58.9	61.9	62.3	59.5	57.2	54.6	53.5	60.5	55.5	60.0	57.2	50.1	45.0	49.2
6 p. m.	58.6	61.5	62.0	59.1	56.8	54.3	52.5	60.0	55.0	60.0	56.5	49.8	44.9	48.9
7 p. m.	58.2	60.9	61.3	58.9	56.8	53.9	52.0	60.0	54.0	59.4	56.0	49.7	44.6	48.5
8 p. m.	57.9	60.3	60.0	58.7	56.6	53.7	52.0	59.9	54.0	59.4	55.7	49.5	44.3	48.2
9 p. m.	57.3	59.7	60.0	58.8	56.5	53.7	51.0	59.9	53.7	59.2	55.5	49.3	43.9	48.2
10 p. m.	57.0	59.3	60.0	58.8	56.3	53.8	51.5	59.8	53.5	58.6	54.9	49.1	43.6	48.1
11 p. m.	56.9	59.3	59.7	58.7	56.1	53.6	52.0	59.7	53.5	57.4	54.8	49.0	43.3	47.6
Mid ...	56.7	59.0	59.3	58.5	56.1	53.5	52.0	59.5	53.7	57.4	54.4	48.8	42.9	47.3
Range.	55-72	55-68	57-66	56-61	52-61	50-59	49-55	56-62	52-57	54-62	49-64	42-57	38-51	40-45

A series of temperatures taken in Oakland Creek from September 7, 1890, to May 20, 1891, at 4 a. m. daily, range from 49.8° for December to 64.9° for September. The temperatures are here reduced to means of ten days.

Temperature of the water at the surface in Oakland Creek, San Francisco Bay, from September 1, 1890, to May 20, 1891.

[Taken by Coast Survey steamer *McArthur*, Lieut. W. P. Ray, U. S. N., commanding.]

1890.	° F.	1891.	° F.
Aug. 28 to Sept. 7	64.9	Jan. 1 to 10	50.0
Sept. 8 to 17	63.4	Jan. 11 to 20	50.6
Sept. 18 to 27	55.0	Jan. 21 to 30	51.4
Sept. 28 to Oct. 7	51.9	Jan. 31 to Feb. 9	51.2
Oct. 8 to 17	49.2	Feb. 10 to 19	50.1
Oct. 18 to 27	49.0	Feb. 20 to Mar. 1	51.0
Oct. 28 to Nov. 6	51.0	Mar. 2 to 11	53.8
Nov. 7 to 16	55.2	Mar. 12 to 21	56.4
Nov. 17 to 26	54.3	Mar. 22 to 31	56.2
Nov. 27 to Dec. 6	53.7	Apr. 1 to Apr. 10	57.1
Dec. 7 to 16	49.8	Apr. 11 to 20	57.0
Dec. 17 to 31	49.8	Apr. 21 to 30	58.6
		May 1 to 10	61.4
		May 11 to 20	61.4

Recent summer temperatures taken by authority of the United States Fish Commissioner at the extreme southern end of the bay, through the coöperation of the Morgan Oyster Company, have yielded valuable information, the water of that part of the bay having been found to have a summer warmth amply sufficient for the propagation of the oyster. The important table of temperatures from this locality is condensed to means of ten days from a lengthy series of daily observations at both high and low tide.

Temperature at the oyster beds, 1 mile from Dumbarton Point, San Francisco Bay, July 12 to October 12, 1891.

Date.	Air temperature.	Surface-water temperature.		Range of water temperature.
		High tide.	Low tide.	
	°F.	°F.	°F.	°F.
July 12 to 19	68.	69. 6	71. 9	67 to 73
July 20 to 29	68. 9	70. 9	71. 9	69 to 74
July 30 to Aug. 8	67. 3	69. 5	69. 7	68 to 72
Aug. 9 to 18	68. 4	70. 3	70. 7	68 to 72
Aug. 19 to 28	72. 3	71. 4	72. 0	69 to 74
Aug. 29 to Sept. 7	66. 8	70. 7	69. 1	67 to 72
Sept. 8 to 17	66. 4	67. 8	68. 0	64 to 71
Sept. 18 to 27	65. 7	66. 1	67. 3	64 to 70
Sept. 28 to Oct. 7	64. 2	65. 6	62. 9	58 to 70
Oct. 8 to 12	61. 9	63. 2	64. 0	62 to 65

Peculiar situation of the oyster beds.—There are at present no eastern oysters in San Francisco Bay that are not laid upon tide lands, or so-called mudflats, completely exposed at the time of low tide. The principal reason for the selection of such situations is that the beds may be readily fenced in by closely set stakes to protect them from the depredations of the stingray (*Myliobatis californicus*), which enters the bay every spring and is the principal enemy of the oyster in these waters. In this complete dependence for oyster-growing upon tide lands, frequently left dry, is doubtless to be found one explanation of the slow increase of the species. The California summer is absolutely dry and rainless. It is a season of cloudless skies and regularly recurring heat in the daytime; therefore an oyster bed at this season, when the tide is out, is exposed not merely to the air, but to a heat sufficient to dry the moisture off from all the oysters in sight, and perhaps injure the majority of the spat that might have been attached to their shells. If embryo oysters, set free on the beds, drift with the receding tides to deeper waters outside the stake-protected area of the flats, they are exposed to the stingrays when they have attained sufficient size.

Stingrays, and the stake protection employed against them.—The California stingray (*Myliobatis californicus*) enters San Francisco Bay in large numbers in the spring and remains until late in the fall. It is said to be as destructive to oysters in these waters as the starfish is on certain parts of the Atlantic coast. It has heavy flat teeth, arranged in a sort of pavement in each jaw, and is essentially a feeder on shell-

fish. Its presence requires the fencing in of all the oyster beds in the bay with closely set stakes about 12 feet long, which are driven about 4 feet into the ground. Plates 8 and 9 show the nature of these fences. When a broken stake allows a school of stingrays to raid an oyster bed, the surface, after the tide has gone out, presents much the appearance of a field that has been rooted by hogs. Sometimes the oystermen, discovering their presence, manage to entrap them inside the line of stakes, and thus destroy many of them during one low tide.

Fencing oyster beds against stingrays constitutes another heavy expense to the California oystermen, in addition to the annual outlay for seed oysters from the Atlantic coast. The fences must be looked after constantly and kept in repair. The heavy winds that sometimes during the winter season cause vessels in San Francisco Bay to drag their anchors do great damage to the fences of the oystermen, which they must manage to have in good condition by the time the stingrays reappear in the bay.

I do not know how late in the fall stingrays continue to menace the oysters, but I netted a few small specimens in San Pablo Bay as late as November 7, 1890. They first appear in April.

The danger from stingrays is probably overestimated, in view of the natural increase of oysters upon wide tracts unprotected by stakes.

Other enemies of the oyster.—The drill (*Urosalpinx cinerea*) has not become troublesome upon the oyster beds of San Francisco Bay until very recently, and even now is abundant only in the southern part of the bay. The oystermen showed me heaps of shells, all more or less drilled with small holes, in evidence of its ravages. At the Belmont beds I had no difficulty in gathering a quart of these mollusks in less than ten minutes by merely turning over the large oysters when the water had receded from the beds. Sometimes half a dozen were to be found on a single oyster. With its minute "tongue-file" this creature drills a hole through the oyster's shell, and inserting its proboscis into the opening, barely large enough to admit a pin, it feeds directly upon the soft parts.

This destructive animal may have been introduced much earlier than the oystermen suppose, as a few individuals accidentally imported among the original oysters would require several years to increase to the present numbers. Mr. Moraghan informed me that there were no drills upon his beds at Millbrae, which, as stated above, are much nearer the sea than the Belmont beds. If they are restricted to the Belmont beds, as seems to be the case, it would pay the oyster-growers to pick them off as far as possible. Any gathering of drills that would keep them in check is important, as their increase will cause great loss in the future.

Two species of crabs are found upon the San Francisco oyster beds, one of which is exceedingly abundant, but their presence has probably no effect upon the oysters.

Large numbers of shells were found honeycombed by the boring sponge.

The starfish has never proved troublesome to the oyster beds of the bay, and, in fact, is seldom found upon them. It is doubtful if it occurs, except as a straggler, farther south in the bay than the wharves of San Francisco and Oakland, and requires no special mention in this connection, as its presence upon a bed would be readily detected at low water, when stray specimens would be picked off by hand and disposed of effectually. The original bedding-grounds for oysters at Sausalito, being so close to the sea, were sometimes visited by starfish, but they were not considered troublesome.

Preparation of ground for laying out the oysters.—The mudflats are always more or less prepared for oyster-ground by gangs of workmen, who level the surface by removing the elevations and filling in the depressions. This is done, of course, when the proposed oyster bed is laid bare at low tide. There seems to be very little improvement of the ground by the use of old shells of the eastern species. Mr. Moraghan returns the shells from his restaurant stands in the California market in San Francisco to his beds at Millbrae, but he uses them for filling depressions, and does not distribute them over the beds as spat-collectors.

Fixation of spat.—Not only are the chances for the fixing of spat diminished by the use of ground in some places where there are very few old shells upon the bottom, but almost all of the shells of *Ostrea virginica* are returned from the marketmen to the principal oyster company, who sell them for the manufacture of lime, instead of using them for the improvement of the beds. These shells of eastern oysters, if returned to the beds where they were grown, or to other portions of the bay, would certainly increase the chances for the fixation of spat set free from the beds where adult oysters are growing. It is probable that careful attention to this matter of increasing the fixing surface required by the young oyster might make just the difference between rapid self-propagation and the present slow increase.

So far as has been ascertained, no recent attempt has been made by anyone to collect the spat of *Ostrea virginica* in San Francisco Bay, and it is evident that the prevailing impression that there is no propagation of the species here is not founded upon conclusions based upon actual investigations. Previous to my first examination of the oyster beds, a gentleman as keenly alive to matters of public interest as anyone in California, and a member of the original Tide Lands Commission, said to me, "You will find that the oyster does not propagate here." A general impression had simply grown into a widespread belief. With the exception of a few persons connected with the management of the oyster business, the men employed in the industry know little of the subject outside of the peculiar methods practiced in California.

Hundreds of thousands of bushels of oyster shells have been distributed over the bottom of Long Island Sound in deep water, as cultch to which the oyster spat could attach itself, with the very best results. Strewing the shells of eastern oysters in the slightly deeper waters just outside the existing beds upon the tide lands, and in other parts of the bay, might furnish the lacking element in these waters—viz, fixing-surfaces for spat. Young oysters found in such situations could be taken up before the next annual appearance of the stingray and used as seed oysters in the customary way. It would seem that there are possibilities for oyster-culture in San Francisco Bay by methods entirely distinct from those now practiced there.

Evidences of natural propagation.—One of the first indications I had of the natural propagation of the oyster was the finding of young oysters six months or a year old upon beds where those three or four years old were kept. They were in most instances attached to clusters of dead shells of the small native oyster. Very few were to be found attached to adult specimens of *Ostrea virginica*, but this may be explained by the fact that such oysters are frequently handled and "laid out" to keep them well upon the surface and prevent any settling in the mud. The handling is done in order to select and clean the largest for market, the others being also cleaned of the ever-accumulating native oysters, which would involve the destruction of such small eastern oysters as might be among them upon the shells of the large oysters.

The fact of young eastern oysters being attached to anything is proof that they grew in the bay where they were found, for oysters do not have the power of fixing themselves a second time. All these small oysters are knocked off the large shells with a small cleaning hatchet, and the operation is a necessary one, as the extremely productive natives cluster upon the large species in such numbers as to greatly interfere with their growth.

In October, 1891, I discovered some oysters of large size in certain sloughs of the south bay, where they had long escaped the stingrays in consequence of bars which shut off the sloughs from all but the highest tide. These were the largest oysters seen at San Francisco, and had evidently lain there for several years. More recently I obtained a quantity of oysters, apparently two years old, in Oakland Creek. As the oyster beds maintained there several years ago by Mr. Doane, now of the Morgan Oyster Company, have long since been abandoned and the stakes removed, it is evident that a limited number of oysters have found conditions suitable for their development and growth, even in this muddy place. They are no longer found on the mudflats, where they were originally kept, but live in the mud of the channel, from which I obtained them with tongs.

Mr. Cleaveland Forbes, of the Spring Valley Water Company, informed me that several years ago he found full-grown eastern oysters

upon the piles of an old narrow-gauge railroad trestle, across a slough, near Dumbarton Point, and that the men of his party frequently found many upon banks composed of shells of the native species, near where the pipes of the company cross the bay.

Mr. H. D. Dunn has recently reported, through the press, the discovery of a full-grown eastern oyster near Mile Rock, in the Golden Gate.

It is possible that during the long time eastern oysters have been kept in the bay they have become in a measure acclimated, and that there is a constantly increasing tendency to propagate—that is, the progeny of oysters grown here become hardier with each generation and better adapted to the colder but more equable waters.

During my latest examinations of the bay (May and June, 1891) eastern oysters, very large and old, were found in the following places near the sites of former oyster beds: Several adhering to the piles of the narrow-gauge railroad trestle across San Leandro Bay; a few upon the rocks at the extreme north point of Sheep or Brooks Island, near low-water mark; a few upon the rocks at Point San Pedro (at entrance to San Pablo Bay). Those from San Leandro Bay doubtless originated as spat from the oyster bed near the entrance to that bay, at the end of the bay northwest from the island. Those from Sheep Island had merely drifted as young across the half mile of distance from the old beds near Ellis Landing, while the San Pedro oysters originated upon the beds between Marin Island and Point San Quentin, a couple of miles distant.

Mr. H. D. Dunn informed me that wild eastern oysters had been reported to him from some other place near Point San Pedro, but I did not discover them, being without a pilot. These finds are very interesting, as showing not only the breeding of the oyster in various parts of the bay, but that the species began breeding several years ago when oysters were laid out in those northern parts of the bay. At Point San Pedro oysters are directly exposed to the influences of the Sacramento River. But the largest and most important tract of oyster propagation is in the region of the natural shellbanks of native oysters along the east side of the bay, beginning at Bay Farm Island and extending well southward and off into deep water. Here wild eastern oysters may be found during the low tides that expose the outer portions of the shellbanks. At this place they are numerous, and when the tides are sufficiently low it is possible to gather them by the score, ranging in size from yearlings to those several years old. This deposit is at least 4 miles removed from the nearest site of a former oyster bedding-ground, and there is no doubt about the oysters upon the whole tract being of volunteer growth. A channel several feet wide separates this tract from the old bed on the north, while it is nearly 10 miles to the nearest beds on the south.

Examination of two or three hundred oysters gathered in this region shows the fixing surface for the spat to have been the shells of the

native oyster (*Ostrea lurida*). Indeed, there is nothing on this whole bank but clean shells of the native species. The bank is exposed to heavy seas during the season of strong winds, and many eastern oysters doubtless become buried beneath the easily drifted shells of the small natives. It is probable that there is a very great production of eastern oysters here that we know nothing of, as the whole tract is accessible to stingrays, which prey upon every kind of shellfish outside of the stake-protected beds. It is also probable that the heavy seas which at times sweep across this shallow section of the bay and actually break up the clusters of native oysters by rolling them toward the beaches, have an injurious effect upon newly fixed eastern spat by burying them beneath the drifting shells.

Considerable quantities of wild eastern oysters are annually gathered upon this and other shellbanks in the bay. They are retailed in Oakland and Alameda at $1.50 per 100, or sold to the oyster companies who lay them out on their fenced beds for further growth. They are obtained when unusually low tides happen to expose them. No tonging or dredging is done, the oysters being gathered by hand. The work is performed chiefly by boys. I have no means of knowing the quantity of oysters derived from this source.

It appears, therefore, that there are other parts of San Francisco Bay as good for oyster-culture as those now inclosed, and that the increase of wild oysters now growing there would be more rapid if they were inclosed and afforded similar protection from heavy seas, stingrays, etc.

Spawning season.—It is not unlikely that the oyster spawns here as early as on the north Atlantic coast, as the warming to which adult oysters are often exposed early in the spring during low tides must have a tendency to hasten the process. I have not examined them earlier than the 1st of May, but from that time until July 15 plenty of them are to be found ripe with eggs. Of other months I can not speak personally. Dr. H. W. Harkness, president of the California Academy of Sciences, informed me that during one year he examined many oysters from the market stalls with the microscope, and he expressed the belief that oysters could be found with eggs during most months of the year. Opinions of oystermen differ as to the duration of the spawning season, but from April to August seems to be the decision of the majority.

Notes on the general history of the oyster industry of San Francisco Bay.—Live oysters were first brought here by A. Booth, of Chicago, about the year 1870, when the first overland railroad was completed. Afterwards, from time to time, others engaged in the introduction of eastern oysters, and they eventually brought only supplies of seed oysters, which were bedded until they became marketable.

Corville & Co. established an oyster bed a short distance south of Point San Bruno about 1872. This place was subsequently owned by Swanberg & West, who had both eastern and Willapa Bay oysters at Pinole Point at one time.

Doane & Co. once had Shoalwater Bay oysters a short distance north of Point San Bruno, but they were lost during a "northeaster," and the locality was abandoned. The same firm kept both species of oysters in Oakland and Alameda creeks, but these localities were abandoned with the increase of traffic and on account of sewers.

Before the introduction of the eastern species, oyster-dealers in San Francisco maintained a trade in Willapa Bay oysters, which is continued up to the present time. As these oysters are obtained readily from their natural beds, no attempt is made to propagate them here; they are simply freshened before they are marketed. The localities originally used for bedding oysters by Morgan & Co., Doane & Co., Swanberg & West, and other firms now consolidated with the Morgan Oyster Company, viz, Sausalito, Point San Quentin, Sheep Island, and Oakland and Alameda creeks, have all been abandoned in favor of localities south of San Francisco, where the nearest are from 10 to 15 miles removed from the influence of the Sacramento River, and where they are almost free from deposits of sediment. There was always a large percentage of loss from oysters settling in the mud at the old localities. I examined all these old beds, but found no oysters on any of them.

When oysters are removed from certain localities to others better suited to their fattening, the shells of the native oysters are knocked off them with a light, long-bladed, adz-shaped instrument adapted to the purpose.

In the frequent transplanting of oysters may be found another feature of their treatment tending to reduce propagation; many eastern oystermen consider "plants" (transplanted oysters) infertile for a year or two. If there is truth in this the extent to which oysters are moved at San Francisco must certainly have its influence.

Seed oysters are brought to San Francisco in the fall by fast freight. Not more than 10 per cent loss is expected under ordinarily favorable circumstances. The mere freezing of the liquid about the oyster is not considered injurious. In illustration of the length of time cold or frozen oysters may remain out of water without losing their vitality, Mr. Morgan told me that from a number of carloads of oysters consigned to his company one car was lost through some mistake and turned up in St. Louis. When it finally arrived at San Francisco, after being two months on the way, and the frozen oysters were bedded, it was found that there was but little more loss than in shipments of ordinary duration.

A new company, the Chesapeake Oyster Company, a branch of the International Oyster Company of New York, has lately begun the shipment of fresh marketable oysters to San Francisco, and at present has a quantity of them deposited at Sausalito.

Quantity of oysters put upon the market.—Statements on this subject were conflicting. Certain oyster-dealers said that there were from 350 to 400 boxes of oysters (containing 200 full-grown oysters to each box) put upon the San Francisco market daily; while from the statements of certain outsiders, it appeared that the quantity was much greater. Neither did I learn what proportion to this amount the shipments to outside towns bear. From certain sources I heard that there were about 100 carloads of seed brought west annually, while others discredited this statement and placed the amount at half that number.

The consumption of eastern oysters on the Pacific coast has greatly increased of late years, while the rate of importation of seed oysters has not; in fact, after considerable inquiry, the conclusion is that it has decreased; so we may infer that the beds, although not self-sustaining, are nevertheless contributing something in the way of natural increase to meet the demand.

The market for oysters in San Francisco is good, and all that are produced sell readily. They are ordinarily packed in boxes containing 200, worth $4 per box. It will be seen that they cost twice as much as on the Atlantic coast, where choice oysters are worth $1 per 100, and good oysters, not specially selected, can usually be bought for 75 cents per bushel. Californians will undoubtedly consume more oysters when they can get them at eastern prices.

Oysters are always in season in California, the sales and prices being the same in summer as in winter.

The Pacific coast native oyster (*Ostrea lurida*).—This small oyster abounds in San Francisco Bay, where it is utterly worthless as compared with the oyster from Washington. It is present upon all the bedding-grounds of the eastern species. When the latter are permitted to lie too long undisturbed they become coated with the small shells of *O. lurida*. There are extensive deposits of this species in the shallow waters all along the western part of the bay, and their dead shells washed ashore by the high seas that accompany the strong winds of the winter season have formed a white glistening beach that extends from San Mateo for a dozen or more miles southward. So abundant are they that this constantly increasing deposit of shells covers everything alongshore and forms bars extending into the bay.

Schooners frequently carry away loads of them for the making of garden walks and for other purposes to which old oyster shells are adapted. Quantities are ground up and scattered about poultry ranches. The supply is unfailing. Their small size and thin, light shells permit them to be readily drifted about the bay, and thus render them unsuitable as collectors of the spat of eastern oysters. They break apart and disintegrate, and shift so freely when exposed to heavy waves that they can not be considered good fixing-surfaces for the large species when in exposed places. If the banks formed of these little shells

could be protected from the heavy waves by some firm outside barrier, and be covered with an abundance of large shells not so likely to drift, a permanent bed might readily be formed. The eastern oysters laid out on the natural shellbanks in some places are frequently rolled along the bed and washed high and dry upon the beaches. The original bedding-grounds along the east side of the bay have been abandoned mainly on this account.

It is possible that I have not attached sufficient importance to the evil of overcrowding by the remarkably fertile native species. This little oyster, naturally adapted to these places, finds the large shell of the eastern oyster a fixing-surface specially adapted to its needs. It is thus protected from the bad results attendant upon the changing surface of its natural shellbanks; it has the advantage of the protection of the fences; it is nearer to the muddy bottom, from which much of its food is derived, and yet is lifted by the shell of the large oyster to a safe height above that bottom, where the under shells of a cluster of any species of oyster would be smothered in the mud. So closely do these indigenous oysters crowd upon the shells of the large species that when a heap of the latter have been cleaned for market the accumulated parasites almost equal in bulk the edible species. Doubtless they are responsible for crowding many of the young of the less adaptive eastern species completely out of existence.

The native oyster (*O. lurida*) grows twice as large at Willapa Bay, Washington, as it does at San Francisco, and is constantly misnamed the "California oyster." But no use is made of the small California coast oyster, except as its shells are utilized in the ways previously mentioned.

The Morgan Oyster Company.—This company now maintains six important stations or groups of oyster beds in San Francisco Bay, where oysters imported from the Atlantic coast are kept until they reach a marketable size. All are situated in the southern part of the bay, and are from 15 to 35 miles back from the Golden Gate. At each of these localities there is a comfortable building for housing the employés. Each station is supplied with fresh water by an artesian well, which usually elevates the water a few feet above high tide, windmills being added at three of the stations to raise the water to tanks. At four stations (Dumbarton, San Bruno, Millbrae, and Alvarado, the last now abandoned) the houses are built upon piles, and are 1 or 2 miles from the nearest land. At the other stations they are upon islands or the shores of the bay. There are several inclosed oyster beds near each of the houses, varying in extent from 50 to 100 acres each. I had no means of knowing the actual extent of the oyster beds of this company, but will roughly estimate the territory fenced in by stakes at 1,500 or 2,000 acres. This should, perhaps, be regarded as a guess rather than as an estimate.

The station known as San Bruno was established by Corville & Co. about 1872. It was subsequently owned by Swanberg & West, and finally passed into the hands of the Morgan Oyster Company.

The establishment at Millbrae dates from 1874, and is one of the most valuable. The house is nearly 2 miles off shore, and is connected by telephone with the city office.

Dumbarton was begun in 1877 and may be considered the most important station of all. The oyster beds here are the most remote from the sea. There is probably sufficient warmth of water here in summer to admit of more extensive oyster-spawning than elsewhere. South of this point the tide water backs up many sloughs and creeks far inland, where it can become warm, and there is little doubt that future tests will show this to be decidedly the warmest part of the bay and the best adapted for raising seed oysters.

The Alvarado place, about 8 miles north of this and in a very exposed situation, has been abandoned on account of the heavy seas, caused by winter winds, to which it was subjected. The South Belmont place was started in 1877 and North Belmont in 1884. The last, founded by Doane & Co., was later consolidated with the Morgan Oyster Company, of which Mr. Doane is now the field superintendent. The San Mateo oyster station has been in operation for five or six years. The employés are moved from station to station as the beds at different places require attention.

Seed oysters are usually laid out at the Dumbarton beds or the Belmont beds (all of which are near the head of the bay) for a couple of years, and are then transferred to the beds at Millbrae and San Bruno for the final year before being put on the market, as the latter localities are supposed to be better adapted to fattening them.

This company employs a schooner, quite a fleet of sloops or "plungers," many scows or barges, and some floats. No retail stands or restaurants are operated. They have considerable territory in Willapa Bay, Washington, devoted to the cultivation of the Washington coast oyster (*Ostrea lurida*). Large regular shipments of this species are made to San Francisco. The wholesale oyster business of the company is transacted at a commodious building on Third street, San Francisco, from which oysters, opened or in the shell, are supplied to the hotels and restaurants of the city, and, boxed or canned, are shipped to all the large towns of the Pacific region, from Victoria to San Diego, and from Salt Lake to Honolulu.

Oyster establishment of M. B. Moraghan.—Mr. M. B. Moraghan, an importer, planter, and wholesale and retail dealer in oysters in the California Market, San Francisco, established his oyster bedding-ground at Millbrae about 1882, where he owns 200 acres and leases 900 acres of tide lands. Much of the product of these beds is used at his restaurant stalls in the California Market. The methods of the Morgan Oyster Company, previously described, apply also to this place.

Vessels.—The vessels employed are schooners, sloops, scows, floats, and a few small rowboats.

The floats are large barges with the bottom planks sufficiently separated to admit the water freely. They are used as temporary receptacles for oysters that have been culled and cleaned, and to keep them fresh while awaiting transfer to market. They are kept afloat by "air boxes," *i. e.*, air-tight compartments along the sides and ends, and, in extra large floats, lengthwise through the middle. The bottom is made of 3-inch square timbers separated by half-inch spaces. The float thus constructed has a free circulation of water among the oysters stored in it, and will hold great quantities of them in a fresh and healthy condition. Floats are constructed in varying sizes adapted to the requirements of each station, the large double floats with central air box being usually 40 feet long by 20 wide. The single compartment floats are about half this size.

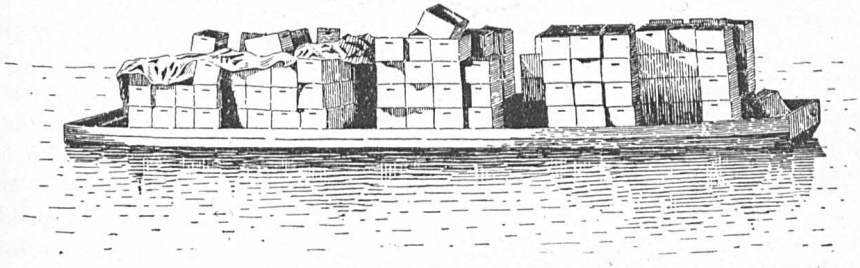
The scows are used in tonging up oysters and for sorting and otherwise handling them. They are shallow and flat-bottomed, with sides very slightly tapering from the middle to the square ends. The flush decks slope a little toward the low rail strip at the sides. Each end is fitted with a large iron ring, through which the heavy propelling poles are passed and driven by hand into the mud to steady it in tonging. In this operation the scow is gradually moved broadside across the oyster bed, permitting a thorough taking-up of all oysters in its course, which is previously laid out by occasional light poles set up on the bed at low tide. When loaded, the scow is pushed alongside the float and moored to it until its oysters are culled. Scows are made in different sizes, with decks averaging 8 feet by 24 feet.

The sloops or "plungers" in use are built upon several models, some of them with flush decks and a large central cockpit divided by a centerboard. A larger size is a keel boat with low deckhouse. Both forms are commonly cat-rigged. They are employed for general transportation between the oyster stations and to carry oysters to market.

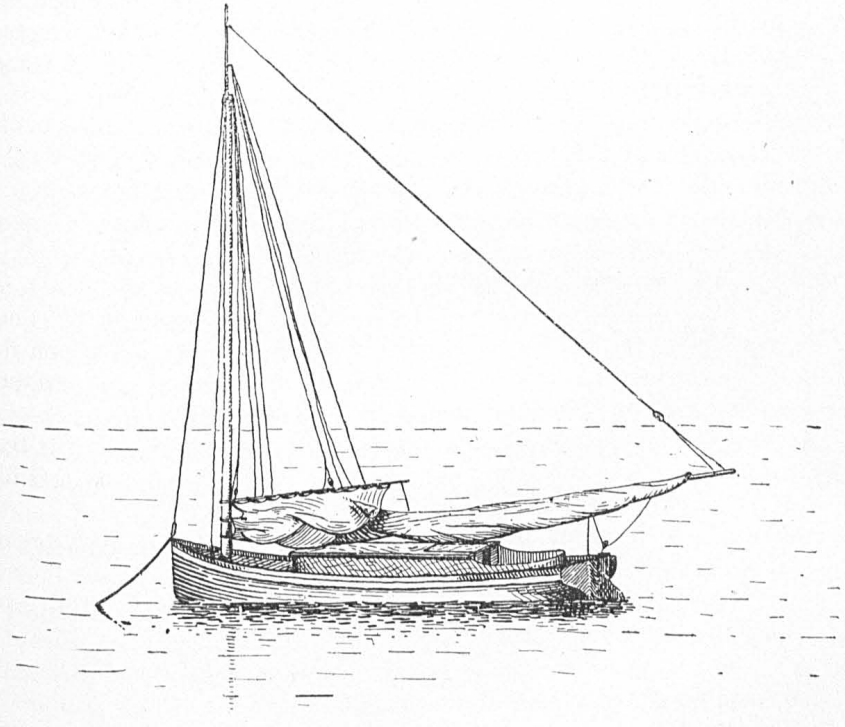
A good-sized schooner of unusually light draft has been built by the Morgan Oyster Company for oyster work in the bay and has been found very efficient.

When the tide goes out and all these craft are left high and dry upon the tide lands, the workmen, putting on leather-soled rubber boots for wading in the mud, are employed in leveling or otherwise improving the surface for oyster bedding.

Employés.—Usually about 100 men are employed upon the oyster beds of San Francisco Bay, this number being considerably increased at certain times. They are recruited from the ranks of the sea-going class, nearly always numerous about the wharves of San Francisco, and are constantly changing, none of them developing into regular oystermen. About 90 per cent of them are of Scandinavian origin.



FLOAT AND PACKING-BOXES, SAN FRANCISCO BAY.



OYSTER SLOOP, SAN FRANCISCO BAY.

San Pablo Bay.—The most diligent dredging from a steam launch failed to reveal any shell life, except clams, upon the bottom of San Pablo Bay. The native oyster, *O. lurida*, so abundant in San Francisco Bay, particularly far south of the city, was not found here at all. It is probable that it formerly lived here, for there are extensive deposits of shells of this species to be seen in the faces of the bluffs along the west side of Mare Island fronting on San Pablo Bay. Nearly all the supply of soft-shelled clams is derived from the mudflats of San Pablo Bay. This species is apparently as abundant here as if it had always existed in these waters.

While San Pablo Bay appears to be devoid of shell life, except clams, it is rich in shrimps and fishes. Many of the Chinese shrimp-fishers' nets are set here constantly and the Italian fishermen take many sturgeon. The shrimp nets also take sculpins, young flounders, and other small fish in abundance.

The muddy character of the bottom is due to its being a favorable place for the waters of the Sacramento River to expand and thereby deposit the sediment carried by its current. The river maintains a deep channel along the south side of the bay on its course to the sea, but when it meets an incoming tide at the entrance to San Francisco Bay its muddy flood is spread all over the broad extent of San Pablo.

Mr. M. Manson, engineer for the Harbor Commission, states that the shoaling of San Pablo Bay dated from the time of hydraulic mining, but that since the cause of débris has been removed the bay has improved and will doubtless continue to do so. He recommended an examination of the west side of San Pablo Bay with reference to the possibility of its being made bedding-ground for oysters, but as far as I was able to examine it there were no indications of firm bottom like that of the west side of San Francisco Bay.

Mr. McNear, proprietor of the wharves at McNear's Landing, on San Pablo Bay, once laid out eastern oysters upon a narrow mudflat near the landing, but lost most of them from continued rough weather, during which they were either washed upon the beach or covered by soft mud. The experiment was not repeated.

Though I have as yet found no oysters in San Pablo beyond McNear's Landing, the discovery of many eastern and Willapa Bay oysters about the narrows at the entrance to the bay is interesting as showing the propagation of oysters exposed to the fresh water of the river, and is an indication that something might be done for oyster-culture in San Pablo Bay if firmer bedding-grounds can be secured.

Tide lands.—The sale of the tide lands of San Francisco Bay has hitherto been considered as exercising a retarding influence upon the development of the oyster industry, as well as of other branches of business. These lands, surveyed and sold by the State at $1.25 per acre, have gradually passed into the hands of the larger oyster companies. This is especially true of the extensive flats in the southern

part of the bay most available for the present system of laying out oysters, and the managers of the Morgan Oyster Company informed me that they owned about all that they considered valuable for their method of growing oysters. Many consider the sale of the tide lands an injustice to the people. It is said that the railroad companies are proprietors in tide lands to such an extent that the city of Oakland is greatly handicapped for water frontage and wharf facilities.

The law permitting the sale of the tide lands is not, however, an unmixed evil, for while it might lead to monopoly it would allow oyster-planters to reap the harvests they sow. It is now conceded by many who have long upheld the system of public dredging in the Chesapeake region, that private cultivation must be provided for before there can be any marked increase in the oyster supply.

The Tide Land and Water Front Company of San Francisco are proprietors of the tide lands to a considerable extent, and offer them for sale at the uniform price of $25 per acre. Notwithstanding the fact that much desirable oyster-bedding ground is already fenced in, there is still much good oyster-ground unoccupied in the southern part of the bay. In the Long Island Sound region, where the oyster-ground can be bought or leased from the States, the system of private ownership of the beds has been found perfectly practicable and very advantageous.

In reply to inquiries respecting the value of the tide lands now inclosed and used by the oyster-growers of San Francisco, Mr. Moraghan writes me:

> The price depends upon the location, the kind of bottom, whether mud, shell, or sand, etc., and more than all, upon the improvement or amount of labor bestowed on the land. We have some beds that are worth fully $1,000 per acre to us, as we have been improving and working upon them for the past ten years in bringing them to their present condition.

Mr. Moraghan adds that unimproved tide land, such as is used in the Californian method of bedding oysters, is very cheap, being worth $10 per acre, and that such lands can be had adjacent to the best inclosed beds for $20 per acre.

Suggested introduction of other species of oysters.—With evidence at hand of the propagation of our own oyster (*O. virginica*) in California, the introduction of foreign species seems superfluous; but Prof. George Davidson and Mr. H. D. Dunn, of San Francisco, both of whom have resided in Japan, have frequently spoken to me of the large oyster of Japan in connection with the subject of oyster-growing in California. Prof. Davidson sends the following note on this subject:

> The oyster I knew in Japan was found in the vicinity of Nagasaki, where I was stationed during the three months October, November, and December, 1874, and part of January, 1875. The oyster is there very large, full, and well flavored. I obtained some shells that were fully 12 inches long. I tried to interest some of our steamship captains to bring them to San Francisco, but at that time the trip frequently consumed a full month, with a change of steamer at Yokohama, and they

doubted the success of such an experiment. With the present more rapid transportation and a better knowledge of their treatment en route, I think it very advisable to try and introduce them to the Pacific coast.

The introduction of oysters from Japan would probably not be difficult, as a great many species of shellfish from that region are identical with California species.

Attempts have been made by oyster-growers in San Francisco Bay to introduce the large oysters of the Yaqui River lagoons and other parts of western Mexico, which strikingly resemble *O. virginica*, but a large percentage of the oysters died on the voyage. The change from the warm waters of that latitude to the bay of San Francisco was supposed to be too great, even if they survived the voyage. I can testify to the large size, good flavor, and great abundance of the Yaqui River oysters from personal experience. They are so abundant that we frequently loaded the dingey of the *Albatross* by merely gathering them from the borders of the shell heaps exposed everywhere at low tide. The temperature of the water while we were there (March 31 and April 1, 1889) ranged from 69° to 73° F. Now that there is railroad connection between Guaymas, Mexico, and San Francisco, the introduction of these oysters by rail might give better results.

Table showing the temperature of the water in the vicinity of the natural oyster beds near the mouth of the Yaqui River, Mexico, March 31 and April 1, 1889.

Locality and time.	Air.	Water.	Locality and time.	Air.	Water.
Off Algodones Lagoon:			Off Algodones Lagoon—cont'd.		
Mar. 31, 12 m.	73	69	Apr. 1, 4 a. m.	65	67
Mar. 31, 1 p. m.	71	72	Apr. 1, 5 a. m.	65	69
Mar. 31, 2 p. m.	71	73	Apr. 1, 6 a. m.	64	69
Mar. 31, 3 p. m.	72	73	Apr. 1, 7 a. m.	65	69
Mar. 31, 4 p. m.	71	72	Apr. 1, 8 a. m.	66	69
Mar. 31, 5 p. m.	73	72	Apr. 1, 9 a. m.	71	72
Mar. 31, 6 p. m.	72	72	Apr. 1, 10 a. m.	73	73
Mar. 31, 7 p. m.	71	70	Apr. 1, 11 a. m.	73	74
Mar. 31, 8 p. m.	70	70	Off Yaqui River:		
Mar. 31, 9 p. m.	69	70	Apr. 1, 12 m.	71	73
Mar. 31, 10 p. m.	69	69	Apr. 1, 1 p. m.	72	73
Mar. 31, 11 p. m.	68	68	Apr. 1, 2 p. m.	72	73
Mar. 31, 12 p. m.	70	70	Apr. 1, 3 p. m.	73	73
Apr. 1, 1 a. m.	69	68	Apr. 1, 4 p. m.	74	73
Apr. 1, 2 a. m.	65	68	Apr. 1, 5 p. m.	74	73
Apr. 1, 3 a. m.	65	68			

It should be stated that the hourly temperatures taken by the *Albatross* were not in Algodones Lagoon or in the mouth of Yaqui River, but at the ship's anchorage, a mile or two outside, in the Gulf of California.

In December, 1890, a large shipment of oysters was made from Acapulco to San Francisco, but most of them died on the way. The few that reached market were considered good. This species was doubtless the *Ostrea iridescens*, a large oyster common in the vicinity of Acapulco.

The oyster of the Gulf of California has been referred by some conchologists to *Ostrea virginica*. In Carpenter's Shells of Mazatlan it is referred to that species, and in the collection of the U. S. National

Museum are many specimens from the Gulf of California so labeled. Compared with *Ostrea virginica*, it is of similar size and appearance, and to the superficial observer undistinguishable from it. It is found in the lagoons of the eastern shore of the Gulf from Mazatlan to the vicinity of the Rio Colorado, and is said to abound at a point opposite George Island, well up the gulf. It is found also on the western side of the gulf at Angeles Bay, opposite the southern end of Angel Guardia Island, and near Salinas Bay on Carmen Island. The oysters of both of these localities are said to be well flavored, and shipments from the latter have been made to San Francisco.

Dr. Edward Palmer, of the Department of Agriculture, informs me that he first saw the natural oyster deposits of the Yaqui River lagoons twenty years ago, and that there was then more traffic in them than at the present time. He ascribes the origin of the large mounds of oyster shells so conspicuous there to the drying of oysters by Indians, for sale among the mines of Sonora and Sinaloa. These oysters are still gathered by Indians, and are used in the hotels of Guaymas the year round. They are usually stored in the bay awaiting the arrival of the steamers. Many are sent by rail to Hermosillo, and a few are shipped by steamer to La Paz. Considerable quantities are taken from a stream near Altata, at the mouth of the gulf, and sent to Culiacan, in the interior, over the Sinaloa and Durango Railway.

I found a small oyster (*Ostrea palmula*, variety *glomerata*) abundant on the roots of the mangroves in Concepcion Bay, on the west side of the gulf. I obtained another species (*Ostrea palmula*) farther south at San Josef Island, but it was represented only by dry shells, our stay there being too brief to permit any extended search for the original deposits. The large *Ostrea iridescens* was occasionally brought up by the beam trawl of the *Albatross* in dredging along the western shores of the gulf.

The Mexican Oyster Company.—This company was in existence in 1868, 1869, and 1870. Oysters were brought from the natural beds of Altata and Acapulco, and sold readily in San Francisco at 25 cents apiece. Their arrival was announced by placards on steamer day. As many died on the voyage, the business was never profitable, and was finally ruined by the introduction of eastern oysters upon the completion of the overland railway in 1870.

Australian oysters.—A sack of oysters was recently brought to San Francisco by a steward of one of the Australian steamers. These oysters were sold by M. B. Moraghan at his stand in the California market and were considered as good as eastern oysters.

Suggestions.—In view of the fact that there is considerable propagation among the oysters of San Francisco Bay and that no attempt has been made to collect spat, it would be desirable to experiment in the vicinity of the most southerly beds of the bay with a variety of spat-collecting surfaces. There are many suitable channels, creeks, and tracts of deep water close to the beds. Bundles of brush could be anchored outside the lines of stakes about the beds or in the creeks, and floating collectors could be moored anywhere; these could be made scow-shaped, the sides and ends of coarse timbers of any sort, and the bottom of wide-meshed wire netting; such a craft, loaded with all the shells it could conveniently float, could be towed anywhere and might be large or small. In view of the existence of stingrays, this pattern of collector or the brush collectors would be safest, to say nothing of the ease with which they could be inspected for presence of spat.

If there were fixing surface of any description in the creeks or sloughs that extend from the southern part of the bay far back toward San Jose, Redwood, Belmont, Newark, and through the marsh lands generally, it is probable that oysters would attach. When the cold tide flows in across the extensive sun-heated flats in the springtime, it warms rapidly and fills the creeks with water of a much higher temperature than is found elsewhere in the region of the bay. The warm water flowing across the oysters brings them into spawn very suddenly when the weather conditions are favorable. My attention was called to this fact by the oystermen.

The creeks are, without exception, very muddy and absolutely without any firm surfaces upon which drifting oyster spat might settle. These creeks are similar in character. Most of them retain a considerable depth of water at low tide. They are named on the charts of San Francisco Bay as follows: Union City Creek, Cayote Creek, Beard Creek, Mud Creek, Alviso Slough, Redwood City Creek, Steinberger Creek, Angela Creek. Quantities of brush from the drier lands, just back of the marshes through which they flow, could readily be deposited in them as spat-collectors. From the fact that oysters have been taken from the timbers of two or three old trestles that cross them, we might reasonably expect favorable results from a careful experiment with brush collectors.

Should it finally be found advantageous, these creeks could readily be sown with quantities of shells of the native oyster from the shell heaps about the shores of the bay. That the native species has never penetrated into them is no argument against the propagation of the eastern species there. Occasional specimens have already been found growing there, and the creeks may prove as favorable to them as similar creeks are on the Atlantic coast.

The proper time for placing collectors in San Francisco Bay is yet to be determined.

OTHER BAYS OF THE CALIFORNIA COAST.

In Tomales Bay, Messrs. Weinard and Terry laid out about 17 carloads of eastern oysters in 1875. They remained there only two or three years, until all were marketed or removed to more accessible places in San Francisco Bay. The experiment was not repeated. Capt. Lawson, one of the oldest residents upon Tomales Bay, says that these oysters lived and fattened as well apparently as those in San Francisco Bay. They were laid out at Millerton Station, near the southern end of the bay, where some of the stakes used in fencing the bed are still standing. There is perhaps no reason why the extensive mudflats of Tomales Bay should not be used for laying out oysters in the same manner as is done in San Francisco. The bay is nowhere very deep. With two or three good-sized streams flowing into it, the natural conditions ought to prove very similar to those of San Francisco. It is 18 miles long and averages 2 in breadth. There are no signs of the propagation of eastern oysters there, although *Ostrea lurida* is not uncommon.

From correspondents in southern California I have recently learned that eastern oysters are reported as propagating in San Diego Bay. A few years ago a quantity of oysters were placed there, and they still remain in good condition. It is said also that a lot of Mexican oysters, brought in a steamer from Guaymas several years ago, were found to be dying rapidly when the vessel arrived in San Diego Harbor, and were thrown overboard. It is claimed that survivors from this accidental planting are occasionally found. This bay, more than 400 miles south of San Francisco Bay, is much warmer, and it might be that the oyster of the Gulf of California, which failed to live in the cold water of San Francisco Bay, would be a success in San Diego Bay. The greater part of this bay is shallow and there are extensive mudflats. There are no constant streams flowing into it, though False Bay, immediately north of it, receives San Diego River, a stream which disappears in midsummer.

Humboldt Bay, 200 miles north of San Francisco, is a large and shallow bay that may be found available for oyster-growing when the question of temperature has been studied. By far the greater area of this bay consists of tide lands, exposed at low water. My personal recollection of Humboldt mudflats, visited in 1885, is that they are altogether firmer than those of San Francisco, the bottom being more sandy.

Ballona Bay, near Santa Monica, in southern California, is a small bay where, I am informed, oysters have been placed and found to grow well, but it is not known whether they breed there. A report upon the small bays about Wilmington, near Los Angeles, has already been published by the Fish Commission.*

* Report upon certain investigations relating to the planting of oysters in southern California. By Charles H. Gilbert. Bull. U. S. F. C., 1889, p. 95-98.

LAWS OF CALIFORNIA RELATIVE TO OYSTERS.

CHAPTER XVII.—*An act to encourage the planting and cultivation of oysters.*

[Approved March 30, 1874; Stat. Cal. 1874, p. 940.]

SEC. 1. Any citizen of the United States may lay down and plant oysters in any of the bays, rivers, or public waters of this State, and the ownership of and the exclusive right to take up and carry off the same shall be continued and remain in such person or persons who shall have laid down and planted the same.

SEC. 2. Any person or persons who now have or may hereafter lay down and plant oysters, as hereinbefore provided, shall stake or fence off the land upon which the same is or hereafter may be laid down and planted, and such stakes or fences shall be sufficient marks of the boundaries and limits, and entitle such person or persons to the exclusive use and occupation thereof for the purposes prescribed in this act: *Provided*, That nothing herein contained shall be deemed to authorize any impediment or obstructions to the navigation of any channels.

SEC. 3. Parties planting or laying down such oyster beds shall record a full description of said bed or beds in the county recorder's office in the county where the same is situated. The recorder shall record the description so furnished in a book to be kept by him for that purpose, to be entitled a "Record of oyster beds."

SEC. 4. Any person or persons who shall enter upon any lot of land in which there shall be oysters laid down and planted, and which at the time of such entry shall be fenced or staked off pursuant to the provisions of this act, and who shall take up and carry off therefrom such oysters, without the consent or permission of the occupants and owners thereof, and shall willfully destroy or remove, or cause to be removed or destroyed, any stakes, marks, or fences intended to designate the boundaries and limits of any land claimed and staked or fenced off pursuant to the provisions of this act, shall be guilty of a misdemeanor.

SEC. 5. The penalties of the penal code relative to misdemeanors are hereby made applicable to any violation of the provisions of this act.

SEC. 6. All fines and penalties collected for a violation of any of the provisions of this act over and above the costs of suit shall be paid into the common school fund of the county where the offense was committed.

SEC. 7. All parties availing themselves of the provisions of this act shall erect or cause to be erected, on some conspicuous part of the grounds devoted to the planting of oysters, a sign not less than 6 feet in length and 1 foot in width, on which shall be painted in black letters upon a white ground the words, "oyster beds."

SEC. 8. All acts and parts of acts in conflict with the provisions of this act, and especially an act entitled "An act concerning oysters," passed April 28, 1851 (Cal. Stat., 1851, p. 432), as also the act entitled "An act concerning oyster beds," approved April 2, 1866 (Cal. Stat., 1866, p. 848), are hereby repealed.

SEC. 9. This act shall not apply to any tide lands which the State may have sold to private parties: *Provided further*, That nothing herein shall be construed as to interfere with the right of the State to sell or dispose of any of the tide lands, nor to affect in any manner the rights of purchasers at any sale of the tide lands by the State.

SEC. 10. This act shall take effect and be in force from and after its passage.

NOTE.—The acts mentioned in section 8 were continued in force by Political Code.

CHAPTER XVIII.—*Penal code.*

602. Every person who willfully commits any trespass by either:

7. Entering upon any land owned by any other person or persons, whereon oysters or other shellfish are planted or growing, or injuring, gathering, or carrying away any oysters or other shellfish planted, growing, or being on any such lands, whether covered by water or not, without the license of the owner or legal occupant thereof, or destroying or removing, or causing to be removed or destroyed, any stakes, marks, fences, or signs intended to designate the boundaries and limits of any such land, is guilty of a misdemeanor.

WASHINGTON.

NATIVE OYSTER INDUSTRY OF WILLAPA OR SHOALWATER BAY.

The total annual output of native oysters from Willapa Bay is about 40,000 sacks. Oysters are taken from the natural deposits below low-water mark, the large ones marketed and the small ones transplanted to the adjacent tide lands until they attain a marketable size.

This large but shallow bay is cut by many intricate channels of deeper water where small oysters (*Ostrea lurida*) are obtained by tonging from flat-bottomed boats. They are then culled or sorted, and the bulk of each boat load, not being at once marketable, is scattered broadcast with shovels upon the selected bedding-grounds above low-water mark. This is done when such oyster-grounds are sufficiently covered by the tides to permit the free passage of boats. Two and a half years is the usual time required for the desired growth.

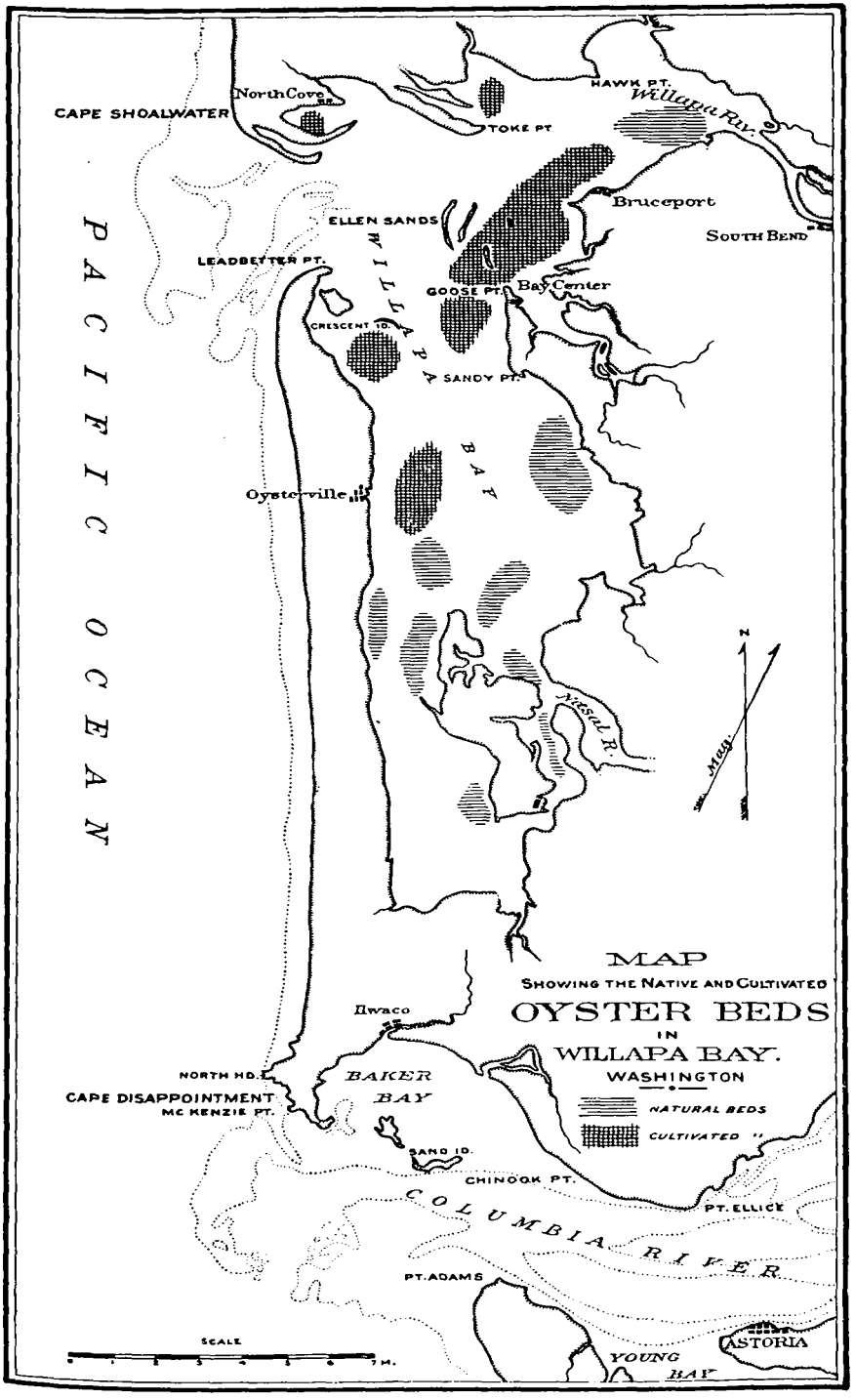
Each oysterman marks the boundaries of his bed of transplanted oysters with young pine saplings from which most of the branches have been trimmed, the tops being left to render such marks more conspicuous. Some planters occupy as much as 100 acres of tide land in this way.

For transplanting, sandy or other smooth bottom is preferred; it should be clean and free from seaweed. It is claimed that in such situations oysters reach their full size much sooner than on muddy bottom. Seaweed or grass grows rankly in many parts of Willapa Bay, and in the vicinity of Oysterville has taken full possession of large tracts that were formerly valuable for oysters. It is frequently mowed, but this is difficult work and can only be favorably done at one stage of the tide when the depth of water is only a few inches, while floating weed is likely to accumulate against boundary stakes and break them down.

Oyster beds here are not inclosed by closely set stakes, there being no destructive stingrays as at San Francisco. Starfish are abundant upon the natural beds along the channels, and are constantly destroyed by the oystermen when tonged up. Occasionally severe winters are ruinous to the transplanted beds, as the oysters freeze by being left exposed at low tide. In 1888 the cold weather killed 60 per cent of all oysters laid out above low-water mark.

After the culling operation, salable oysters are thrown into floats, through which the water passes freely, for safe keeping until sacked for shipment. Sacks holding nearly 2 bushels of oysters sell for $1.75 per sack.

An average of nearly 400 baskets of Willapa Bay oysters go to San Francisco by each steamer. Steamers run every four days, and as the baskets hold nearly a bushel, it is probable that over 35,000 bushels are


CAPE SHOALWATER
North Cove
HAWK PT.
Willapa Riv.
TOKE PT
Bruceport
ELLEN SANDS
SOUTH BEND
LEADBETTER PT.
WILLAPA
GOOSE PT.
Bay Center
CRESCENT ID.
SANDY PT.
PACIFIC OCEAN
BAY
Oysterville
N
Mag.
NISQUALLY R.
MAP
SHOWING THE NATIVE AND CULTIVATED
OYSTER BEDS
IN
WILLAPA BAY.
WASHINGTON
NATURAL BEDS
CULTIVATED "
Ilwaco
NORTH HD.
CAPE DISAPPOINTMENT
MC KENZIE PT.
BAKER
BAY
SAND ID.
CHINOOK PT.
PT. ELLICE
COLUMBIA RIVER
PT. ADAMS
SCALE
M.
YOUNG
BAY
ASTORIA

used in San Francisco annually. These, at the Willapa Bay price of $1.75 per sack (of 2 bushels), are worth $30,625. Very nearly as many go to Portland as to San Francisco. The remainder goes to the smaller towns of Washington and Oregon.

Bay Center.—Three or four times as much oystering is carried on here as at any other place in the bay, and during the past two years the business has greatly increased. The total population is about 200, one-third being Indians. The latter class is largely employed in the labor of culling. A few Chinamen are also employed as cullers and render excellent service. There are fifteen proprietors in the business here, employing a fleet of 15 plungers, 35 bateaux, and 18 floats. "The Native Oyster Company" of Bay Center ships chiefly to the Portland market.

Oysterville.—There are over 1,000 acres of transplanted beds here. The village is of about the same size as Bay Center, and like it is supported chiefly by the oyster industry. Oysterville was formerly the chief seat of the fishery, but the beds have become so thickly covered with grass that much of the business has been transferred to Bay Center. There are at present but ten proprietors engaged in the oyster business.

Bruceport and North Cove.—At Bruceport, which occupies the third place in oyster production in Willapa Bay, similar methods and conditions prevail. The oyster business at North Cove is chiefly carried on by the crew of the life-saving station located there, who restrict it to the cultivation of "plants" purchased from other parts of the bay. The area of transplanted beds in the latter place amounts to about 25 acres, yielding nearly 500 sacks per annum.

Temperature.—It is not unlikely that the summer temperature of the extreme southern part of Willapa Bay may be close to that of San Francisco, and that eastern oysters would propagate there. From the shelly nature of the bottom they might be expected to do well, provided the conditions of temperature were similar. It is certain that the native oysters of this bay breed freely at San Francisco. We know nothing as yet about the summer temperature of the water in this bay, except as it is indicated by observations made by the Coast Survey steamer *Gedney* in the northern part. The temperature even there may be higher than the following table indicates, as the observations were all made at 4 a. m., when the temperature is usually lowest, day temperatures being as a rule higher. Ranging, as it does, usually no lower than 60° at 4 a. m., for August and for that part of July covered by the record, it is probable that the temperature would not be lower than 65° for afternoon observations. Assuming a summer temperature of 60° to 65° for that part of the bay nearest the sea, we may reasonably expect to find the water decidedly warmer in those parts of the bay 15 or 20 miles back from the sea. A careful study of the temperature of this locality would no doubt yield important information.

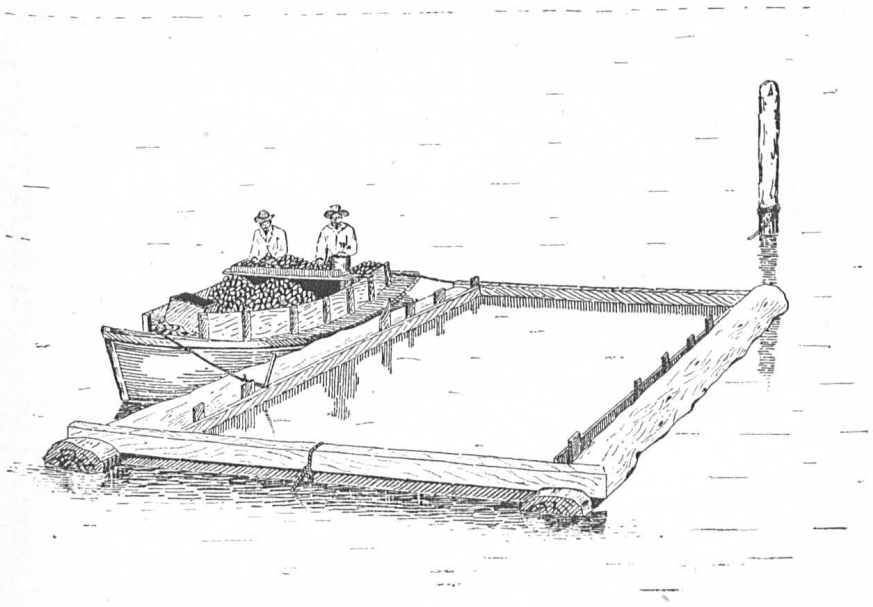
Surface temperatures taken at 4 a. m., daily, by the U. S. Coast Survey steamer Gedney in Willapa Bay, 1890.

Locality.	Date.	Temp.	Locality.	Date.	Temp.
North Cove	July 26	57°	North Cove	Sept. 4	58°
Do	27	62	Do	5	58
Do	28	58	Do	6	59
Do	29	61	Do	8	59
Do	30	60	Do	9	56
Do	31	62	Do	15	58
Toke Point	Aug. 1	61	Do	16	59
South Bend	2	65	Do	17	52
Do	3	65	Do	20	55
Do	4	64	Do	23	54
North Cove	5	60	Willapa Bay	24	55
Do	6	61	Do	27	53
Toke Point	7	61	North Cove	29	60
South Bend	10	61	South Bend	Oct. 5	56
Toke Point	12	62	Do	6	56
Do	13	62	Do	8	54
Do	14	63	Do	9	55
Do	15	63	Do	12	54
Do	16	60	Do	13	54
South Bend	17	64	Do	17	52
Do	18	64	Do	18	52
Willapa Bay	19	60	Do	19	54
Sunshine (Nasal River)	20	60	Do	21	52
Sealand	21	61	Sunshine (Nasal River)	23	53
Do	22	62	Do	25	53
Do	23	62	Do	27	54
Do	24	63	Do	29	53
Do	25	62	Do	Nov. 2	56
North Cove	29	62	Do	4	54
Do	30	62	Do	5	52
Do	31	59	North Cove	8	50
Do	Sept. 3	58			

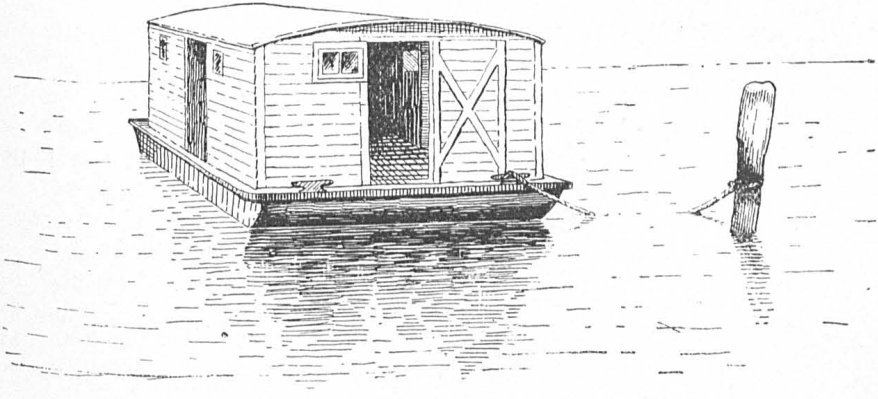
Boats, etc.—The sloops employed in Willapa Bay are usually similar to those in use at San Francisco, where most of them are built. In fact, both the oyster-planting companies of San Francisco have large interests in the oyster industry of Shoalwater Bay, and when possible similar fishery appliances are employed. In both localities the sloop is designated as "plunger."

The "float" in which oysters are stored for market is a simple affair with the floor pieces separated to admit the water freely. It is supported at the sides and ends upon unhewn logs or other solid timbers, sufficient to keep it afloat even when heavily loaded with oysters. Air boxes are not used for that purpose, as in the San Francisco type of float. The usual size is 12 feet by 30 feet.

The "bateau," as the craft for tonging, culling, etc., is locally styled, is quite different from the oyster barge or scow of San Francisco, where a larger and heavier boat is used. It is usually about 30 feet long, with the general plan of the sharpie—the bow sharp, stern square, bottom flat, and sides flaring. The bow and stern are partially decked, and there is a washboard along the sides. Sometimes it is fitted for sailing, being then cat-rigged, with centerboard and outside rudder. A few bateaux are decked entirely over, the oysters taken in tonging being heaped upon the deck, where they are afterward culled. This style is now preferred by many oystermen, because it requires no bailing out, and permits the ready washing of oysters in culling, as the water dashed upon them runs freely over the sides. When the great



OYSTER FLOAT AND BATEAU, WILLAPA BAY.



HOUSE BOAT.

rainfall of this region is taken into consideration, there is an advantage for the boat that requires no bailing out.

This light-draft type of boat is well adapted to the shallow waters of the bay where it has developed. It will float more oysters in slight depths of water than any vessel of its size with which I am acquainted. A couple of them have recently been taken to San Francisco, where they are known as Shoalwater Bay boats. In the form with flush deck the oysters are kept from rolling overboard by light bulwarks, 8 or 10 inches high, at the sides. Another craft in use here is the house boat, which is a simple scow, upon the deck of which a house is constructed for warmth and protection in winter culling of oysters. A stove may be added if desired.

PUGET SOUND.

The following statement of the oyster fishery of Puget Sound is from the report of the State fish commissioner, Mr. James Crawford, for 1890. To this I can add but little, as heavy rains and unfavorable tides did not permit satisfactory investigations during my brief stay at Olympia:

The table below gives the location of the principal transplanted oyster beds on Puget Sound, average number of sacks produced per week, and number of acres in cultivation:

Location.	Acres.	Weekly output, sacks.
Mud Bay	40	45
Oyster Bay	75	100
Big Skookum	45	40
North Bay	70	100
Hood Canal	50	25
Samish Bay	25	25
Scattering	40	15
Total	345	350

The above average is for eight months in the year. During four months of summer not more than one-third of the amount given above is averaged. The number of acres now in cultivation could easily be doubled if the demand required it, and will most probably be, as now perfect title can be secured to the tide lands upon which the oyster beds are located. There are about 125 persons engaged in gathering oysters in the district, 60 of whom are Indians. Oysters are valued at $1.75 per sack of 2 bushels each.

The industry does not appear to be a thriving one. In fact, a dozen years ago, before eastern oysters and the native oysters of Willapa Bay were commonly available on Puget Sound, the local resources were more systematically worked than they are now. Capt. W. J. Doane, of Olympia, informed me that he once had a wholesale oyster business amounting to nearly 1,000 sacks a week. These were supplied to all the towns of the region, from Olympia to Victoria. His trade is at present confined to Olympia.

The best native oyster localities of the region are doubtless in the vicinity of this place. Budd Inlet was formerly good oystering ground,

but the growth of the town and the conversion of the inlet into the present harbor of Olympia have been disastrous to the original oyster deposits. Those bays and inlets of the sound which receive rivers are better adapted for oyster cultivation than those with more salty waters. The inlets of the Olympia region are well supplied in this respect. There are extensive natural oyster deposits in the vicinity of Bellingham Bay, Samish Bay, Port Discovery, Port Orford, Hood Canal, and many other places in Puget Sound, but many of them are remote from fresh water. Oyster Bay, near Olympia, is considered the most favorable of the localities for oyster-cultivation.

Puget Sound abounds in starfish, which are considered very destructive to the native oysters.

The close season from May 15 to September 1 is not enforced.

Indians are the natural laborers in this field of industry, and the few whites engaged in it have expended very little money in any branch of oyster-cultivation.

Surface temperatures taken by U. S. Coast Survey steamer McArthur at Olympia, 1891.

Nov. 25.....	46° (4 a. m.)	52° (4 p. m.)	Dec. 1.....	46° (4 a. m.)	44° (4 p. m.)
Nov. 26.....	49° (4 a. m.)	50° (4 p. m.)	Dec. 2.....	40° (4 a. m.)	43° (4 p. m.)
Nov. 27.....	48° (4 a. m.)	50° (4 p. m.)	Dec. 3.....	37° (4 a. m.)	43° (4 p. m.)
Nov. 28.....	41° (4 a. m.)	51° (4 p. m.)	Dec. 4.....	32° (4 a. m.)	38° (4 p. m.)
Nov. 29.....	44° (4 a. m.)	48° (4 p. m.)	Dec. 5.....	34° (4 a. m.)	36° (4 p. m.)
Nov. 30.....	47° (4 a. m.)	51° (4 p. m.)			

EASTERN OYSTERS IN PUGET SOUND AND WILLAPA BAY.

Governor E. P. Ferry, of Washington, informed me that he, in company with Col. Laramie and Mr. William P. Wright, made an experiment in planting eastern oysters near Olympia many years ago. The history of the experiment is lost, but Governor Ferry's recollection of it is that two sacks of oysters were put in Budd Inlet, about 2 miles from Olympia. They were perhaps not properly looked after, as they were soon lost sight of. It was observed, however, that they lived for several weeks. The history of eastern oysters in Willapa Bay is similar; a few sacks only were laid out in the vicinity of Oysterville. They lived as well as those at San Francisco, but no signs of propagation were ever discovered. It was conceded by oystermen that there were hardly enough of them to insure fertilization. This experiment was made several years ago and has never been repeated. Many oystermen of Willapa Bay are disposed to try bedding eastern oysters when they can get direct railway communication with the Atlantic coast.

TIDE LANDS OF WASHINGTON.

The following, relative to the sale of tide lands in Washington, is from the report of the State fish commissioner for 1890:

The law passed by the recent legislature (known as the "tide-land bill"), giving the right to purchase tide land from the State, thus securing perfect title to their transplanted beds, will, in the opinion of nearly all the most prominent oystermen, cause a remarkable growth in the oyster industry, as prior to the enactment

of such a law many were deterred from embarking in the business because they could not acquire perfect title to the tide lands on which young oysters are planted after being taken from their natural beds. The railways now being built to Willapa Bay will also be an incentive to many, as the lack of transportation facilities and the high tariff charged by the present transportation lines make the margin of profit so small that none but large dealers can successfully carry on the business.

THE OYSTER LAWS OF WASHINGTON.

[Hill's Statutes and Codes of Washington, 1891.]

2585. (*Right to plant oysters may be acquired.*) A person being a citizen of this State, who has planted or who may hereafter plant oysters in any bay or arm of the sea where there are no natural beds of oysters within or bordering upon this State, may acquire, by conforming to the requirements of this chapter, an exclusive right for such a purpose to that portion of such bay or arm of the sea as he shall so occupy, not exceeding for any one person an area of more than 20 acres: *Provided*, That no person or persons shall locate or cause to be located oyster beds in any way interfering with the free use and privilege of any person or persons cutting timbers or logging, or conveying said logs to market.

2586. (*Oyster claims—How initiated—Must be recorded.*) The person desiring the benefits of the preceding section shall cause the place or portion he desires to claim to be marked, so far as is practicable, with stakes or other artificial marks at the corners, with bearings to adjacent natural objects, and shall make, before some officer qualified to administer oaths, an affidavit that he has taken the premises so described for the purpose of planting oysters, and that he has planted or is about to plant oysters thereon; that said premises are not upon and do not include any natural bed of oysters, and that the same are not occupied and claimed, in accordance with law, except by himself; and if said premises shall have heretofore been taken and oysters planted thereon, then within three months after the passage of this act, and if they shall hereafter be taken, then within one month after taking the same, the person having so taken or taking the said premises shall cause his claim, with a description thereof and affidavit as above required, to be recorded by the county auditor of the county in which they may be situated.

2587. (*Extent and number of oyster beds of single claimant.*) The same person may claim and occupy more than one place: *Provided*, The premises so claimed by him do not in all occupy an area greater than 20 acres: *And provided further*, That in those places used and occupied for the purpose of bedding marketable oysters, no one person shall occupy an area greater than 100 by 200 feet, or 20,000 feet of superficial area.

2588. (*Conveyance of right to oyster beds.*) Any person may transfer his right to any other person qualified to hold, by signing the transfer upon record, in the presence of the auditor, or by a written transfer witnessed and acknowledged in the same manner as is or may be required for deeds.

2589. (*Record of oyster claims.*) It shall be the duty of the county auditor of any county, where claims and transfers made under the provisions of this chapter are presented to him for record or entry, to receive and record the same in a separate book provided for this purpose, upon being paid the same fees as are allowed in similar cases.

2590. (*Unlawful for non-residents to take oysters.*) From and after the approval of this act it shall not be lawful for any person who is not at the time an actual inhabitant and resident of this State, and who has not been for six months next preceding an actual inhabitant or resident as aforesaid, to take or gather oysters, either on his own account or on account of others, for sale or transportation, in any of the rivers, bays, or waters of this State; and on conviction shall be fined in any sum not exceeding $500 nor less than $100, or to imprisonment in the county jail for a period not exceeding six months nor less than one month, or both, at the discretion of the court.

2591. (*Dredging for oysters below lowest ebb tide prohibited.*) It shall not be lawful for any person to rake for or gather oysters in any of the rivers, bays, or waters of this State with a dredge, or implement so called, or be employed upon any canal boat, or vessel engaged in the taking of oysters by the process of dredging in any of the waters aforesaid, not above the lowest ebb tide; and on conviction thereof shall be fined in any sum not exceeding the sum of $50, or to imprisonment in the county jail for a period not exceeding twenty days nor less than ten days, or both, in the discretion of the court.

2592. (*Taking of oysters prohibited during certain times.*) It shall not be lawful for any person to rake, scrape, or gather oysters in any of the rivers, bays, or waters of this State, for any purpose whatever, from the 15th day of May until the first day of September of each year; and on conviction thereof shall be fined in any sum not exceeding the sum of $50 for each offense, or to imprisonment in the county jail for a period not exceeding twenty days nor less than ten, or both, at the discretion of the court.

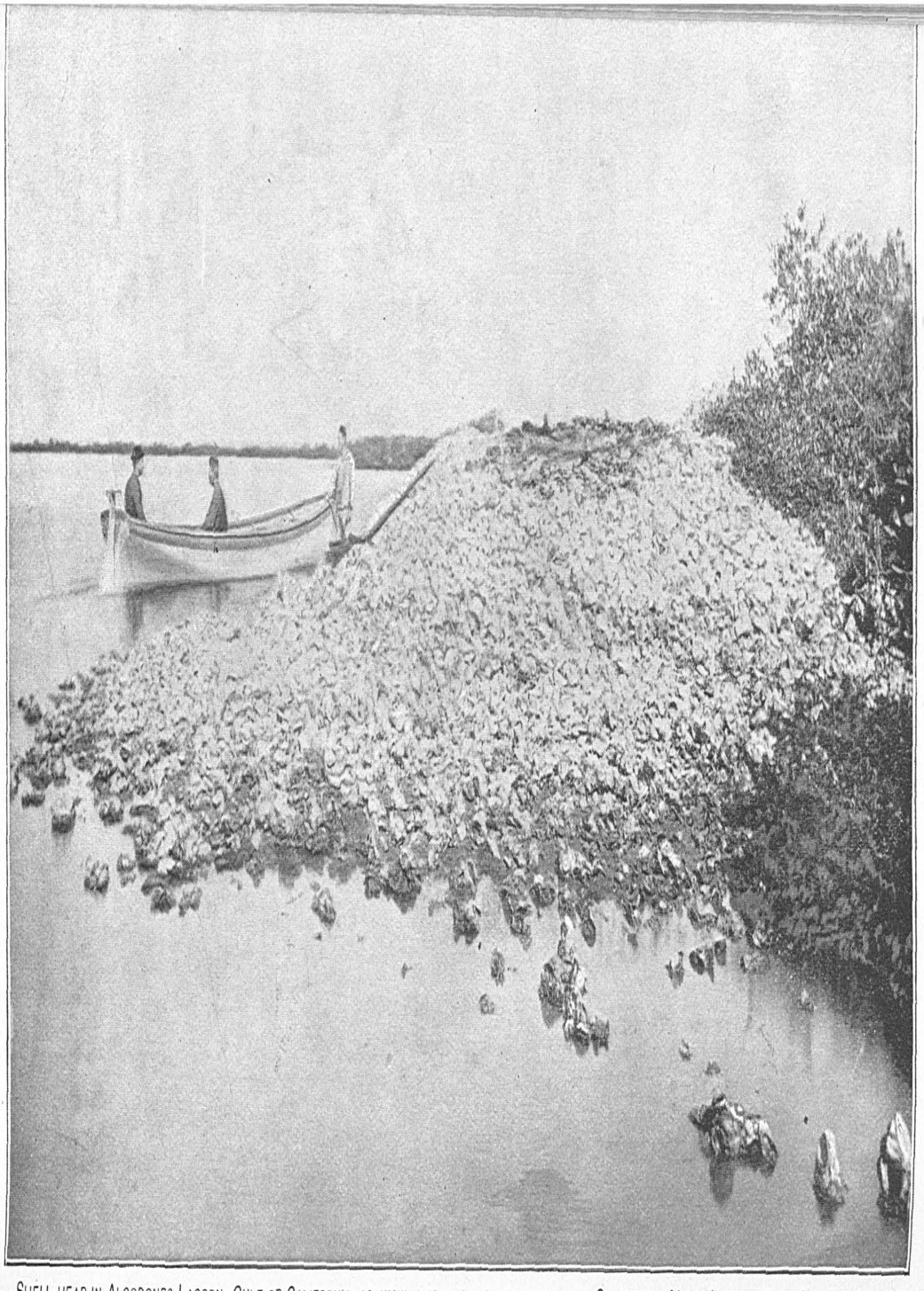
2593. (*Small oysters to be returned to beds.*) It shall not be lawful for any person to destroy oysters taken from the natural beds by assorting or culling them on land or shore and leaving the small oysters that are there to die; but in all cases the small oysters shall be returned to their natural beds, or to private beds for cultivation. And if any person shall offend against the provisions of this section, or in any way wantonly destroy the small oysters, he shall, on conviction thereof, be liable to a fine for each offense, or imprisonment as prescribed in section 2591 of this volume of general statutes.

2594. (*Right acquired by discovery of oyster bed.*) Any person or persons, being a citizen or citizens of the United States, who shall discover any bed or beds of oysters in any bay or arm of the sea bordering upon this State that has not been before discovered, shall, by right of said discovery, be entitled to the exclusive right or privilege of gathering or dredging oysters on said bed or beds for the term of five years. The person or persons making such discovery, who desires to avail himself of the rights and privileges hereby granted, shall be required to designate the place and area of the bed or beds so discovered, with the stakes or other artificial marks, and shall make affidavit before the county auditor of the county in which such discovery has been made that he located the premises so discovered, accompanied by a description and diagram of the same, which shall be filed in the office of said county auditor: *Provided*, That the restriction and protection of the discoveries shall be 10 acres.

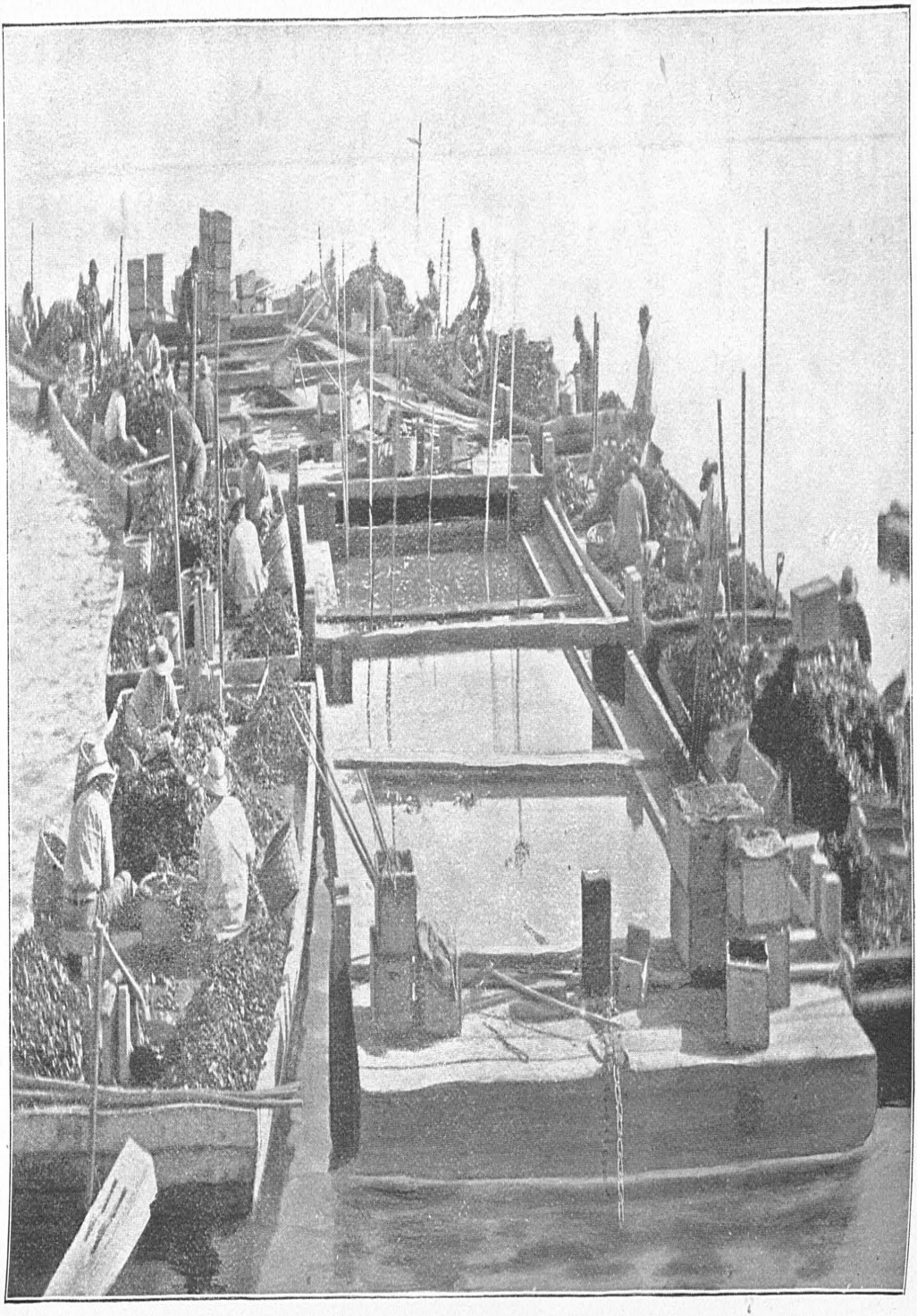
2595. (*Unlawful to gather oysters from beds located by another—Penalty.*) It shall not be lawful for any person to gather by any means on any beds located in accordance with the preceding section, except at the option and by the permission of the party or parties holding the same, under a penalty of $500 fine for so offending, or imprisonment, to be recovered in a civil action, to be brought in the name of the State.

2596. (*Time allowed certain persons in which to remove oyster beds.*) Any person who has, prior to the 26th day of March, A. D. 1890, planted oyster beds upon any of the shore lands of this State, shall be granted a period of not less than six months nor more than three years after said land has been sold by the State to remove the same; the time to be determined by the commissioner of public lands. And any person shall have the exclusive possession of said tide or shore lands during the time that he has to remove said oyster beds under the provisions of this act: *Provided*, That in case any planter of oysters shall fail within the time allotted to remove the said oysters, he shall be deemed to forfeit the same to the purchaser or owner of said lands: *Provided*, That this shall not apply to tide lands within two miles of an incorporated city.

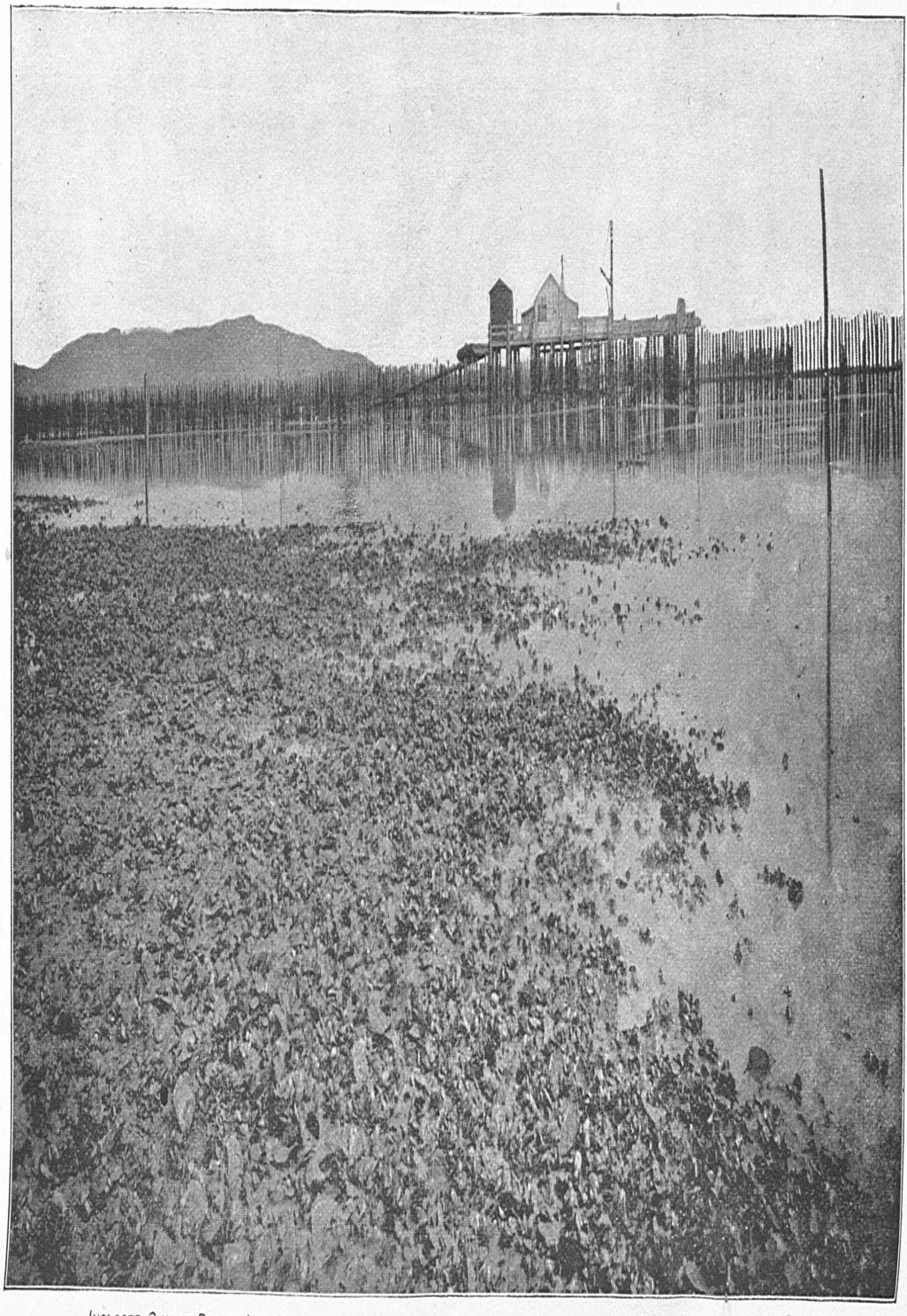
2597. (*Construction of word "person."*) Wherever the word "person" is used in this act, it shall be deemed to mean person, persons, firm, or corporation.



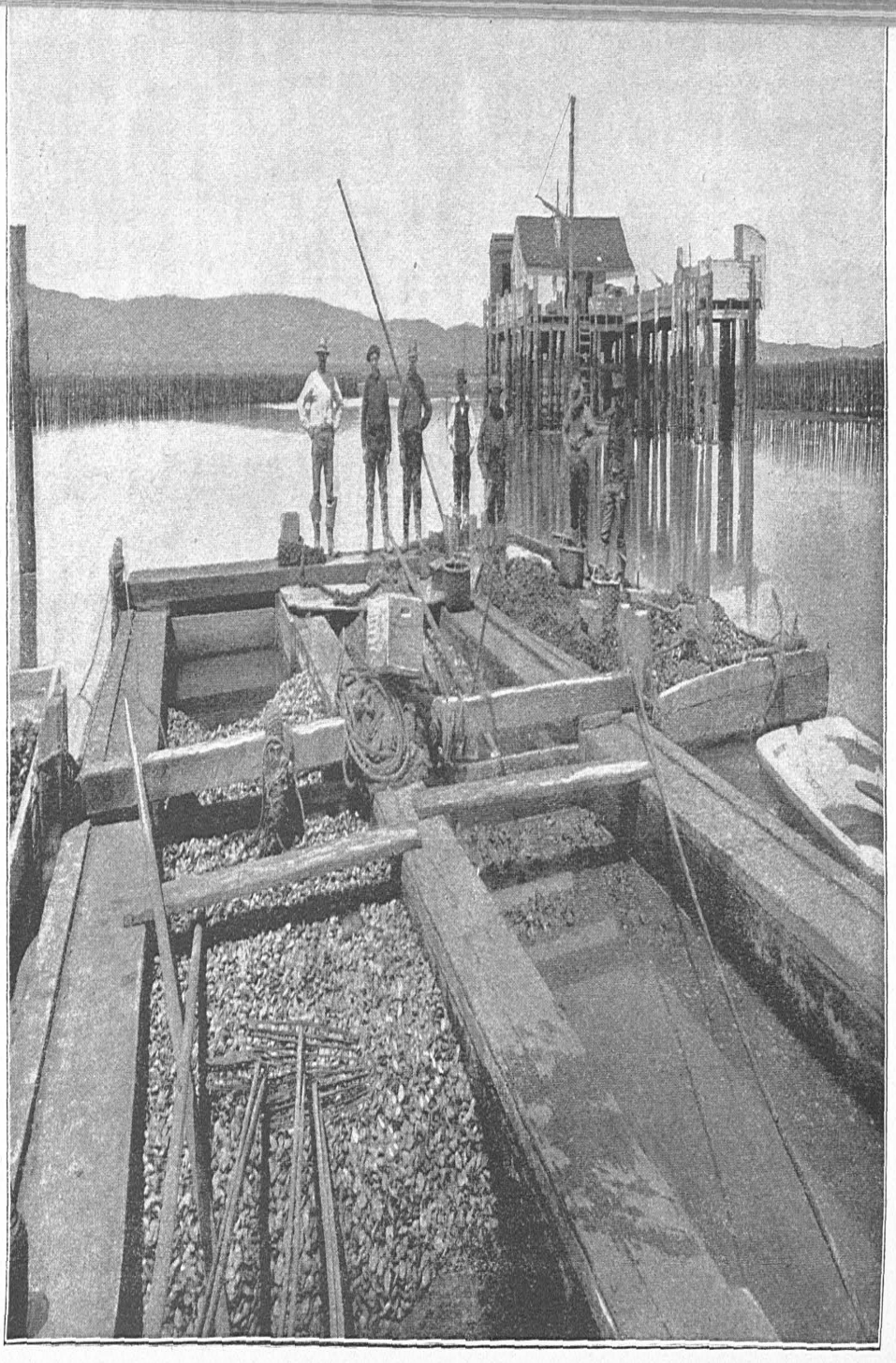
SHELL-HEAP IN ALGODONES LAGOON, GULF OF CALIFORNIA, ACCUMULATED THROUGH THE DRYING OF OYSTERS BY YAQUI INDIANS. LIVE OYSTERS AROUND MARGIN.



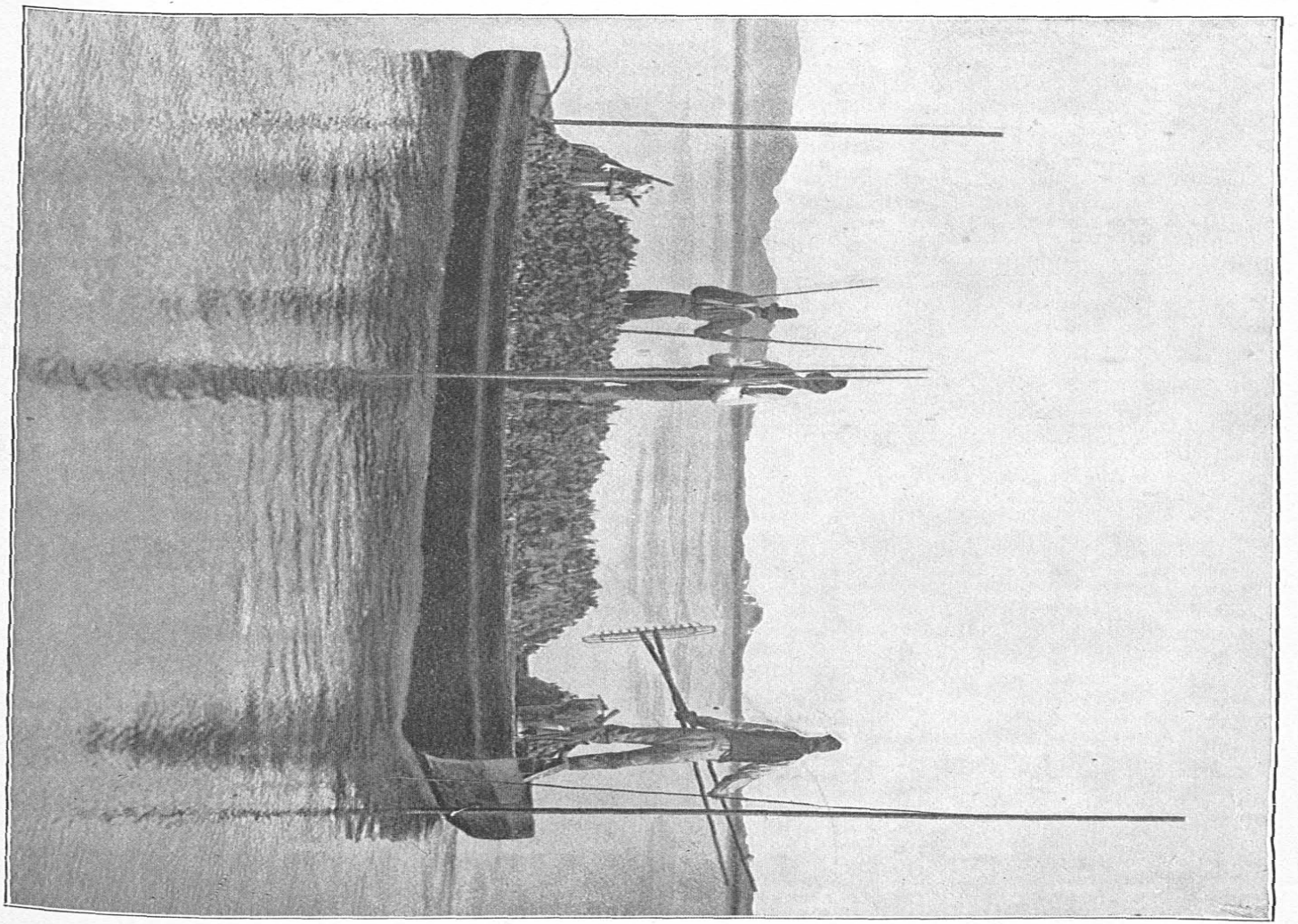
CULLING OYSTERS; SINGLE FLOAT IN FOREGROUND, DOUBLE FLOAT IN BACKGROUND; SCOWS, ETC. THE MORGAN OYSTER COMPANY'S STATION AT MILLBRAE.



INCLOSED OYSTER BED AT LOW TIDE, SHOWING HOW THICKLY OYSTERS ARE LAID OUT. M. B. MORAGHAN'S ESTABLISHMENT.



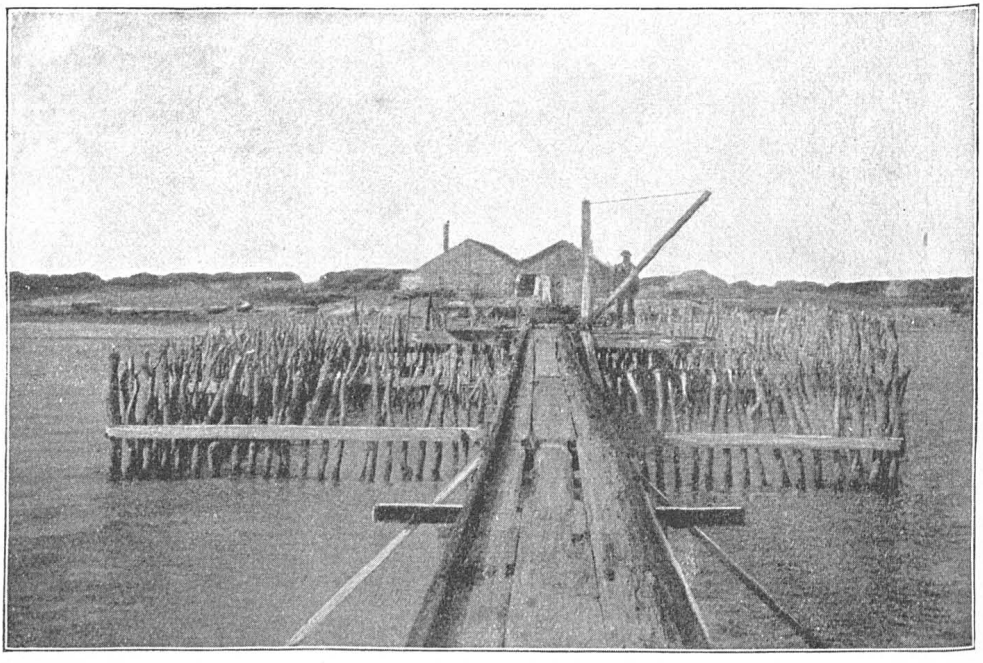
LARGE DOUBLE FLOAT, WITH SCOWS, TONGS, BASKETS, AND OTHER FEATURES OF THE OYSTER FISHERY. M. B. MORAGHAN'S ESTABLISHMENT.



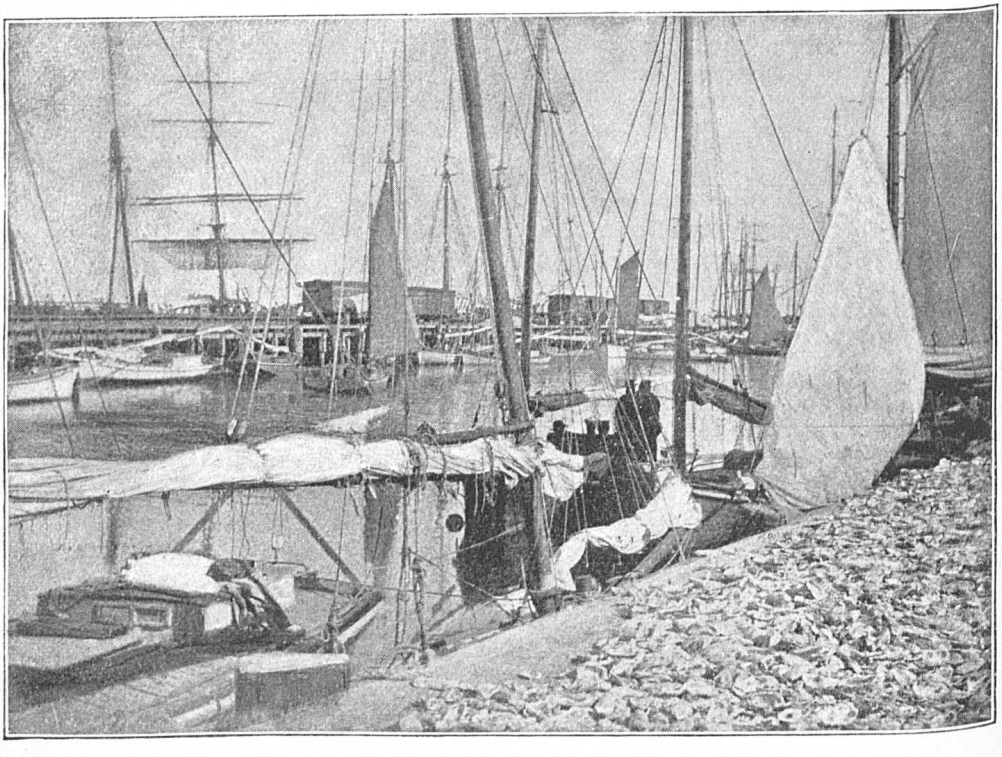
TONGING OYSTERS IN SAN FRANCISCO BAY.

BAY CENTER, WASHINGTON. CENTER OF OYSTER FISHERY OF WILLAPA BAY.

Report U. S. F. C. 1889 to 1891. (To face p. 372.)



GREEN-TURTLE CANNERY AT FULTON, WITH TURTLE PEN IN THE FOREGROUND.



FISH AND OYSTER BOATS IN "VEGETABLE SLIP," GALVESTON.