11.—AN INVESTIGATION OF THE COAST WATERS OF SOUTH CAROLINA WITH REFERENCE TO OYSTER-CULTURE.

BY JOHN D. BATTLE.

INTRODUCTORY NOTE.

[By Richard Rathbun, Assistant in charge of Scientific Inquiry.]

During the winter of 1890–91, the Fish Commission steamer *Fish Hawk*, Lieut. Robert Platt, U. S. Navy, commanding, was detailed to investigate the coast waters of South Carolina, with the object of determining the position, extent, and characteristics of the natural oyster beds, and also of the bottom areas not now producing oysters, but suitable for their cultivation. Similar surveys of the coasts of North Carolina and Georgia had previously been made by the U. S. Coast and Geodetic Survey, and the impetus thereby given to the oyster industry in those States was considered to warrant the same attention to the requirements of the intervening district. In arranging for this undertaking it was deemed advisable to add several new features to the examination, namely, a careful study of the biological characteristics of the region with special reference to the feeding of the oyster, chemical analyses of the water, and a more detailed inquiry than has been customary respecting its physical condition.

The hydrographic work, including the delineation of the natural oyster beds, the determination of suitable bottoms for oyster-planting, and the specific-gravity observations, was placed in charge of Mr. John D. Battle, formerly associated with Lieut. Francis Winslow, U. S. Navy, in the oyster survey of North Carolina, and with Ensign J. C. Drake, U. S. Navy, in that of Georgia. The services of Dr. Bashford Dean, tutor in biology in the College of the City of New York, were secured for the more special biological researches respecting the oyster and its food and the chemical and physical considerations, subjects to which he had previously given much attention in connection with the investigations of the oyster grounds of New York State. The general natural history of the waters was attended to by Mr. James E. Benedict, of the U. S. National Museum, and Mr. W. C. Kendall, the former, however, remaining with the steamer only about two months. The officers of the *Fish Hawk* participated in all the branches of the work, and their hearty coöperation, especially in regard to the hydrographic survey, was essential to its success.

Operations were begun December 23, 1890, in the neighborhood of Winyah Bay, in the northeastern part of the State. The creeks in that vicinity had already been examined by Mr. Battle in the interest of an oyster company, and the privilege of using his results being obtained, but little time was spent there. The steamer then proceeded to the Savannah River and worked thence northward to the northern part of Bull Bay, near Cape Romain, completing the survey March 30, 1891.

The coast region of South Carolina consists chiefly of very low land, marshy to a great extent, which in many places extends inland a considerable distance. It is indented or cut through by a number of sounds, bays, and river mouths, which are connected by an intricate system of winding creeks and rivers, separating the sea islands from one another and from the mainland. Oysters are found in most of the creeks and rivers which are suited to their growth, but they occur mainly as fringing ledges along the borders between the levels of high and low tide. In only a few localities do they grow naturally in the stream bed, and their cultivation or improvement by transplanting has not hitherto been attempted, except upon a very limited scale.

The water that circulates through these oyster-bearing channels is derived from several sources, the sea on the one side, the rivers from the interior, neighboring springs, and land seepage on the other. That coming from the sea has the high salinity or density of the ocean, while the rest is fresh. As is naturally to be expected from the positions and relations of these numerous bodies, their contents, resulting from the mixture of different waters, present a great diversity as regards their saltness, and the density in each is subject to great and frequent variations through the tides and seasonal changes. Moreover, the larger rivers bring down an immense quantity of sediment, which, becoming widely disseminated, fills many of the channels with highly discolored water, especially during times of freshets. From this source and probably from others also the channels have derived, over a large part of their extent, a very soft, muddy bottom, not capable of supporting heavy objects of any character.

The reason for the peculiar distribution of the oysters, above referred to, which obtains also in Georgia, in some parts of North Carolina, and on the outer coast of Virginia, has not positively been determined, but the most plausible explanation yet given to account for it would make it dependent upon the high specific gravity of the water. The heavy sediment and the soft character of the bottom may also have some influence in that respect. The solution of this question is of great practical importance, as the result will have much weight in determining the methods of oyster-culture best suited to the State, and it is proposed to give further attention to the matter at the first convenient opportunity. The problem involved is as to whether the spat derived from mature oysters planted on the bottom will attach themselves in similar situations; in fact, as to whether such beds would be self-sustaining, as they are in all the principal oyster regions farther north. The present indications are that, in the South Carolina waters whose salinity is above a certain standard, the spat or embryos, which are free-swimming during the earlier part of their existence, float only at the surface, and, therefore, have the means of attaching themselves only between the levels of high and low tide. In any case, however, a very simple and effective means of cultivation is presented in the transplanting of the raccoon oysters from the tide ledges to suitable bottoms in deeper water, where they rapidly attain a better shape and quality. The raccoon ledges are a source of seed, which, if properly protected, can be made the basis of an extensive industry, and one probably of great profit.

The total water area surveyed amounts to about 81,280 acres, or 127 square miles, of which it is estimated that about one-fourth, in its present condition, is suitable for oyster-planting. The extent of the natural oyster beds in the same area is placed at about 775 acres. Other territory, which was not examined from the lack of time, would greatly increase these figures, and much of the bottom not now regarded as favorable might be rendered so by proper treatment. Furthermore, it is believed that the marshes and flats along the coast channels are well adapted for the establishment of tidal ponds, which could readily be constructed by excavating the soft material to a slight depth, or in some places by building dikes. In this manner the oyster-producing territory could be greatly extended, and the plan suggested would give the oysterman complete control over his stock. This system of oyster-culture, however, has not yet been introduced into this country, and until experiments have been made which shall determine the best and most economical methods it is deemed inexpedient to enlarge upon the subject.

In the present report, by Mr. John D. Battle, will be found a detailed account of the hydrographic survey, including the density observations at all the localities visited. It is accompanied by seven charts showing the topography of the coast region, the location and extent of all the natural oyster beds discovered, and the specific gravity of the water in each stream. These charts are based upon the field sheets of the U. S. Coast and Geodetic Survey, the use of which for this purpose was freely granted by the Superintendent, Dr. T. C. Mendenhall. In fact, the only additions actually made to them by the Fish Commission have been the indications of the oyster beds, the specific gravities, the delineation of a few streams not previously surveyed, and some references to the depths and character of the bottom.

The report of Dr. Bashford Dean will treat especially of the character and conditions of the natural oyster beds and their environment; the food of the oyster, its character, distribution, and abundance in the region examined; and the chemical composition and physical characteristics of the water upon the oyster grounds. The account of the general natural history of the region has not yet been completed.

REPORT OF THE INVESTIGATION.

The oyster-bearing waters of South Carolina present the same characteristic features found in Georgia, consisting of small open sounds connected by a number of winding rivers and creeks which separate the sea islands from each other and from the mainland. The tides ebb and flow swiftly through these streams with a current ranging from 1 to 2 miles an hour. It was decided to conduct the hydrographic survey of this State in the same manner and by the same methods that were employed in Georgia, with the object not only of fixing the position and extent of the natural oyster beds, but also of determining the general conditions of the streams, the character of the bottom, and the specific gravity of the water.

With very few exceptions, the natural oyster beds lie along the shores in narrow strips, the greater part being left bare at low water. Care was taken that the observations, whenever practicable, should be made from half ebb to half flood, when the outer limits of the oyster beds are visible. This, coupled with the detailed topography of the Coast Survey charts, on which the work was platted in the field, enabled us to locate their positions with considerable accuracy. It would have taken several years to make a complete survey of all the streams embraced within the territory examined, but it is believed that sufficient data have been collected and are presented in this report to enable anyone who is interested in the subject to recognize without much trouble at least the majority of localities that are adapted to oyster cultivation. Pains were taken to obtain as much information as possible from the more intelligent fishermen and oystermen with whom we came in contact, especially as regards the streams not visited by the party.

The present State laws are entirely inadequate to meet the requirements of oyster-planting. A penalty is prescribed for stealing oysters from planted grounds, but there is no provision for taking and holding grounds for that purpose, and the right to such possession can only be obtained by special legislation. It is hoped that one of the results of the present survey will be to influence liberal action on the part of the State legislature to the extent of affording every legitimate means for the promotion of this important industry. Since the completion of the oyster survey of Georgia several large companies have been formed, which are now operating extensively on the coast of that State, and much ground has been leased or taken up by them. The territory which they occupy is similar in character to that occurring in South Carolina, and their experiments are being watched with much interest. None of these companies succeeded during last year in catching a set of spat on the shells or cultch thrown over in deep water, the cause of which is still subject to inquiry, but good success has been had from the use of the raccoon oyster from the ledges as a seed for planting in deep water.

The steam launches attached to the steamer *Fish Hawk* were generally employed in making the examinations, especially in the smaller streams. Soundings were made continuously during the survey, and the dredge was used occasionally along the same lines. Density observations were taken at frequent intervals both at the surface and at the bottom, the stage of the tide being carefully noted in each instance. All the data were immediately plotted on Coast Survey charts taken on the launches for that purpose, the same being subsequently transferred to clean sheets on board the *Fish*

Hawk. The presence of raccoon oyster ledges was readily detected at nearly all times of the tide, and their length and width were easily determined. The positions of submerged oyster beds were ascertained by the use of sounding or dredging apparatus or from information given by the fishermen. The territory examined extends from the Savannah River in the south to North Inlet in the north, omitting the region between Winyah and Bull bays, and a few smaller areas farther south. On the accompanying charts the natural oyster beds and the density observations are indicated in red. Four degrees centigrade has been used as the standard for the density observations, which are in all cases reduced to a temperature of 15° C. (approximately 60° F.).

DESCRIPTION OF AREAS EXAMINED.

Wright River is a narrow, tortuous stream, about 13 miles in length, with an average width of not more than 200 yards. It rises in the marshes near the Savannah River, and, flowing in a southerly direction, empties into the same river opposite Long Island. The water is thick with mud in suspension received from the Savannah River, and it becomes practically fresh 3 miles above its junction with the latter. The specific gravity of the water at the mouth, at high tide, was 1.0121 surface and 1.0133 bottom; 1 mile above the mouth at the same time of tide, 1.0104 surface and 1.0112 bottom; and at the mouth of Walls Cut, 1.0060 surface and 1.0146 bottom. Above this point the water is practically fresh, both at the surface and at the bottom. No oysters are found in this river, and the general conditions existing there preclude the possibility of successful cultivation. It deserves mention, however, by reason of its being the most southern stream within the jurisdiction of the State. The only source of salt water is the last of the flood, and even this small quantity is influenced by the freshets of the Savannah River, for in time of freshets little or no salt water could reach it.

New River is a narrow, winding stream 16 miles long, which also has a general southerly direction, and enters Tybee Roads 2½ miles north of the mouth of Wright River. It has an average width of 200 yards, and ranges in depth from 5 to 20 feet. The character of the bottom corresponds favorably with that indicated on the Coast Survey charts, being generally hard mud or sand, or sticky, with occasional soft spots. This river presents many favorable conditions for oyster-culture. The greatest drawback, perhaps, is the mud in suspension in its waters, received from the Savannah River through Walls Cut, and from its mouth on the flood tides, when the outflowing water from this river is thrust back up New River and discolors its waters to a point about 6 miles above the mouth, where it becomes clear again. This is due, no doubt, to the salt-water circulation through the Cooper River at its junction with New River, and through Rams-horn Creek, as the division of the tides occurs in New River about 1 mile below this junction.

The observations were made on the last of the flood and throughout the entire ebb tide, and it will be observed that the changes in the specific gravity of the water is marked. Commencing at its mouth with 1.0176, it declines until it reaches a minimum of 1.0107 at the surface and 1.0113 at the bottom, at a point about one-half mile above the lower mouth of Rams-horn Creek, when it begins to rise again, caused by the salt water from the Cooper River, and reaches a maximum, at the highest point examined, of 1.0157 at the bottom.

An area of scattered oysters in the bed of the river is found between the mouth of Rams-horn Creek and a point a mile below, where the river divides to make a junction again at its mouth. These oysters are large, have deep shells, and were in good condition, but they were covered with barnacles, like those found in the mouth of the Savannah River and at Winyah Bay, and, indeed, everywhere where the same conditions have been found. I have observed, too, that while these barnacles are found in large quantities on oysters taken from deep and muddy water of low density, they are not found on the raccoon oysters contiguous, which are left bare by the ebb tide for several hours. It would seem from this that, unlike the raccoon oyster, they require constant submersion to sustain life.

The only raccoon oysters observed along the shores are found between Rams-horn Creek and the mouth of the river, mainly on the western shore, in narrow patches about 10 feet wide of dead shells and living oysters, the former largely in excess, due in a measure to overfishing in this limited area. Several boats were found picking up these oysters at low water. Oyster boats were also seen tonging the single oysters in deeper water, which have also been reduced in numbers from the same cause. The greatest density observed was 1.0176 at the mouth, at half flood; the least, 1.0113 one-half mile above Rams-horn Creek, at one-third ebb. The current is very swift. The total area examined was 830 acres; area of natural oyster beds, about 21.4 acres.

Cooper River has a length of 10 miles from its lower mouth or junction with New River to its upper mouth at Calibogue Sound. It is a winding, narrow stream for the first 6 miles, of an average width of 150 yards, when it becomes a bold stream with a rapid current, and with an average width of 400 yards. Removed from the source of fresh water from the Savannah River, it receives only a limited amount from the drainage of the surrounding marshes and woods, and presents entirely different features from those of Wright and New Rivers, having, in consequence, a much greater specific gravity, which ranges from 1.0143 at its lowest mouth to 1.0247 at its upper mouth at Calibogue Sound. Little or no variation was found between the surface and bottom observations. The character of the bottom is generally favorable, being hard or sticky from its mouth to Page Island. Above this island the bottom is a very soft mud. No oysters are found in this river below low-water mark; but, along the shores on both the north and south sides, raccoon oysters occur in considerable quantities, forming a series of narrow ledges extending from high to low water mark, and not more than 10 feet wide. These ledges reach from the mouth at Calibogue Sound to a distance of 3 miles above, or to the first abrupt bend of the river. The depth of the water varies from 5 to 30 feet. The total area of the river is 960 acres; area of natural oyster beds, about 5.4 acres.

Calibogue Sound has a northward trend, and through its tributaries connects Tybee Roads with Port Royal Sound, the "divide" of the tides occurring near the mouth of Skull Creek. From its mouth at Braddock's Point to its head at the mouth of the May River, it has a length of 6 miles and an average width of 1 mile. The examination was made on the flood tide. The specific gravity near the mouth was 1.0206 at the surface and 1.0215 at the bottom; near Marsh Island, it was 1.0208 at the surface and 1.0207 at the bottom; at the head, or mouth of the May River, 1.0206 at the surface and 1.0207 at the bottom. In 9 fathoms of water at the last locality (station No. 1651) the dredge brought up a considerable quantity of small single

oysters. They were small, but of good shape, yet they had the appearance of being stunted, and were foul with sponge. The fact is a noticeable one, for it is the first and only instance on the cruise when oysters have been found in deep water of this density. The character of the bottom is favorable, and corresponds with the indications on the Coast Survey charts. Raccoon oysters extend in a narrow ledge, 10 feet wide, along the west shore from the mouth of Cooper River to the mouth of May River, but only a few are found on the east shore. The total area of the sound is about 2,944 acres; area of natural oyster beds, about 4.8 acres.

Broad Creek rises in the marshes of Hilton Head Island and, flowing westerly 7 miles, enters Calibogue Sound opposite the mouth of the Cooper River. No density observations were made in the creek, but from information received the same formation of raccoon oysters exists along the shores in ledges which were located approximately. Total area of creek, about 496 acres; approximate area of natural oyster beds, 6.5 acres.

May River, the principal tributary of Calibogue Sound, was examined from its mouth a distance of 12 miles. The topography of the Coast Survey charts had only been completed to a point 1 mile above Bluffton, and the additional part surveyed was sketched as accurately as possible. The general trend of this river is southeast, and it has an average width of three-eighths of a mile. Belonging throughout to the same system of salt-water circulation, no marked changes are noticeable at different times of the tides. The specific gravity at the mouth was 1.0206 at the surface and 1.0207 at the bottom; at the highest point reached it was 1.0205 at the surface and the same at the bottom. The character of the bottom from its mouth to Bluffton is favorable from mid-channel to the south shore. On the north shore a softer bottom is found. The soundings corresponded fairly with the characteristic soundings of the Coast Survey charts. The same type of raccoon oysters are found on both shores from the mouth to, and even above, Bluffton, but 3 miles above there they disappear entirely. No oysters are found below low-water mark, except the droppings from the parent ledges, and this limited area is over-fished. I see no reason why art can not assist nature and extend this area by removing the young oysters from the ledges to deeper water and a suitable bottom. The total area of the river is about 2,000 acres; area of the natural oyster beds, about 13.1 acres.

Bull Creek is a narrow, winding stream, connecting the Cooper River with May River, and separating Bull Island from the mainland. It is about 5 miles in length, and has an average width of 150 yards. Starting with a specific gravity of 1.0210 at the surface and bottom at its lower mouth, it reaches a maximum of 1.0213 at the surface and 1.0218 at the bottom at its upper mouth. The least density observed was at a point 2 miles above the lower mouth, being 1.0206 at surface and bottom, at half flood. The bottom is favorable, being generally hard, and the soundings correspond with those given on the Coast Survey charts. The same characteristic growth of raccoon oysters occurs along the shores in narrow strips about 10 feet wide, but no oyster beds are found in deep water. Total area of creek, about 340 acres; area of natural oyster beds, about 7.6 acres.

Mackay Creek connects Port Royal with Calibogue Sound, and may be said to be a continuation of the latter. It is about 6 miles in length, and consists for the first 5 miles of a series of flats or bays of shallow water, with an average width of a quarter of a mile. Commencing with a density of 1.0214 at surface and bottom at its lower

mouth during low water, it reaches a maximum at its upper mouth, during high water, of 1.0225 at surface and bottom. No difference between surface and bottom density was observed anywhere in this creek. Raccoon oysters not only extend along the shores but are found also in patches on the mud flats. The character of the bottom for the first 3 miles above the lower mouth is favorable, being generally hard and sticky, when it becomes very soft for 2 miles, and then hard and sticky again to the upper mouth. The total area of the creek is about 904 acres; area of natural oyster beds, about 14.5 acres.

Skull Creek is a series of shallow flats, through which runs a winding channel. It separates Pinckney Island from Hilton Head Island and enters Port Royal Sound 1½ miles below the upper mouth of Mackay Creek, while the lower mouth enters this creek near its lower mouth (Mackay) and completes the circulation of the creeks between Port Royal and Calibogue Sound. The bottom is favorable and agrees closely with the Coast Survey soundings. No natural oyster beds occur in the channel, but raccoon oysters of a fine type are found not only along the shores but around the numerous islands and on the mud flats. The ledges are about 10 feet wide and are exposed at low water. At the outer edge of these ledges some fair single oysters which have fallen away from them may be taken, but local oystermen glean this narrow strip, the demand being greater than nature can supply in her slow way. The possibilities for oyster cultivation here, and in other localities of the same character and conditions, where the oysters are not subject to rapid and radical changes of density, seem good, and I know of no better plan than removing the best of these raccoon oysters, which are left bare at low tide, to deeper water and more favorable environments. The specific gravity of the water at the lower mouth at one-sixth flood was 1.0213 surface and 1.0219 bottom; 2 miles above the lower mouth it was 1.0219 at both the surface and bottom; and one-half mile below the upper mouth at the first of the flood tide, 1.0221 at both surface and bottom. The total area of the creek is about 720 acres; area of natural oyster beds, about 13.4 acres.

Port Royal Sound separates St. Helena Island on the north from Hilton Head Island on the south. It has an average width of 2½ miles, and, from its mouth to its head, at Daws Island, a length of 6 miles. It is formed by the confluence of three large tributaries, the Chechessee, Broad, and Beaufort rivers. The inlet is broad and open, and the density of the water high, being 1.0231 surface and 1.0233 bottom at the mouth of Beaufort River, two-thirds ebb; 1.0224 surface and 1.0226 bottom at the mouth of Broad River, early flood; and 1.0224 surface, 1.0227 bottom, one-half ebb, at the mouth of the Chechessee River. The bottom is generally hard and the depth ranges from 17 to 40 feet, but a strong current and exposure to the open sea, with shifting sands, render the sound unsuitable for oyster-culture. On the west shore, between the mouth of Skull and Mackay creeks, and on the east shore from Paris Island Spit to a point 2 miles above, narrow ledges of raccoon oysters are found, but no oysters are found in deep water. Area of natural oyster beds, about 3.6 acres.

Chechessee River takes its rise near the northern point of Lemon Island, and flowing in a southeasterly direction a distance of 9 miles enters Port Royal Sound at the southern end of Daws Island. For the first 4 miles it has an average width of one-fourth mile, when it becomes a broad, bold stream, seven-eighths of a mile wide. The specific gravity at the mouth during the last of the ebb tide was 1.0224 surface and 1.0227 bottom; and near the mouth of the Colleton River, early flood, 1.0221 surface

and 1.0224 bottom. The depths correspond with the Coast Survey soundings, and there is a strong tidal current. While no oysters were found in deep water the characteristic growth was found along the shores, extending in narrow ledges from near its head to the mouth. The upper part of the river was not examined, but reliable information was had from the natives of the conditions existing above the mouth of the Colleton River. The total area of the river is 2,810 acres; approximate area of natural oyster beds, 14.5 acres.

Colleton River has its rise near the west end of Callawassie Island, where it is a broad bay or flat dotted with marsh islands. Its general trend for the first 5 miles is southeast, when it makes an abrupt bend to the north, and 2 miles farther forms a junction with the Chechessee opposite the upper end of Daws Island. The specific gravity near the mouth at early flood was 1.0221 surface and 1.0224 bottom. At the head, at the same time of the tide, the specific gravity was 1.0216 surface and 1.0217 bottom. Having no large source of fresh water, the variations in density at different stages of the tide are not great. The character of the bottom is very favorable, being hard and sticky for the most part, and the depths correspond with the Coast Survey soundings. While this river was thoroughly dredged, no oysters were discovered in deep water, but it presents a good field for the transplanting of the oysters growing along the shores between high and low tide mark, to deeper water where the bottom is favorable. The total area of the river is about 1,640 acres; area of natural oyster beds, about 12.4 acres.

Okeetee River is properly a continuation of the Colleton River and joins it at the head of the bay. The topography of the charts had not been completed beyond its mouth, but an examination was made 2 miles above and the shore line sketched in. The bottom is favorable, being hard and sticky. The specific gravity at the mouth during the early flood was 1.0212 surface and 1.0213 bottom. At the highest point reached it was 1.0215 at both surface and bottom. Total area examined, 256 acres; area of natural oyster beds, 2.2 acres.

Broad River.—This large stream, a continuation of Port Royal Sound, heads at the junction of the Coosawhatchie and Pocotaligo rivers near Hall Island, and, flowing in a southeasterly direction, enters Port Royal Sound 17 miles below this junction at the south end of Daws Island. As its name would indicate, it is a bold, broad stream, some 2 miles wide at the mouth and with an average width of 1¼ miles. The tides run very swift and strong, and a part of its bottom is covered with quick and shifting sands, which would make the cultivation of oysters in the lower part of the river unsafe. This shifting character of bottom was noted by the discrepancy between our soundings and those of the Coast Survey charts in places. The specific gravity of the water near the mouth at early flood was 1.0224 surface and 1.0226 bottom; at the mouth of Whale Branch during first of ebb it was 1.0212 at both surface and bottom; and at the head or mouth of the Pocotaligo River during half ebb, 1.0172 surface and 1.0179 bottom. It will be observed that the specific gravity of the water at the head is much less than at the mouth. This is due to the fresh water from the Coosawhatchie and Pocotaligo rivers, which drain a large area of fresh-water swamps and give the water here a dark color like that from the juniper swamps. Neither dredging nor sounding discovered oysters in deep water in the river, but the usual accompaniment of raccoon oysters is found along the shore from the mouth to the head, the ledges becoming less frequent and the oysters of poorer type as you approach the head.

The entire area of the river is about 12,274 acres: area of natural oyster beds, about 22.8 acres.

Pocotaligo River, the eastern branch of Broad River, was examined at its mouth to a point a mile above where the topography of the chart ceases, and which is a distance of 3½ miles. Its general course is south and its average width about 200 yards. The water is very darkly discolored, like swamp water, from its mouth to the highest point examined. The bottom is favorable, being hard and sticky for the greater part, and the depth ranges from 2 to 17 feet. The specific gravity at the mouth at half ebb was 1.0172 surface and 1.0179 bottom; at the mouth of Haulover Creek it was 1.0148 surface and 1.0149 bottom, and at the highest point examined 1.0145 surface and 1.0144 bottom. As one ascends the river the raccoon oyster ledges become less frequent and the type poorer until they cease altogether about 3 miles above the mouth. At two different places, namely, the mouth of Haulover Creek and a mile above it, small single oysters were taken in deep water, but they were like the raccoon oysters, poor in quality although of good shape. They have the usual attachment of barnacles, which have been found on all the oysters taken from deep water presenting the same conditions. I think it more than likely that the poor quality and condition of the oysters taken from deep water here is caused in part by the coloring matter in the water. Total area of part examined is about 300 acres; area of natural oyster beds, about 3.2 acres.

Whale Branch.—This winding stream separates Port Royal Island on the south from Barnwell and Chisholm islands on the north, and connects Broad River with the Coosaw. It has an average width of one-fourth of a mile and a distance through the Coosaw of 8 miles. For the first 5 miles it takes a northerly direction, and thence extends east to the Coosaw, of which it is a continuation. The depths range from 7 to 18 feet. The bottom from the ferry to the Coosaw River is generally hard and sticky, and therefore favorable, but the water, like that of the Pocotaligo, and coming from the same source, is darkly discolored on the ebb tide even below Port Royal Ferry. The only oysters found were along the shores and around the several islands, but these were of poor type and quality. The specific gravity of the water at the lower mouth, Broad River, during early ebb was 1.0210, surface and bottom; at the railroad bridge, 1.0193 surface and 1.0194 bottom; at its junction with the Coosaw River during early flood, 1.0198 surface and 1.0200 bottom. The total area is about 1,024 acres; area of natural oyster beds, about 11 acres.

Archer Creek is a narrow passage connecting Broad River with Battery Creek, and separating Port Royal Island from Paris Island. It is about 3 miles long and ranges in depth from 3 to 10 feet. The specific gravity at the upper mouth was 1.0228 surface and 1.0230 bottom, at half ebb. The total area of the creek is 150 acres; area of natural oyster beds, about 3.2 acres.

Beaufort River heads at the junction of Brickyard and Albergottie creeks, and, flowing in a southerly direction for 13 miles, enters Port Royal Sound at the southern point of Paris Island. For the first 8 miles, or to the mouth of Battery Creek, it has an average width of three-eighths of a mile, and from this point to the mouth a width of seven-eighths of a mile. The depths range from 3 to 30 feet, and there is a strong tidal current. The bottom agrees well in depth and character with the Coast Survey soundings, much of it being favorable for oyster cultivation, but shifting bottom may be apprehended in the broad part near its mouth. The usual growth of raccoon oys-

ters is found along the shores and around the islands in the river, but no oysters occur below low-water mark. The specific gravity at the mouth of the river at two-thirds ebb was 1.0231 surface and 1.0233 bottom; at Beaufort, 1.0226 surface and 1.0227 bottom, and at the junction of Albergottie and Brickyard creeks, one-half flood, 1.0226 surface and 1.0227 bottom. The total area of the river is about 3,840 acres; area of natural oyster beds, about 19.6 acres.

Chowan Creek is a small tributary of Beaufort River. Rising in St. Helena Island, it flows westward and empties into Beaufort River 4 miles above its mouth. It is about 5 miles long and has a depth of water ranging from 3 to 16 feet. The bottom is generally hard and sticky. Some fair oysters were taken here at the outer limit of the raccoon ledges. The specific gravity at the mouth was 1.0228 surface and 1.0230 bottom, at last of ebb, and 1.0224 both surface and bottom, near the head at early flood. The total area of the creek is 720 acres; area of natural oyster beds, 8.7 acres.

Jericho and Battery Creeks.—This tributary, called Jericho in its upper and Battery in its lower part, takes its rise in Port Royal Island near the town of Beaufort, and winding in many directions, with a general trend southward, empties into Beaufort River 5 miles above its mouth, near the terminus of the Port Royal Railroad. It is a narrow, deep stream, ranging in depth from 3 to 20 feet, and much of the bottom is well adapted to the cultivation of oysters, being hard and sticky. Very good oysters are taken here, in limited quantity, just below the outer limit of the raccoon oysters, having evidently fallen off from the latter into the deeper water.

During the examination of the coast of Georgia the previous winter, my attention was called to the fact that never in water presenting the same conditions of density as this (the general conditions are similar in the two States) were oysters found in deep water, unless they had dropped from the ledges above, and yet they grow and thrive between high and low tide mark. It is also a notable fact that there is an abundance of oyster life near the inlets in the Southern waters, as is manifested by the numerous and continuous ledges of raccoon oysters, and it may be laid down as a rule that as you approach the heads of the streams, where the specific gravity is much lower, the beds along shore become less frequent and the type of oyster becomes poorer; but when this condition is reached one may look for and expect to find deep water oyster beds. These facts were so patent that Lieut. Platt suggested a careful series of density observations at two points in this creek, to be made at different times of the tide and in different depths of water, to determine, if possible, the cause of the absence of oysters in the deeper water. These observations were conducted in cross sections of the creek opposite the railroad wharf at Port Royal and opposite the wharf of the Messrs. Brotherhood's phosphate mills in Jericho Creek, the water being also analyzed by Dr. Bashford Dean. Other experiments will be made during the spawning season to test the specific gravity of the oyster spat itself.

Other interesting experiments were undertaken in this vicinity, the outcome of which will be watched with much interest. A number of oysters were selected from the raccoon beds, which are left bare at low water, counted and carefully marked with tin tags, and transplanted to deeper water. The death rate of these will be carefully noted at a future date, and they will be examined closely to see if there has been a set of spat. Oysters from the adjacent shores were also planted in midstream on suitable bottom opposite the wharf of the Messrs. Brotherhood's phosphate works, for a similar purpose.

The specific gravity at the mouth of Battery Creek at half ebb was 1.0228 surface and 1.0230 bottom; just above the junction of Jericho and Battery creeks, early flood, 1.0223, surface and bottom; abreast the phosphate works, one-fourth flood, 1.0222, surface and bottom. The total area of the creeks is about 512 acres; area of natural oyster beds, about 9 acres.

Brickyard and Albergottie creeks.—The former of these creeks is but a continuation of Beaufort River and connects it at its northern extremity with the Coosaw River. It is about 4 miles long and has an average width of 150 yards. The bottom is generally hard and sticky, and underlaid in places by phosphate rock. The specific gravity at the upper mouth, on the early flood, was 1.0215 surface and 1.0213 bottom; and at the lower mouth or junction with Albergottie Creek, 1.0226 surface and 1.0227 bottom. No oysters were observed in the Albergottie, its bottom and sides consisting of very soft mud. The total area of creeks is 560 acres; area of natural oyster beds, 2.1 acres.

Station Creek, Story and Harbor Rivers.—The territory south of St. Helena Island, between Trenchard Inlet and St. Helena Sound, was not examined, but we know that the usual conditions of salt-water circulation exist in this system, and the natural oyster beds were not located. From the best information that could be obtained it is safe to say that ledges of raccoon oysters occur along the shores which will not average more than 10 feet in width. The characteristic soundings of the Coast Survey charts can be relied on to give an idea of the bottom.

Coosaw River.—This large tributary of St. Helena Sound is but a continuation of Whale Branch and completes the northern circulation between Port Royal and St. Helena Sound. It is about 13 miles long with an average width of 1 mile. It flows in an easterly direction and empties into St. Helena Sound at the southeast point of Morgan Island. The bottom is generally hard, consisting mainly of phosphate rock, but constant changes are being made by the phosphate dredgers. The extensive prosecution of this great industry precludes the successful cultivation of oysters within this territory, even if the conditions were very favorable. The specific gravity near the mouth during the first of the flood was 1.0206 surface and 1.0207 bottom; off the mouth of Dale Creek, 1.209 surface and 1.0211 bottom; and at the junction with Whale Branch, 1.0198 surface and 1.0202 bottom. Raccoon oysters are found along the shores but are of poor quality, there being many dead shells and a small proportion of live oysters. In the upper part, the water is tinged on the ebb tide by the swamp water coming through Whale Branch. The total area of the river is about 7,104 acres; area of natural oyster beds, about 19.6 acres.

Parrott Creek is a short arm connecting Morgan and Coosaw rivers and separating Morgan Island from Coosa Island. It is about 2 miles long and will average one-fourth mile in width. The bottom is generally hard and sticky, and the specific gravity at its mouth was 1.0209 surface and 1.0211 bottom. Phosphate rock underlies the bottom of this creek also. It is now being mined in a small way, and subject to extensive operations at any time under the phosphate laws of the State. The total area of the creek is 355 acres; area of natural oyster beds, 4.6 acres.

Dales Creek also connects Morgan River near its head with Coosaw River and separates Coosa Island from Ladies Island. It is about 4 miles long and 150 yards wide. The bottom is generally hard and sticky and the depth ranges from 11 to 15 feet. This creek is also in the phosphate region, and the Farmer's Phosphate Works are

situated on its west shore. The total area of the creek is about 290 acres; area of natural oyster beds, about 2.6 acres.

Morgan River is about 8 miles long from Dales Creek to its mouth at St. Helena Sound. Its trend is east; it has a depth of 3 to 30 feet, and will average one-half mile in width. The bottom is generally hard and corresponds with the indications on the Coast Survey charts. It is liable to be disturbed at any time by the phosphate dredgers. The specific gravity at the head of the river at dead low water was 1.0193 surface and 1.0194 bottom; at the mouth near St. Helena Sound, on the first of the flood, 1.0206 surface and 1.0207 bottom. The total area is about 2,496 acres; area of natural oyster beds, 9.1 acres.

Bull River and its tributaries.—This river is formed by the confluence of the North and South Wimbee and has a general southeast course, flowing into the Coosa River opposite Parrott Creek. The bottom is generally hard and underlaid by phosphate rock; the depth ranges from 2 to 30 feet. Several large phosphate companies are located on this river, and the bottom is extensively mined for rock. No oysters were found in deep water, but raccoon oysters of poor type extend along the shores, decreasing in quantity as one ascends both the North and South Wimbee. The water, while it is not muddy, has a dirty look with an oily scum on the surface. The specific gravity of the water at the highest point on the North Wimbee, at one-half ebb, was 1.0185 surface and 1.0183 bottom; at the highest point examined on the South Wimbee, at low water, 1.0184 surface and bottom; and at the mouth of Bull River, on the early ebb, 1.0179 surface and 1.0180 bottom. The total area is about 928 acres; area of natural oyster beds, 7.1 acres.

Combahee River also has a southeast trend and empties into the Coosa 2 miles below the mouth of Bull River. While it has all the disadvantages of Bull River, being in the phosphate region, it becomes absolutely fresh 4 miles above its mouth. The bottom is generally hard and sticky, and the raccoon oysters extend along its shores to a point 1½ miles above its mouth. One mile above the mouth of Old Cheehaw Creek the water was practically fresh both at the surface and bottom. At the mouth of Old Cheehaw Creek, at three-quarters ebb, the specific gravity was 1.0113 surface and 1.0132 bottom; and at the mouth of the river, one-half ebb, 1.0162 surface and 1.0179 bottom. Total area of oyster-producing part, 1,088 acres; area of natural oyster beds, about 5 acres.

Ashepoo River was examined only from its mouth to the mouth of Mosquito Creek, which connects this river with the South Edisto. It is about 6 miles from the mouth to this point and will average about 200 yards in width. The bottom is favorable, being hard and sticky, with a depth ranging from 2 to 30 feet. But very few oysters were observed in this river, the largest area being near the west shore about 1 mile below the mouth of Mosquito Creek. The water is slightly tinged near the mouth and grows yellowish as one ascends the stream. I was informed by native fishermen that the water is fresh about 5 miles above the mouth of Mosquito Creek. This creek itself becomes absolutely fresh 3 miles above its mouth. The specific gravity of the water at the mouth of the river at one-sixth ebb was 1.0231 surface and 1.0234 bottom; near the mouth of Mosquito Creek, one-half ebb, 1.0152 surface and 1.0154 bottom. The area of the part examined was 760 acres; area of natural oyster beds, about 12 acres.

St. Helena Sound separates Edisto Island on the north from St. Helena Island on the south and is about 8 miles wide. It is open and exposed to the northeast and southerly gales and is considered totally unfit for the cultivation of oysters, not only on account of the great density of its waters, but also of the shifting character of its bottom. Area of natural oyster beds, about 4.9 acres.

South Edisto River takes its rise in Edgefield County, drains a large extent of country, and reaches the tide-water section of the State charged with mud, entering St. Helena Sound at the southwestern point of Edisto Island. Five miles above the mouth the water is practically fresh, and no doubt during heavy freshets the fresh-water point is carried nearer to the sea. From this place to the mouth the bottom is generally hard, except in the channel, and corresponds in depth and character with the Coast Survey soundings. A bed of oysters is found just off the upper mouth of Bailey Creek, a part of which is left bare at dead low water, but the bed extends into deep water. The oysters are small and have the usual attachment of barnacles. From this point raccoon oysters extend down the east shore in patches to the mouth of St. Pierre Creek, where they cease. The specific gravity of the water 1 mile above the point of Raccoon Island is 1.0000; at the point of Raccoon Island, two-thirds flood, 1.0087; in the west mouth of Bailey Creek, two-thirds flood, 1.0120, and at the mouth of St. Pierre Creek and near the mouth of the river, at one-half ebb, it was 1.0141. The area of the river from the point of Raccoon Island to its mouth is 1,150 acres; area of natural oyster beds, about 6.3 acres.

St. Pierre Creek.—This narrow winding creek takes its rise in the central part of Edisto Island and, with a westward trend, empties into the South Edisto River 1 mile above its mouth. It is about 7 miles long, will average about 175 yards in width, and has depths ranging from 2 to 20 feet. The bottom is favorable, being hard and sticky for the greater part. The density of the water is very uniform in this creek, and much less dense than that usually found in the streams near the ocean, for the fresh water of the South Edisto is met, diffused, and rebutted by the flood tides, thus tempering the water.

The ledges of raccoon oysters are not so numerous as in water of greater density, but deep-water beds are found in several places in this creek, the largest beginning at Peters Point and extends up the creek for half a mile on the south shore, and even out to the middle of the stream. This creek has furnished more seed oysters for the different planters in the State than any other locality, according to Mr. John Griffin, who is the pioneer planter in this region and who kindly accompanied us in the examination of these creeks. I am much indebted to him for information received and shall have occasion to speak of him again in connection with his planted grounds in Bailey Creek. The specific gravity of the water at the mouth of the creek at half ebb was 1.0141; 1 mile above the mouth, 1.0138; at Peters Point, 1.0138; at the eastern mouth of Bailey Creek, 1.0130; and at the mouth of Store Creek, which is a continuation of St. Pierre Creek, 1.0120. The total area of the creek and its tributaries is about 750 acres; area of natural oyster beds, about 42 acres.

Bailey Creek is a very narrow winding stream which has one outlet at its western mouth in the South Edisto 2 miles above the mouth of St. Pierre Creek, and connecting with the latter, 3½ miles above the mouth, it separates Scanawah Island on the north from Bailey Island on the south. It is especially deserving of mention because the eastern part, for 2 miles before reaching St. Pierre Creek, contains the planted

oyster grounds of Mr. John Griffin. His operations consist in taking the seed from St. Pierre Creek and transferring it to suitable bottom in Bailey Creek. The oysters are marketed from one to two years after planting. He has about 3,000 or 4,000 bushels planted and sells about 1,000 bushels a year, which he disposes of entirely in Charleston at the rate of 75 cents per bushel. Mr. Griffin informs me that a large part of the bottom of this creek is either very soft mud or quicksand and that he can only find small areas here and there suited to his purpose. Seed oysters are so near and so conveniently obtained that he has never deposited shells to catch the young oysters, but I do not doubt that it would be feasible to do so here. The planted oysters here, as well as in St. Pierre Creek and New River, are covered with barnacles. The specific gravity of the water at the western mouth is 1.0120; 3 miles above, 1.0126; 1 mile from the eastern mouth, 1.0130; at the eastern mouth, 1.0130. The entire area of the creek is about 80 acres; area of planted grounds about 20 acres.

Dawho River connects at its western mouth with the South Edisto River, and furnishes the inland passage from the South to the North Edisto rivers. The fresh water from the South Edisto renders the upper part of this river totally unfit for oyster cultivation, and the raccoon oysters only begin to show at a point about 2 miles above the eastern mouth on the mud flats. The specific gravity of the water off the eastern mouth during the early flood was 1.0199 surface and 1.0205 bottom; 1 mile above this mouth, at the mouth of Long Creek, high water, 1.0192 surface and 1.0209 bottom. The area of the lower part of the river is about 384 acres; area of natural oyster beds, about 8.5 acres.

Steamboat Creek, called Russell in its upper part, takes its rise in the northwestern part of Edisto Island and, flowing in an easterly direction, makes a junction with the North Edisto River 5½ miles below its head. The depths correspond with the Coast Survey soundings; the bottom is hard and sticky along the sides and soft in the channel. Raccoon oysters extend along the shores in patches, and the mud flats between this creek and the Dawho River contain a labyrinth of oyster beds. The specific gravity of the water at Edisto Island post-office, at low tide, was 1.0175 surface and 1.0185 bottom; at its mouth, early flood, 1.0235 surface and 1.0212 bottom. The total area, including mudflats, amounts to about 1,360 acres; area of natural oyster beds, about 71 acres.

North Edisto River, unlike the South Edisto, is simply a short arm of the sea, and through its continuation with the Wadmelaw River, New Cut, and Church Flats, merges into the Stono River at Rantowles Creek, and furnishes an inland passage from this river to Stono Inlet. It may be said to head at Wadmelaw Point, from which place to the mouth it has a length of 7¼ miles and an average width of one-half mile. The bottom is generally hard and underlaid in places by phosphate rock. No oysters are found in deep water, but those of the raccoon type extend along the shores to the mouth of Bohicket Creek. The specific gravity of the water at the mouth of Townsend River was 1.0233 surface and 1.0234 bottom, on the last of the flood; at the mouth of Leadenwah Creek, 1.0209 surface and 1.0208 bottom, on the first of the flood; and off Wadmelaw Point, or the mouth of Dawho River, 1.0199 surface and 1.0205 bottom, during early flood. The total area from Wadmelaw Point to the mouth is about 2,112 acres; area of natural oyster beds, about 7.9 acres.

Bohicket Creek, the most southern tributary of the North Edisto on the eastern shore, was examined from its mouth to a point 6 miles above. It has a general trend

westward and will average 200 yards in width with a depth ranging from 3 to 16 feet. The bottom is generally hard and favorable for cultivation. The specific gravity is high. At the uppermost point reached it was 1.0220, surface and bottom, at half flood; at Rockville, at the same time of the tide, it was 1.0222, surface and bottom; and at its mouth, about the same time of tide, 1.0228, surface and bottom. The total area examined was about 450 acres; area of natural oyster beds, about 2.2 acres.

Leadenwah Creek heads in Wadmelaw Island and also trends westward, emptying into the North Edisto 2 miles above the mouth of Bohicket Creek. It was examined to a point 1 mile beyond the limit of the topography of the Coast Survey charts, and that part was sketched in by course and distance as accurately as possible. The bottom is generally hard while the depth ranges from 2 to 25 feet. Raccoon oysters extend along the shores for the first mile and a half, when they become less frequent and finally cease altogether. The specific gravity of the water 4 miles above the mouth was 1.0212 surface and 1.0208 bottom, on the first of the flood. The area of the part examined amounted to about 384 acres; area of natural oyster beds, about 3.2 acres.

Townsend River is the most southern tributary of the North Edisto on the west side, and is reinforced by Ocella Creek, which makes a junction with it 1 mile from its mouth. The character of the bottom is generally hard. The specific gravity of the water in this river 1 mile above the junction of Ocella Creek was 1.0230 surface and 1.0231 bottom, at high tide. At the fork or mouth of Ocella Creek, on the last of the flood, it was 1.0233 surface and 1.0234 bottom; in Ocella Creek, 1 mile above the junction with Townsend River on the last of the flood, 1.0230 surface and 1.0228 bottom; and at the mouth of the river, 1.0233 surface and 1.0234 bottom. The total area of the river and creek is about 240 acres.

McCloud Creek.—This narrow but deep creek rises to the westward of Park Island, and has a length of 6 miles and a depth of 3 to 20 feet. It empties into the North Edisto River 1 mile above the mouth of Dawho River. The specific gravity of the water 4 miles above the mouth during high tide was 1.0200 surface and 1.0194 bottom; at the mouth, on the early flood, 1.0204 surface and 1.0200 bottom. The total area of the creek is 80 acres; the area of natural oyster beds is inconsiderable.

Togodo Creek is about 200 yards wide and is formed by the junction of Little and Big Togodo creeks, 2½ miles above its mouth, or one-half mile beyond the finished topography of the Coast Survey charts. No oysters occur in deep water in the creek and very few raccoon oysters were found. These were near the mouth on the west shore. The bottom is favorable, being hard and sticky. The specific gravity, 1 mile above the fork of Little and Big Togodo creeks in Little Togodo Creek, at one-third flood, was 1.0196 surface and 1.0195 bottom; and at the mouth of Togodo Creek, one-sixth flood, 1.0196 surface and 1.0198 bottom. The total area examined was about 384 acres; the area of the natural oyster beds is inconsiderable.

Wadmelaw River is a continuation of the North Edisto River, and may be said to constitute that part included between Wadmelaw Point and the New Cut. It is about 8 miles long and consists of a series of bays or flats, dotted by numerous islands. From this point to the mouth of Rantowles Creek, or the head of Stono River, the inland passage is a narrow, winding stream, about 7 miles in length. The bottom in the Wadmelaw River is generally hard and sticky except directly in the channel. The specific gravity is uniform, being 1.0199 at the surface and 1.0205 at the bottom at the lower mouth, and 1.0197 surface at one-third flood at the upper mouth or the

mouth of Church Creek. Raccoon oysters not only occur along the shores, but the wide bays and flats are covered by a series of oyster beds which are left bare at low water and which, it is estimated, will cover one-eighth of the entire area where they are found. These oysters disappear as one approaches New Cut, and none are found from this point to the Stono River. The bottom is generally much softer in this part of the Inland Passage. The total area is about 2,450 acres; area of natural oyster beds, about 150.5 acres.

Stono River is about 16 miles long from Rantowles Creek to Stono Inlet, which is formed by the junction of this with Kiawah River. For the first 7 miles it takes an easterly direction and then a general southerly direction to the inlet, with an average width of about 400 yards. The bottom corresponds in depth and character with the Coast Survey soundings; much of it being hard enough to support the weight of the oysters, is therefore favorable for planting. This river was examined on flood tide; but few oysters were observed in the upper part, but I was informed by the pilot who conducted the *Fish Hawk* through the passage that raccoon oyster ledges occur along the shores in its more southern part. The specific gravity of the water at the head, at five-sixths flood, was 1.0179; at Buzzard Roost Point, on the first of ebb, 1.0194; at the mouth of Legare Creek, early ebb, 1.0229; and at the mouth or junction with Kiawah River, one-fourth ebb, 1.0234 surface and 1.0232 bottom. The total area of the bottom is 2,580 acres; approximate area of natural oyster beds, 14.5 acres.

Kiawah River takes its rise in the eastern part of Seabrook Island and, flowing in an easterly direction, separates Johns Island on the north from Kiawah Island on the south. It is about 7 miles long and heads in a series of mud flats. The bottom is generally hard and the depth ranges from 2 to 24 feet. The specific gravity is high. At the mouth, at one-fourth ebb, it was 1.0234 at the surface and 1.0232 at the bottom; 3 miles above the mouth, five-sixths ebb, 1.0237 surface and bottom; while at its head in the flats it reaches a maximum of 1.0242, surface and bottom, on the first of the flood. Raccoon oysters extend continuously along both shores and small beds are numerous on the flats near the head. The total area is about 900 acres; area of natural oyster beds, about 33.8 acres.

Folly River was not examined, but it presents the same features and conditions which occur in Light-house and Schooner creeks, and furnishes a circulation from Light-house Inlet through to Stono Inlet, the specific gravity being, no doubt, very similar to that found in those creeks. I am informed on good authority that the raccoon ledges are found here along the shores and on the flats also. A fair idea of the bottom can be had from the Coast Survey charts. The total area is about 700 acres.

Stono Inlet is small, and being open to the sea the specific gravity of the water is high, and a shifting bottom may be expected in times of storm. It is deemed impracticable to utilize its bottom for oyster cultivation.

Schooner and Light-house creeks head in a series of mud flats in James Island and separate this island from Morris Island. Schooner Creek flows easterly and enters Charleston Harbor on the south, while Light-house Creek takes a southeasterly course and enters the small inlet of the same name, which is only a continuation of the creek. The depth of water ranges from 2 to 30 feet, and the bottom is generally hard and sticky except in the channel near the middle, where it is softer. It will be observed that the specific gravity of the water is lower in Light-house Inlet than at any point between there and the mouth of Schooner Creek. The water there was also slightly

tinged, resulting no doubt from the waters of the Ashley and Cooper rivers being met at sea by the rising tide and forced back through this inlet. The specific gravity at the mouth of Schooner Creek was 1.0221 surface and 1.0222 bottom, on the last of the ebb; near the head of the flats, early flood, 1.0226 surface and 1.0222 bottom; and in Light-house Inlet, abreast of the light-house, one-third flood, 1.0204 surface and 1.0210 bottom. Raccoon oysters not only extend along the shores in patches, but are also found in great numbers on the mud flats. Hard-shell clams or quahogs also occur in considerable quantities in these creeks. The total area of the creeks, including the mud flats at the head, is about 820 acres The area of the natural oyster beds is about 57.5 acres, and that of the planted ground about 20 acres.

Mr. Henry Merritt is engaged in planting oysters in Light-house Creek from the beacon to a point 2 miles above. Unfortunately he was not at home when this locality was examined, and but little information could be obtained as to the extent of the planted area and the quantity of oysters marketed. But specimens of the planted oysters were taken, which showed a wonderful improvement over those occurring in the adjacent raccoon beds. The method pursued is to transplant the raccoon oysters from the borders of the creek to deeper water. The worst enemy encountered, Mrs. Merritt states, is the conch, which devastates the planted beds, sometimes destroying 50 per cent of their contents. The improvement in the quality of the planted oysters, coupled with the success of Mr. Merritt (everything about his premises indicating thrift) tends to prove that this is a good field for the transplanting of the raccoon oysters to more suitable bottoms. In fact, while his operations are restricted to a small area, he seems to be the most successful planter in the State. A scarcity of reliable labor interferes with the increase of his business, most all of the work being performed by himself.

Ashley River.—The topography of this river, as well as of the Cooper and Wando rivers, has never been completed above the city of Charleston, and the shore line had to be sketched in as accurately as possible by course and distance while the survey was being made. The Ashley River was examined to a point about 12 miles above its mouth, or 2 miles above the railroad bridge, where it becomes practically fresh. It averages three-eighths of a mile in width, and the depths range from 2 to 30 feet. The bottom is favorable, being generally hard and sticky with occasional soft places. The raccoon oyster ledges are inconsiderable along the shores of this river, and cease altogether about 2 miles above the Charleston bridge, but oysters are found in deep water near the railroad bridge, and in a cove 2 miles below it on the west shore. The specific gravity is 1.0116 at the former locality and 1.0166 at the latter. The water is yellowish, with mud in suspension, in the upper part of the river. The oysters found in deep water have the usual attachment of barnacles. There is such a wide range of specific gravity that any desired density may be obtained, but that part of the river between the railroad bridge and the Wando Phosphate Works is especially recommended as suitable ground. It is also possible that this area can be stocked by the catching of spat on bottom shells or cultch, if such is desired.

A series of density observations was made at both ends and at the middle of the Charleston bridge at different times of the tide, at the surface, mid depth, and bottom. The specific gravity of the water in the mouth off Charleston at one-half flood was 1.0217, surface and bottom; 1 mile above the Charleston bridge, one-sixth flood, 1.0198 surface and 1.0200 bottom; at the Wando Phosphate Works, one-sixth flood, 1.0188

surface and bottom; 1 mile below the railroad bridge, one-half flood, 1.0137 surface and bottom; and at the railroad bridge, 1.0089 surface and 1.0116 bottom. The total area of the part examined was about 2,600 acres; area of natural oyster beds, about 10.4 acres.

Cooper River was examined and sketched in to a point about 16 miles above its mouth at Charleston. It will average about one-half mile in width with a range of depth from 3 to 30 feet. The bottom is generally favorable in the lower part, being usually hard and sticky. But few raccoon oyster beds were found along the shores, but from local information it was learned that oysters are taken from deep water in Slack Reach and farther up the stream in Groves Creek. A series of density observations was also made across this river at the custom-house dock, buoy No. 3, mid stream, and a point on the opposite shore being in range. The specific gravity at the mouth at ebb tide was 1.0224, surface and bottom; at the mouth of the Wando River, last of the ebb, 1.0213, surface and bottom; 5 miles above the mouth, early flood, 1.0192 surface and 1.0203 bottom; 12 miles above the mouth, last of ebb, 1.0168 surface and bottom; and at the highest point reached, 2 miles above Slack Reach, 1.0156 surface and bottom, on the early flood. The area of the part examined was about 6,052 acres; area of natural oyster beds, about 10.9 acres.

Wando River, unlike the Ashley and the Cooper, does not drain an extensive territory, and hence has a much higher and more uniform density. It was examined and sketched in to a point about 16 miles above the mouth. It has a general southerly direction, and empties into the Cooper River opposite Drum Island. For the first 8 miles it has an average width of one-half mile, and then begins to narrow, contracting at the highest point reached to a width of 150 yards. Raccoon oysters were found growing continuously on both shores as far as the uppermost place examined, but no oysters were discovered in deep water except the droppings from the ledges, and among these some fine specimens were obtained. The bottom is generally hard and favorable, underlaid in places by phosphate rocks, while the depth ranges from 2 to 30 feet. The specific gravity at the mouth of the river on the last of the ebb was 1.0213, surface and bottom; 4 miles above the mouth, on the last of the ebb, 1.0208, surface and bottom; near village wharf, early flood, 1.0206, surface and bottom; and at the highest point examined, one-third flood, 1.0201, surface and bottom. Little or no variation was found in the surface and bottom densities, and I have seen no locality of the same specific gravity where the conditions seem to be more favorable. How far the mining for phosphate rock in the future would interfere, can not be predicted, but parties are now taking some rock from the bottom of this river. The approximate area of the part examined is about 4,992 acres; approximate area of natural oyster beds, 34.8 acres.

Charleston Harbor is about 1½ miles wide at its mouth, from Cummings Point to Fort Moultrie, and about 3 miles long from its mouth to the mouth of Cooper River. It is exposed to southerly and easterly gales. The specific gravity ranges high, and is tempered in its upper part on the ebb tide by the water from the Ashley and Cooper rivers. A few raccoon oyster beds are found on both the eastern and western shores, but extensive dredging with the launches and with the steamer *Fish Hawk* failed to discover any oysters in deep water, and its value as a possible oyster ground is deemed inconsiderable. The specific gravity at the mouth of Cooper River was 1.0224, surface and bottom; at the mouth of the Ashley River, on the last of the ebb, 1.0217 surface

and bottom; at the mouth of Schooner Creek, at last of the ebb, 1.0221 surface and 1.0222 bottom; and at the mouth of Sullivan Island Narrows, at one-half ebb, 1.0207. The area of the natural oyster beds is 3.8 acres.

Sullivan Island Narrows.—This name is given to the narrow inland passage connecting Charleston Harbor with Breach Inlet. It is about 3 miles long, and will barely average 100 yards in width, with a range in depth of 1 to 15 feet. The bottom varies from hard and sticky along the shores to soft mud in the channel. That part lying between the channel and the shore is suitable for cultivation. The specific gravity at the lower mouth, one-half ebb, was 1.0207; 2 miles below upper mouth, at the same time of the tide, 1.0203 surface and 1.0202 bottom; and at the upper mouth or Breach Inlet, about the same time of the tide, 1.0205 surface and 1.0209 bottom. The total area of the narrows and its tributaries is 120 acres; area of natural oyster beds, 7.2 acres.

Breach Inlet, a small and insignificant inlet, is formed by the confluence of Sullivan Island Narrows, Goat Island Creek, Little Goat Island Creek, and Meeting Reach, a ramification of creeks which intersect the marshes between Charleston Harbor and Grays Bay and connect with that bay through their various drains and tributaries.

Goat Island Creek is the largest of the tributaries of Breach Inlet, and rises about 3 miles north of it in a mud flat or bay. The water has a yellowish tinge. The specific gravity at the mouth, at one-half ebb, was 1.0205 surface and 1.0209 bottom. Raccoon oysters are found in patches along the shores and also in the mud flat at the head. The total area of the creek is 140 acres; area of natural oyster beds, about 5.8 acres.

Little Goat Island Creek heads in the vicinity of Grays Bay and, with a trend southward, enters Breach Inlet one-fourth of a mile east of the mouth of Goat Island Creek. The bottom is generally hard and sticky. The lower part, from its mouth to a point 1 mile above, contains the planted grounds of Mr. Thomas Swinton. When this locality was visited Mr. Swinton was absent, and the only information regarding his operations was obtained from a negro who is sometimes employed by him in connection with the planting. This man informed me that he had never used the raccoon oysters, but secured all his planting stock from St. Pierre Creek. I also had it from the same source that Mr. Swinton was going out of the business, and that the property was for sale. Mr. Swinton disposes of about 1,000 bushels a year, and it requires from one to two years after they are transplanted before they become marketable.

No young oysters were found on the planted oysters secured here. The water was yellowish with mud in suspension and is said to be always so. The specific gravity of the water at Swinton's oyster-house at one-half ebb was 1.0200 at the surface and 1.0202 at the bottom, and at the mouth of creek, one-half ebb, 1.0198 at the surface and 1.0201 at the bottom. The total area is about 80 acres; area of planted oyster ground, about 20 acres; area of natural oyster beds, inconsiderable.

Meeting Reach.—This creek, through the Seven Reaches at its eastern extremity, connects Breach Inlet with Dewees Creek and furnishes a part of the inland passage to Bull Bay. For the first 2 miles it is a continuation of Breach Inlet and has a width of 150 yards, when it becomes very narrow and at dead low water it is almost dry. The bottom is variable, and the range of depth from 6 inches to 15 feet. The specific gravity at the lower mouth was 1.0198 surface and 1.0201 bottom, at one-half ebb;

2 miles above, 1.0199, at surface, and 1.0200, at bottom, about the same time of the tide; at junction with Morgan Creek, one-half flood, 1.0199 surface and 1.0210 bottom; and in Dewees Creek, at the mouth of Seven Reaches, at one-half flood, 1.0201 surface and 1.0207 bottom. The total area of passage to Dewees Creek is about 184 acres; area of natural oyster beds, about 9.6 acres.

Dewees Creek.—Only a portion of this creek was examined, while Grays Bay and Hamlin and Copahee Sounds were not surveyed, but we know that they have a salt-water circulation and that the only fresh water which tempers this area must come from the drainage and seepage of the surrounding marshes and woods. Hence the specific gravity will average high and, no doubt, will vary but little from the observations taken through the inland passage south of these sounds. I am informed by the Messrs. Magwood, managers respectively of the Bull Bay and the Edisto Fish and Oyster companies, that the characteristic ledges of raccoon oysters are found not only along the shores of the creeks, but also in the shallows of the numerous sounds and bays between this creek and Bull Bay. The area can be arrived at approximately and will add largely to the acreage of the natural oyster beds in the State.

The specific gravity at the mouth of the Seven Reaches at one-half flood was 1.0201 surface and 1.0207 bottom. An idea of the bottom can be obtained by reference to the Coast Survey charts. I do not see why the deeper portions of these bays and sounds where the bottom is hard and stable could not be utilized, and in course of time they probably will be, notwithstanding they are so far distant from a market and are now surrounded by uninhabitable marshes for the most part. The total area of the creek, Grays Bay, Hamlin, and Copahee Sounds is about 2,500 acres. The area between Dewees Creek and Bull Bay consists of a series of bays, sounds, inlets, creeks, and passes, through which there is a narrow intricate inland passage. The same conditions exist here which are found in the area between Dewees and Breach Inlet. There is but little variation in the density, either at the surface or the bottom. The bottom through this passage corresponds with the soundings of the Coast Survey, both in its character and depth, and is variable, being generally hard along the shores and soft in the channel.

The specific gravity at Bullyard Sound, one-half mile from the lower entrance, at one-half flood, was 1.0200, surface and bottom; near the upper entrance, 1.0200, surface and bottom; at the junction of Whiteside and Capers creeks, 1.0214, surface and bottom; at the lower mouth of Santee Pass, two-thirds flood, 1.0200, surface and bottom; at Videls Landing, at two-thirds flood, 1.0202, surface and bottom; Santee Pass near Mark Bay, three-fourths flood, 1.0214 surface and 1.0213 bottom; Santee Pass, at the Edisto Fish and Oyster Company's planted grounds, 1.0223 surface and bottom. This company is transplanting the raccoon oyster to deeper water here with fair success. A specimen of their stock which had been planted about one year was secured. In Price Creek, at the lower mouth of Bull Narrows, the density was 1.0206 surface and 1.0209 bottom; 1 mile above Price Creek and Bull Narrows, at three-fourths flood, 1.0202 surface and 1.0211 bottom; in Bull Creek, at the mouth of Bull Narrows, 1.0194 surface and bottom; at the mouth of Bull Creek, at low water, 1.0197 surface and 1.0198 bottom; and at high water, 1.0190 surface and 1.0218 bottom. It was noteworthy that all through this inland passage the water had a yellow tinge of mud in suspension, the cause of which will be spoken of later, and I think can be traced in part to the muddy water from the Santee and Pedee rivers.

The total area of this section, including bays, creeks, and sounds, is about 2,600 acres. The approximate area of natural oyster beds through the inland passage is about 15.5 acres. The numerous bays, sounds, and flats which lie north of the inland passage, and which were not examined, would largely increase the acreage of natural oyster beds and furnish a large supply of seed oysters.

Bull Bay.—This bay is about 6 miles long from Bull Bay Light to the western point of Raccoon Key at the mouth, and will average 3½ miles in width. It is very shallow except in the numerous narrow channels. Shifting sands cover the larger portion of this area, and, being open to the sea, it is subject to constant changes. It has more than ordinary interest, because two of the largest oyster companies in the State are engaged in cultivating oysters there, namely, the Bull Bay Oyster Company, which has planted the reef on which stands the lighted beacon in the northern part of the bay, and the Edisto Fish and Oyster Company, occupying the small reef, lying about one-fourth of a mile west of that place. The former company since it began operations has planted in all about 35 acres; the latter about 10 acres, the greater part of which is left bare at low water. The shifting sand is slowly but surely encroaching on these grounds, and will eventually wipe them out. The Messrs. Magwood Brothers, the managers of these companies, are aware of the changes going on and are fearful of the final result.

Density observations were made across this bay at intervals of 1 mile from the mouth of Bull Creek to the planted grounds, and it will be observed that the least specific gravity was found on the latter. The water in this bay is also discolored with mud in suspension. About a bushel of material was obtained from the planted grounds, but the bulk consisted mainly of dead shells. Only about 30 oysters were found in the lot, and these were in a very poor condition, being thin and watery. Conchs are very destructive to the oysters and the beds require constant watching to prevent their depredations. Many living oyster drills were found in the rubbish taken, but there were little or no signs of the shells having been bored by them. Raccoon oysters and dead shells occur all around the margin of the bay. While we were in this locality Mr. Magwood, the manager, took to Charleston a load of oysters obtained not from his planted grounds, but from what is known locally as the Horn, situated to the northward of Cape Romain. These oysters were much finer than the planted oysters here, and evidently came from the brackish water of the Santee River. Except Winyah Bay and vicinity, this was the highest point to the northward that was examined.

The specific gravity of the water 1 mile from the mouth of Bull Creek, at one-third flood, was 1.0236; 2 miles from the mouth, 1.0226; 3 miles from the mouth, 1.0215; 4 miles from the mouth, 1.0216; and at the Bull Bay Oyster Company's grounds, 1.0196, surface and bottom, at one-third flood. The area of the planted grounds is about 45 acres; area of natural oyster beds around the bay, about 13.3 acres.

Referring again to the yellow tinge of mud found in all the waters between Sullivan Island and Bull Bay, including the latter, it is a noteworthy fact that as the steamer *Fish Hawk* proceeded up this coast from Bull Bay to Winyah Bay the water was thick and yellow all along the coast, close to shore, the yellowish tinge growing fainter off shore until it merged gradually and imperceptibly into the green sea water. As the steamer passed through the different gradations of color in our progress toward Winyah Bay, density observations were made, which showed a great variation in the specific gravity to a point 8 miles from Georgetown Light, where it was practically fresh. This was caused by the immense volume of fresh and muddy water discharged through the

mouth of the Santee River and through the inlet of Winyah Bay, and which is undoubtedly an important factor in the discoloration of the water for many miles south, accounting in part, perhaps, for the variation of the specific gravity observed. The extent of its distribution is, no doubt, dependent on long-continued northeast gales.

Winyah Bay and vicinity.—This territory was granted or leased to Messrs. Hazard, Alexander, and Donaldson by the State legislature of 1889, for the purposes of oyster cultivation, and was surveyed in detail by the writer before the examination by the Fish Commission. Additional observations have been made, however, and are included in the following descriptions.

Winyah Bay, formed by the junction of the Peedee, Black, and Waccamaw rivers, is totally unsuitable for oyster cultivation, on account of the quantity of fresh water flowing into it from these rivers.

Muddy Bay is a part of Winyah Bay and lies between Marsh Islands and the marshes to the northward and eastward. It is a shallow bay or cove, and receives through the Peedee River a large volume of fresh and muddy water, which is constantly making a deposit of exceedingly soft material on the bottom. The water of this bay is entirely too fresh for the cultivation of oysters, to say nothing of the unsuitable character of the bottom. This limits the ground to that portion of the various creeks which flow through the marshes between the bay and North Inlet, where favorable conditions may be found. North Inlet, on the other hand, presents a very salt condition of the water, and its bottom is covered by quick and shifting sands blown in by fresh northeast winds. This character of bottom is even more dangerous to the oyster than soft mud, which may be remedied by throwing a sufficient quantity of shells up on it to give it the proper consistency for bearing up the weight of oysters.

Within this large area two separate and distinct features present themselves: (1) Soft, muddy bottom, over which flows fresh and muddy water in the more southern and western portions of the creeks; (2) salt water flowing over quicksands in their most northern and eastern parts. In the former there is the accompanying evil of those conditions producing organisms which not only lessen the supply of food by sharing it with the oyster, but clog and foul the shells themselves, and by making them unsightly render them unfit for the raw-box trade, or to be opened on the shell. Notwithstanding the unfavorable character of the place, a small area of oysters is found in Muddy Bay off the mouth of No Man's Friend Creek. The conditions barely enable the hardiest to live, and those which survive constitute a very small proportion of the bulk of the shells whose tenants have succumbed. The conditions, already unfavorable, are rendered even more so by heavy freshets in the Peedee River, which, coupled with prolonged southwest winds, destroy large quantities of oysters in the more southern portions of the creeks by forcing the fresh and muddy water through the several outlets of Muddy Bay, toward North Inlet. Two of these outlets connect Muddy Bay with Oyster Bay. One, small and insignificant, called the Haulover Creek, has been produced artificially by cutting through the marshes between the bays. The other, No Man's Friend Creek, is a bold stream through which the tides ebb and flow swiftly. These two creeks furnish the supply of fresh water to Town Creek and its tributaries. The other two outlets into Muddy Bay are the lower mouths of Jones and Sign creeks, which enter Muddy Bay south of Oyster Bay.

Oyster Bay, lying to the northward and eastward of Muddy Bay, is a shallow mud flat of considerable area. Being nearer to the supply of salt water from North Inlet,

it presents more favorable conditions, as is shown by the large number of raccoon oysters which cover about one-fifth of the entire area, a part being left bare at low water. These oysters are small and of poor quality, and are covered by barnacles. The water of this bay is very fresh in its normal condition and subject to radical changes in density in time of freshets. The bottom is also too soft, and its general characteristics render it unsuitable for cultivation. Along the northeast shore of the bay are three outlets to Town Creek, namely, Mud Creek, the Cutoff, and Sawmill Creek. The first two are small narrow streams, the last a bold stream with a swift current. The specific gravity of the water at the upper mouth of No Man's Friend Creek was practically fresh at the surface and 1.0114 at the bottom, while one-fourth of a mile southeast of this position, in the bay, it was 1.0041 surface and 1.0138 bottom. The water is always yellow from the mud held in suspension.

Sawmill Creek heads in the northeast part of Oyster Bay and winds through the marshes to a point where the Cutoff enters it and where it makes a junction with, and is called, Town Creek. The character of the bottom is favorable, being hard and sticky generally, and the depth ranges from 3 to 16 feet. Very few raccoon oysters are found along the shores, but oysters and dead shells covered with barnacles occur at places extending from shore to shore. This area has been very much overfished, and the "nubbings" have been thrown back on the bottom, not only furnishing points of attachment for barnacles, but also rendering the bottom very foul. The specific gravity of the water is variable and subject to radical changes, caused by the freshets in the Peedee River; at the lower mouth, near Oyster Bay, it was 1.0235 in January, while at the time of our last visit, in March, during the spring freshets, the water was practically fresh. Near the mouth of Clam Bank Creek, in January, the density was 1.0235 surface and 1.0244 bottom, but in March it had become practically fresh, both at the surface and bottom.

Clam Bank Creek is a small stream which connects Sawmill Creek with Town Creek. The narrow mouth where it enters Sawmill Creek does not admit a large volume of fresh water, and a part of the bottom is very favorable for cultivation. While oysters are not found in deep water, raccoon oyster ledges extend along the shores. The specific gravity at the lower mouth was 1.0235 surface and 1.0244 bottom, and at Mr. Donaldson's oyster house, on the first of ebb, 1.0227. In this creek also a great change in density was found in March.

Town Creek is a continuation of Sawmill Creek, and, flowing through the marshes, enters North Inlet at its junction with Jones Creek. The bottom is either too quick or soft for cultivation from its junction with Sawmill Creek to a point above the mouth of Sixty Bass Creek; but below this point several areas of suitable bottom are found. No oyster beds occur in deep water, except those which have been planted, but raccoon oysters are found along the shores and are left bare at low tide. These oysters improve in quantity and quality toward the mouth of the creek. In the mouth of Old Man Creek the specific gravity of the water in March, during the period of freshets, was 1.0166 surface and 1.0194 bottom, at one-third ebb; near the mouth in January, at the last of the flood, 1.024 surface and 1.0249 bottom. At last of the ebb the water is sometimes discolored, even to its mouth, by the muddy water from Winyah Bay.

North Inlet separates North Island on the south from De Bordieu Island on the north, and being open to the sea the density of the water is high. Its bottom is composed of shifting sands, which even extend in places up Jones and Town creeks. These conditions render this area unsuitable for the cultivation of oysters.

Jones Creek is the longest and one of the largest of this system of creeks, and flows entirely through the marshes between Muddy Bay and North Inlet. It has two outlets into the bay, its own mouth, and a second through Sign Creek, which is a short branch of Jones Creek and enters Muddy Bay farther to the westward. In the lower or southern part, between its mouth and Divide Creek, the water is too fresh and muddy and the bottom too soft for successful cultivation. The tides meet and divide near Divide Creek, which derives its name from this fact; but the exact point of the division is dependent on the prevailing winds and the freshets in the Peedee River. These conditions affect this part of the creek as they do No Man's Friend Creek, Oyster Bay, and in a lesser degree Sawmill Creek. This is shown at several places where many dead shells and a few live oysters are found. The type of shell is fine, being deep and cup-shaped. These oysters grew during long periods of drought, to be destroyed subsequently by freshets. Nature does all she can here, but man's hand must assist in cutting off the supply of fresh and muddy water, by closing the mouths of Jones and Sign creeks with flood-gates, before oysters can be raised successfully.

To the northward and above Divide Creek there is found an area which corresponds with Sawmill Creek and presents the same conditions and features. Oysters are found there in deep water among many dead shells and much rubbish, covered with barnacles and mussels. The living individuals are poor; the older, having contended against adverse circumstances in a crowded community, have reached old age with sponge-bored shells and covered with barnacles, stunted in growth, and unfit for market. The water is too muddy in this locality to rely with certainty on a catch of spat; the deposit of sediment is constantly going on and would very quickly foul the shells or cultch. In approaching North Inlet the conditions become more favorable, as they do in Town Creek, the greatest obstacle being the quicksands or shifting bottom, which limit the available ground to a small proportion of the entire area.

No oysters are found in deep water in the bed of the stream, except in the locality above mentioned and in those areas of suitable bottom which have been planted; but raccoon oysters are found along both shores. The water at the lower mouth of Jones Creek is practically fresh, both at the surface and at the bottom. Near the mouth of Divide Creek, while in January the specific gravity was 1.0171 surface and 1.0173 bottom, in March the water had become approximately fresh. At the mouth of Duck Creek the specific gravity was 1.0238 surface and 1.0239 bottom; and near its mouth at North Inlet on the last of the flood, 1.0247 surface and 1.0249 bottom.

Old-Man Creek is a short, wide arm which connects Town Creek, through its upper part called Cook Creek, with De Bordieu Creek. The average specific gravity of the water is higher than in the creeks heretofore mentioned, because this creek is nearer to the inlet and is cut off from the main volume of fresh water which pours through Town Creek into North Inlet on the ebb tide, only a part being forced back by the flood tide and finding its way through the side issue of its mouth into Old-Man Creek. The latter ebbs and flows with Town Creek, the divide of the tides taking place in that part of the creek called Cook Creek, which in turn ebbs and flows with De Bordieu Creek. The conditions of the water are thus rendered more favorable, inasmuch as Old-Man Creek is not subject to the rapid and radical changes in density which we have found in other places. It is also less charged with mud in suspension, but the proximity of the inlet and the strong tides give rise generally to an

unsafe bottom of quick and shifting sands, with some soft ground in the coves. At its most northern part, near its junction with Cook Creek, it widens out into a mud flat which is called Sea Creek Bay, and which is studded with patches of small raccoon oysters, left bare by the ebb tide, as are the ledges along the shores. The specific gravity of the water at one-third ebb, in the lower mouth during a period of freshet in the Peedee River, was 1.0166 surface and 1.0194 bottom, and in the mouth of Blythe Creek 1.0198 surface and 1.0197 bottom.

Cook Creek is that part of Old-Man Creek which lies between the mouth of Crab-Hall Creek and De Bordieu Creek. It is a shallow stream whose bed is generally a shifting bottom of quicksands. This evil limits the available ground to a very small area. The usual growth of raccoon oysters is found along the shores, but the few oysters which have dropped away from the ledges into deeper water are taken up as rapidly as they assume a favorable shape and quality.

Blythe Creek heads in the marshes near the mainland, and, flowing in an easterly direction, enters Old-Man Creek about 400 yards north of its mouth. Near its head it embraces a series of marsh islands, and is connected by numerous drains with Crab-Hall Creek, which also heads in the same locality. The greater part of the bottom consists of very soft mud, which, brought down from the flats by the strong ebb tides, is being constantly deposited. Near its mouth a shifting bottom of quicksand is found. No natural oyster beds are found here in deep water.

Crab-Hall Creek rises in the same locality and has the same characteristic features as Blythe Creek, flowing like it in an easterly direction and entering Old-Man Creek at its junction with Cook Creek. Much soft bottom occurs in its upper part and a quicksand bottom near its mouth.

Childrens Creek connects Crab-Hall Creek with De Bordieu Creek and takes a northerly direction between the two. The main part of this creek is a muddy flat, unsuitable for oyster cultivation. A small area near its mouth at Crab-Hall Creek appears favorable.

De Bordieu Creek is the last and most northern of this system, and has the greatest length. It takes its rise near a fresh-water lake in the mainland, and flows in a southerly direction, entering North Inlet below its northern point. Another branch of it heads in the marshes near the head of Crab-Hall Creek. The only bottom found available for oyster planting is below the junction of this branch with the main creek, and lies along both shores near its mouth in narrow strips. A quicksand bottom is the most serious obstacle encountered, as nearly all of the area between the fork and mouth is of this character. Raccoon oysters of a fine type occur along the shores, and where they have fallen below low-water mark and have been allowed to remain long enough to lose their raccoon features, they produce a good marketable oyster. This limited area, however, has been exhausted by overfishing. An examination of the narrow strip of bottom in deeper water adjacent to the ledges occasionally discovers a fine oyster, and shows what might be accomplished in the main body of the creek wherever the bottom is sufficiently stable and hard. The density of the water in this system of creeks or tributaries of North Inlet is necessarily high, having no large source of fresh water like the creeks which flow into it from the southward; the water is therefore not subject to the rapid and radical changes in specific gravity peculiar to the creeks between the South and North inlets. The total area of all the creeks between Muddy Bay and North Inlet is about 1,200 acres; area of suitable oyster ground, about 173 acres.

CONCLUSION.

While the survey described in the foregoing pages was not as detailed or exhaustive as it could have been made had there been more time available for that purpose, yet the results obtained in the areas examined are approximately accurate as well as sufficiently extensive to serve as a basis for the development of oyster-cultural operations. Of the total area surveyed, the natural oyster beds cover only a very small proportion. The proportion of natural oyster ground suitable for the production of marketable oysters is still less, being limited to the narrow space below low tide adjacent to the ledges now occupied in part by the detached raccoon oysters and to a few localities in the deeper water where the density is moderated by the inflow of a sufficient quantity of fresh water. These latter conditions obtain in St. Pierre Creek and New River, as has already been explained.

In order to establish more extensive beds recourse must be had to other bottoms, on which oysters do not occur at present, but which seem suited to the purpose by reason of their firm consistency and their abundant food supply. Owing, however, to the high specific gravity of the water in most places of that character, or to other causes now unknown, it is doubtful if such beds would prove self-sustaining through the natural attachment of the spat to the shells or cultch deposited in the deeper water. While the Georgia oyster-planters, up to the present season, have been unsuccessful in obtaining a set of spat on the shells provided for that purpose, the oysters transplanted by them from the tide ledges to deeper water have prospered in the latter, notwithstanding its high density, and the mortality has been no greater than would be expected from the changed conditions of their environment. It is probable that the South Carolina planters will have to rely, in the stocking of their grounds, upon the raccoon oysters living on the adjacent ledges or in the few other favored spots which have been described. While a rather uniform density, somewhere between 1.014 and 1.018, is considered preferable, oysters are successfully cultivated in water of a much higher density.

The extensive marshes and flats, which compose so large a proportion of the low lands along the coast, probably offer the best advantages for oyster-culture by the construction of tidal ponds somewhat on the principle now resorted to in some parts of Europe. With the natural limitation of oyster growths to the area between tides, this region evidently commends itself to the attention of oyster-growers, who could thus not only control the flooding of their beds but also maintain a close supervision upon their stock. As a rule, the oysters do not attain their best condition in South Carolina until late in the winter and early in the spring. But few persons in the State are now interested in the oyster industry, and the planted area is very small, not amounting, outside of the creeks south of Winyah Bay, to more than about 150 acres.

The principal natural enemies of the oyster which fell under our observation or were called to our attention are the conchs, drumfish, and sheepshead, the first mentioned being the most dreaded by the planters. Starfishes and drills were also seen, but they appear to do little if any damage. All of these natural enemies seem to be chiefly restricted to water of a high density, and none were found in the fresher areas represented by New River and St. Pierre Creek.

Below is given a table showing the approximate extent of the water territory examined and the approximate area of the natural beds discovered. Probably one-fourth or one-fifth of the total area will be found suitable for oyster planting. The region not surveyed, principally between Breach Inlet and North Inlet, would undoubtedly add a considerable acreage to that enumerated in the table. The season being limited, operations were chiefly directed to those localities which were regarded as of most importance and seemed to present the most favorable conditions. The natural oyster beds are being depleted, as they are in North Carolina and in Georgia, and the only way in which the supply may be maintained or increased is by utilizing for planting the suitable bottoms now producing no oysters. The total area surveyed amounted to about 81,289 acres, and the areas of the natural oyster beds to about 773 acres.

Table of areas examined.

Locality.	Acres.		Locality.	Acres.	
	Total.	Natural oyster beds.		Total.	Natural oyster beds.
New River (part examined)	830	21.4	North Edisto River	2,112	7.9
Cooper River	960	5.4	Bohicket Creek	450	2.2
Calibogue Sound	2,944	*4.8	Leadenwah Creek	384	3.2
Broad Creek	496	6.5	Townsend River	240	.....
May River	2,000	13.1	McCloud Creek	80	.....
Bull Creek	340	7.6	Togodo Creek (part examined)	384	.....
Mackay Creek	904	14.5	Wadmelaw River	2,450	150.5
Skull Creek	720	13.1	Stono River	2,580	14.5
Port Royal Sound	.....	3.6	Kiawah River	900	33.8
Chechessee River	2,810	14.5	Folly River	700	(†)
Colleton River	1,640	12.4	Schooner and Light-house creeks	820	57.5
Okeetcet River	256	2.2	Ashley River (part examined), approximate	2,600	10.4
Broad River	12,274	22.8	Cooper River (part examined), approximate	6,052	10.9
Pocotaligo River	300	3.2	Wando River (part examined), approximate	4,992	34.8
Whale Branch	1,024	11.0	Charleston Harbor	.....	3.8
Archer Creek	150	3.2	Sullivan Island Narrows and tributaries	1,020	7.2
Beaufort River	3,840	19.6	Goat Island Creek	140	5.8
Chowan Creek	720	8.7	Little Goat Island Creek, planted ground, 20 acres	80	.....
Jericho and Battery Creeks	512	9.0	Meeting Reach to Dewees Creek	180	9.6
Brickyard and Albergottie Creeks	560	2.1	Dewees Creek, Grays Bay, Hamline and Copahee sounds	2,500	.....
Coosaw River	7,104	19.6	Inland Passage, between Dewees Creek and Bull Bay	.....	15.5
Parrott Creek	355	4.6	Inland Passage and all the bays and sounds north of it, planted ground, 45 acres	.....	13.3
Dale Creek	290	2.5			
Morgan River	2,496	9.1			
Bull River	928	7.1			
Combahee River	1,088	5.5			
Ashepoo River (part examined)	760	12.0			
St. Helena Sound	.....	4.9			
South Edisto River from Point of Raccoon Island to the mouth	1,150	6.3			
St. Pierre Creek and tributaries	750	42.0			
Bailey Creek, planted ground, 20 acres	80	.....	Total	81,289	773.0
Dawho River (lower part)	334	8.5			
Steamboat Creek and its tributaries, including Mud Flat	1,360	71.0			

* Approximate.

† Not examined.

33°20'

79°15'

Rabbit I.

Hare I.

Frazier's Pt.

WINYAH BAY

MUD BAY

Pumpkinseed Islands

Jones

Cotton patch

Mans Friendship Cr.

Town Cr.

Go Bass Cr.

Jones Cr.

Old Mans Friendship Cr.

Oyster Bay

Marsh Pt.

Marsh Pt. Shoals

S.F. B1.012

S.F. B1.0115

S.F. B1.020

S.F. B1.0140

S.F. B1.0220

S.F. B1.0221

S.F. B1.0165

S.F. B1.023

S.F. B1.022

CAT I.

SOUTH ISLAND

NORTH ISLAND

Mother Norton Shoal

Fishing Bank

SLUE CHANNEL

GEORGETOWN LIGHT HOUSE

33°15'

79°15'

33°10'

79°10'

79°05'

SOUNDINGS.

Depths beyond the 18 foot curve given in fathoms, all others expressed in feet.

The figures show the depths at mean low water.

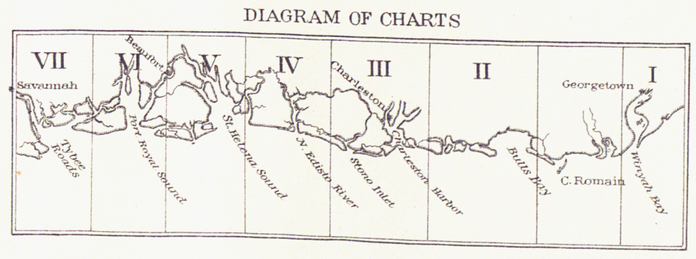
6 ft. curve ..... *12 ft. curve* - - - - *18 ft. curve* — — — —

The shaded areas are bare at low water.

Var. in 1890 0°20' W.
Annual increase 3'

6 FT. CURVE
12 FT. CURVE
18 FT. CURVE

DIAGRAM OF CHARTS



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79°15'

79°10'

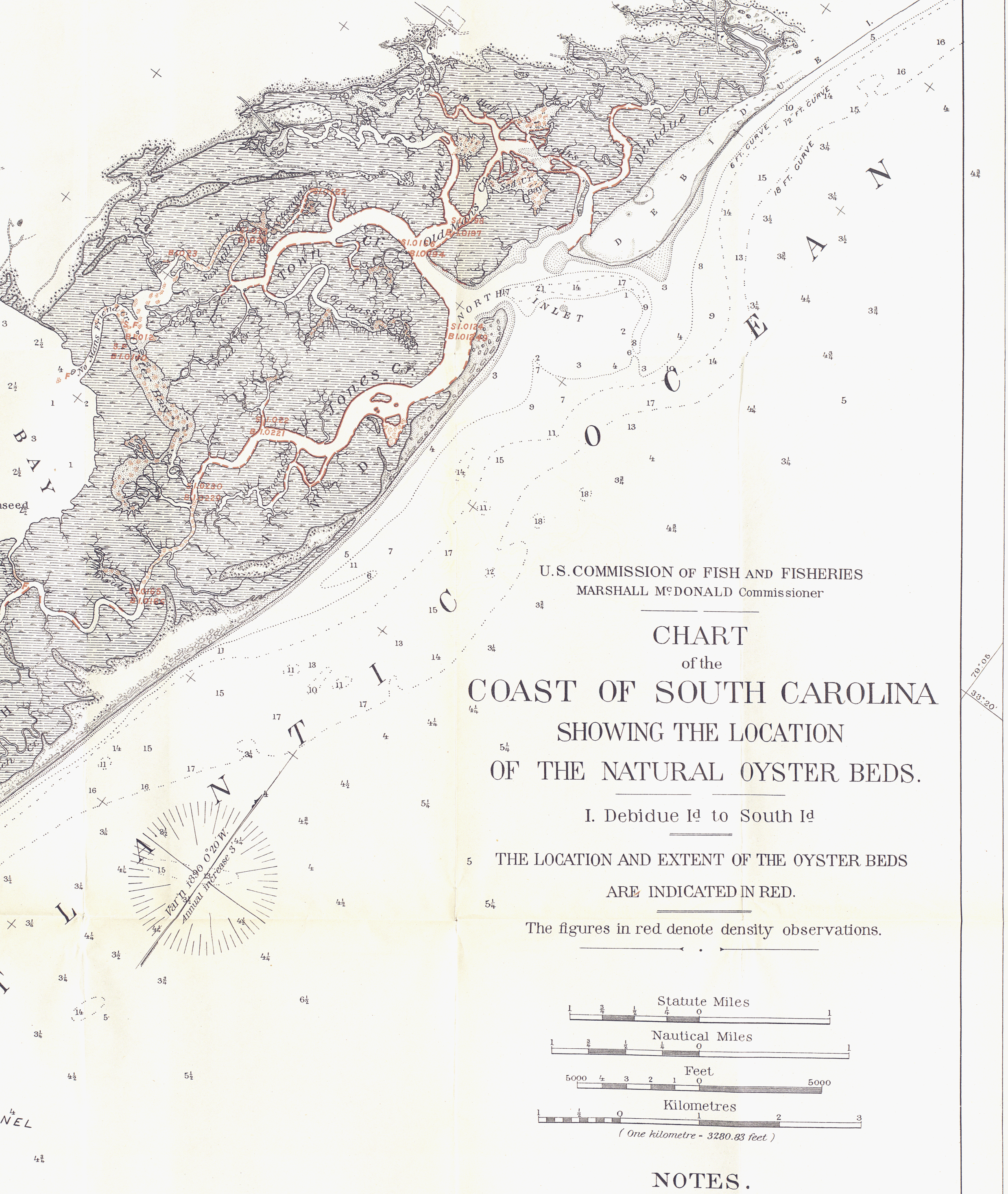
SOUNDINGS.

Depths beyond the 18 foot curve given in fathoms, all others expressed in feet.

The figures show the depths at mean low water.

6 ft. curve ..... 12 ft. curve - - - - - 18 ft. curve — — — —

The shaded areas are bare at low water.



U.S. COMMISSION OF FISH AND FISHERIES

MARSHALL McDONALD Commissioner

CHART

of the

COAST OF SOUTH CAROLINA

SHOWING THE LOCATION

OF THE NATURAL OYSTER BEDS.

I. Debidue Id to South Id

THE LOCATION AND EXTENT OF THE OYSTER BEDS ARE INDICATED IN RED.

The figures in red denote density observations.

Statute Miles

1 3/4 1/2 1/4 0 1

Nautical Miles

1 3/4 1/2 1/4 0 1

Feet

5000 4 3 2 1 0 5000

Kilometres

1 1/2 0 1 2 3

(One kilometre - 3280.83 feet)

NOTES.

To accompany a Report on an Investigation of the Coast Waters of South Carolina with reference to Oyster Culture, by John D. Battle.

Oyster survey made by the U. S. Fish Commission steamer "Fish Hawk," Lieut. Robert Platt, U.S. Navy, commanding. December 1890 to April 1891.

Base chart compiled from published charts and other information furnished by the U.S. Coast and Geodetic survey.

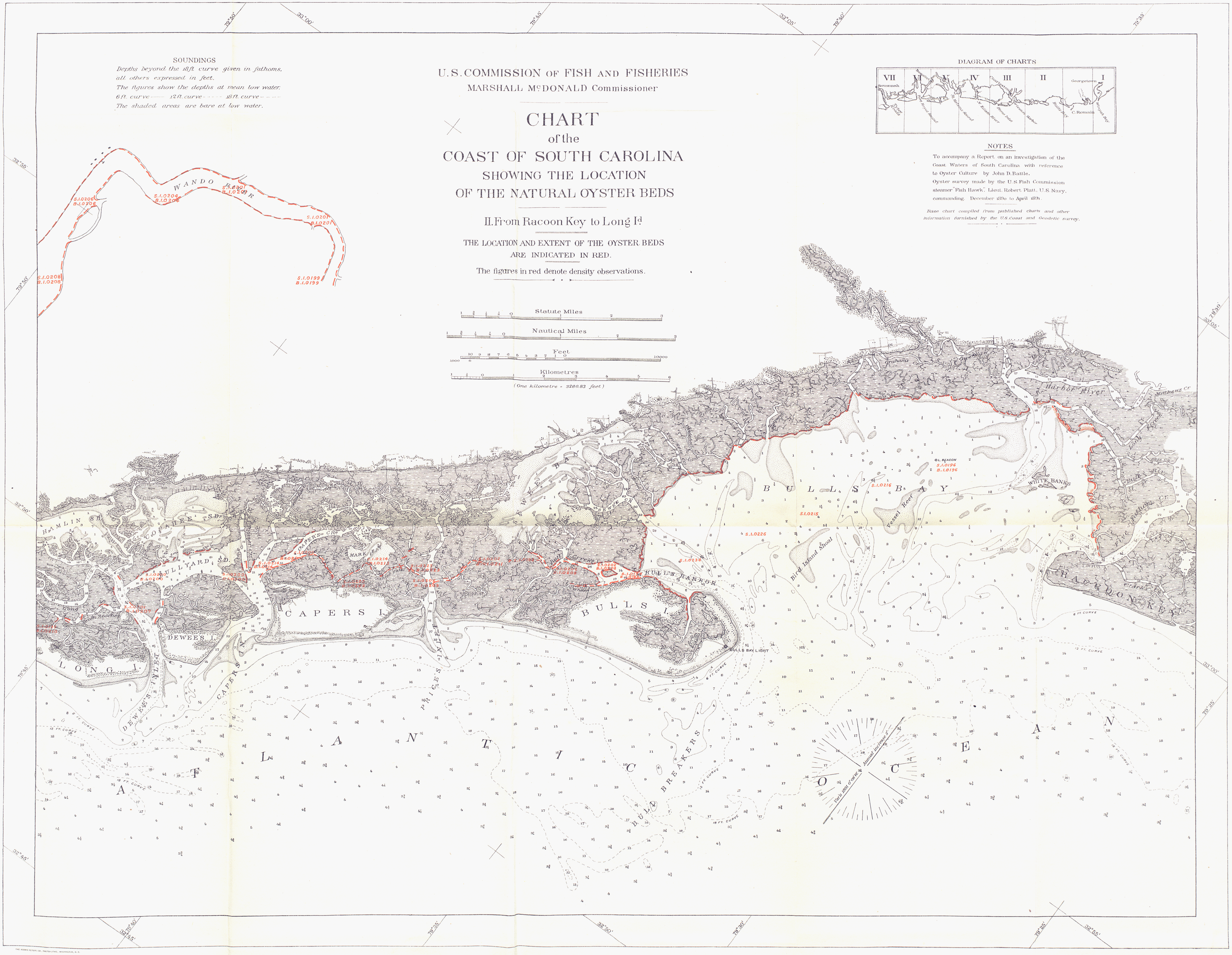
DIAGRAM OF CHARTS

79°05'

79°06'

33°20'

33°15'



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U. S. COMMISSION OF FISH AND FISHERIES

MARSHALL McDONALD, Commissioner

CHART

of the

COAST OF SOUTH CAROLINA

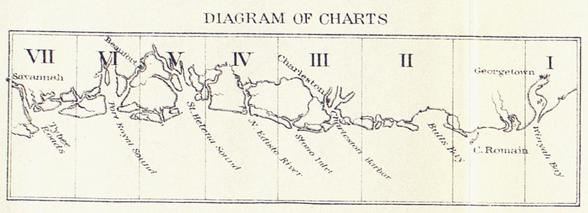
SHOWING THE LOCATION OF THE NATURAL OYSTER BEDS

III. From Long Id. to Kiawah Id.

THE LOCATION AND EXTENT OF THE OYSTER BEDS ARE INDICATED IN RED.

The figures in red denote density observations.

DIAGRAM OF CHARTS



Statute Miles

Nautical Miles

Feet

Kilometres

(One kilometre = 3280.83 feet)

SOUNDINGS.

Depths beyond the 18foot curve given in fathoms, all others expressed in feet.

The figures show the depths at mean low water.

6 ft. curve ——. 12 ft. curve – – – –. 18 ft. curve — — —.

Shaded areas are bare at low water.

NOTES

To accompany a Report on an investigation of the Coast Waters of South Carolina with reference to Oyster Culture by John D. Battle. Oyster survey made by the U. S. Fish Commission steamer "Fish Hawk". Lieut. Robert Platt, U.S. Navy, commanding. December 1890 to April 1891.

Base chart compiled from published charts and other information furnished by the U.S. Coast and Geodetic survey.

THE JUDGE PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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U. S. COMMISSION OF FISH AND FISHERIES
MARSHALL McDONALD Commissioner

CHART
of the
COAST OF SOUTH CAROLINA
SHOWING THE LOCATION OF THE NATURAL OYSTER BEDS

IV. From Kiawah Id to Otter Id

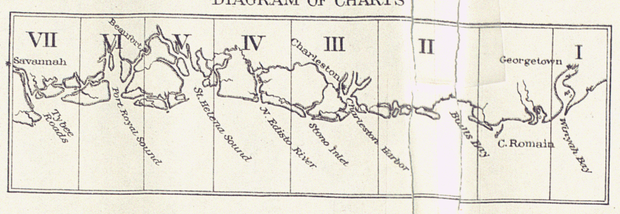
THE LOCATION AND EXTENT OF THE OYSTER BEDS ARE INDICATED IN RED.

The figures in red denote density observations.

SOUNDINGS.

Depths beyond the 18foot curve given in fathoms.
all others expressed in feet.
The figures show the depths at mean low water.
6 ft. curve ..... 12 ft. curve ..... 18 ft. curve .....
The shaded areas are bare at low water.

DIAGRAM OF CHARTS



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Oyster survey made by the U.S. Fish Commission steamer "Fish Hawk," Lieut. Robert Platt, U.S. Navy, commanding. December 1890 to April 1891.

Base chart compiled from published charts and other information furnished by the U.S. Coast and Geodetic survey.

Statute Miles
Nautical Miles
Feet
Kilometres
One kilometre = 3280.83 feet)

Var. 1890 0° 21' E. Annual decrease 3'

THE ROBB PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

NOTES.

THE LOCATION AND EXTENT OF THE OYSTER BEDS ARE INDICATED IN RED.

The figures in red denote density observations.

SOUNDINGS

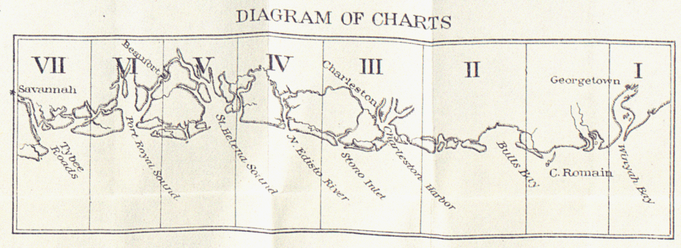
Depths beyond the 18foot curve given in fathoms, all others expressed in feet.

The figures show the depths at mean low water.

6 ft. curve..... 12 ft. curve..... 18ft. curve .....

The shaded areas are bare at low water.

DIAGRAM OF CHARTS



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To accompany a Report on an investigation of the Coast Waters of South Carolina with reference to Oyster Culture by John D. Battle.

Oyster survey made by the U.S. Fish Commission steamer "Fish Hawk", Lieut. Robert Platt, U.S. Navy, commanding. December 1890 to April 1891.

Base chart compiled from published charts and other information furnished by the U.S. Coast and Geodetic survey.

Statute Miles 1 ¾ ½ ¼ 0 1 2 3

Nautical Miles 1 ¾ ½ ¼ 0 1 2 3

Feet 10.000 5.000 0 10.000 1.000 0

Kilometres 1 ½ 0 1 2 3 4 5 6

(One kilometre = 3280.83 feet.)

U. S. COMMISSION OF FISH AND FISHERIES

MARSHALL McDONALD, Commissioner

CHART

of the

COAST OF SOUTH CAROLINA

SHOWING THE LOCATION OF THE NATURAL OYSTER BEDS

V. From Otter Id to Pritchard's Id

U. S. COMMISSION OF FISH AND FISHERIES
MARSHALL McDONALD, Commissioner

CHART
of the
COAST OF SOUTH CAROLINA
SHOWING THE LOCATION OF THE NATURAL OYSTER BEDS

VI. From Capers Id. to Hilton Head Id.

THE LOCATION AND EXTENT OF THE OYSTER BEDS ARE INDICATED IN RED.

The figures in red denote density observations.

NOTES

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Oyster survey made by the U. S. Fish Commission steamer "Fish Hawk". Lieut. Robert Platt, U. S. Navy, commanding. December 1890 to April 1891.

Base chart compiled from published charts and other information furnished by the U.S. Coast and Geodetic survey.

Statute Miles
Nautical Miles
Feet
Kilometres
(One kilometre = 3280.83 feet)

SOUNDINGS

Depths beyond the 18 foot curve given in fathoms, all others expressed in feet.
The figures show the depths at mean low water
6 ft. curve .... 12 ft. curve - - - - 18 ft. curve ... ...
The shaded areas are bare at low water.

Statute Miles

Nautical Miles

Feet

Kilometres

(One kilometre = 3280.83 feet.)

SOUNDINGS

Depths beyond the 18foot curve given in fathoms, all others expressed in feet.

The figures show the depths at mean low water.

6 ft. curve ..... 12 ft. curve - - - - 18 ft. curve ... ...

The shaded areas are bare at low water.

PORT ROYAL I.

PORT ROYAL R.R.

Beaufort

Port Royal

LEMON I.

SPRING I.

CALLAWASSIE I.

Colleton R.

Broad R.

Chechessee R.

Chechessee Creek

Eutaw Cr.

Skull Cr.

Battery Creek

Beaufort R.

Foot Pt.

Dawfuskie Island

HORSE I.

PARIS I.

GIBBS I.

CANE ID.

CAT I.

DISTANT I.

Chowan Cr.

PINCKNEY I.

MACKAYS

JENKINS

MAY R.

Bobbs

HILTON HEAD I.

Fixed Red

RANGE BEACONS

Fixed White

ST. HELENA I.

Middle Shoal

BAY PT.

HELTON HEAD

ST. PHILLIP'S I.

RENHARD'S I.

CAPERS I.

Folly's Bank

Fishing Bk.

Prichards

Varn 1890 0°45E Annual decrease

ATLANTIC OCEAN

32°30'

32°25'

32°20'

32°15'

32°10'

32°05'

80°56'

80°50'

80°45'

80°40'

80°35'

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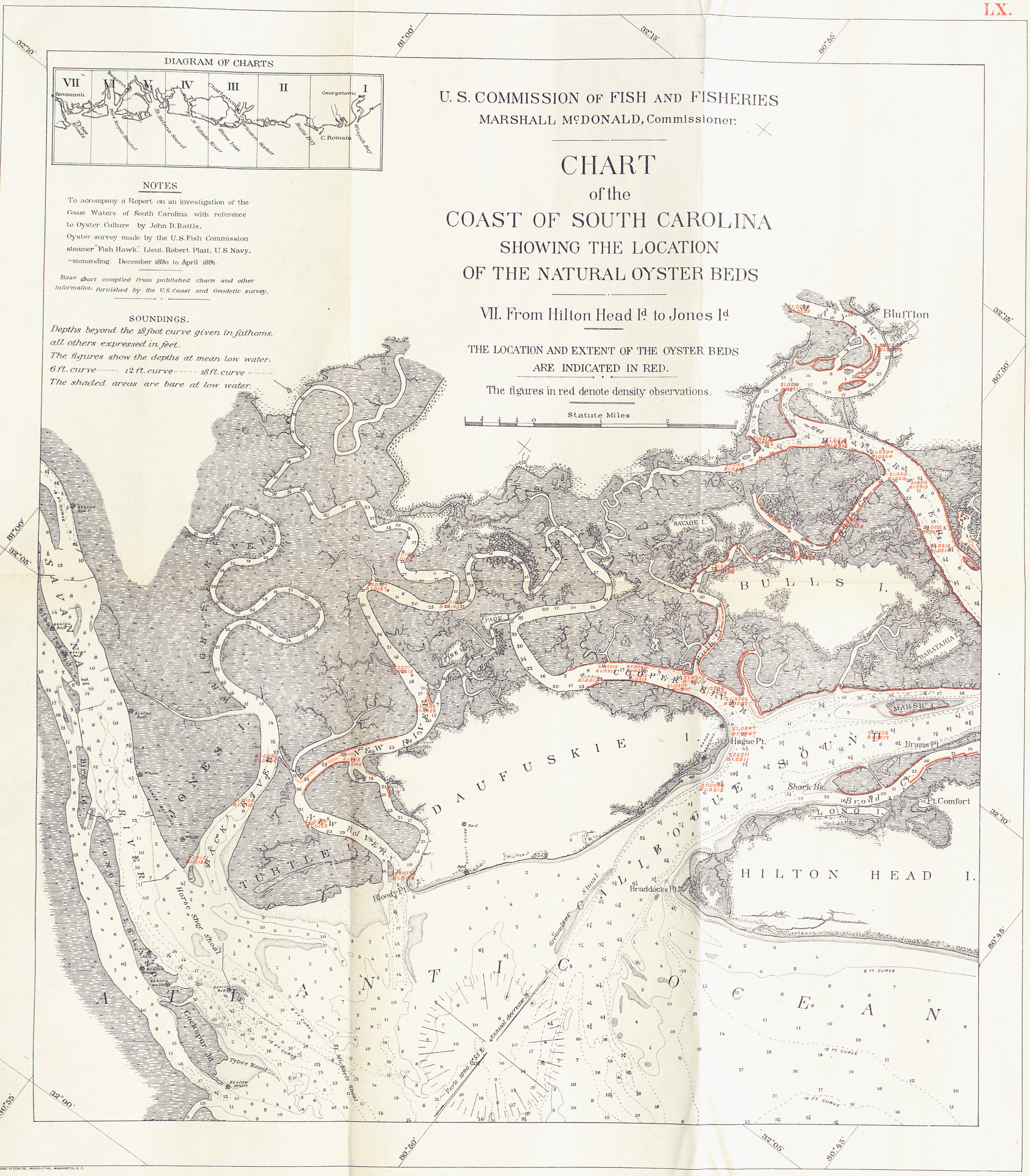

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