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DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

HUGH W. SMITH, *Commissioner*

CONDITION AND EXTENT OF THE NATURAL  
OYSTER BEDS AND BARREN BOTTOMS  
OF LAVACA BAY, TEXAS

By H. F. MOORE

*Assistant in Charge of Scientific Inquiry*  
*U. S. Bureau of Fisheries*

AND

ERNEST DANGLADE

*Scientific Assistant*

APPENDIX II TO THE REPORT OF THE U. S. COMMISSIONER  
OF FISHERIES FOR 1914



Bureau of Fisheries Document No. 809

WASHINGTON  
GOVERNMENT PRINTING OFFICE

1915

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# CONDITION AND EXTENT OF THE NATURAL OYSTER BEDS AND BARREN BOTTOMS OF LAVACA BAY, TEXAS.

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By H. F. MOORE, *Assistant in Charge of Scientific Inquiry, Bureau of Fisheries,*

AND

ERNEST DANGLADE, *Scientific Assistant.*

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## INTRODUCTION.

This survey was made at the request of Col. W. G. Sterett, game, fish, and oyster commissioner of Texas, preferred through Hon. A. S. Burleson, at that time Representative in Congress from Texas, who secured an act of Congress authorizing the work.

The investigation began on February 1, 1913, and was concluded May 12. The steamer *Fish Hawk* served as the base of operations until the examination of the lower two-thirds of the bay had been completed, after which, from April 1 until the end of the work, the field party, consisting of the scientific staff and a detail from the vessel, made their headquarters on a shallow-draft schooner which could enter the shoal waters not practicable for the steamer.

The survey was under the immediate direction of Mr. T. E. B. Pope, scientific assistant, whose subsequent resignation from the service prevented his preparation of the report. Mr. Danglede was second in charge and the biological investigations were made by him. Chief Boatswain William Martin was in command of the vessel until his detachment, after which Boatswain J. J. O'Brien assumed command.

The work was much hampered by bad weather, and after practically all of the signals had been erected they were blown down by a gale. The triangulation was carried into the bay from two old stations ("Sand" and "La Salle") of the Coast and Geodetic Survey which were recovered. The signals were cut in as carefully as possible with the sextant, the accuracy of the work being checked by erecting certain of the signals in two ranges diverging from "Sand." While this method does not give the precision exacted by the Coast Survey, it is sufficiently exact for the purposes of the present investigation.

No previous oyster survey has been made in Lavaca Bay, but in 1905 an investigation similar to this was conducted in Matagorda Bay, above Half Moon Reef, a report being published in the following year.

## METHODS OF THE SURVEY.

The methods employed were those pursued in former surveys of like character, and are explained in detail in a description of the beds of the James River,<sup>a</sup> from which some of the following is repeated:

A "boat sheet" was prepared, on which were accurately platted the positions, as determined by triangulation, of lighthouses, buildings, tripods, etc., used as signals. These data were furnished by the United States Coast and Geodetic Survey.

The oyster beds were discovered by soundings with a lead line, but principally by means of a length of chain dragged over the bottom at the end of a copper wire running from the sounding boat. The wire was wound on a reel and its unwound length was adjusted to the depth of water and the speed of the launch, so that the chain was always on the bottom. Whenever the chain touched a shell or an oyster the shock or vibration was transmitted up the wire to the hand of a man whose sole duty it was to give heed to such signals and report them to the recorder.

The launches from which the soundings were made were run at a speed of between 3 and 4 miles per hour. At intervals of three minutes—in some cases two minutes—the position of the boat was determined by two simultaneous sextant observations of the angles between a set of three signals, the middle one of which was common to the two angles, the position being immediately platted on the boat sheet. At regular intervals of 15 seconds, as measured by a clock under the observation of the recorder, the leadsman made a sounding and reported to the recorder the depth of the water and the character of the bottom, immediately after which the man at the wire reported the character of the chain indications since the last sounding—that is, whether they showed barren bottom or dense, scattering, or very scattering growths of oysters.

With the boat running at 3 miles per hour the soundings were between 60 and 70 feet apart, and, as the speed of the boat was uniform, the location of each was determinable within a yard or two by dividing the platted distance between the positions determined by the sextant by the number of soundings. The chain, of course, gave a continuous indication of the character of the bottom, but the record was made at the regular 15-second intervals observed in sounding.

The chain, while indicating the absence or the relative abundance of objects on the bottom, gives no information as to whether they are shells or oysters, nor, if the latter, their size and condition. To obtain these data it was necessary to supplement the observations already described by others more definite in respect to the desired

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<sup>a</sup> Moore, H. F.: Condition and extent of the oyster beds of James River, Va. Bureau of Fisheries Document no. 729.

particulars. Whenever, in the opinion of the officer in charge of the sounding boat, such information was required, a numbered buoy was dropped, the time and number being entered in the sounding book. Another launch, following the sounding boat, anchored alongside the buoy, and a quantity of the oysters and shells were tonged up, separated by sizes, and counted.

This boat at each station made a known number of "grabs" with the oyster tongs, exercising care to clean the bottom of oysters as thoroughly as possible at each grab. In a given depth of water and using the same boat and tongs, an oysterman will cover practically the same area of the bottom at each grab, but, other factors remaining the same, the area of the grab will decrease with an increase in the depth.

Careful measurements were made and tabulated showing the area per grab covered by the tonger employed on the work at each foot of depth of water and for each pair of tongs and boat used. With these data, and knowing the number of "grabs," the number of oysters of each size per square yard of bottom was readily obtainable by simple calculation. The following example will illustrate the data obtained and the form of the record:

## DEPARTMENT OF COMMERCE AND LABOR.

## BUREAU OF FISHERIES.

*Field record of examinations of oyster beds.*

General locality, <i>Mississippi Sound.</i>	
Local name of oyster ground, <i>Scranton Reef.</i>	
Date, <i>February 1, 1911.</i>	Time, <i>2.00 p. m.</i>
Angle, <i>H 101.</i>	Buoy No. <i>6.</i>
Depth, <i>4.3.</i>	Bottom, <i>Soft, over 7½'.</i>
Condition of water, <i>Thick.</i>	
Density, <i>1.016.</i>	Temperature, <i>19.</i>
Current,	Stage of tide, <i>Flood.</i>
No. grabs made, <i>8.</i>	Tongs, <i>10 feet.</i>
Total area covered, <i>2.36 square yards.</i>	
No. oysters taken	{ —1 in., <i>20.</i>
	{ 1 in.—3 in., <i>101.</i>
	{ 3 in.—4 in., <i>11.</i>
	{ 4 in., <i>0.</i>
Quantity shells, <i>0. 8 dead.</i>	
Result	{ Spat per square yard, <i>8.3.</i>
	{ Culls per square yard, <i>42.2.</i>
	{ Counts per square yard, <i>4.6.</i>

This furnishes an exact statement of the condition of the bed at the spot, which can be platted on the chart with error in position of not more than a few yards. From the data obtained a close esti-

mate may be formed of the number of bushels of oysters and shells per acre in the vicinity of the examination, and, by multiplying the observations, for the bed as a whole. In the course of the survey 472 observations were made at various places, principally on the natural rocks, but some on the barren bottoms also.

In estimating the productiveness of the bottoms it appeared desirable to use the method employed in Delaware Bay <sup>a</sup> rather than that followed in the James River survey.

Where tongs are used exclusively a bed with a given quantity of oysters lying in shoal water is more valuable commercially than one with the same quantity of oysters in deeper water; owing to the fact that the labor of the tonger is more efficient on the former. As has been pointed out, the area covered by a "grab" decreases with the depth, other factors being the same; and, moreover, the deeper the water the greater is the labor involved in making the grab and the smaller is the number of grabs which can be made in a given time. Where, however, the depth is practically uniform and shoal, as in the region treated in this report, it is unnecessarily refined and laborious to make such allowance for depth, and it is nearly as accurate and satisfactory to rate the bottoms in accordance with an arbitrary standard.

In this report the classification of the relative productiveness of the various beds and parts of beds, as exhibited on the chart and discussed in the text, is as follows:

Dense growth.....	Bearing over 150 bushels per acre.
Scattering growth.....	Bearing between 75 and 150 bushels per acre.
Very scattering growth.....	Bearing between 25 and 75 bushels per acre.
Depleted bottom.....	Bearing less than 25 bushels per acre.

This classification refers solely to oysters of a size assumed to be large enough for the market, in this case to those 3 inches or more in length. As the classification takes no account of the smaller oysters, certain areas bearing a heavy growth of young may be described and shown on the chart as depleted, owing to the paucity of mature oysters. While the charts can not indicate this, the descriptions of the beds show it in all cases. The charts show in general terms the character of the beds in respect to the product available for market, so far as mere size of the oysters is concerned, at the time of the survey. If the oysters were of ordinarily good condition and shape, which unfortunately in most cases they were not, the areas indicated as bearing dense and scattering growth would yield a product sufficient to make tonging remunerative under the economic conditions existing. Where the market oysters are rated as very scattering, the growth is insufficient to support a fishery at the low price which the product

<sup>a</sup> Condition and extent of the natural oyster beds of Delaware. By H. F. Moore, assistant, United States Bureau of Fisheries. Bureau of Fisheries Document no. 745, 1911.

would yield. The depleted bottom is that on which the product of market oysters, at the time of the survey, was very small, and is not necessarily formerly productive bottom now denuded, as might be supposed from a strict definition of the descriptive term employed. On the contrary, it may be formerly barren bottom now coming into production.

The barren bottom, which is that totally devoid of oysters, and in most cases of shells, vastly exceeds the oyster bottom in extent. Its interest in connection with the survey lies in its relative availability for oyster culture; that is, whether or not its general character is such as to enable it to become productive, if proper measures to that end be taken. The most important consideration is, usually, the character and degree of stability of its constituent materials. If the bottom be too soft, the shells and oysters deposited thereon will soon become engulfed.

In previous surveys the method ordinarily used by oystermen has been employed, the consistency of the bottom being determined by probing with a pole. By noting the resistance which the bottom imposes to the penetration of the probe, the observer forms an opinion of its relative hardness and of its suitability in that respect for oyster culture. In many cases different observers will not agree as to the proper term by which to describe the bottom so tested, and it is therefore difficult to convey to another the meaning desired. To overcome this difficulty an instrument <sup>a</sup> has been devised which gives these data mechanically, by measuring the number of inches the bottom is penetrated by a plunger of a constant weight and size falling through a uniform distance. The instrument is used from an anchored boat, from 6 to 10 tests being made at each station. Any readings which are markedly higher or lower than the others are discarded on the assumption that the plunger has fallen into a crab hole or other depression, or that it has encountered a shell or similar accidental obstruction. The average of the remaining depths of penetration, as indicated on the scale of inches inscribed on the rod, is regarded as the measure of the consistency of the bottom.

The following designations used to indicate the different degrees of hardness, as shown by the instrument, are arbitrary, although based on the terms used by the oyster growers:

Hard.....	Penetration less than 4 inches.
Stiff.....	Penetration between 4 and 8 inches.
Soft.....	Penetration between 8 and 13 inches.
Very soft.....	Penetration between 13 and 18 inches.
Ooze.....	Penetration over 18 inches.

<sup>a</sup> Illustrated and described in "Condition and extent of the natural oyster beds and barren bottoms of Mississippi Sound, Alabama." By H. F. Moore, Bureau of Fisheries Document no. 769.

These various types of bottom are shown on the chart by means of circles, the relative area of black included within them indicating the relative degree of hardness, as follows: Hard, a black circle; stiff, a black semicircle; soft, a black quadrant; very soft, two crossing diameters; ooze, one diameter.

The bottoms classed as hard and stiff, those in which the plunger will not penetrate more than 8 inches, are suitable for planting without preparation, provided they are not composed of shifting sand. As sand invariably gives a reading of less than 4 inches, and is therefore rated as "hard," it follows that all "stiff" bottom shown on the chart by a black semicircle can be accepted as safe for planting. Part of the hard bottom is composed of mud and part of sand. The former may be accepted without hesitation, but the latter should be examined with respect to its liability to shift. Soft bottom should be planted with care, and toward its upper or less consistent limits may require some preliminary hardening with shells or sand. Very soft bottom and ooze should not be considered, as oysters planted there will sink, and if not killed, as is probable, will be ill-shaped and inferior in every respect. The ratings on which the classification is based have been checked by observation on bottoms actually used for oyster culture in Chesapeake Bay.

The instrument employed has been thoroughly tested and is reliable for the purposes of oyster surveys, but there may be errors in cases where hard bottom is overlaid by several inches of soft mud and ooze. Such bottoms are always readily detected by probing with a pole.

#### LAVACA BAY.

Lavaca Bay is the northwest arm of Matagorda Bay and, exclusive of minor bays, covers an area of about 60 square miles. Its greatest width, including Kellers Bay, is about 7 miles, and it has a length, from Sand Point to the head of Garcitas Bay, of about  $12\frac{1}{2}$  miles. It is about 2 miles wide at its mouth, but the effective width for purposes of navigation is much reduced by bars and oyster reefs. The mouth is about 15 miles from Pass Cavallo, the entrance from the Gulf of Mexico, in which there is a variable depth of 9 to 10 feet on the bar. Most of the lower half of the bay, excluding the shore waters and the reefs, is from 7 to 9 feet deep, and a draft of about 7 feet can be carried at low water through the two short dredged channels and to within a short distance of Lavaca, the only town on the bay and the center of the oyster industry of the region. The upper half of the bay has an average depth of 4 to 5 feet. The streams tributary are Cavallo River, Garcitas River, Benado Creek, and Lavaca River, of which the latter is the largest. All of these flow into the upper part of the bay.

In the survey 16,153 soundings were made on lines aggregating 362 miles, the position of the boat being instrumentally fixed at about 800 places. The character of the oysters and the nature of the bottom were determined at 464 stations, of which 228 were on the reefs and 236 on barren bottom, in addition to continuous chain readings over a distance of 362 miles. The data available, therefore, are sufficient to give an unusually accurate idea of the conditions for both natural growth and oyster culture.

### DESCRIPTION OF NATURAL BEDS.

#### SAND POINT REEF.

This reef is located on the northwest side of Sand Point and extends in a southwesterly direction to join the more productive Middle Ground Reef. There is no distinct line of demarcation between these two reefs, but there is a gradual change in the character of the bottom from sand to stiff mud. The average width of the reef is about one-fourth of a mile, the length is about seven-eighths of a mile, and the area is about 160 acres. Comparison of the charts of the present survey with the coast survey charts shows that this bed is gradually extending westward.

This reef bears singles and scattering bunches of good oysters, nearly all of which are marketable. It has been fished for at least the last 16 years and has never been entirely depleted, and at the time of the survey the average tonger could take about three barrels of oysters per day. On account of the protection afforded by Sand Point it is fished principally when weather conditions prevent the working of the more productive neighboring beds. The area, condition of oyster growth, and estimated content of this bed are shown in the following table:

OYSTER GROWTH ON SAND POINT REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Dense.....	78	336	212	26,208	16,536	42,744
Very scattering.....	20	604	57	12,080	1,140	13,220
Depleted.....	62	136	6	8,432	372	8,804
Total.....	160			46,720	18,048	64,768

## DETAILS OF EXAMINATION OF SAND POINT REEF.

Sta- tion.	Date of examina- tion.	Depth of water.	Area cov- ered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
48	Mar. 6	4.5	1.79	12.3	4.4	2.2	13	201	532	733	Dense.
101	Mar. 11	5.5	1.99	2.5	7.0	8.5	10	115	219	334	Do.
12	Mar. 6	5.5	1.99	43.7	42.2	4.1	29	1,031	99	1,130	Do.
100	Mar. 11	6.5	1.82	29.6	20.4	2.2	15	604	57	661	Very scat- tering.
47	Mar. 6	4.0	1.99	5.0	.0	.0	9	60	0	60	Depleted.
98	Mar. 11	5.0	2.12	10.4	7.1	0.5	12	212	13	225	Do.

The areas of more scanty growth lie along the eastern margin of the bed, the dense growth being found in the parts contiguous to the middle ground. The bottom over practically the entire bed is hard, owing to the preponderance of sand. The oysters for Sand Point Reef were, at the time of the survey, superior in shape and fatness to those from adjacent beds.

## LUMPS NORTHEAST OF SAND POINT REEF.

There is a small lump of 5 acres about one-half mile to the north-east of Sand Point Reef. One station was made which disclosed 23.6 counts and 24 shells per square yard. Between this lump and Sand Point Reef the bottom is generally hard and affords more or less scattered and irregular clusters rather close to the shore line, but does not interfere with seining. There were formerly oysters of good quality here, although they were never dense, but they have been practically fished out.

A patch containing 67 acres of very scattering oysters is located near the main reef off Sand Point. The bottom is hard sand and the shells are more or less covered with yellow sponge.

The conditions on these unimportant patches are shown in the following table:

## OYSTER GROWTH ON LUMPS NORTHEAST OF SAND POINT REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Dense.....	5	662	611	3,310	3,055	6,365
Very scattering.....	67	426	40	28,542	2,680	31,222
Total.....	72			31,852	5,735	37,587



## DETAILS OF EXAMINATION OF LUMPS NORTHEAST OF SAND POINT REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
94	1913. Mar. 11	Feet. 4.0	Sq. yds. 1.99	31.1	23.6	23.6	24	Bush. 662	Bush. 611	Bush. 1,273	Dense. Very scattering. Do.
96	...do....	7.0	1.79	35.8	15.2	2.3	44	616	53	669	
97	...do....	6.5	1.82	22.0	17.6	1.1	40	236	28	264	

## MIDDLE GROUND REEF.

This lies at the entrance of Lavaca Bay and extends from near the western shore line in a northerly direction for approximately  $1\frac{7}{8}$  miles, with an average width of about one-fourth mile. The upper half of the reef broadens toward the east and merges with Sand Point Reef, the arbitrary line of demarcation used in this report being the strip of deep water running toward the northeast. The greatest depth found in tonging on this reef was  $8\frac{1}{2}$  feet at the extreme western point and the least was  $3\frac{1}{2}$  feet near the beacons. There are, however, a number of depressions along the eastern border with a depth of 10 to  $13\frac{1}{2}$  feet, and the dredged channel marked by beacons no. 1 and no. 2 has a depth of 7 feet. The material dug from this channel was thrown to the westward of the beacons and becomes exposed during low tides. The extent and general condition of the bed are shown in the following table:

## OYSTER GROWTH ON MIDDLE GROUND REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	Acres. 444	Bushels. 809	Bushels. 960	Bushels. 359,196	Bushels. 426,240	Bushels. 785,436
Scattering.....	28	761	137	21,308	3,836	25,144
Total.....	472	.....	.....	380,504	430,076	810,580

With the exception of a comparatively small area of scattering oysters near the northeast margin of the bed adjoining Sand Point Reef, the entire reef is covered with dense growth, which in some places amounts to nearly 4,900 bushels per acre, about equally divided between small and adults. It is not probable that this extraordinary denseness of growth obtains over a very wide area, but there are many places on which there are in excess of 2,500 bushels per acre. As is to be expected under such conditions, the oysters are clustered and rough, and in quality they are generally inferior to

those on the less densely populated Sand Point Reef. The bed was tonged through the season and the average tonger could take about 4 barrels per day.

A few drills were found and some specimens of the yellow boring sponge.

The following table shows the details of the examination of the bed:

DETAILS OF EXAMINATION OF MIDDLE GROUND REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
1	Mar. 5	4.0	2.65	31.6	17.7	23.0	8	578	555	1,133	Dense.
2	do.	5.0	1.59	18.3	17.6	17.6	8	430	428	858	Do.
13	Mar. 6	5.5	1.99	53.8	37.2	55.3	20	1,092	1,336	2,428	Do.
14	do.	6.0	1.39	10.8	17.3	12.3	8	338	299	637	Do.
15	do.	5.5	1.99	25.6	15.6	35.7	11	496	862	1,358	Do.
16	do.	5.5	1.99	31.2	31.6	40.2	18	759	971	1,730	Do.
17	do.	5.5	1.99	33.2	32.2	69.9	20	789	1,687	2,476	Do.
18	do.	4.0	1.99	22.1	36.2	38.7	7	704	937	1,641	Do.
19	do.	5.0	1.59	34.6	40.8	52.8	19	909	1,279	2,188	Do.
20	do.	4.0	1.99	23.2	36.7	51.8	7	722	1,254	1,976	Do.
21	do.	5.0	1.59	28.9	48.5	47.2	8	934	1,141	2,075	Do.
22	do.	5.0	2.12	7.6	12.8	19.5	7	246	472	718	Do.
23	do.	6.0	1.86	21.5	22.1	27.1	5	526	657	1,183	Do.
24	do.	6.0	1.86	20.4	19.9	30.6	13	485	740	1,225	Do.
27	do.	6.5	1.82	14.3	15.4	19.8	8	359	478	837	Do.
50	Mar. 10	5.5	1.99	74.8	57.8	55.5	26	1,601	1,464	3,065	Do.
83	Mar. 11	6.5	4.17	6.0	7.5	5.8	6	163	150	313	Do.
84	do.	6.0	5.21	9.6	10.2	8.4	3	239	218	457	Do.
85	do.	6.0	3.91	21.0	12.3	20.5	7	402	530	932	Do.
86	do.	6.0	3.91	15.2	15.4	20.5	13	371	530	901	Do.
87	do.	5.0	4.41	16.1	19.8	38.6	17	434	998	1,432	Do.
90	do.	4.5	1.56	3.8	17.3	21.2	15	255	550	805	Do.
91	do.	4.5	4.73	19.2	18.9	28.9	12	578	749	1,327	Do.
102	Mar. 13	5.0	5.90	101.0	84.5	53.8	12	2,241	1,299	3,540	Do.
103	do.	6.5	3.13	86.0	105.0	107.0	22	2,312	2,582	4,894	Do.
104	do.	5.5	4.17	70.5	79.2	78.5	14	1,805	1,893	3,698	Do.
105	do.	6.0	3.90	108.5	74.7	72.5	9	1,780	1,746	3,526	Do.
106	do.	6.5	1.82	32.9	39.5	38.4	12	874	927	1,801	Do.
107	do.	6.0	1.39	51.7	56.1	60.4	26	1,302	1,457	2,759	Do.
108	do.	6.0	1.39	10.1	40.0	38.8	39	607	936	1,543	Do.
113	do.	5.5	1.99	12.1	17.1	16.1	14	353	389	742	Do.
114	do.	4.5	1.79	61.9	75.9	75.9	42	1,669	1,830	3,499	Do.
115	do.	8.5	2.00	14.0	14.5	15.0	30	344	362	706	Do.
11	Mar. 6	5.5	2.12	43.0	35.0	6.2	28	937	149	1,086	Scattering.
109	Mar. 13	7.0	1.79	35.2	39.6	5.6	44	906	135	1,041	Do.
112	do.	7.0	1.79	16.7	19.7	5.0	25	440	128	568	Do.

OLD TOWN BED.

This bed, which is rudely triangular in shape, with the broader end to the north, is located in the southern end of the bay near the entrance. It is separated from the preceding bed by a channel about 11 to 12 feet deep. It is about  $1\frac{1}{4}$  miles long by one-third mile wide, and including the small lump to the south contains approximately 342 acres. The depth on the western side is from 4 to  $4\frac{1}{2}$  feet, while the greatest depth, that of  $6\frac{1}{2}$  to  $7\frac{1}{2}$  feet, is along the northern and eastern borders.

The oysters of this bed are frequently covered to some extent with yellow sponge, and they usually occur in large irregular clusters with sharp edges. But few drills were observed.

The quality of the oysters is not as good as that of the near-by Middle Ground Reef, and the bed was not being worked during the survey. The bed is composed entirely of dense growth, as shown in the following tables:

OYSTER GROWTH ON OLD TOWN BED.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	<i>Acres.</i> 328	<i>Bushels.</i> 683	<i>Bushels.</i> 943	<i>Bushels.</i> 224,024	<i>Bushels.</i> 309,304	<i>Bushels.</i> 533,328

DETAILS OF EXAMINATION OF OLD TOWN BED.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
25	Mar. 6	5.5	1.99	37.2	27.6	30.2	32	782	729	1,511	Dense.
26	do	7.0	1.34	47.7	34.4	48.5	20	871	1,172	2,043	Do.
57	Mar. 10	7.5	1.34	48.4	21.6	40.9	14	845	1,060	1,905	Do.
58	do	7.5	1.34	23.8	15.6	24.5	13	250	642	892	Do.
60	do	8.0	1.34	40.0	20.4	40.1	15	476	1,038	1,514	Do.
61	do	7.0	1.34	70.1	46.8	60.8	30	1,412	1,576	2,988	Do.
79	Mar. 11	7.0	3.13	26.2	15.0	17.6	7	498	456	954	Do.
81	do	6.5	3.13	20.5	13.4	21.8	16	409	564	971	Do.
88	do	6.5	3.13	25.0	19.8	26.8	22	542	694	1,236	Do.
89	do	6.0	3.91	60.8	20.5	60.8	23	981	1,575	2,556	Do.
117	Mar. 13	7.0	2.34	28.5	42.1	42.1	24	856	1,020	1,876	Do.
165	Mar. 18	7.0	1.79	11.2	12.3	33.0	11	284	796	1,080	Do.

LUMP SOUTH OF OLD TOWN BED.

This small lump, which is about 125 yards south of Old Town Bed and 50 yards from the west shore, contains 14 acres. Two stations were made, each showing a dense growth of clustered oysters, which were more or less covered with yellow sponge. The bottom was hard and the depth of water from 3½ to 5 feet. No work was being conducted on this lump during the survey. The following tables sufficiently indicate its character:

OYSTER GROWTH ON LUMP SOUTH OF OLD TOWN BED.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	<i>Acres.</i> 14	<i>Bushels.</i> 499	<i>Bushels.</i> 665	<i>Bushels.</i> 6,986	<i>Bushels.</i> 9,310	<i>Bushels.</i> 16,296

DETAILS OF EXAMINATION OF LUMPS SOUTH OF OLD TOWN BED.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
92 118	1913. Mar. 11	<i>Feet.</i> 7.0	<i>Sq. yds.</i> 2.35	18.4	21.0	30.8	10 11	<i>Bush.</i> 477	<i>Bush.</i> 793	<i>Bush.</i> 1,270	Dense. Do.
	Mar. 13	5.5	4.17	19.7	23.3	22.3		521	538	1,059	

A small lump, covering about 13 acres, lies about a quarter of a mile northwest of this bed, but although its position was determined no examination of the oysters was made.

BED NORTH OF MIDDLE GROUND REEF.

This bed, which has no local name, lies but a short distance to the north of Middle Ground Reef and is approximately 1 mile in length by one-fifth of a mile wide. It is not fished much for the market, as the stock is poor and largely of the sharp-edged long snapper or raccoon type, which occurs in scattering clusters more or less covered with yellow sponge. The average depth of water is about 6½ feet. The bottom varies from almost an ooze to rather hard mud and contains many buried shells. During the last two or three years a new growth has developed on old, partly buried shells south of the middle of the bed. The growth is all rated as dense, and its general condition is shown in the following tables:

OYSTER GROWTH ON BED NORTH OF MIDDLE GROUND REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	<i>Acres.</i> 173	<i>Bushels.</i> 410	<i>Bushels.</i> 431	<i>Bushels.</i> 70,930	<i>Bushels.</i> 74,563	<i>Bushels.</i> 145,493

DETAILS OF EXAMINATION OF BED NORTH OF MIDDLE GROUND REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
9 55 71 132 124	1913. Mar. 5	<i>Feet.</i> 6.5	<i>Sq. yds.</i> 1.37	14.6 43.8 37.2 16.2 .0	9.5 18.3 16.7 13.9 .0	11.7 27.6 36.4 8.9 .0	1 15 10 7 0	<i>Bush.</i> 289	<i>Bush.</i> 282	<i>Bush.</i> 571	Dense. Do. Do. Do. Do.
	Mar. 10	6.5	1.37					750	715	1,465	
	do. ....	7.5	1.34					651	944	1,595	
	Mar. 17	7.5	1.79					364	215	579	
	Mar. 14	7.0	.....					0	0	0	

## KELLERS BED.

Kellers Bed begins at the shoal water off Rhodes Point and extends southeastward for 3 miles. At its upper end it is half a mile in width, which gradually broadens to a mile near the center, then narrows rather suddenly to about 300 yards for the rest of its length.

Disregarding the shallow water off Rhodes Point, varying from 1 foot to 2½ feet, and the water immediately south of the point, ranging from 3 to 3½ feet, the average depth of water on the bed approximates 6½ feet.

The bottom is composed generally of hard mud, although four stations made at points along the eastern and southern edges revealed a barren bottom of stiff mud 5 to 8 inches deep, and at three tonging stations the bottom was found to be ooze.

The oysters occur in large, sharp-edged clusters and are generally "snappers" of poor quality, although at some stations well shaped but watery. Oysters were found on the southern end of the bed, which is depleted, the bottom being hard and covered with scattering dead shells on which were but few spats. The bed is not fished much except at the southern end, where, especially during the past two or three years, oysters have grown on shells thrown overboard by boats passing from Sand Point to Kellers Bay. This same condition applies to all parts of the bay, especially the lower end. The general conditions on the bed are shown in the following tables:

OYSTER GROWTH ON KELLERS BED.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Dense <sup>a</sup> .....	1,275	312	426	397,800	543,150	940,950
Depleted.....	12	65	0	780	.....	780
Total.....	1,287	.....	.....	398,580	543,150	941,730

<sup>a</sup>No stations were made on the shore skirting south of Rhodes Point.

## DETAILS OF EXAMINATION OF KELLERS BED.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Fect.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
6	Mar. 5	7.0	1.79	23.5	10.6	22.9	26	408	553	961	Dense.
7	do.	7.0	1.34	10.4	8.9	11.2	13	256	272	528	Do.
8	do.	7.0	1.34	17.2	11.9	9.7	11	349	234	583	Do.
39	Mar. 6	7.5	1.79	5.6	6.1	27.9	22	141	674	815	Do.
30	do.	8.0	-----	.0	.0	.0	0	0	0	0	
53	Mar. 10	8.0	1.34	17.8	13.4	32.7	12	375	847	1,222	Do.
65	do.	8.0	1.34	45.4	30.5	64.6	28	934	1,372	2,606	Do.
68	do.	7.5	1.34	27.0	14.6	24.8	16	503	643	1,146	Do.
69	do.	7.5	1.34	27.0	18.8	28.4	15	554	734	1,288	Do.
125	Mar. 14	8.0	1.79	24.0	16.2	26.8	26	485	646	1,131	Do.
126	do.	8.0	-----	.0	.0	.0	0	0	0	0	Do.
134	Mar. 17	7.0	1.79	15.1	10.0	28.2	11	303	683	986	Do.
136	do.	6.5	1.82	14.3	14.3	17.0	19	346	410	756	Do.
137	do.	7.0	1.79	17.9	9.5	24.0	19	332	577	909	Do.
148	do.	7.5	1.79	16.2	12.9	24.0	18	352	579	931	Do.
149	do.	7.0	-----	.0	.0	.0	0	0	0	0	Do.
152	do.	3.5	2.92	12.0	8.8	15.4	6	251	372	623	Do.
424	May 7	7.5	1.79	9.8	21.8	19.0	33	382	458	840	Do.
425	do.	7.5	1.79	11.7	15.1	19.5	33	324	471	795	Do.
426	do.	6.5	1.82	11.0	20.9	12.6	27	385	305	690	Do.
427	do.	6.0	1.85	4.8	8.6	10.2	9	185	246	431	Do.
151	May 17	7.5	-----	.0	.0	.0	0	0	0	0	Do.
45	Mar. 6	6.0	.93	5.4	.0	.0	18	65	0	65	Depleted.

There is a fringe of oysters occurring more or less regularly along the shore from the outer part of Rhodes Point eastward for about a mile. No stations were made here. A similar skirting is found along the shore north of Cox Bay, and also to the west of Lavaca River.

There is a small patch 90 by 300 yards to the southeast of the main bed with rather hard bottom and scattering clusters in about 6½ feet of water. The area of the patch is about 7 acres, and it is estimated to bear 4,018 bushels of small and 3,444 bushels of market oysters—an average of 574 and 492 bushels per acre, respectively. Some of the shells are more or less covered with a growth of yellow sponge. The oysters are about equal in quality to those of the main bed.

## RHODES POINT REEF.

This is a sickle-shaped bed extending from the end of Rhodes Point to the middle of the bay, with a total length of about 3 miles and an average width of somewhat less than one-half mile. The bottom is generally hard with the exception of a few limited areas near the end. The extent and general character of the oyster growth is shown in the following table:

OYSTER GROWTH ON RHODES POINT REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense <sup>a</sup> .....	<i>Acres.</i> 1,093	<i>Bushels.</i> 366	<i>Bushels.</i> 565	<i>Bushels.</i> 400,038	<i>Bushels.</i> 617,545	<i>Bushels.</i> 1,017,583
Scattering.....	121	103	87	12,463	10,527	12,990
Very scattering.....	3	12	53	36	159	195
Total.....	1,217	.....	.....	412,537	628,231	1,030,768

<sup>a</sup> Including a 9-acre detached patch.

With the exception of a scattering growth near the middle of the northern edge of the bed, and a very small patch of very scattering oysters, the entire bed is covered by a dense growth on which there is an average of over 500 bushels of large oysters per acre and a maximum of over 1,200 bushels. There is an abundance of small oysters, but both large and small are in commingled clusters and of poor quality. Mussels were found on the southern part of the reef and there is an abundance of yellow sponge.

The details of the examination of this reef are shown in the following table:

DETAILS OF EXAMINATION OF RHODES POINT REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
146	Mar. 17	6.0	1.86	15.7	19.4	40.0	11	425	965	1,390	Dense.
147	do.....	5.5	1.99	26.2	24.6	48.3	26	614	1,175	1,789	Do.
153	do.....	5.5	1.99	17.6	27.6	40.0	10	546	966	1,512	Do.
154	do.....	6.5	1.82	29.6	36.8	50.5	17	803	1,228	2,031	Do.
155	do.....	8.0	1.79	4.5	17.9	20.8	8	272	503	775	Do.
160	do.....	8.0	1.79	13.4	16.8	35.8	20	365	865	1,230	Do.
161	do.....	8.0	1.79	21.8	15.1	25.2	6	506	609	1,115	Do.
163	do.....	8.0	1.79	7.8	14.5	41.8	15	269	1,010	1,279	Do.
168	Mar. 18	8.0	1.79	11.2	10.6	27.4	17	264	661	925	Do.
170	do.....	6.0	1.86	25.9	17.7	24.3	11	527	586	1,113	Do.
171	do.....	5.5	1.99	25.6	4.0	7.0	5	358	169	527	Do.
179	Mar. 27	6.0	1.85	30.2	19.9	15.6	12	606	376	982	Do.
211	Mar. 28	7.5	1.79	3.3	10.0	10.0	6	163	242	405	Do.
255	Apr. 1	8.0	1.79	11.2	6.1	15.1	8	204	364	568	Do.
256	do.....	7.5	1.79	12.3	14.5	12.3	18	323	297	620	Do.
257	do.....	7.5	1.79	12.8	5.6	9.5	7	222	247	469	Do.
260	do.....	8.0	1.79	14.5	15.0	16.8	9	356	405	761	Do.
261	do.....	8.0	1.79	14.5	12.3	24.5	7	323	592	915	Do.
262	do.....	8.0	1.79	22.3	13.4	11.2	30	431	270	701	Do.
263	do.....	8.0	1.79	9.5	11.2	10.6	9	250	258	508	Do.
264	do.....	8.0	1.79	12.3	12.8	20.6	7	304	496	800	Do.
428	May 7	4.5	1.79	21.8	34.6	40.7	13	680	986	1,666	Do.
460	May 10	8.0	1.79	7.2	4.4	8.9	1	140	214	354	Do.
461	do.....	7.5	1.79	2.8	11.2	24.6	9	169	594	763	Do.
464	do.....	6.5	1.82	16.5	16.5	25.8	21	399	624	1,023	Do.
176	Mar. 27	7.0	.....	.0	.0	.0	0	0	0	0	Do.
462	May 10	8.0	1.79	9.5	10.6	10.0	7	142	142	284	Scattering.
463	do.....	8.5	1.79	5.6	8.3	5.0	9	168	121	289	Do.
162	Mar. 17	6.5	.....	.0	.0	.0	0	0	0	0	Do.

COX BED.

Cox Bed lies in and off the entrance to Cox Bay, and, like Rhodes Point Reef and Kellers Bed, with which it is continuous, it begins at Rhodes Point, extending north for about a mile and a half, and has a width of approximately the same distance.

On the southern part of the bed at Rhodes Point the depth is from 1 foot to 3½ feet, but the remainder, with few exceptions, has a uniform depth of about 6 feet.

The bottom is generally hard and covered by a dense growth of from about 250 to 550 bushels of market oysters per acre. These occur in scattered clusters and are of poor quality.

The character of the oyster growth is shown in summary and detail in the following tables:

OYSTER GROWTH ON COX BED.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	<i>Acres.</i> 1,177	<i>Bushels.</i> 364	<i>Bushels.</i> 358	<i>Bushels.</i> 428,428	<i>Bushels.</i> 421,366	<i>Bushels.</i> 849,794

DETAILS OF EXAMINATION OF COX BED.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
184	Mar. 27	6.0	1.85	9.7	16.3	10.2	31	314	246	560	Dense.
185	...do....	6.5	1.82	26.9	15.1	14.5	6	507	350	857	Do.
186	...do....	7.0	1.79	26.8	19.0	19.0	24	554	458	1,012	Do.
214	Mar. 28	6.0	1.85	22.6	28.5	22.6	20	616	545	1,161	Do.
215	...do....	6.0	1.85	21.2	18.9	19.9	8	485	480	965	Do.
216	...do....	6.0	1.85	6.5	7.5	11.8	8	159	285	444	Do.
217	...do....	7.5	1.79	10.6	12.8	20.9	10	283	505	788	Do.

Several small lumps east of this bed show oyster growths as follows:

OYSTER GROWTH ON LUMPS EAST OF COX BED.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense <sup>a</sup> .....	3	423	572	1,269	1,716	2,985
Scattering.....	31	267	120	8,277	3,720	11,997
Total.....	34	.....	.....	9,546	5,436	14,982

<sup>a</sup> Including a 3-acre patch west of main reef.



GALLINIPPER REEF.

This lies immediately adjacent to Gallinipper Point, from which it extends northward to the dredged channel, marked by beacons no. 3 and no. 4. It is somewhat circular in outline, with a diameter of three-fourths of a mile. The eastern portion is covered by 4 feet or less of water, the reef rising rather abruptly 2 feet or more above the general level of the surrounding barren bottom. From the crest of this ridge it slopes westward to the general level of the bottom.

The general conditions on the bed are shown in the following table:

OSTER GROWTH ON GALLINIPPER REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense <sup>a</sup> .....	Acres. 329	Bushels. 766	Bushels. 586	Bushels. 252,014	Bushels. 192,794	Bushels. 444,808
Scattering.....	32	231	145	7,392	4,640	12,032
Total.....	361			259,406	197,434	456,840

<sup>a</sup> Including a 3-acre patch west of main reef.

The oysters occur generally in clusters and are of rather poor shape but fair flavor. The reef has not been fished for the market to any extent in recent years, although it produces oysters of fair quality for shucking. Tongers can take but four or five barrels per day, owing to the time consumed in culling. It is understood that oysters from this bed have been used to some extent for seed. There are a few mussels and many barnacles and the yellow sponge is rather common. The details of the examination of this bed are shown in the following table:

DETAILS OF EXAMINATION OF GALLINIPPER REEF.

Station.	Date of examination.	Depth of water.		Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
		Feet.	Sq. yds.		Spat.	Culls.	Counts.		Seed.	Market.	Total.	
158	1913. Mar. 17	7.5	1.79	7.8	15.9	26.8	8	Bush. 286	Bush. 646	Bush. 932	Dense.	
201	Mar. 23	6.5	1.82	30.1	24.1	24.6	9	654	593	1,247	Do.	
202	do.....	6.5	1.99	34.1	21.6	34.1	10	673	821	1,494	Do.	
203	do.....	5.5	2.12	34.8	46.7	67.0	10	987	1,615	2,602	Do.	
265	Apr. 5	7.0	1.79	20.6	39.7	10.6	18	729	258	987	Do.	
266	do.....	7.0	1.79	28.1	34.1	15.1	15	750	364	1,114	Do.	
267	do.....	5.0	2.12	28.3	36.8	20.7	6	784	500	1,284	Do.	
268	do.....	5.0	2.12	32.1	38.7	20.8	15	856	500	1,356	Do.	
269	do.....	5.0	1.59	59.8	82.4	42.1	24	1,719	1,016	2,735	Do.	
311	Apr. 14	5.5	1.99	28.6	35.2	31.6	13	580	762	1,342	Do.	
312	do.....	5.5	1.49	65.7	52.4	36.2	13	1,061	874	1,935	Do.	
313	do.....	5.5	1.49	94.0	57.7	21.4	15	1,375	508	1,883	Do.	
314	do.....	7.0	1.79	9.5	19.0	8.4	4	258	185	443	Do.	
315	do.....	7.0	1.79	38.5	18.5	14.5	14	517	350	867	Do.	
317	do.....	5.0	1.59	64.7	50.3	16.3	15	1,043	394	1,437	Do.	
316	do.....	6.5	1.82	10.9	13.6	6.0	17	231	145	376	Scattering.	

To the east of Gallinipper Point there is a small lump which covers about 55 acres and is one-half mile long by 200 yards wide. It is but slightly raised above the general bottom level of the bay, excepting the central and southern portions, which have about 1 foot elevation. Depth of water is 6 to 7 feet.

The quality of the oysters is about equal to that of those found on the near-by reef, and there is an average of about 257 bushels per acre.

There are in this immediate vicinity three small patches, which were located by the chain, but the character of the oyster growth was not determined. The area of these patches will total 34 acres.

#### MITCHELL POINT REEF.

This and Gallinipper Reef form practically one continuous body of oysters and extend almost the entire distance across the bay from Point Comfort to Gallinipper Point. The separation of the two reefs at the channel near beacons no. 3 and no. 4 is arbitrary, as there is no interruption of oyster growth and but little essential difference in the character of the oysters and of the bottom.

The reef runs in a north and south direction and has a length of 3 miles with an average width of 500 yards. At the northern extremity the depth of water varies from 2 to 3½ feet, and on a narrow ridge a mile long, in the center, the depth is from 2 to 4 feet. The average depth for the remainder is about 6 feet. The entire reef is elevated approximately 1 foot above the level of the bay.

The oysters consist largely of clusters, with some singles. It is fished more for planting purposes than for the market, excepting at the northern border, where some good marketable oysters were taken. The reef has never been depleted, excepting a small portion on the northeast side.

At most of the stations from 1 to 6 mussels were found, and near the center of the reef from 25 to 55 barnacles were noted at the tonging stations.

The general conditions on this bed are shown in the following tables:

OYSTER GROWTH ON MITCHELL POINT REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Dense.....	532	998	737	520,956	392,084	913,040
Scattering.....	39	84	127	3,276	4,953	8,229
Very scattering.....	19	205	48	3,895	912	4,807
Total.....	590			528,127	397,949	926,076

## DETAILS OF EXAMINATION OF MITCHELL POINT REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
166	Mar. 18	5.5	1.99	55.2	42.2	49.7	12	1,177	1,204	2,381	Dense.
174	Mar. 27	5.0	2.12	50.9	41.5	28.3	11	163	684	847	Do.
175	do	5.0	2.12	109.8	66.1	35.8	18	2,120	864	2,984	Do.
190	do	5.0	1.59	81.6	48.4	34.6	19	1,565	836	2,401	Do.
210	Mar. 28	4.0	2.65	34.7	35.9	35.9	9	852	866	1,718	Do.
220	do	5.5	1.99	45.6	18.1	47.7	8	772	1,151	1,923	Do.
232	Mar. 29	3.0	2.39	34.7	51.2	47.3	12	1,038	1,140	2,178	Do.
258	Apr. 1	6.0	1.85	38.1	25.4	32.8	8	751	791	1,542	Do.
306	Apr. 14	6.5	1.82	31.8	25.9	7.7	12	525	186	711	Do.
307	do	6.0	1.86	40.8	48.4	20.2	15	809	487	1,296	Do.
308	do	5.0	2.12	68.4	66.9	69.8	32	1,240	1,688	2,928	Do.
309	do	6.0	1.86	41.4	33.4	16.7	9	680	404	1,084	Do.
310	do	7.0	1.79	37.4	32.4	10.1	7	634	244	878	Do.
319	do	5.0	2.12	23.1	12.3	11.7	19	321	282	603	Do.
320	do	3.5	2.19	79.0	42.5	38.8	7	1,103	936	2,039	Do.
321	Apr. 15	6.0	1.86	10.2	12.9	8.6	6	279	208	487	Do.
322	do	4.0	2.65	93.2	34.6	29.3	13	1,544	708	2,252	Do.
323	do	4.5	2.39	87.1	74.1	40.5	25	1,958	979	2,937	Do.
324	do	5.0	2.12	49.5	18.9	25.5	14	826	616	1,442	Do.
325	do	3.5	2.92	82.1	31.7	23.9	8	1,686	577	2,263	Do.
326	do	4.5	2.39	46.4	28.1	25.9	17	915	625	1,540	Do.
191	Mar. 27	7.0	1.79	6.1	5.6	6.1	2	137	147	284	Scattering.
223	Mar. 29	6.5	1.82	.0	2.7	4.4	8	32	107	139	Do.
318	Apr. 14	5.5	1.99	10.0	12.1	2.0	10	205	48	253	Very scattering.

Between Mitchell Point Reef and the entrance to Chocolate Bay lies a small lump, 150 yards by 300 yards in extent. The oysters of this lump are of poor quality, clustered, and of the snapper type; they are not fished for market.

## POINT COMFORT BEDS.

Within the limits of these beds, which lie one-half mile northwest of Point Comfort, there are six lumps, one large and five small ones. The largest is roughly heart-shaped and is about one-third mile by one-half mile in extent, while the others are small irregular patches.

On the large lump two stations were made, both of which showed comparatively soft bottoms. At one station the oysters were scattering and on black shells in soft mud; at the other there were large irregular clusters. A station made on the small lump north of the largest revealed a soft bottom and shells burrowed by the little boring clam *Martesia*. There were many mussels and also some barnacles and yellow sponge. The oysters of these beds are of new growth and have not been fished for the market.

The remaining four lumps, comprising 24 acres, were located and have been plotted on the chart, but the character and quality of the oysters were undetermined. The following tables furnish further data of a general character.

## OYSTER GROWTH ON POINT COMFORT BEDS.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	<i>Acres.</i> 116	<i>Bushels.</i> 358	<i>Bushels.</i> 184	<i>Bushels.</i> 41,528	<i>Bushels.</i> 21,344	<i>Bushels.</i> 62,872
Scattering <sup>a</sup> .....	10	302	127	3,020	1,270	4,290
Total.....	126			44,548	22,614	67,162

<sup>a</sup> An adjacent lump.

## DETAILS OF EXAMINATION OF POINT COMFORT BEDS.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
284	Apr. 12	5.0	2.12	32.1	11.8	8.5	11	398	186	584	Dense.
459	May 9	6.0	1.86	1.6	24.7	7.5	14	318	183	501	Do.
285	Apr. 12	4.0	2.65	15.5	17.8	6.0	3	302	127	429	Scattering.

## LAP REEF.

Lap and Chicken Reefs together stretch almost entirely across the constricted portion of the upper bay, off Nobles Point, and form practically a line of demarcation in the character and quality of the oysters of the lower and upper parts of the bay. The two reefs are separated by a narrow channel from 7 to 9 feet deep, bearing the local name of "Hole in the Wall."

Lap Reef begins 200 yards off Nobles Point and reaches to the northward for a mile and a quarter. It reaches its maximum width of about 800 yards at the northern extremity and gradually tapers to a point at the southern end.

On the eastern half of the reef the depth of water ranges from 1½ to 4 feet, several feet less than the adjacent barren bottom. The depth on the southern and western parts ranges from 3½ to 6 feet, being about equal to that of the surrounding bottom of the bay. The oysters occur as singles and in small clusters and generally are of excellent flavor; some were used as shell stock in 1912. This reef has been fished for the last seven or eight years, and will now yield about 4 barrels per day. It has never been depleted.

There are many mussels and some barnacles on this reef. The general extent and condition of the bed are shown in the following table:

## OYSTER GROWTH ON LAP REEF.

Character of oyster growth.	Area.	Oysters per acre:		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	Acres. 194	Bushels. 576	Bushels. 333	Bushels. 111,744	Bushels. 64,602	Bushels. 176,346
Scattering <sup>a</sup> .....	14	376	73	5,164	1,022	6,186
Very scattering.....	33	99	3	3,267	99	3,366
Depleted.....						
Total.....	241			120,175	65,723	185,898

<sup>a</sup> Counted in with dense.

## DETAILS OF EXAMINATION OF LAP REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
292	Apr. 12	4.0	2.65	63.7	12.1	16.5	6	688	352	1,040	Dense.
327	Apr. 15	5.5	1.99	28.1	25.1	8.0	2	642	231	873	Do.
417	May 6	6.5	1.82	30.9	42.7	14.8	12	891	357	1,248	Do.
419	do	5.5	1.99	6.5	12.6	19.1	3	253	462	715	Do.
420	do	5.0	2.12	15.6	24.5	12.7	16	484	307	791	Do.
421	do	4.5	2.39	34.8	23.4	23.0	18	702	556	1,258	Do.
422	do	4.5	2.39	16.3	9.6	10.3	4	312	261	573	Do.
297	Apr. 12	3.5	2.92	45.5	25.0	6.5	3	640	138	778	Scattering.
296	do	3.5	2.92	32.9	8.5	3.4	10	376	73	449	Very scattering.
418	May 6	6.5	1.82	.5	14.6	.0	20	182		182	Depleted.
423	do	4.5	2.39	.0	9.6	.4	4	116	10	126	Do.
293	Apr. 12	6.0		.0	.0	.0	0	0	0	0	Do.

## CHICKEN REEF.

This begins at the channel—the “Hole in the Wall”—from which it extends in an easterly direction to the shoal water of a projecting point of the east shore. The reef is long, narrow, and with a slight dip southward near the center. The length is approximately 1½ miles, while the average width is about 200 yards.

The depth of water varies from 1 foot to 5 feet, averaging about 3 feet; there are two narrow ridges, one at the western and the other at the eastern extremity, which are awash at low tide. Other than at the eastern limit, where the depths on and near the bed are practically the same and do not exceed 3½ or 4 feet, this reef is markedly shoaler than the surrounding parts of the bay. Like all such elevated reefs, its mass is composed of compacted shells and débris, the accumulation of many years of existence.

The character of these oysters is about the same as those of Lap Reef. On the top of the reef there were fine white shells, and some excellent oysters in the guts near shore, but they have been practically fished out.

## OYSTER GROWTH ON CHICKEN REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Dense.....	88	305	252	26,840	22,176	49,016
Scattering.....	40	252	110	10,080	4,400	14,480
Very scattering.....	20	82	49	1,640	980	2,620
Depleted.....	12	22	5	264	60	324
Total.....	160			38,824	27,616	66,440

## DETAILS OF EXAMINATION OF CHICKEN REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
449	May 9	3.5	2.92	18.3	16.8	6.5	10	424	154	578	Dense.
450	do.....	4.5	2.39	15.1	13.4	12.5	4	344	302	646	Do.
451	do.....	6.0	1.86	4.8	7.5	12.4	11	148	300	448	Do.
452	do.....	4.0	2.66	7.2	23.7	3.8	6	373	91	464	Scattering.
453	do.....	3.5	2.92	10.3	15.4	5.8	13	310	140	450	Do.
457	do.....	3.5	2.92	.0	6.2	4.1	3	75	99	174	Do.
448	do.....	4.5	2.39	2.9	5.4	2.5	10	100	61	161	Very scattering.
454	do.....	4.5	2.39	1.6	3.8	1.6	2	65	38	103	Do.
455	do.....	4.0	2.66	.0	3.8	.4	9	44	10		Depleted.
456	do.....	3.5	2.92	.0	.0	.0	0	0	0		Do.

North of the barrier of these cross reefs the salinity of the water is reduced and the mussels become more numerous and, contrary to the accepted view that barnacles occur more frequently in waters of higher salinity, the reverse was found to be true in Lavaca Bay.

There is a small patch one-half mile north of the western extremity of Chicken Reef. It is practically circular in outline, having a diameter of 175 yards. Depth of water 5 feet. An examination showed an average of about 323 bushels of market oysters and 253 bushels of small ones per acre, the area of the patch being about 8 acres.

## BEDS NORTHWEST OF LAP REEF.

About three-quarters of a mile northwest of Lap Reef there are three beds, two of which are small, varying from 250 to 350 yards in length, while the third is about three-fourths of a mile long, and narrow, excepting near the northern margin, where it broadens to a width of 500 yards.

The depth of water ranges from 4 to 5½ feet and the beds are but little elevated above the adjacent bottom. The patch nearest to the west shore bears scattering clusters of large oysters of the snapper type, with some mussels and barnacles, and the second lump showed

a better growth of oysters, but twice the number of mussels and barnacles. On the large patch five stations were made, showing oysters, together with a large number of mussels and barnacles. At two of these stations on the widest part of the patch the bottom was rather soft, and some of the shells were black, having been taken from below the surface. This bed is fished but little and consequently not much is known about it. It will probably not yield more than 4 or 5 barrels per man per day.

Three additional beds of 44 acres were located in the vicinity of the large patch, but no investigations were made on them.

The following tables exhibit the results of the examination of these beds:

OYSTER GROWTH ON BEDS NORTHWEST OF LAP REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	Acres. 79	Bushels. 328	Bushels. 295	Bushels. 25,912	Bushels. 23,305	Bushels. 49,217

DETAILS OF EXAMINATION OF BEDS NORTHWEST OF LAP REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913	Feet.	Sq. yds.					Bush.	Bush.	Bush.	
298	Apr. 12	5.0	2.12	5.2	8.0	7.1	7	129	152	281	Dense.
411	Apr. 29	6.0	1.86	23.6	31.7	22.6	25	668	546	1,214	Do.
412	...do.....	5.5	1.99	4.0	3.0	12.6	9	85	305	390	Do.
413	...do.....	6.5	1.82	18.1	12.1	9.3	5	374	224	598	Do.
414	...do.....	6.5	1.82	18.7	20.9	14.3	21	478	344	822	Do.
415	...do.....	6.0	1.86	16.6	30.0	20.2	8	563	486	1,049	Do.

CHAIN BEDS.

These beds, 12 in number, lie off Signal Bay and, with one exception, are small isolated patches, none of which have a local name. The depth varies from 3½ to 5 feet with an elevation of from one-half to 1 foot above the surrounding bottom. Four beds were examined. The largest of the series has a length of 1 mile and a width of 350 yards, and on this five stations were made. The southern end showed about 24 counts, 14 culls, 41 spat, and 90 mussels per square yard; near the center of the bed the bottom was rather soft, with some mussels, barnacles, and buried shells along with the oysters; at the northern end there were about 7 counts, 8 culls, and 4 spat per square yard, also some buried shells. This bed is fished but little, although the oysters are of fair flavor. The first small lump of 6 acres north of

the large patch produced mostly singles, rather small, but of extra fine shape and good quality, probably the best of the entire bay. This lump yielded 18 counts, 17 culls, and 20 spat per square yard. The second lump north of the large patch yielded scattering clusters, mussels, barnacles, and dead shells in black mud, and another lump south of Benado Creek Reef produced 34 counts, 56 culls, and 37 spat, with some mussels and barnacles per square yard.

These small patches are all fished for the market. The remaining lumps, containing 31 acres, were located, but the character of the oyster growth was not determined.

## OYSTER GROWTH ON CHAIN BEDS.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	<i>Acres.</i> 94	<i>Bushels.</i> 483	<i>Bushels.</i> 496	<i>Bushels.</i> 45,402	<i>Bushels.</i> 46,624	<i>Bushels.</i> 92,026
Scattering.....	29	27	105	783	3,045	3,828
Total.....	123			46,185	49,669	95,854

## DETAILS OF EXAMINATION OF CHAIN BEDS.

Sta- tion.	Date of examina- tion.	Depth of water.	Area cov- ered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
352	1913. Apr. 16	<i>Fect.</i> 5.0	<i>Sq. yds.</i> 2.12	41.0	13.8	24.1	17	<i>Bush.</i> 662	<i>Bush.</i> 583	<i>Bush.</i> 1,245	Dense.
354	do. ....	5.5	1.99	12.6	23.6	20.1	9	437	485	922	Do.
361	Apr. 17	4.0	2.65	19.9	16.9	18.0	6	334	435	769	Do.
367	do. ....	2.5	2.64	37.1	55.7	34.1	12	845	822	1,667	Do.
430	May 8	6.5	1.82	3.8	7.7	6.6	11	139	159	298	Do.
355	Apr. 16	6.0	1.86	.0	.5	4.8	27	6	116	122	Scattering.
369	Apr. 17	5.0	2.12	.0	.0	3.3	-----	0	79	79	Do.
429	May 8	6.0	1.85	.5	5.9	5.0	8	77	121	198	Do.

## HOPPE LUMP.

Hoppe lump lies three-quarters of a mile north of Signal Bay, and about 175 yards off the west shore. The lump is approximately 500 yards wide and 700 yards long and is somewhat quadrate in outline. The depth of water varies from 3 to 5 feet and the northernmost part of the lump rises from one-half to 1 foot above the general level of the neighboring bottoms.

Three stations were made. One near the west-central margin revealed a soft bottom, some buried shells, but no oysters; another near the center of the lump showed a rather soft bottom, but 21 counts, 54 mussels, and 35 barnacles per square yard; while the third station, near the southern margin, showed a hard bottom with 3 counts and 3 mussels per square yard.



The oysters of this lump are in clusters and singles, long, flat, and with sharp edges but of fair flavor. It is fished but little.

## OYSTER GROWTH ON HOPPE LUMP.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense .....	<i>Acres.</i> 41	<i>Bushels.</i> 75	<i>Bushels.</i> 198	<i>Bushels.</i> 3,075	<i>Bushels.</i> 8,118	<i>Bushels.</i> 11,193

## DETAILS OF EXAMINATION OF HOPPE LUMP.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
445	1913. May 8	<i>Feet.</i> 6.5	<i>Sq. yds.</i> 1.82	4.3	13.7	21.4	22	<i>Bush.</i> 218	<i>Bush.</i> 516	<i>Bush.</i> 734	Dense.
444	...do....	6.5	1.82	.0	.0	.0	0	0	0	0	Do.
372	Apr. 17	5.5	2.12	.0	.9	3.3	1	8	79	.....	Scattering.

## HALF MOON REEF.

This lies one-half mile south of Long Reef and a quarter of a mile north of Hoppe Lump. Its length is one-half mile, and its greatest width, 300 yards, is near the southern half, whence it contracts suddenly to the northward to a width of 50 yards.

The depth of water ranges from 3 to 5 feet, and the reef is approximately on the general level of the surrounding bottoms, excepting along the western margin, where there is an elevation of about 1 foot.

Three stations were made, one on the 50-yard projection, which gave the best returns—about 11 counts, 3 culls, and 6 spat per square yard. An average of the other stations near the center of the reef showed 4 counts, 3 culls, and 4 spat. Mussels and barnacles were found at all stations.

The oysters of this reef resemble those of Hoppe Lump. They are of fair flavor, of good shape, but generally too small for market, excepting on the edges, where they occur in clusters. They sell for 98 cents per barrel, 2 cents tax. The reef was first fished in 1910, and the work has been carried on during most of the present season (1912-13). One man can tong seven barrels per day. During "northers" the reef is liable to become dry.

As a rule, fishing does not begin in the upper bay until October. However, if freshets are early and the weather becomes cool, fishing is pursued earlier.

## OYSTER GROWTH ON HALF MOON REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	<i>Acres.</i> 33	<i>Bushels.</i> 78	<i>Bushels.</i> 151	<i>Bushels.</i> 2,574	<i>Bushels.</i> 4,983	<i>Bushels.</i> 7,557

## DETAILS OF EXAMINATION OF HALF MOON REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
441	May 8	6.0	1.39	5.7	2.9	10.8	25	104	261	365	Dense. Scattering. Do.
377	Apr. 17	4.5	2.39	7.5	3.3	4.6	5	98	111	209	
442	May 8	5.5	1.49	.0	2.7	3.4	9	33	82	115	

## LONG REEF.

This long, narrow, crescent-shaped reef of 64 acres lies a few hundred yards southeast of the mouth of Garcitas Bay and has a length of 1 mile, with an average width of about 150 yards. It is practically at the level of the general bottom, excepting at the western extremity, where there is a rise of about 6 inches. The depth of water varies from 3½ to 4 feet.

Along the edge of the reef there are large oysters in clusters resembling those on Half Moon Reef, while on top there are small ones. Considerable fishing is done here for seed, which are worth as much as marketable oysters. Permits are obtained to take whatever is on the bottom without the payment of any tax. This reef was first fished about two years ago, and, with the exception of Chicken Reef, this is true for the upper bay generally. One man can take seven barrels per day.

A small patch of 3 acres, 100 by 200 yards in extent, lies just east of Long Reef and has dense oysters of about the same character and quality as those of the main reef. The depth of water varies from 3½ to 4 feet. A station on the patch showed 705 bushels of seed and 1,122 bushels of marketable oysters per acre, making, all told, for the patch 2,115 bushels of seed and 3,366 bushels of marketable oysters.

The following tables show the data obtained from this bed:

OYSTER GROWTH ON LONG REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	Acres. 64	Bushels. 340	Bushels. 332	Bushels. 21,760	Bushels. 21,248	Bushels. 43,008

DETAILS OF EXAMINATION OF LONG REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
382	Apr. 17	4.5	2.39	15.1	13.8	18.8	3	262	454	716	Dense.
396	Apr. 25	2.5	3.52	4.0	5.7	14.9	6	117	360	477	Do.
437	May 8	3.0	2.39	19.3	22.2	9.6	15	501	232	733	Do.
440	do.....	5.5	1.49	47.8	16.3	19.5	41	774	471	1,245	Do.
438	do.....	5.5	1.99	.0	4.0	6.0	1	48	145	193	Scattering.

PATCHES NEAR SIGNAL GAR.

There are two small patches in the vicinity of Signal Gar, about 250 yards offshore and three-quarters of a mile off Long Reef. They are each about 150 yards in length by 100 yards in width. Depth 2½ feet.

The patch to the west, containing 3 acres, was discovered in 1911, but first fished the year following. The oysters on top are very dense and are of the snapper type. On the southeast edge there are large oysters in mud; the other edges do not bear such good stock, but better than is found on top. As many as 18 barrels have been fished in one day and at least 200 barrels of oysters have been taken in one week. The oysters are of good quality and fair flavor, but too large for raw stock.

The patch to the east, containing 2 acres, is fished but little, and not at all last season. The oysters are dense and in clusters, but scattering on the edges, and are not up to the standard, being of poor shape, watery, and poor in flavor and meat.

OYSTER GROWTH ON PATCHES NEAR SIGNAL GAR.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	Acres. 5	Bushels. 1,027	Bushels. 1,088	Bushels. 5,135	Bushels. 5,440	Bushels. 10,575

## OYSTER BOTTOMS OF LAVACA BAY, TEX.

## DETAILS OF EXAMINATION OF PATCHES NEAR SIGNAL GAR.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
435	May 8...	4.0	2.61	21.1	26.3	29.3	21	572	708	1,280	Dense.
436	...do....	4.0	1.99	70.7	53.2	60.3	35	1,483	1,468	2,951	Do.
399	Apr. 25..	3.5	-----	.0	.0	.0	0	0	0	0	

## BENADO CREEK REEF.

Benado Creek Reef lies approximately 1 mile southwest of the mouth of Benado Creek, and one-half mile off the north shore of the bay. The reef is 1 mile in length and about 300 yards in width at the central section, narrowing to both the north and south. The depth of water on and adjacent to the reef ranges from 3½ to 5 feet.

This reef was first fished in 1910-11, but has never been given a fair test because oysters are more plentiful elsewhere. Three or four barrels is considered a good day's yield per man. The oysters are of fair shape, occurring mostly in clusters, and are of fair flavor. The reef never ebbs dry.

The following tables show its area and distribution of oyster growth:

## OYSTER GROWTH ON BENADO CREEK REEF.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Dense.....	39	257	333	10,023	12,987	23,010
Scattering.....	15	17	92	255	1,380	1,635
Very scattering.....	20	0	24	0	480	480
Total.....	74	-----	-----	10,278	14,847	25,125

## DETAILS OF EXAMINATION OF BENADO CREEK REEF.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
	1913.	<i>Feet.</i>	<i>Sq. yds.</i>					<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	
384	Apr. 17	4.0	2.66	20.2	13.9	12.0	3	315	289	604	Dense.
416	Apr. 30	4.5	2.39	7.9	10.9	17.2	5	243	415	658	Do.
432	May 8	5.0	2.12	6.6	10.4	12.7	5	205	306	511	Do.
433	...do....	5.0	2.12	.0	1.4	3.8	6	17	92	109	Scattering.
431	...do....	6.0	1.85	.0	.0	1.0	2	0	24	24	Very scattering.

PATCHES BETWEEN BENADO CREEK AND LAVACA RIVER.

Between Benado Creek and Lavaca River there are seven rather small patches which were located during the survey, but only two of these were examined in detail.

The first patch, about 1½ miles southeast of the mouth of Benado Creek and 700 yards off the east shore, is 100 yards wide by 200 yards long. A station made on this patch revealed a hard bottom and about 425 bushels of seed and 754 bushels of market oysters per acre, the depth of the water being 3 feet.

The second patch examined lies one-third of a mile south of the first, and about 400 yards off the east shore. It is somewhat circular in outline, but with a projecting arm and a slight indentation on the eastern margin. The diameter is approximately 300 yards and the depth of water 3 feet.

An examination of this patch showed about 443 bushels of small oysters and 578 bushels of large ones per acre. On both patches the oysters are larger than on the lumps to the westward, but they are fished but little.

There is a fringe of oysters covering upward of 100 acres along shore north of the mouth of Lavaca River, but no detailed examination was made.

OYSTER GROWTH ON PATCHES BETWEEN BENADO CREEK AND LAVACA RIVER.

Character of oyster growth.	Area.	Oysters per acre.		Estimated content of oysters.		
		Under 3 inches.	Over 3 inches.	Seed.	Market.	Total.
Dense.....	<i>Acres.</i> 22	<i>Bushels.</i> 443	<i>Bushels.</i> 578	<i>Bushels.</i> 9,746	<i>Bushels.</i> 12,716	<i>Bushels.</i> 22,462

DETAILS OF EXAMINATION OF PATCHES BETWEEN BENADO CREEK AND LAVACA RIVER.

Station.	Date of examination.	Depth of water.	Area covered.	Oysters caught per square yard.			Shells per square yard.	Estimated quantity oysters per acre.			Character of oyster growth.
				Spat.	Culls.	Counts.		Seed.	Market.	Total.	
446	1913. May 8	<i>Feet.</i> 5.0	<i>Sq. yds.</i> 1.59	13.2	22.0	31.2	8	<i>Bush.</i> 425	<i>Bush.</i> 754	<i>Bush.</i> 1,179	Dense.
447	...do....	4.0	1.99	13.6	24.6	16.6	8	461	402	863	Do.

REVIEW OF THE NATURAL OYSTER BEDS.

Of the total area of Lavaca Bay, about one-sixth, 6,853 acres, or 10.7 square miles, is covered with oyster growth. In the lower half of the bay the beds, with the exception of some insignificant patches, are all east of a line joining Gallinipper Point and Point Comfort.

Why the western third of this region should be barren while the remainder is covered by extensive and prolific beds was not determined by the survey. The beds are practically continuous and in many cases the lines of demarcation between them are arbitrarily assumed for the purposes of this report.

In the upper part of the bay, above the line between Noble Point and Point Comfort, the beds are smaller and more generally distributed, although somewhat more numerous in the western half. So far as the quality of the oysters is concerned, their flavor, condition, and to some extent their shape, those of the upper bay were the better during the time of the survey and it is probable that this is true at most times.

In respect to the uniform prolificness of the beds as a whole, Lavaca Bay is the most remarkable region which has been surveyed by the Bureau. Not less than 91 per cent of the total area of oyster bottom is classed as dense growth, 5 per cent as scattering, a little over 2 per cent as very scattering, and a little less than 2 per cent as so-called depleted bottom. It appears as if the bottom must spring into great productivity very soon after it begins to bear oysters at all, and the large areas of sparsely productive bottom usually found in oyster-producing regions are lacking.

A glance at the chart accompanying this report will show this, and it is also exhibited in the following table which shows the acreage of each class of growth for each of the large beds and for groups of the smaller patches.

SUMMARIZED STATEMENT OF AREAS OF MARKET OYSTERS ON PUBLIC BEDS.

Name of bed.	Character of oyster growth.				Total. Acres.
	Dense.	Scatter- ing.	Very scatter- ing.	De- pleted.	
	Acres.	Acres.	Acres.	Acres.	Acres.
Sand Point Reef.....	73		20	62	160
Lumps northeast of Sand Point Reef.....	5		67		72
Middle Ground Reef.....	444	28			472
Old Town Bed.....	328				328
Lumps south of Old Town Bed.....	14				14
Bed north of Middle Ground.....	173				173
Kellers Bed.....	1,275			12	1,287
Rhodes Point Reef.....	1,093	121	3		1,217
Cox Bed.....	1,177				1,177
Lumps east of Cox Bed.....	3	31			34
Gallinipper Reef.....	329	32			361
Mitchell Point Reef.....	532	39	19		590
Point Comfort Beds.....	116	10			126
Lap Reef.....	194		14	33	241
Chicken Reef.....	88	40	20	12	160
Northwest of Lap Reef.....	79				79
Chain Beds.....	94	29			123
Hoppe Lump.....	41				41
Half Moon Reef.....	33				33
Long Reef.....	64				64
Patches near Gar Signal.....	5				5
Benado Creek Reef.....	39	15	20		74
Between Benado Creek and Lavaca River.....	22				22
Total.....	6,226	345	163	119	6,853

As is explained in the introductory part of the report, the classification is based on the relative abundance of oysters over 3 inches long, which is assumed to be the minimum size which could be used for market purposes. The smaller oysters, while recorded and elsewhere discussed, do not enter in any way into the classification. Neither does the term dense mean a continuous cover of massed oysters. It is used to express the condition where oysters in excess of 150 bushels per acre are found on the bottom, either as a continuous growth or in separated clusters, lying on the mud or sand.

The following table gives the estimated total content of each class of growth of each bed:

SUMMARIZED CONTENT OF MARKET OYSTERS ON PUBLIC BEDS.

Name of bed.	Character of oyster growth.				Total.
	Dense.	Scatter- ing.	Very scatter- ing.	De- pleted.	
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Sand Point Reef.....	16,536		1,140	372	18,048
Lumps northeast of Sand Point Reef.....	3,055		2,680		5,735
Middle Ground Reef.....	426,240	3,836			430,076
Old Town Bed.....	309,304				309,304
Lumps south of Old Town Bed.....	9,310				9,310
Bed north of Middle Ground.....	74,563				74,563
Kellers Bed.....	543,150				543,150
Rhodes Point Reef.....	617,545	10,527	159		628,231
Cox Bed.....	421,366				421,366
Lumps east of Cox Bed.....	1,716	3,720			5,436
Gallinipper Reef.....	192,794	4,640			197,434
Mitchell Point Reef.....	392,084	4,953	912		397,949
Point Comfort Beds.....	21,344	1,270			22,614
Lap Reef.....	64,602		1,022	99	65,723
Chicken Reef.....	22,176	4,400	980	60	27,616
Northwest of Lap Reef.....	23,305				23,305
Chain Beds.....	46,624	3,045			49,669
Hoppe Lump.....	8,118				8,118
Half Moon Reef.....	4,983				4,983
Long Reef.....	21,248				21,248
Patches near Gar Signal.....	5,440				5,440
Benado Creek Reef.....	12,987	1,380	480		14,847
Between Benado Creek and Lavaca River.....	12,716				12,716
Total.....	3,251,266	37,771	7,373	531	3,296,881

This table shows an extraordinary average of 525 bushels of large oysters per acre of the areas classed as bearing a dense growth and of nearly 500 bushels per acre for the entire area of oyster beds in the bay. Therefore, not only is the ratio of dense growth to the whole greater, but the density of growth on that area and on the beds as a whole is much greater than in any other region of approximately equal extent which has been examined by the Bureau.

Middle Ground and Old Town Beds are the most productive, each producing over their extensive areas an average of about 950 bushels of large oysters per acre. This is exceeded slightly by some of the small lumps in the upper part of the bay. This, however, constitutes but part of the oyster content, for the smaller oysters are numerically

more numerous than the larger ones and as a whole approximately equal them in bulk, as is shown in the following table:

SUMMARIZED CONTENT OF YOUNG OYSTERS ON PUBLIC BEDS.

Name of bed.	Character of oyster growth.				Total.
	Dense.	Scatter- ing.	Very scatter- ing.	De- pleted.	
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Sand Point Reef.....	26,208		12,080	8,432	46,720
Lumps northeast of Sand Point Reef.....	3,310				31,852
Middle Ground Reef.....	359,196	21,308			380,504
Old Town Bed.....	224,024				224,024
Lumps south of Old Town Bed.....	6,986				6,986
Bed north of Middle Ground.....	70,930				70,930
Kellers Bed.....	397,800			780	398,580
Rhodes Point Reef.....	400,038	12,463	36		412,537
Cox Bed.....	428,428				428,428
Lumps east of Cox Bed.....	1,269	8,277			9,546
Gallinipper Reef.....	252,014	7,392			259,406
Mitchell Point Reef.....	520,956	3,276	3,895		528,127
Point Comfort Beds.....	41,528	3,020			44,548
Lap Reef.....	111,744		5,164	3,267	120,175
Chicken Reef.....	26,840	10,080	1,640	264	38,824
Northwest of Lap Reef.....	25,912				25,912
Chain Beds.....	45,402	783			46,185
Hoppe Lump.....	3,075				3,075
Half Moon Reef.....	2,574				2,574
Long Reef.....	21,760				21,760
Patches near Gar Signal.....	5,135				5,135
Benado Creek Reef.....	10,023	255			10,278
Between Benado Creek and Lavaca River.....	9,746				9,746
Total.....	2,994,898	66,854	51,357	12,743	3,125,852

Although in a sense the young oysters are the most important elements of the reef contents, they have no immediate commercial value except as seed. It is not until they grow to market size that they can be used, and as they grow it is self-evident that the number per bushel will decrease. A comparison of their quantity with that of the market oysters is therefore less important as an index of the probable future of a reef than an examination of their relative numbers, and for the purpose of making this numerical comparison the following table has been prepared from the data collected by the survey.

NUMBER OF OYSTERS UNDER THREE INCHES LONG FOR EACH ONE OVER THAT LENGTH ON THE SEVERAL BEDS.

Name of bed.	Character of oyster growth.			
	Dense.	Scat- tering.	Very scatter- ing.	De- pleted.
Sand Point Reef.....	7.6		2.3	45.0
Lumps northeast of Sand Point Reef.....	2.3		26.7	
Middle Ground Reef.....	1.7	11.2		
Old Town Bed.....	1.6			
Lumps south of Old Town Bed.....	1.5			
Bed north of Middle Ground.....	2.0			
Kellers Bed.....	1.3			No large.



## NUMBER OF OYSTERS UNDER THREE INCHES LONG FOR EACH ONE OVER THAT LENGTH ON THE SEVERAL BEDS—Continued.

Name of bed.	Character of oyster growth.			
	Dense.	Scat-tering.	Very scat-tering.	De-pleted.
Rhodes Point Reef.....	1.3	2.3		
Cox Bed.....	2.6			
Lumps east of Cox Bed.....	1.5	4.4		
Gallinipper Reef.....	2.9	4.1		
Mitchell Point Reef.....	3.0	1.4	11.0	
Point Comfort Beds.....	4.4	5.6		
Lap Reef.....	3.7		12.1	61.8
Chicken Reef.....	2.4	4.6	3.3	9.5
Northwest of Lap Reef.....	2.2			
Chain Beds.....	2.2	.5		
Hoppe Lump.....	.8			
Half Moon Reef.....	.8			
Long Reef.....	2.3	.6		
Patches near Gar Signal.....	1.9			
Benado Creek Reef.....	1.7	.4		
Between Benado Creek and Lavaca River.....	1.5			

On all beds except Hoppe Lump and Half Moon Reef there is a considerable numerical preponderance of small oysters, and in consideration of the rapidity of oyster growth on the Gulf coast there is no probability that any of the beds will fail to perpetuate themselves under present conditions, unless as the result of physical accident or the attacks of some enemy which has not yet appeared.

## BARREN BOTTOMS.

The area of barren bottoms—that is, those which are not naturally productive of oysters even in small quantities—vastly exceeds that of the natural beds, including in the latter those so-called depleted areas which bear practically nothing. These bottoms are barren, mainly because of one character in which they differ from the productive areas—namely, that they are devoid of shells or other objects lying on the surface. They consist of sand and mud of varying degrees of stability and consistency. Oysters, immediately after they develop from the egg, for a brief period swim or float freely in the water, settling to a fixed condition only after they reach a stage of considerable development.<sup>a</sup>

It is not necessary to give more detail to this subject other than to say that at the time at which they are undergoing fixation the oysters are very minute, and a slight film of mud or slime is sufficient to stifle them. During the spawning season these little organisms are present in the water in untold myriads and are precipitated to the bottom in a continuous gentle drizzle of tiny specks. If they fall on an oyster bed they find firm supports on the shells and oysters, attach themselves and grow, but if they fall on the mud or bare sand they die.

<sup>a</sup> For a more extended account see "Oysters and methods of oyster culture," by H. F. Moore, Bureau of Fisheries Document no. 349, which may be obtained by application to the Bureau at Washington, D. C.

The natural beds have been slowly developed on bottom similar to that which surrounds them solely because through some agency there originally lodged on the mud or sand some hard objects to which the young oysters could safely cling. Oysters developing there and their shells scattered about by the waves furnished additional places for fixation of new generations of young, with the result that the original growth extended in area and its bed became a compact mass of shells and fragments, beneath which can still be found by excavation or probing the original bottom differing in no essential particular from the adjacent barren areas.

All that is required by the barren bottom in order that it may become productive is that its surface should be supplied with hard objects or cultch, either through natural agencies or by the hand of man. The capacity of the bottom to sustain material deposited on it and to maintain it in proper condition to serve as cultch depends largely on its stability and consistency. Moving sands gradually cover objects deposited on their surface and soft mud permits them to sink. It is therefore of prime importance for the oyster culturist to have information concerning the character of the bottom, and it was one of the purposes of the survey to supply it.

The methods and the instrument employed have been described in the introductory part of this report and the results attained are shown graphically on the chart.

The symbols on the chart designating the character of the bottom do not show all of the places at which examinations were made, but only those which have been selected as representative of the general conditions obtaining in the vicinity. It may be assumed that between any two adjacent symbols of different significance the change in the character of the bottom is more or less gradual.

While practically none of the bottom of Lavaca Bay is composed of ooze, practically all of it, except in places alongshore and in the immediate vicinity of the reefs, is composed of soft or very soft mud, which under the economic conditions of the locality are hardly worthy of serious consideration for purposes of oyster culture.

The bottoms which are classed in this report as hard and stiff mud are more or less scattered along the margins of the bay, usually within one-half mile of shore. The largest body of bottom naturally firm enough for planting oysters without danger of having them engulfed and smothered is in the southeastern part of the bay between Sand Point and the mouth of Kellers Bay. The location of other areas may be most readily determined from the chart.

## GENERAL PHYSICAL AND BIOLOGICAL CONDITIONS.

## TIDES AND CURRENTS.

Primarily for the reduction of the soundings to approximate mean low-water level, a tide gauge, a plain staff graduated in feet and tenths, was established at Port Lavaca, the most convenient and central point on the bay. During the entire period of the survey readings were made every two hours during daylight. The highest tide recorded was on April 23, when the water stood at 4.7 feet on the gauge and the lowest was on March 16, when it fell to 1.2 feet on the staff, a maximum range of 3.5 feet. The daily range was usually from 0.4 to 0.8 feet, and was to a great degree affected by the winds, which in many cases obscured or obliterated the apparent lunar influences.

Although the normal tidal range is small, the currents are sufficiently strong to insure ample circulation for the conveyance of oyster food and the renewal of water for respiratory purposes.

## SALINITY AND TEMPERATURE OF THE WATER.

As the amount of salt carried by the waters is a factor important to oyster growth and flavor, as well as conditioning the presence or absence of destructive enemies, a series of observations relating to the salinity and water temperature were continued throughout the survey. It is well known that oysters reach their maximum development and finest quality in waters of brackish character, having a specific gravity of 1.012 to 1.018, about midway between fresh water (specific gravity 1.000) and open-sea water (specific gravity 1.025). Water nearly fresh, on the one hand, or very salt, on the other, if present for any length of time over the oyster beds, is extremely detrimental, if not absolutely prohibitive, to the mollusks. Certain enemies of the oysters are also greatly influenced by the amount of salt in solution, the drill, for example, avoiding waters of low salinity, while the common black sea mussel thrives in them.

In order to obtain a reasonably accurate or reliable estimate of the proportion of salt in Lavaca Bay, two separate but simultaneous series of observations of salinity and water temperature were made. From the *Fish Hawk*, anchored in the vicinity of the Middle Ground and Sand Point Reefs, observations were made at 8 a. m., noon, and 6 p. m. The depth of water varied from 8 to 10 feet. The other series was made by the biological party, and extended over the greater part of the bay, including points both on the reefs and barren grounds.

The water samples in both series of observations were taken a few inches from the bottom of the bay, regardless of depth. The instrument or apparatus used for collecting the samples is illustrated and

described in "Volumetric Studies of the Food and Feeding of Oysters," by H. F. Moore (Bulletin Bureau of Fisheries, vol. xxviii, p. 1297-1308).

For purposes of comparison the bay was divided into three areas of approximately equal extent, the first of which was that section of the lower bay extending northward to a line connecting Rhodes and Gallinipper Points; the second from this line to Chicken and Lap Reefs; the third from these reefs to the head of the bay. The following table summarizes the results of the observations, the boldface type showing the data obtained by the *Fish Hawk* at the mouth of the bay, coincidentally with the conditions observed in the several regions by the survey party.

SALINITY AND TEMPERATURE OBSERVATIONS IN LAVACA BAY.

Locality.	Date.	Water temperature.			Specific gravity.		
		Max.	Min.	Av.	Max.	Min.	Av.
	1913.	°F.	°F.	°F.			
<b>Fish Hawk</b> .....	Feb. 24-28.....	<b>66</b>	<b>59</b>	<b>63</b>	<b>1.0176</b>	<b>1.0166</b>	<b>1.0172</b>
<b>Fish Hawk</b> .....	Mar. 1-5.....	<b>66</b>	<b>59</b>	<b>61</b>	<b>1.0172</b>	<b>1.0160</b>	<b>1.0168</b>
Area 1, vicinity of Kellers Bed.....	Mar. 5.....			64			1.0166
<b>Fish Hawk</b> .....	Mar. 6-10.....	<b>66</b>	<b>57</b>	<b>64</b>	<b>1.0184</b>	<b>1.0156</b>	<b>1.0173</b>
Area 1, vicinity of Old Town, Middle Ground, Kellers Beds.	.....do.....	66	63	64	1.0178	1.0152	1.0160
<b>Fish Hawk</b> .....	Mar. 11-17.....	<b>68</b>	<b>54</b>	<b>61</b>	<b>1.0176</b>	<b>1.0142</b>	<b>1.0164</b>
Area 1, southeast Gallinipper Point, entrance Kellers Bay; southeast Old Town Bed, east of Kellers Bed.	.....do.....	68	57	60	1.0178	1.0147	1.0153
<b>Fish Hawk</b> .....	Mar. 18-31.....	<b>72</b>	<b>57</b>	<b>65</b>	<b>1.0208</b>	<b>1.0154</b>	<b>1.0176</b>
Area 2, vicinity of Cox Bed, Mitchell Point Reef, off Chocolate Bay, off Port Lavaca.	.....do.....	64	57	61	1.0164	1.0112	1.0130
<b>Fish Hawk</b> .....	Apr. 1-9.....	<b>73</b>	<b>68</b>	<b>71</b>	<b>1.0185</b>	<b>1.0160</b>	<b>1.0173</b>
Area 2, vicinity of Rhodes Point Reef, off Port Lavaca, entrance Chocolate Bay.	.....do.....	70	66	69	1.0152	1.0134	1.0140
<b>Fish Hawk</b> .....	Apr. 10-15.....	<b>70</b>	<b>61</b>	<b>66</b>	<b>1.0178</b>	<b>1.0154</b>	<b>1.0168</b>
Area 2, vicinity of Mitchell Point Reef, south of Chicken Reef, Lap Reef.	.....do.....	72	63	67	1.0138	1.0063	1.0116
<b>Fish Hawk</b> .....	Apr. 16-May 2.....	<b>75</b>	<b>61</b>	<b>70</b>	<b>1.0187</b>	<b>1.0152</b>	<b>1.0169</b>
Area 3, off Lavaca River, Hoppe Lump, Benado Creek.	.....do.....	75	66	73	1.0137	0.0110	1.0120

From this table it will be observed that while there was the usual seasonal increase in the temperature during the progress of the investigation, there was no material change in the saltness of the water at the mouth of the bay, nor, probably, in the other regions. There was, however, a progressive decrease in the salinity of the water from the mouth of the bay to its head, a condition to be expected from the fact that the fresh water is all discharged in the upper part of the bay. At no time during the survey did the saltness fall below that which oysters will tolerate indefinitely, and at no time was it below the most desirable degree of salinity, with the exception of a short period in the first half of April. It is probable, however, that during times of prolonged rainfall some of the oysters in the upper part of the bay may be killed or injured by excessively fresh water.

## OYSTER ENEMIES.

Comparatively few oyster enemies were observed during the survey and there was but little evidence of any considerable destruction of oysters through their agency. Probably more oysters are destroyed by mud, or through being overgrown and smothered by their own kind, than are killed by other marine animals.

*Drills or conchs.*—There occur in Lavaca Bay two species of these marine snails, known to zoologists as *Thais hæmastoma* var. *floridana* and *Busycon perversum*, the former being the more common and larger species, one specimen taken measuring over 4 inches in length. Not over two or three dozen of both kinds were found during the survey and practically no oysters killed by them were found. These drills are essentially salt-water animals and are confined to the lower part of the bay. It is commonly supposed by oystermen that they secrete an acid by which they perforate the oyster shells by solution, but in reality the holes are made mechanically by means of a rasp-like tongue which can be protuded from the mouth.

*Mussels (Mytilus hamalus).*—The mussels found on the oyster beds must not be confused with either the large edible sea mussel of the Atlantic coast or the fresh-water mussel, which is used for button making. So far as is known this species has no present economic use, although doubtless it would make a good fertilizer.

Mussels were found very sparingly on the beds of the lower half of the bay and none at all were observed below a line uniting Gallinipper and Rhodes Points. From Chicken and Lap Reefs northward they became more abundant, and on some beds 100 or more were found within an area of 2 or 3 square yards. This increased abundance is correlated with the lowered salinity of the water, this mussel being an inhabitant of brackish waters. Although this mollusk is classed as an oyster enemy, it is not one in the sense of preying on the more valuable shellfish. It is injurious in that it eats the same kind of food as the oyster, and therefore lessens the supply for the latter, while at the same time its more prolific growth enables it to cover the latter, interfere with its growth and eventually to stifle and starve it.

*Drumfish (Pogonias cromis).*—The black drum was not observed during the survey, nor was it learned that it had ever caused destruction in Lavaca Bay. It is mentioned here because it is likely to appear suddenly on any part of the coast and at such times it is often very destructive, particularly to the planted oysters of better quality. Owing to the clustered growth and sharp edges of the oysters the natural beds of Lavaca Bay are not likely to be seriously injured by this fish.

*Minor enemies and pests.*—The yellow sponge, which overgrows the oysters and produces the "worm-eaten" condition of the shells, barnacles which crowd the oysters and roughen the shells, and the

little boring clam, *Martesia*, which burrows its oval chamber in the shells, are all more or less nuisances, and therefore objectionable, but they do comparatively little harm in Lavaca Bay.

#### SPAWNING.

The conditions of spawning probably do not differ from those generally obtaining on the Gulf coast, and it is, therefore, not necessary to discuss the subject at any length. It will suffice to repeat what has been said in a previous report.<sup>a</sup>

The spawning of oysters consists, in brief, of the discharge of eggs from the female and spermatozoa from the male to meet and fuse in the surrounding water. The fertilized eggs develop into minute embryos, each furnished with a little brush of cilia or hairlike processes which vibrate in rhythm and propel it feebly through the water. After a time varying with the temperature of the water the embryos develop a tiny shell, which by its weight eventually precipitates them to the bottom, where, if they fall upon a suitable, clean, firm, support, they attach and grow into spat, but if not they speedily die. As their own powers of locomotion are inconsiderable, the wide distribution of the young oysters in their swimming stage is dependent upon the currents.

Oysters in the spawning condition are of a peculiar creamy color, with branching lines traced over the surfaces of the body. When they are cut the ripe genital products at once exude from the wound, but if the shell be opened carefully and a gentle pressure exerted upon the body they will be discharged from a definite opening lying below the muscle (usually called by the oystermen the "eye" or "heart") which extends between the two valves. This is the pore from which they flow in the normal process. Ripe oysters in the language of the oystermen are aptly described as "milky."

Spawning takes place, in the main, during spring and summer, in any given region extending over a period of some months, depending upon the latitude and the climate. On the Gulf coast I have found during almost every month oysters which were apparently ripe, and from which there were obtained eggs which readily separated in the water and had every appearance of maturity. Whether such eggs would be extruded during the winter under natural conditions is doubtful, and if they were it is practically certain that they would not develop, as the experience of all investigators has shown that development is inhibited if the temperature of the water drops materially below 70°.

In Lavaca Bay the critical temperature is not permanently passed until about May, and the major part of the spawning undoubtedly takes place between May 1 and October 1.

<sup>a</sup> Oyster bottoms in Matagorda Bay. By H. F. Moore. Bureau of Fisheries Document no. 610. 1905.

## OYSTER CULTURE.

One of the primary purposes of the survey was to determine the reasons for the unsatisfactory results heretofore attained in oyster culture in the bay and to suggest measures to alleviate the difficulties enumerated. The reasons are apparent, the principal if not the sole difficulty being that the bay is already much overstocked with oysters on the natural reefs.

In summarizing the conditions on the oyster beds it has been shown that they bear, as a whole, an average of nearly 1,000 bushels of oysters per acre, about equally divided between small and market stock.

The beds are also unusually extensive as compared with the barren bottoms, and this, in connection with their productiveness, produces a condition of overpopulation such as the Bureau has not encountered in any other region of even approximately such large extent. The survey showed that for each acre of Lavaca Bay's area of about 60 square miles there were upward of 165 bushels of oysters, large and small. In some localities this would be regarded as a good average productiveness of the beds themselves, which would be surrounded by large areas of barren bottom serving as food reservoirs.

The important effects of this overpopulation of the waters are two-fold. In the first place any circumscribed bay or estuary can produce but a more or less definite maximum quantity of oyster food, and, theoretically at least, there will be a definite limited quantity available for each oyster living therein. As a fact, some of the oysters, by virtue of their more favorable location on the bottom, will probably get much more than their fellows, but if there be four or five times as many oysters as there should be, few or none will get enough to eat and all, or practically all, will be poor and of little value in the markets. Under the conditions prevailing in Lavaca Bay this will obtain not only with the oysters on the densely crowded beds, but also to a slightly reduced extent with such oysters as may be laid down on the barren bottoms. The food of the oyster consists of minute plants and finely divided organic matter generally, and as it is water-borne, carried from place to place by the currents, the excessive consumption of food in one place must make itself felt in other places more or less remote.

The second effect of the prodigious population of the natural beds on planted oysters is that the latter become overburdened and eventually overgrown with young oysters; 6,500,000 bushels of oysters in the circumscribed limits of Lavaca Bay must produce spawn in such volume that at the height of the season there are hundreds of oyster embryos in each quart of water. As the region is not subject to the cold rains and sudden chilling of the water which is so destructive to

fry near the northern limit of the oyster's range, and as there are no unusual enemies to the tiny free-swimming embryos, they pass through their development in vast numbers and set on every available suitable body exposed to the water, the shells of the planted stock being no exception.

Under such conditions, however carefully the seed may have been culled into singles and small clusters, each becomes a center of attachment for new growth, and there is soon produced a bunch of oysters, none of which has room to grow into good shape, as a planted oyster should in order to bring the price necessary to pay for the expense of planting. Not only are the oysters so produced inferior in shape, but they are invariably poor in quality, as the conditions under which they grow are such that they are unable to get the proper amount of nutriment for the same reasons causing the impoverishment of the food supply of oysters on the natural beds.

The difficulties recounted appear to be insuperable under the conditions at present obtaining. In places where currents slacken and silt deposits the difficulty with the set on the old oysters would be somewhat reduced but not overcome, for the rapid production of new shell characteristic of the region would continually supply clean material on which the spat could settle. Moreover, in such locations the poverty of food would almost invariably be accentuated.

Under the circumstances the best thing which could happen to the oyster fishery would be the very material or even drastic depletion of every oyster bed in the bay. If they contained one-fifth or, perhaps better, one-tenth of their present content, they would produce more marketable oysters than they do at present. According to the data adduced in this report, they contained in the season 1912-13 about eight times the quantity of large oysters which were marketed from the beds of the entire State in the preceding year and a corresponding surplus of young oysters. Here is a case in which the principles of true conservation demand destruction rather than preservation, and cull laws and other measures designed to protect the natural beds would work harm rather than good. Some efficient oyster enemies would be a blessing, provided, of course, that their ravages could be repressed at the critical time when their work had progressed to the proper point.

As has been pointed out in several places in this report, the conditions are unusual and the only practical suggestion which the authors have to offer is that those desiring to engage in oyster culture take the oysters from the reefs without regard to size, break up the clusters and plant them in some other region where oysters are not abundant. Possibly the more open waters of Matagorda Bay might be utilized for this purpose, but we are not informed as to the situa-



bility of the bottoms there, and there may be difficulties due to other conditions.

In any event, we do not recommend oyster culture in Lavaca Bay so long as the present dense oyster population is maintained.

#### RÉSUMÉ, CONCLUSIONS, AND RECOMMENDATIONS.

The following is a synopsis of the results of the survey detailed in the foregoing report, with the conclusions and recommendations based on them:

1. The survey covered the entire area of Lavaca Bay, approximately 38,103 acres, or nearly 60 square miles.

2. The area covered by oyster beds was found to be 6,853 acres, about 18 per cent of the entire bay. Of this, about 6,571 acres, or 96 per cent, bore oysters in sufficient quantity to make tonging profitable, provided a market could be found for the product.

3. It is estimated that during the winter 1912-13 the content of these beds was 3,296,881 bushels of oysters over 3 inches long and 3,125,852 bushels of smaller ones.

4. Although the quantities of the two classes of oysters were approximately equal, the small oysters were in considerable numerical preponderance. There is, therefore, no reason to believe that there is imminent any decrease in the present population of the beds except as the result of the operation of wholly unforeseen agencies, such as extraordinary freshets or the inroads of hosts of oyster enemies.

5. The beds are, at present, greatly overpopulated, and this, in connection with their great extent in comparison with the area of the bay, militates against the production of high-grade oysters in any considerable quantities. The oyster industry would be benefited if the oyster population in the bay could be reduced from one-fifth to one-tenth of its present size. For this reason it is recommended that cull laws and other usual measures to preserve the oysters on the natural beds be repealed or otherwise suspended until such time as the content of the beds shall be materially reduced.

6. While there is considerable bottom in Lavaca Bay suitable for oyster culture, it is not believed that the industry can be profitably pursued until the content of the natural beds is greatly reduced. Under present conditions the supply of food is insufficient for the proper feeding of the oyster population, and the purposes of oyster culture, the production of a superior oyster, can not be achieved. The enormous fecundity of the beds, furthermore, makes it difficult or impossible to grow oysters of fine shape. Possibly seed oysters taken from the reefs could be planted to advantage in Matagorda Bay, but lack of information as to the general conditions of that body of water causes the suggestion to be made with some hesitancy.





PLANTED OYSTERS, UPPER BAY, WITH MUSSELS AND BARNACLES.

(Natural size.)



CLUSTER OF NINE MARKETABLE OYSTERS FROM OLD TOWN BED.

(Three-fifths natural size.)



1. YOUNG DRILL (THAIS HÆMASTOMA VAR. FLORIDANA).  
(Natural size.)



2. ADULT DRILL (THAIS HÆMASTOMA VAR. FLORIDANA)  
(Natural size.)



OYSTER FROM CHAIN BEDS.

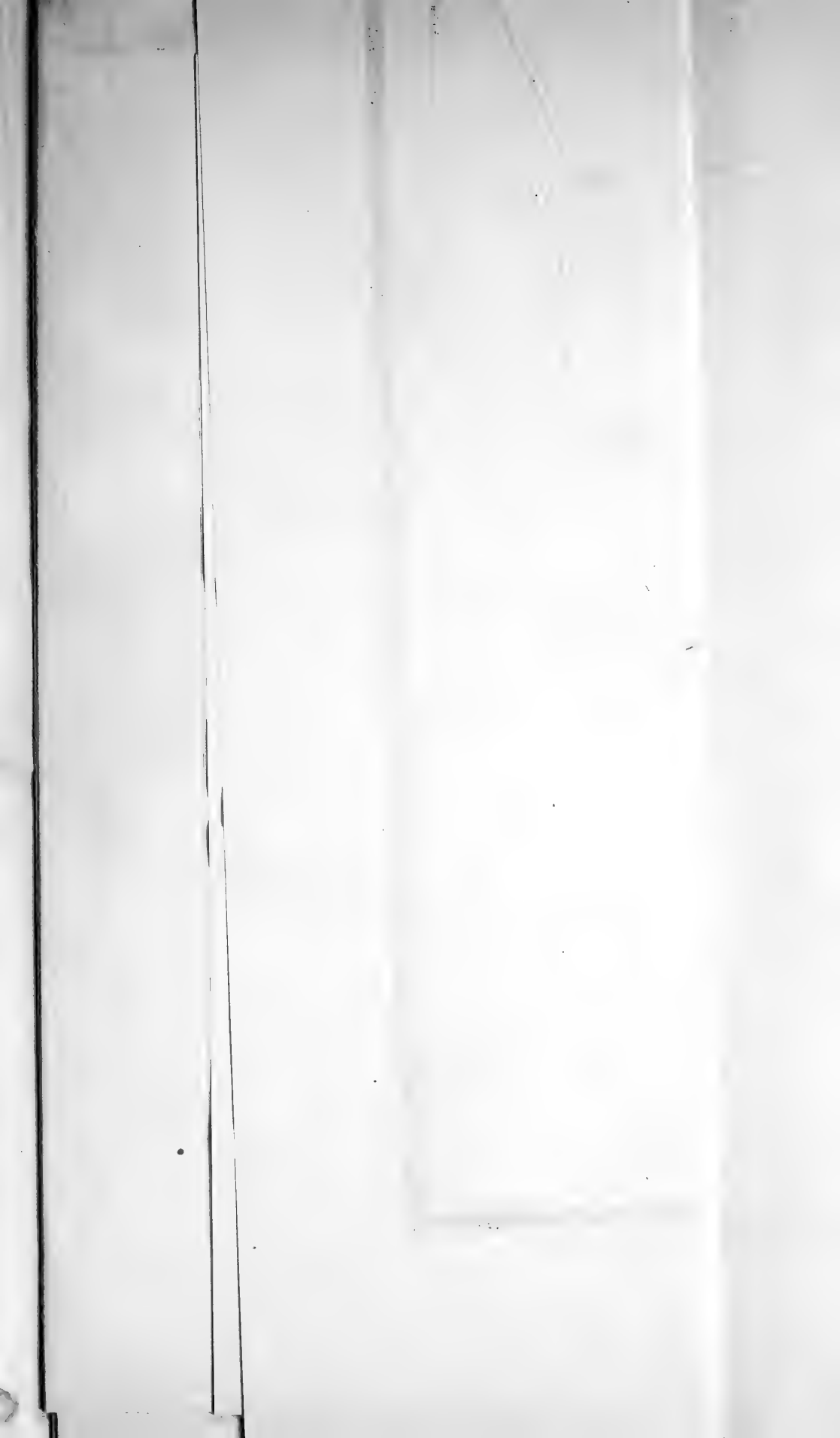
(Natural size.)



"SNAPPER" FROM LAGOON REEF.  
(Natural size.)









# OYSTER BOTTOMS —OF— LAVACA BAY, TEXAS

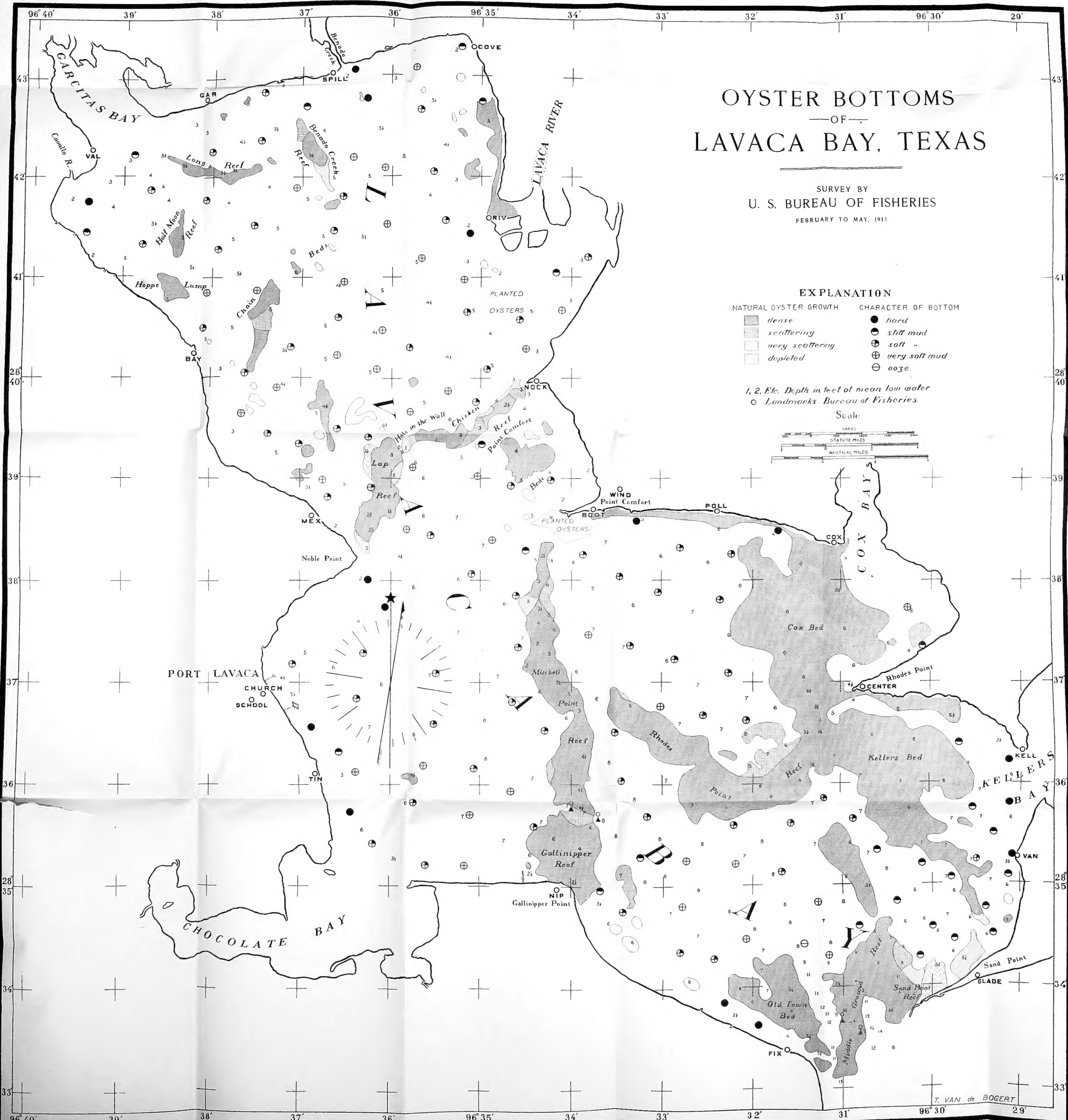
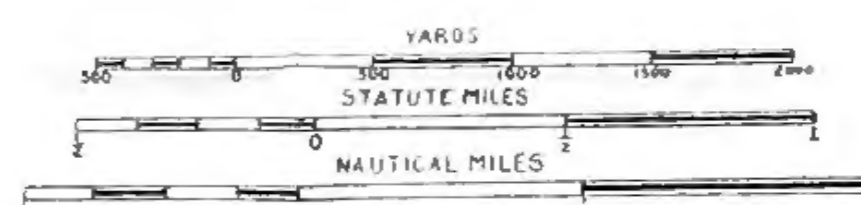
SURVEY BY  
U. S. BUREAU OF FISHERIES  
FEBRUARY TO MAY, 1913

## EXPLANATION

NATURAL OYSTER GROWTH	CHARACTER OF BOTTOM
dense	hard
scattering	silt mud
very scattering	soft "
depleted	very soft mud
	ooze

1, 2, Etc. Depth in feet of mean low water  
○ Landmarks Bureau of Fisheries

Scale



T. VAN de BOGERT

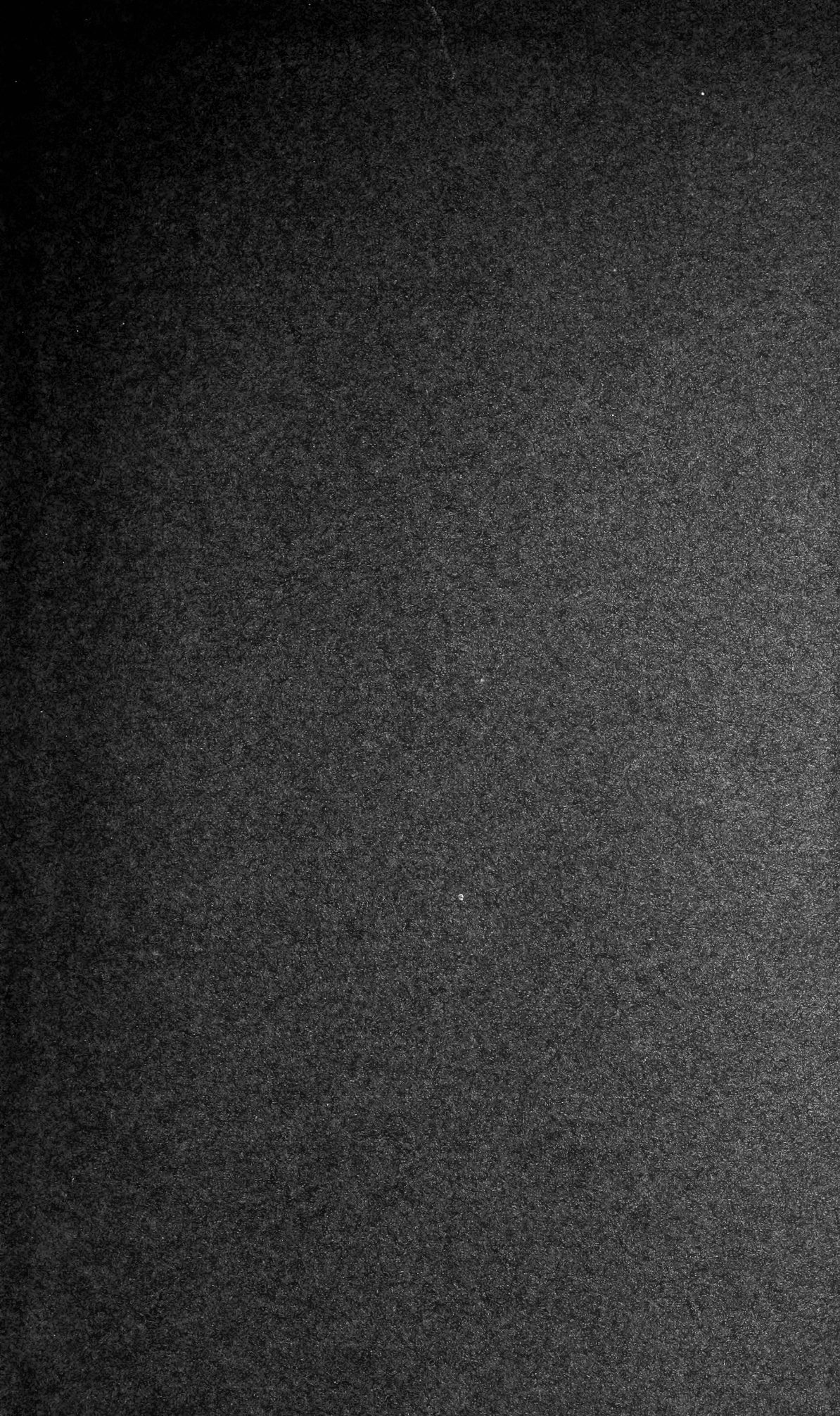


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