

## V.

## FIRST REPORT ON THE "BARREN OYSTER BOTTOMS" INVESTIGATION, RICHMOND BAY, P.E.I.

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In this investigation, which began early in May and was carried on until the middle of September, 1914, the following points were considered:—

1. Nature of the bottom in the various parts of the area.
2. Extent of level portions and of banks and deep gullies.
3. Depths in the various parts of the area.
4. Presence of eel-grass and seaweeds.
5. Salinity.
6. Temperatures at top and bottom.
7. Plankton and floating oyster food.
8. Inflow and amount of fresh water; number of flowing streams.
9. Presence of oyster enemies, starfish, drill, whelk, etc.
10. Occurrence of small oysters as evidence of spatting.
11. Occurrence of dead oyster shells, as evidence of former production.
12. Freezing to bottom in winter.
13. Time of spawning.
14. Time and extent of spatting.
15. Former output of the bay.

## NATURE OF THE BOTTOM IN THE VARIOUS PARTS OF THE AREA.

Dredgings and soundings were made in the various parts of the bay for the purpose of investigating the nature of the bottom, but owing to the lack of proper facilities for ascertaining the exact location of the individual soundings and dredgings, an accurate map of the nature of the bottom cannot yet be given. The account of the bottom given here is also quite general.

The bottom consists for the most part of the red sand, so characteristic of Prince Edward Island. Rocky areas, composed of red sandstone, extend out from several points of the islands and of the mainland. In the deeper places the sand is mixed with a higher percentage of humus forming, in certain locations, a very soft black mud into which a pole can be shoved for several feet. Shell beds (oysters and quahaug) are found scattered over the mud areas and on the edges of the sand areas, while oysters are plentiful on the rocky points.

In the Inner bay or March Water (that portion of the bay between the Curtain islands and the Shipyard river), the sandy area extends around the shore along the south of Grover (Ram) island, across to Princetown point and on to Malpeque wharf and the Shipyard river. Thence it follows the south shore to Beech point, where it turns northward along the Curtain islands. The width of this area is not at all uniform. An extension southward from Princetown point forms the Middle Ground shoals which are separated from the point by only a shallow channel. The sandy area also extends out somewhat farther from the points on either side of the mouth of the Shipyard river and is more extensive, too, near Beech point and along Curtain (Little Curtain) and Bunbury (Curtain) islands. Patches of rock occur east of the Curtain islands, to the northwest of the Middle Ground shoals, and to the northeast

of Beech point. The muddy area comes in from the outer bay between Grover and Bunbury islands, widens out in the Inner bay, where it is encroached upon by the Middle Ground shoals and finally narrows down towards the mouth of Shipyard river. Oyster beds are found in that portion of the area, around the Middle Ground shoals and in that which lies between these shoals and the Shipyard river. They are, however, not very numerous.

In the Big bay (that part of the bay south of the line joining Charles point (cape Malpeque) and the north end of Bunbury island, the sandy area sweeps south along the Curtain islands, over to Beech point and on past Oyster cove to the Indian river. Thence it continues along the south shore past the Barbara Weit and Plat rivers to Shemody creek, from which it extends along the west shore to Charles point. As in the Inner bay, this area is everywhere of considerable width, but is especially wide in some places. This is particularly the case off Bentinck (Fraser's) point where the Bentinck shoals stretch out far into the bay and are separated from the point by a quite shallow channel. Rocky areas are found, in this part of the bay, west of Bunbury and Curtain islands, south of Beech point, off Taylor's, Chichester (Mill's), and Webber's (Townsend's) points, and from Charles point well down towards Bentinck point. The deeper muddy portion enters between Charles point and Bunbury island and extends towards the Indian and Barbara Weit rivers, sending off a long spur to the mouth of the Shemody creek. Oyster beds are numerous, widely distributed and extensive in this part of the bay.

In the Outer bay (that part of the bay north of Charles point, Bunbury island and Grover island) a sandy area extends from Royalty point past Princetown point to Grover island, a very extensive area stretches out to the north and northwest from Bunbury island, a third reaches from Charles point to the mouth of the Grand river, while another wide area lies along the west shore from the Grand river past Bald, Red, and Gillies (Low) points into the narrows between Lennox island and the mainland. Further and very extensive sand areas lie south from Middle (Bird), George (Hog), and Bill Hook (Fish) islands. The areas last mentioned, interrupted by channels of moderate depth, are continued into the shoals known as the Horseshoe shoals. In this part of the bay the rocky stretches are larger than those previously mentioned in this report. Extensive rocky areas are given off from the north of Grover and Bunbury island and Charles point, and also south from George island. Less extensive areas lie out from Campbell's pond on the west shore, in an area half-way between Charles point and the mouth of the Grand river, and also out from Bald point between the Grand river and Gillies point. The deeper portion of the bay enters between Bill Hook island and Royalty point, runs south of the Horseshoe shoals and, after giving off the two branches already referred to as entering the Inner and Big bays, and also a third running to the Narrows and the mouths of the Bideford and Trout rivers, continues southwesterly to the Grand river. Oyster beds do not occur in the deep muddy portions of this part of the bay although they do occur on the sandy area running out from Bunbury island.

The sandy areas are covered with eel-grass out to depths of 8, 10 or 12 feet. The rocky areas usually have a covering of seaweed.

It should be understood that the transition from the sand areas to the mud areas is a gradual one.

#### EXTENT OF LEVEL PORTIONS AND OF BANKS AND DEEP GULLIES.

The whole bay is remarkably level, and as a rule there are few rapid changes in depth. The deep channels have been referred to in the paragraphs dealing with the nature of the bottom. The channel enters the bay between Bill Hook island and Royalty point, runs westward south of the Horseshoe shoals to a point north of Bunbury island. Here the four branches mentioned above radiate. One enters the inner bay between Grover and Bunbury islands and passing south of the Middle Ground shoals reaches the Shipyard river. Another extends west of Bunbury island south-

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ward into the Big bay towards the Indian and Barbara Weit rivers, and sends off a branch to Shemody creek. A third branch goes to the Grand river and a fourth to the Narrows between Lennox island and the mainland. These channels are for the most part wide and have fairly level bottoms.

The sandy areas near shore are also very level, sloping out gradually to the deep channel and showing a somewhat more abrupt incline on the edges of the latter. The slopes are somewhat more abrupt than usual on the sides of the Bunbury sands and of the Middle Ground shoals facing the main channels. Abrupt slopes occur also among the Horseshoe shoals.

## DEPTHS IN THE VARIOUS PARTS OF THE AREA.

This portion of the investigation has not been completed and the work done on it is withheld, for publication in a later report. Only a very general account is given here. The greatest depth at the entrance of the bay, between Bill Hook island and Royalty point is 53 feet. There are places in the channels among the Horseshoe shoals which are at least 27 feet deep, while parts of the shoals are covered by about 3 feet of water. The channel into the Inner bay has a depth, between Bunbury and Grover islands, of 24 feet, and south of the Middle Ground shoals of 17 feet, while over parts of the shoals the depth is not more than 2 feet. The channel leading into the Big bay has a depth northwest of the Bunbury sands of 42 feet, west of the northern end of Bunbury island of 35 feet, west of its southern end of 32 feet, towards the Indian and Barbara Weit rivers of 14 feet, and towards Shemody creek of 15 feet. The Bentinck shoals are covered in places by about 2 feet of water. The channel at the ferry Grand river is 30 feet deep, and that approaching the Narrows between Lennox island and the mainland is 24 feet in depth.

## PRESENCE OF EEL-GRASS AND SEA-WEEDS.

Eel-grass (*Zostera marina* L.) is very abundant everywhere on the sandy areas in depths up to 10 or 12 feet. It borders the shore of the whole bay except where there are rocky areas, and it is also found on the Horseshoe, Bentinck, and Middle Ground shoals. In many other and deeper places, dredgings show that quantities of dead and decaying eel-grass are lodged on the bottom. In the late summer and, according to reports, to a greater extent in the autumn, the storms tear loose quantities of eel-grass which are swept together into great masses and rolled in upon the shore. This eel-grass is gathered up and used as a fertilizer, or to bank buildings against the cold. The oyster companies do good work in removing the grass from their plots, but too often set it adrift in other parts of the bay instead of taking it ashore. When only small areas are cleared the loose eel-grass rolls over the bottom into the hollows, formed in the process of clearing these areas, and lodges there. Because of this, some of the companies have to clear their areas after each big storm. Eel-grass is detrimental to good catches of spat. In no case was there a good set on any of the collectors set among eel-grass.

Seaweeds are found on the rocky areas. In many cases the rock is well covered, and here the seaweed must interfere with the set of spat. In some places kelp (*Laminaria saccharina* Lamx.) is found attached to the oysters, and must, at times, when from any cause they are not attached to the bottom, result in their being carried to unfavourable localities.

The Marine algae collected during the summer were sent to A. B. Klugh, M.A., of Queen's University, Kingston, and he has very kindly identified them. The collection is not very extensive, specimens which were taken in the dredge, or in the plankton net, alone being represented.

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The following account gives the date and place of collection as well as the species collected:—

July 20.—Curtain Island shoal: *Lyngbya aesturia* Lieb., *Nodularia harveyana*, Thuret.

July 24.—Low Point: *Chordaria flagelliformis* Ag., *Gelidium crinale* (?) Ag.

July 24.—East of Low point: *Chondrus crispus* Stack., *Gelidium crinale* (?) Ag.

July 24.—Outer bay, midway between Bunbury island and Gillies point: *Gelidium crinale* (?) Ag.

July 25.—Gillies point: *Ectocarpus confervoides* Le Jolies, *Castagnea virescens* Thuret.

July 25.—East of Gillies point: *Polysiphonia urceolata* Grev., *Cladophora laete-virens* Dillw., *Anabaena variabilis* Kuetz., *Nodularia harveyana* Thuret., *Lyngbya aestuaria* Lieb.

July 28.—Bentinck point: *Gelidium crinale* (?) Ag., *Gelidium corneum* L., *Ectocarpus littoralis* Lyng.

July 30.—Bunbury island: *Ectocarpus confervoides* Le Jolie.

August 8.—Bunbury island: *Chordaria flagelliformis* Ag., *Chorda filum* L., *Chondrus crispus* Stack., *Gigartina mamilliosa* J. Ag., *Laminaria saccharina* Lamx., *Gelidium crinale* (?) Ag.

September 3.—Grand river, below the ferry: *Cladophora laete-virens* Dillw., *Ulothrix flacca* Thuret.

The following species were preserved in bottles, from which the labels were lost: *Scytosiphon lomentarius* Ag., *Chondrus crispus* Stack., *Gigartina mamilliosa* J. Ag., *Laminaria saccharina* Lamx., *Monostroma fuscum blyttii* Collins, *Entomorpha intestinalis* Grev., *Enteromorpha compressa* Grev., *Porphyra umbilicalis* J. Ag., *Gelidium crinale* (?) Ag.

Twenty species in all are recorded. This number will no doubt be greatly increased by the collections to be made in 1915.

#### SALINITIES AND TEMPERATURES AT TOP AND BOTTOM.

Salinities and temperatures were taken in many places in the bay at various times throughout the summer. The following is the list of locations:—

1. Narrows, west of Indian Chapel.
2. Narrows, near Sharp's beds "Rock bed".
3. West of Grover island.
4. Mouth of Indian river.
5. Bell bed, Grand river.
6. Mouth of Macdonald creek, Grand river.
7. Below bridge, Grand river.
8. Second bed below ferry, Grand river.
9. First bed below ferry, Grand river.
10. Old dump, Inner bay.
11. Wharf, Bideford river.
12. Bed southeast of second barrel buoy, Inner bay.
13. Plot 128 east of Bunbury island.
14. Plot 123 east of Bunbury island.
15. Plot 133 east of Bunbury island.
16. Plot 127 east of Bunbury island.
17. Plot 142 east of Bunbury island.
18. Plot 124 east of Bunbury island.
19. Off Bald point, Outer bay.
20. Little Curtain Island bed, Big bay.
21. Mouth of Plat river.
22. Mouth of Shemody creek.
23. Middle of channel south of Shemody point.
24. Mouth of Indian river.
25. Near mouth of Indian river.
26. Mouth of Barbara Welt river.

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SALINITIES AND TEMPERATURES AT TOP AND BOTTOM—*Continued.*

27. South of Taylor's point.
28. Off Taylor's point.
29. Off Wait's point near mouth of Barbara Weit river.
30. Mouth of Oyster cove.
31. Sharp's "Peter Creek" bed, Narrows.
32. Third bed below ferry Grand river.
33. Burke cove, Grand river.
34. West of Charles point.
35. Lot 11, Grand river.
36. Southeast of Red point, Outer bay.
37. Off Charles point.
38. South of Bunbury island.
39. South of Bunbury island.
40. Off the north point of Bunbury island.
41. Plot 194 near Middle island.
42. Plot 300 near Middle island.
43. Plot 298 near Middle island.
44. Plot 196 near Middle island.
45. Plot 246 near Middle island.
46. Plot 197 near Gillies point.
47. Plot 200 near Gillies point.
48. Plot 294 near Gillies point.
49. Plot 297 near Gillies point.
50. East of Gillies point.
51. Middle of Outer bay, Gillies point, and north of Bunbury island in line.
52. Inman's bed, Shemody creek.
53. East of Shemody point.
54. East of Bentinck point.
- 54a. East of Simpson's Point.
55. Plot 378, Big bay, near Bunbury island.
56. Plot 428, Big bay, near Bunbury island.
57. Plot 424, Big bay, near Bunbury island.
58. Plot 425, Big bay, near Bunbury island.
59. Channel between Grover and Bunbury islands.
60. Plot 375, Big bay, near Bunbury island.
61. Plot 268, Big bay, near Bunbury island.
62. Plot 332, Big bay, near Bunbury island.
63. Plot 266, Big bay, near Bunbury island.
64. Plot 430, Big bay, near Bunbury island.
65. Plot 372, Big bay, near Bunbury island.
66. Plot 267, Big bay, near Bunbury island.
67. Plot 467, Big bay, near Bunbury island.
68. Plot 370, Big bay, near Bunbury island.
69. Plot 283, Big bay, near Bunbury island.
70. Plot 284, Big bay, near Bunbury island.
71. Plot 340, Big bay, near Bunbury island.
72. Plot 434, Big bay, near Bunbury island.
73. Plot 315, Big bay, near Bunbury island.
74. Plot 387, Big bay, near Bunbury island.
75. Plot 436, Big bay, near Bunbury island.
76. Channel between Bill Hook island and Royalty point.
77. Wharf, Malpeque.
78. Shipyard river.
79. First barrel buoy, Inner bay.
80. South side of gap between Grover island and Princetown point.
81. South of Grover island.
82. Northeast of Grover island.
83. North side of gap between Grover island and Princetown point, west end.
84. North side of gap between Grover island and Princetown point, middle.
85. North side of gap between Grover island and Princetown point, east end.
86. South shore Big bay, midway between Princetown and Royalty points.
87. South shore Big bay, towards Royalty point.
88. Shoals near Bill Hook island, Big bay.
89. Middle of Horseshoe Shoals, Big bay.
90. West of south point of George island, Big bay.
91. Off southeastern point of Middle island.
92. Channel between Beech point and Curtain island.
93. South of Curtain island.
94. South of Bunbury island.
95. Little Curtain island bed, Big bay.
96. Little Curtain island bed, Big bay, edge of bed.
97. Mouth of Indian river, right bank point.
98. Chicester (Mill's) mouth of Indian river.
99. Mill's point, mouth of Barbara Weit river.

SALINITIES AND TEMPERATURES AT TOP AND BOTTOM—*Concluded.*

100. Waite's plot, mouth of Barbara Weit river.
101. Off mouth of Webber creek.
102. Off Webber point.
103. Mouth of Plat river.
104. Off Compton point.
105. Southwest of Shemody point.
106. Northeast of Shemody point.
107. North of Bentinck point.
108. Southeast of Charles point.
109. West of Bunbury island.
110. Gap between Bunbury and Curtain islands.
111. Midway between Charles point and south end of Bunbury island, Big bay.
112. Midway between Charles point and Black point, Outer bay.
113. End of Sixteen wharf, Grand river.
114. South shore Grand river, point below R. C. church.
115. North shore Grand river, opposite Southwest arm.
116. Bell's point, Grand river.
117. Black point, Grand river.
118. Off McIntire's pond, north shore near Grand river.
119. Off Red point, Outer bay.
120. Off point left shore mouth Brown's creek, Outer bay.
121. Point above wharf, Bideford river.
122. Lowest point, left shore above mouth, Trout river.
123. Sharp's point, Bideford river.
124. Sharp's bed (Rock bed), Narrows.

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TABLE of Physical Properties.

Station.	Date.	Time.	Tide.	Depth.	Temperature top.	Temperature bottom.	Specific Gravity top.	Specific Gravity bottom.	Chlorine.	Total Solids.
									p. g.	p. c.
1	June 9.	11.00	Going out.....	21					1.509	2.721
2	" 9.	12.00	" .....	5					1.587	2.861
3	" 9.	3.00	Coming in.....	8					1.6325	2.9435
4	" 11.	2.00	Low.....	12.5	56.5	55			1.627	2.934
5	" 12.	11.00	Going out.....	3	56	56				
6	" 12.	3.00	Low.....	7	58	57				
7	" 15.	12.00	High.....	8	60	58.5			1.436	2.589
8	" 15.	2.00	Going out.....	17	56.5	52.5			1.641	2.959
9	" 15.	3.00	" .....		58.5	23.5				
10	" 15.	6.00	Low.....	12	58.5	55				
11	" 19.	2.00	Coming in.....	10					1.454	2.621
12	" 20.	2.00	" .....	7	62	60			1.569	2.829
13	" 22.	3.00	" .....	10	61	58.5			1.579	2.847
14	" 23.	12.00	Low.....	17	63.5	55				
15	" 23.	10.00	" .....	16	66	55.5				
16	" 23.	3.00	Coming in.....	30	63	23.5				
17	" 25.	11.00	Going out.....	7	63	58				
18	" 25.	3.00	Coming in.....	22	61	57			1.694	3.152
19	" 26.	2.00	Low.....	4.5	63.5				1.655	2.984
20	" 27.	11.30	Going out.....	10	58	57				
21	" 29.	11.00	" .....	8	60.5					
22	July 2.	3.00	" .....	2.75	65	62.75				
23	" 3.	2.30	High.....	20	63				1.627	2.934
24	" 4.	10.00	Low.....	8	63				1.619	2.919
25	" 4.	3.00	Coming in.....	5	67				1.588	2.864
26	" 7.	12.00	Low.....	8	67	65	1.0226			
27	" 9.	10.00	Going out.....	5	69					
28	" 9.	12.40	Low.....	3.75	70		1.0216	1.0216	1.581	2.851
29	" 10.	2.30	Coming in.....	3.5	77		1.0222	1.0222	1.627	2.934
30	" 10.	4.00	" .....	4.5	76		1.0209			
31	" 11.	9.00	High.....	6	68					
32	" 11.	10.00	Going out.....	5.5	67	66	1.0221	1.0223		
33	" 11.	12.00	" .....	8	68	67	1.0222	1.0220		
34	" 13.	12.30	" .....	5	69.5	69	1.0223	1.0222	1.606	2.8965
35	" 14.	10.00	High.....	4	66	68	1.0229	1.0226		
36	" 14.	12.00	Going out.....		69					
37	" 14.	1.00	" .....		69					
38	" 14.	2.00	" .....		70	67.5	1.0230	1.0230		
39	" 14.	3.30	" .....	17	70					
40	" 15.	10.00	Coming in.....	5	62					
41	" 15.	1.00	Going out.....	15	67.5	64	1.0231	1.0224	1.672	3.015
42	" 15.	2.00	" .....	13	67					
43	" 16.	10.45	Coming in.....	9	67					
44	" 17.	11.00	" .....	7	71	70	1.0224	1.0224	1.657	2.983
45	" 17.	1.40	High.....	27	68				1.631	2.941
46	" 17.	2.00	" .....	4	69		1.0223	1.0223	1.653	2.981
47	" 20.	11.30	Low.....	17.5	75.5		1.0216	1.0216	1.590	2.869
48	" 21.	9.00	Going out.....	5	70	65	1.0232	1.0221	1.634	2.947
49	" 24.	3.30	Coming in.....	17.5	67					
50	" 24.	3.40	" .....	8.75	68					
51	" 24.	3.50	" .....	22	67.5					
52	" 24.	4.00	" .....	4	69.5					
53	" 24.	4.10	" .....	22	67					
54	" 25.	10.00	Going out.....	7	67.5					
55	" 25.	10.30	" .....	24	66.5					
56	" 25.	11.00	" .....	26	68					
57	" 25.	11.30	" .....	22.5	67.5					
58	" 25.	3.20	Coming in.....	24	68.5	65	1.0223	1.0226	1.621	2.922
59	" 25.	4.00	" .....	30	68.5	66.5	1.0225	1.0224	1.631	2.941
60	" 25.	4.00	" .....	30	68.5	66.5	1.0225	1.0224	1.679	3.023
61	" 25.	4.00	" .....	30	68.5	66.5	1.0225	1.0224	1.638	2.9535

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TABLE of Physical Properties—Continued.

Station.	Date.	Time.	Tide.	Depth.	Temperature top.	Temperature bottom.	Specific Gravity top.	Specific Gravity bottom.	Chlorine.	Total Solids.
									p. c.	p. c.
52	July 27..	12 00	Going out....	5	63.5	68			1.5675	2.826
53	" 27..	1 40	"	8	69					
54	" 27..	1 53	"	12	68					
55	" 28..	10 00	High	5.5	68					
56	" 30..	1 00	"	36	66					
57	" 30..	1 15	Going out....	14	66					
58	" 30..	1 45	"	13	66					
59	" 30..	2 15	"	16	66					
60	Aug. 1..	12 00	Coming in..	27			1.0214	1.0214	1.616 1.614 1.641 1.626	2.913 2.909 2.958 2.931
61	" 4..	9 30	Going out....	21			1.0224	1.0223		
62	" 4..	11 30	Low	36	66					
63	" 4..	12 05	"	19	65.5					
61	" 4..	1 35	Coming in..	33	66					
65	" 4..	2 45	"	8	67					
66	" 4..	3 15	"	15	66.5					
67	" 4..	3 55	"	30	66					
68	" 5..	12 30	Low	12.5	66					
69	" 5..	12 50	"	13	66					
70	" 5..	1 10	Coming in..	19.5	66.75					
71	" 5..	1 15	"	30	66					
72	" 5..	3 45	"	44	67					
73	" 6..	2 00	"	17	67					
74	" 6..	3 00	"	33	67					
75	" 6..	3 20	"	18.5	67					
76	" 7..	3 00	"	27	66.5					
77	" 14..	2 00	Going out....	50			1.0224	1.0224	1.631	2.941
78	" 25..	7 00	Coming in..	4	56	56	1.0216			
78	Sept. 1..	8 00	Going out....	4	62.25	61.75	1.0216			
79	" 1..	8 30	"	2	63	63.25	1.0189			
80	" 1..	9 00	"				1.0218	1.0219	1.600 1.609 1.605	2.885 2.9005 2.976
81	" 1..	9 30	"	2.75	65	65	1.0221			
82	" 1..	10 45	Low	14	63.75	63.5				
80	" 1..	11 20	Coming in..	30	64	63.5	1.0223	1.0222		
83	" 1..	11 50	"	2.5	66	65.5	1.0223	1.0222		
84	" 1..	12 20	"	1	67	67	1.0224			
85	" 1..	12 50	"	2	65	65	1.0220			
86	" 1..	1 30	"	2	69		1.0225			
87	" 1..	2 00	Coming in..	3.3	67	67	1.0220			
88	" 2..	2 15	"	3.6	66	66	1.0220			
77	" 2..	2 40	"	54	63	62.5	1.0222	1.0218	1.617 1.610	2.916 2.903
89	" 2..	3 15	"	5	65	63.5	1.0221			
90	" 2..	3 40	"	27	65	63.5	1.0221	1.0215	1.619 1.623	2.919 2.925
91	" 2..	4 35	High	4	66	65.5	1.0220			
92	" 2..	4 55	"	3	69	68.5	1.0225			
90	" 2..	8 15	Going out....	12.5	64.5	64.5	1.0221	1.0221		
12	" 2..	8 35	"	18.5	65	64.25	1.0219	1.0220		
93	" 2..	8 55	"	2.75	66		1.0223		1.607	2.8965
94	" 2..	9 10	"	3.3	65	65	1.0224			
95	" 2..	9 30	"	3.25	65	65	1.0224		1.616	2.913
96	" 2..	10 00	"	20 00	65	65	1.0221	1.0221	1.616 1.616	2.913 2.913
97	" 2..	10 15	"	8	65	65	1.0222	1.0221		
30	" 2..	11 00	Low	8	66	66.5	1.0210	1.0217		
98	" 2..	11 30	"	2	68		1.0184		1.309	2.361
99	" 2..	11 50	"	3.25	66.5	66.5	1.0217			
100	" 2..	12 30	Coming in..	3	66	66	1.0211			
101	" 2..	12 45	"	2.5	66.5	66.5	1.0217			
102	" 2..	1 00	"	4	68	66	1.0221			



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TABLE of Physical Properties—*Concluded.*

Station.	Date.	Time.	Tide.	Depth.	Temperature top.	Temperature bottom.	Specific Gravity top.	Specific Gravity bottom.	Chlorine.	Total Solids.
									p. c.	p. c.
103.	Sept. 2.	1 22	"	3	66.75	66.75	1.0217			
104.	" 2.	1 45	"	2	66	66	1.0210			
105.	" 2.	2 00	"	3	68	66.75	1.0212			
22.	" 2.	2 30	"	2	68	67.75	1.0210			
106.	" 2.	2 45	"	4	68	67	1.0220			
54.	" 2.	3 00	"	3.5	66.25	66.25	1.0220			
107.	" 2.	3 25	"	4	65.25	65.25	1.0221			
55.	" 2.	3 40	"	2.5	67.5	67.5	1.0224			
108.	" 2.	4 05	"	4	68	66	1.0220			
109.	" 2.	4 10	"	4.25	66	66	1.0222			
37.	" 2.	4 30	"	4	68	67.5	1.0222			
110.	" 2.	4 50	"	4	69	69	1.0228			
111.	" 3.	8 20	Going out	2.5	65.5	65.5	1.0210			
112.	" 3.	8 50	"	28	64.5	64	1.0222	1.0222		
37.	" 3.	9 05	"	5	66	65.5	1.0224	1.0223		
113.	" 3.	9 25	"	5	64.5	64	1.0222			
114.	" 3.	9 40	"	30	65.25	65	1.0222	1.0220	1.576 1.5615	2.841 2.870
5.	" 3.	10 00	"	12	65.75	67	1.0216			
115.	" 3.	10 35	"	4	66	65.75	1.0219			
116.	" 3.	10 45	"	3.3	66	66	1.0212		1.524	2.747
6.	" 3.	11 05	"	4.25	66.5	65.75	1.0212			
117.	" 3.	11 30	Low	3	66	66	1.0218			
118.	" 3.	12 30	"	3.3	67	66	1.0220			
119.	" 3.	12 55	"	3.5	67.5	66.5	1.0228			
19.	" 3.	1 20	Coming in	2.6	67.75	66.5	1.0221			
120.	" 3.	1 45	"	2	67	67	1.0223			
121.	" 3.	2 20	"	3.3	68.5	68.25	1.0220			
50.	" 3.	2 44	"	4.25	66.5	65	1.0220			
122.	" 3.	3 35	"	4.5	71	68.5	1.0221			
123.	" 3.	4 00	"	3	68	67.5	1.0210			
124.	" 3.	4 15	"	3.3	67	66.75	1.0214			
125.	" 3.	4 45	"	2.5	70	70	1.0220			
31.	" 3.	4 50	"	3	66	66	1.0216			
126.	" 3.	5 05	"	3.6	58	68	1.0219			

The table shows the salinities of samples of water taken in various parts of the bay, from the surface and also from the bottom. No samples were taken from intermediate depths. The figures show that the densities are well suited to the life and growth of oysters.

During the early part of the summer, samples were obtained from the bottom by means of a narrow-necked bottle wrapped with a sufficient quantity of sheet lead to cause it to sink readily. The bottle was lowered by means of a trawl-line which was securely fastened to both cork and neck of the bottle in such a manner that a short loop of line was left between them. The cork was tightly inserted and the bottle lowered by means of the cork to the desired depth and the cork released by sharply jerking the trawl-line. The bottle now filled was raised to the surface. On July 1 the brass bottle devised by Dr. H. F. Moore was obtained through the Bureau of Fisheries, Washington, U.S.A., and was used after that date.

The specific gravities were taken by means of delicate hydrometers graduated from 1.0000 to 1.0100, from 1.0100 to 1.0200 and from 1.0200 to 1.0300. The readings obtained were reduced to specific gravities at 60°F.

Samples of water from various localities were sent to Professor A. B. Macallum's laboratory at the University of Toronto, Dr. Roger Manning very kindly determined

the percentage of chlorine and the amount of total solids in these. His results are given in the last two columns of the table. In certain cases two sets of results are given. Those in italics are from the bottom.

The temperatures at top and bottom were taken with a Negretti and Zambra reversing thermometer. A few of these temperatures are shown in the table. The temperatures rose until about the first of July. The highest temperature recorded, 77°F., was taken on the 10th of July. A temperature of 60° F. was not recorded until June 20; after July 1, no temperatures of less than 60° F., except on one occasion, that of August 25. Early in the season there were often great differences between the surface and bottom temperatures. These differences became much smaller towards the end of the summer. A difference of 9.5°F. is recorded for a depth of 30 feet on June 23. On some occasions the bottom temperature was higher than that at the surface, e.g. at station 5 on September 3: top, 65°75; bottom, 67°. Owing to the low temperature of early summer the oysters did not spawn until after the first of August. Spawning began about three weeks later, and thus the season was short for the growth of the young oysters. The lateness of spawning must considerably increase the danger of the fry being destroyed by sudden falls in the temperature. The fry of the Malpeque oyster, however, must be quite resistant to such falls of temperature, since spawning occurred even after the sudden drop to 54°F. on the night of August 24.

#### PLANKTON OYSTER FOOD.

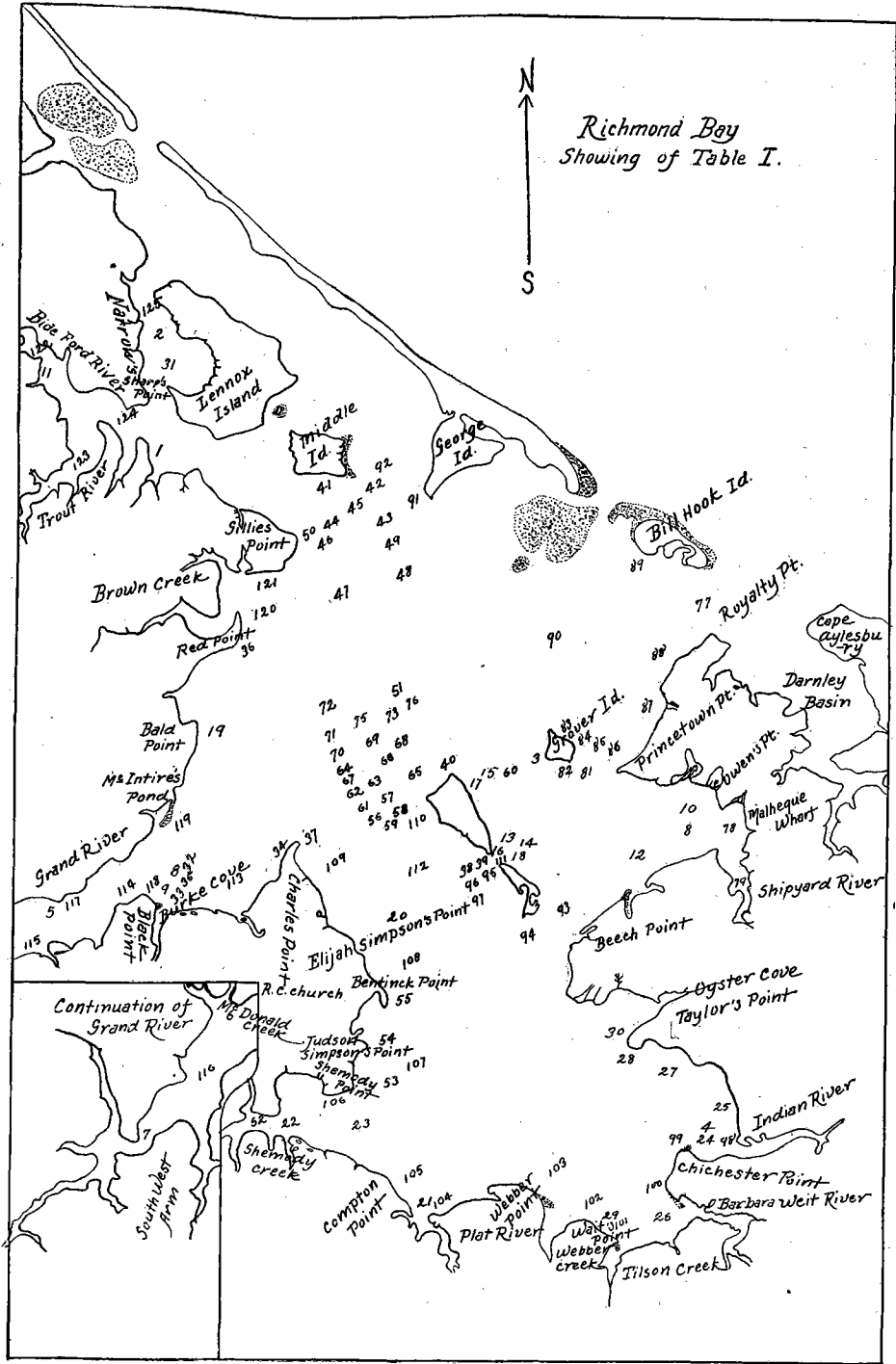
The diatomaceous oyster food collected in various parts of the bay throughout the summer is being worked over by Dr. A. H. MacKay, Superintendent of Education, Halifax, a well-known authority, and his results will be included in a future report.

#### INFLOW AND AMOUNT OF FRESH WATER.

Arrangements were being made to estimate the inflow of fresh water when it was decided that the desired result was more directly attained by taking the salinities. Fresh water affects the oyster by altering the salinity of the water in which the oyster lives. There are a great number of small streams flowing into Richmond bay. Owing to the fact that the woods are largely cleared away, the water rushes down quickly in the spring, and the volume of many of these streams is greatly augmented at this season while it is inconsiderable during the summer months. Unfortunately, records are not yet available of the densities of the water in the various parts of the bay while these spring floods are on.

#### PRESENCE OF OYSTER ENEMIES.

Starfish (*Asterias vulgaris* Verrill.) are abundant now in Richmond bay. A few years ago they were a curiosity. They constitute one of the worst enemies of the oyster in this bay. They are found in all parts of it, but are particularly abundant on the oyster grounds around the Curtain islands and in the Big bay. The government oyster steamer, the *Ostrea*, under Captain Kemp, the Dominion oyster expert, did good work during the summer, cleaning out starfish on the beds to the west of Curtain island and in the Big bay. He was assisted during the month of June by government patrol boats *D* and *E*. Some of the oyster companies also did service in this line. Both government and oyster companies should pursue this line of work much more vigorously, and the good results attained should be conserved and not lost as they were to a great extent last summer. The starfish fished from the beds are removed from the bay of course, but in the case of the work done by the *Ostrea* there was an indirect but none the less important result which was not conserved. The bed effectively cleared of starfish was swept by the starfish-mops and left white and clean and in good condition to secure a set of spat had it not been torn to pieces by oyster-planters dredging for shell. This shell might have been secured from other beds not cleaned in this way.





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Large starfish were obtained in the dredge from the beds in the deep water and great numbers of young starfish were found in certain parts of the eel-grass-covered sand areas. Many of the fishermen are not yet convinced of the fact that a starfish torn in two and thrown back into the water grows into two starfish.

A boring sponge (*Cliona celata* Grant), for the identification of which the writer is indebted to Lawrence M. Lambe, F.G.S., occurs on some of the beds, more particularly in the mud areas. Fortunately one finds only a small percentage of shells attacked. This sponge, however, does considerable damage to the oysters which it attacks. Although it may not kill the oyster it weakens it by forcing it to expend its energy in repairing the shell, which is almost honeycombed by the sponge. The weakened shell leaves the oyster a much easier prey to its other enemies.

The drill (*Urosalpinx cinerea* Say) is not known to occur in Richmond bay, although there is a small borer (*Tritia trivittata* Adams) which does penetrate the soft shells of *Pandora trilineata* Say, and which may possibly do damage to small oysters. It is very abundant in some parts of the bay.

The slipper limpet (*Crepidula fornicata* Lamarck) is very abundant and must come into competition with the oyster for points of attachment and for food. *Crepidula plana* Say, also occurs.

Eel-grass (*Zostera marina* L.) renders areas unfit for planting oysters until it is cleared off, smothers oysters when it is dead by lodging on them, and interferes with the setting of oyster spat, as will be pointed out in the account of the experiments on spatting. Certain seaweeds also grow on the rocks and interfere with the setting of spat here.

Ice, it is stated, destroys many young oysters on such points as those to the north of Grover and Bunbury islands. Many of these would doubtless be saved were these points leased. If leased to fishermen they could carry on operations here without the outlay of much capital. Clean cultch could be distributed over these points in retainers such as those used in our spat-collecting experiments, and these could be lifted and sold to the oyster companies before the ice formed in the autumn.

No doubt some oysters are destroyed by sifting sand, but it does not yet appear that the loss from this source is very great.

Sudden falls of temperatures such as that on the night of August 24 no doubt destroy great numbers of the oyster fry. That even such great drops as this do not destroy all is shown by the fact that spat set in several places after that date.

The most destructive enemy the oyster has, however, is man. Oyster poaching goes on widely, but were the oyster poacher and the man who buys from him severely dealt with, and efficient protective legislation effectively and impartially enforced, there would be a great advance in the oyster industry in Richmond bay.

## OCCURRENCE OF SMALL OYSTERS AS EVIDENCE OF SPATTING.

The small number of young oysters shows either that spatting has not been good in recent years or that there has been a high death-rate among the small oysters. There is almost always, however, a good or at least a fair "set" in a few places such as the north point of Grover island, on the Curtain Island shoals, and in the narrows between Curtain island and the mainland. There is also generally a fair set in the Grand river and often near the mouths of the Indian and Barbara Weit rivers at the south end of the Big bay. There was a very light set in 1913. A few 1-year-old oysters occur at Grover island, in the narrows, and near the mouth of the Barbara Weit river. Two-year-old oysters were more abundant and more widely distributed. Small oysters up to 3 or 4 years old were found in the narrows, on the rocky shoals near George island, the rocky points north of Grover and Bunbury islands, the Grand river and at various points in the Big bay. Spatting does take place, and there is no doubt in the writer's mind that it would take place more abundantly if precautions were

taken to secure the protection of the old beds and to provide suitable cultch for spatting. A few years ago, when the channel to Malpeque wharf was dredged, the material removed, among which was a quantity of old shell, was dumped on what is now known as the "old dump." This shell, partially cleaned in the process, served as cultch for a set of spat and the "old dump" is to-day, as far as an overfished bed can be, a good bed.

#### OCCURRENCE OF DEAD OYSTER SHELLS AS EVIDENCE OF FORMER PRODUCTION.

There are extensive and deep old shell beds all over the Big bay and in many places in the Inner and Outer bays as well. These beds consist in the main of old oyster and quahaug shells, with a smaller proportion of live oysters and quahaugs. These beds occur not only in the main portions of the bay but in the rivers as well. Beds are found in the Grand, Bideford, Trout, Barbara Weit, and Indian rivers, and also in Shemody creek.

An attempt was made to obtain measurements of the thickness of some of these old beds. This can be satisfactorily done only by boring, and boring can best be done through the ice in winter. A rough estimate of the thickness was made by poling across the beds and through the mud at the sides. The sounding over the summit, which usually lies near one edge, was subtracted from that through the mud at the side and the difference taken as the depth of the bed. This estimate is admittedly only an approximation, but it is believed to give a fair idea of the depth. The following are the estimates for some of the beds:—

1. September 2.—Little Curtain Island bed—  
 Off the north side—  
     Top, 7.5 feet; bottom, 24 feet; thickness, 16.5 feet.  
 Off the south side—  
     Top, 8 feet; bottom,  $22 + 6 = 28$  feet; thickness, 20 feet.
2. September 3.—Bell bed, Grand river—  
     Top, 6 feet; bottom,  $10 + 7 = 17$  feet; thickness, 11 feet.
3. September 3.—Bed above the ferry, Grand river—  
     Top, 12 feet; bottom,  $12 + 6 = 18$  feet; thickness, 6 feet.
4. September 12.—Bed northwest of Bunbury island—  
     Top,  $10\frac{1}{2}$  feet; bottom,  $19\frac{1}{2} + 5\frac{3}{4} = 25\frac{1}{4}$  feet; thickness, 15 feet.
5. September 12.—Little Curtain Island bed—  
 Off north side—  
     Top, 7.5 feet; bottom,  $21.5 + 3.5 = 25$  feet; thickness, 17.5 feet.  
 Off south side—  
     Top, 7.5 feet; bottom,  $26 + 5.5 = 31.5$  feet; thickness, 24 feet.
6. September 12.—Little Curtain Island bed, west end—  
     Top, 7.25 feet; bottom,  $21.5 + 6 = 27.5$  feet; thickness, 20.25 feet.
7. September 12.—Bed middle of Big bay, west of Curtain island—  
     Top, 10 feet; bottom,  $22.5 + 7.5 = 30$  feet; thickness, 20 feet.
8. Chinick bed—  
     Top, 16 feet; bottom,  $21.5 + 7.5 = 29$  feet; thickness, 13 feet.

The differences between the measurements of the depth of the Little Curtain Island bed are to be explained by the fact that the bed is a large one, and the measurements were not made in the same places on the two dates.

The mud-diggers take shell from considerable depths. The writer was informed that the face of the cut, which is all shell-bearing, is sometimes 24 feet in height. These points all indicate the oyster has existed in Richmond bay for a very great number of years. Throughout this period the conditions must have been favourable for oyster life. The presence of so much shell in the water insures a supply of lime for shell development in the live oysters.

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## FREEZING TO BOTTOM IN WINTER.

Young oysters are said to have a high death-rate on the north point of Grover island. This would appear to be due more to crushing by the ice than to freezing, since many oysters survive in the depressions, in the small crevices, and on the sides of stones. No evidence was obtained that oysters were killed on the beds by freezing. It was commonly stated that the ice was thin over the beds and that the thinness was a source of danger to travellers on the winter roads across the bay unless these roads avoided the beds. Some attributed it to the "natural heat" of the oyster beds. Others more properly to the currents which are naturally stronger over the shallow beds.

## TIME OF SPAWNING.

Spawning was late this year. Oysters began to shed their spawn and oyster fry to appear in the water about the first of August. Fry was still found in the bay on the 29th of August, but none after that date. The oysters in the warmer water spawned somewhat later than those in the cooler water, there being a difference of about two or three days in the date of spawning at the south end of the Big bay and that in the Inner bay, and the deep-water oysters retained their spawn about a week after those in the shallower beds and in the rivers had shed all theirs. The bulk of the spawning took place during the first three weeks of August.

## TIME AND EXTENT OF SPATTING.

Spat-collectors were made by placing shell in cylindrical containers made of wire netting. These, which were from 2 to 4 feet in height, were placed at various points around the bay. They were kept upright by being firmly wired to stakes. They were numbered, and at the end of the season were removed to deeper water to permit of further observations during subsequent seasons. The attempt to secure spat by the use of glass strips, placed with each collector, proved unsuccessful.

The following account shows in respect to each collector: the date set out, the location, some account of the environmental factors, the date taken up, the set of spat, and some account of the condition of the shell at the time of lifting.

1. August 19.—Bideford river, end of the first point above the wharf; near but not in eel-grass; oyster beds farther up the river; September 14, set heavy; heavily slimed over.

2. August 19.—Trout river, lowest point on the left bank; in 3.5 feet, near but not in eel-grass; oyster beds close at hand; September 14, set heavy; heavily slimed over.

3. August 19.—Bideford river, left bank, Sharp's point; in 3.5 feet on edge of eel-grass; near oyster bed; September 14; set heavy; heavily slimed over.

4. August 19.—Narrows between Lennox island and the mainland, Sharp's bed "Rock bed"; in 2.5 feet, no eel-grass on oyster bed; September 14; set heavy; heavily slimed.

5. August 19.—Narrows between Lennox island and the mainland, Sharp's bed (Peter Creek bed); in 2.5 feet, no eel-grass on oyster bed; September 14; set heavy; heavily slimed.

6. August 19.—Lennox island, first point northwest of the wharf; in 4 feet, among eel-grass, not close to oyster beds; September 14, no set, moderately slimed. (This collector fell over shortly after being set out and was left lying).

7. August 19.—Gillies point; in 2.5 feet, among eel-grass; not close to oyster bed; September 14; set light; slightly slimed.

8. August 20.—Middle island, southwest point; in 3 feet, among eel-grass, not close to oyster beds; September 14; no set; slightly slimed.

9. August 20.—Middle island, southeast point; in 3 feet, among eel-grass, near scattered oysters; September 14, set light; slightly slimed.

10. August 20.—George island, west of south point; in 4 feet, among eel-grass, near scattered oysters; September 14, no set; slightly slimed.

11. August 20.—George island, west of shoal running out from south point, about half-way out on shoal; in 3 feet, among eel-grass, near rock oysters; collector lost.

12. August 20.—George island, end of the shoal running out from south point; in 4 feet, among eel-grass, near rock oysters; collector lost.

13. August 20.—Bill Hook island, end of shoals to the southwest; in 7 feet, among eel-grass, not near oysters; September 14, no set; slightly slimed.

14. August 20.—Bill Hook island, shoals near lighthouse; in 7 feet, among eel-grass, not near oysters; September 14, no set; slightly slimed.

15. August 21.—Shipyards river, left bank, point above Crafer's; in 2 feet, on edge of eel-grass, just above oyster bed; September 16, set fair; slightly slimed.

16. August 21.—Shipyards river, right bank, Crafer's point; in 2 feet, on edge of eel-grass, just below oyster bed; September 16; set fair; slightly slimed.

17. August 21.—Shipyards river, channel above wharf; in 2.5 feet, no eel-grass, on oyster bed; September 16, set fair; slightly slimed.

18. August 21.—Shipyards river, left bank, Ramsey's point; in 3 feet, among eel-grass, not far from oyster beds; September 16; set fair; slightly slimed.

19. August 21.—Shipyards river, Owen's point end of point; in 2.5 feet, among eel-grass, not far from oysters; September 15, set fair; slightly slimed.

20. August 21.—Shipyards river, Owen's point, west of point; in 2.5 feet, on edge of eel-grass, not far from oysters; September 15, set fair; slightly slimed.

21. August 21.—Inner bay, Ellison's point; in 2.5 feet, on edge of eel-grass, not far from oysters; September 15, set fair; slightly slimed.

22. August 21.—Shoals between Princetown point and Grover island, middle of south side; in 2.5 feet among eel-grass, not far from oysters; September 15, set fair; slightly slimed.

23. August 21.—Grover island, middle of the northeast side; in 2.5 feet; among eel-grass, not far from oysters; September 14, set fair; slightly slimed.

24. August 21.—Grover island, off northeast point; in 2.5 feet, among eel-grass, not far from oysters; September 14, set fair; slightly slimed.

25. August 21.—Shoals between Princetown point and Grover island, middle of north side; in 2.5 feet, among eel-grass, not far from oysters; September 14, set fair; slightly slimed.

26. August 21.—Outer bay, shore between Princetown and Royalty points, Montgomery's point; in 2.5 feet, among eel-grass, not far from oysters; collector lost.

27. August 21.—Outer bay, shore between Princetown and Royalty points, point first west of Royalty; in 2.5 feet, on edge of eel-grass, not far from oysters; September 14; set fair; slightly slimed.

28. August 21.—Outer bay, north of Princetown point; in 2.5 feet, among eel-grass, not far from oysters; September 14, set light; slightly slimed.

29. August 21.—Grover island, north point; in 2 feet, on rocks, among very short seaweed, among rock oysters; September 15, set heavy, heavily slimed.

30. August 21.—Grover island, north point; in 1.5 feet, on rocks among short seaweed, among rock oysters; September 15, set heavy; heavily slimed.

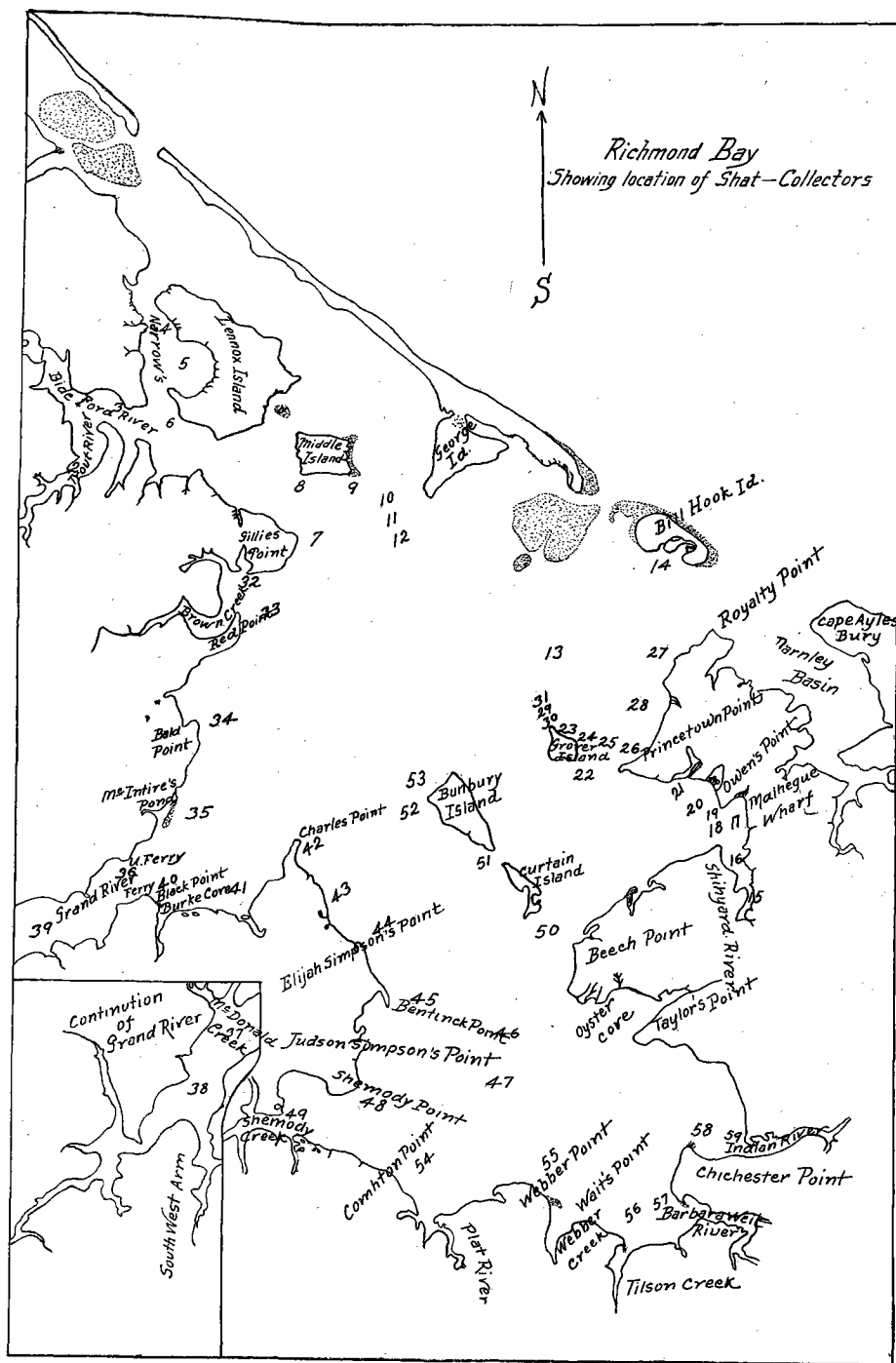
31. August 21.—Grover island, north point; in 2.5 feet, on rocks among short seaweed, among rock oysters; September 15, set heavy; heavily slimed.

32. August 24.—Point west of Gillies point, mouth of Brown creek; in 2 feet, on edge of eel-grass, not near oysters; September 16; set light; slightly slimed.

33. August 24.—Red point; in 3.5 feet, among eel-grass, not near oysters; collector lost.

34. August 24.—Bald point, in 2.5 feet, among eel-grass, not far from oysters; September 16; set light; slightly slimed.







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35. August 24.—Near McIntyre's pond; in 3.5 feet, among eel-grass, not near oysters; September 16; set light; slightly slimed.
36. August 24.—Grand river, Bell's point; in 3 feet, no eel-grass, close to oyster bed; September 16; set light; heavily slimed.
37. August 24.—Grand river, mouth of Macdonald creek; in 4 feet, on rocky bottom near eel-grass, not far from oyster beds; September 16; set heavy; moderately slimed.
38. August 24.—Grand river, point opposite Southwest arm; in 3.5 feet, among eel-grass, near oysters; September 16; set fair; moderately slimed.
39. August 24.—Grand river, point right shore above ferry; in 4 feet, among eel-grass, near oysters; September 16; set light; slightly slimed.
40. August 24.—Grand river, Black point; in 3.5 feet, among eel-grass, not far from oysters; collector lost.
41. August 24.—Half-way between Black and Charles points; in 5 feet, among eel-grass, not near oysters; September 16; no set; slightly slimed.
42. August 24.—Charles point; in 4 feet, no eel-grass, near oysters; September 15; set light; slightly slimed.
43. August 24.—South of Charles point, half-way to Simpson's point; in 4.5 feet, among eel-grass, not far from oysters; September 15; set light; slightly slimed.
44. August 24.—Between Charles and Bentinck points, Simpson's point; in 4 feet among eel-grass; not far from oysters; September 15; set light; slightly slimed.
45. August 27.—Bentinck point; in 2.5 feet, among eel-grass, not far from oysters; September 15; set light; slightly slimed.
46. August 27.—Bentinck shoal, north side; in 4 feet, among eel-grass not far from oysters; September 15; set light; slightly slimed.
47. August 27.—Bentinck shoal, south side; in 3.5 feet, among eel-grass, not far from oysters; September 15; set light; slightly slimed.
48. August 27.—Shemody point; in 4 feet, among eel-grass, not far from oysters; September 15; set light; slightly slimed.
49. August 27.—Shemody creek; in 2 feet, among eel-grass, near oysters; September 15; set light; slightly slimed.
50. August 27.—Curtain Island shoals, west side between Beech point and Curtain island; in 3.5 feet, in clear patch among eel-grass, near oysters; September 15; set heavy; slightly slimed.
51. August 27.—Curtain island shoals, west side, between Curtain and Bunbury islands; in 3.5 feet, among eel-grass, near oysters; September 15; set light; slightly slimed.
52. August 27.—Curtain Island shoals, west side of Bunbury; in 4 feet, among eel-grass, near oysters; September 15; set light; slightly slimed.
53. August 27.—Curtain Island shoals, northwest of Bunbury; in 5 feet, among eel-grass, not far from oysters; September 15; set light; slightly slimed.
54. August 28.—Plat river, Compton's point; in 2.5 feet among eel-grass, not far from oysters; September 15; set light; slightly slimed.
55. August 28.—Webber point; in 3 feet, among eel-grass, not far from oysters; September 15; set light; slightly slimed.
56. August 28.—Barbara Weit river, near Wait's point; in 2.5 feet, among eel-grass, not far from oysters; September 15; no set; slightly slimed.
57. August 28.—Barbara Weit river, west of Mill's point; in 3 feet, among eel-grass, near oysters; September 15; set light; slightly slimed.
58. August 28.—Indian river, east of Chichester point; in 3.5 feet, on edge of eel-grass, near oysters; September 15; set light; slightly slimed.
59. August 28.—Indian river, point at mouth right bank; in 2 feet, among eel-grass, near oysters; September 15; set light; slightly slimed.
60. August 28.—Grover island, north point; in 2 feet, on rocks, among short seaweed, among rock oysters; September 15; set light; moderately slimed.

61. August 28.—Grover island, north point; in 2 feet, on rocks, among short seaweed, among rock oysters; September 15; set light; moderately slimed.

Collectors 1 to 60 were filled with shell picked from oyster-mud, while collector 61 was filled with fresh oyster-shell. Collectors 60 and 61 were placed together in order to test the relative efficiency of fresh and old shell. No difference was observable but, owing to the fact that fresh shell was not obtained before August 28th these collectors were too late in being placed out to make the test a conclusive one.

The tests show that spat sets in practically all parts of the bay, wherever there is suitable cultch material. The set was in general light, although in a few places it was good. The result would, without doubt, have been very much better had it been possible to set out the collectors earlier. The set was best in locations where the water was shallow, easily warmed, and where the bottom, free from eel-grass, was swept by currents from oyster beds not too far distant. The whole investigation leaves the impression that of late years the set of spat has suffered a great decrease. Set of spat is a thing essential to oyster production in Richmond bay, and it would seem advisable to institute a strictly close season until spatting has again reached normal proportions. The attempt to restock the bay by means of American oysters would probably meet with very indifferent success. Even were it demonstrated that they would flourish and grow, there remains the much more doubtful question as to whether they would reproduce themselves or not. Besides, Malpeque oysters have a name which it is good policy to retain. There would, moreover, be the serious danger of introducing the devastating drill along with the oysters.

FORMER OUTPUT OF THE BAY.

The following statement of the number of barrels of oysters shipped from Prince Edward Island through the Charlottetown Steam Navigation Company will give some idea of the relative proportions of the oyster trade from Richmond bay through a series of years subsequent to 1889. The writer is indebted to the kindness of the company for it. Other companies have handled oysters, but information could not be obtained concerning the amounts. All the oysters handled by the Charlottetown Steam Navigation Company were not Richmond Bay oysters, but the bulk of them were. The statement will give a very fair idea of the relative trade from year to year in respect to the oysters from this bay.

	Barrels.		Barrels.
1889..	23,538	1902..	17,271
1890..	20,033	1903..	14,916
1891..	20,825	1904..	12,280
1892..	23,654	1905..	12,406
1893..	20,328	1906..	12,283
1894..	15,565	1907..	7,456
1895..	15,265	1908..	7,472
1896..	15,157	1909..	9,190
1897..	12,661	1910..	7,196
1898..	16,550	1911..	7,589
1899..	15,161	1912..	6,908
1900..	15,683	1913..	12,982
1901..	18,238		

The sudden rise in the number of barrels shipped in the year 1913 is eloquent in support of the contention that there should be a strictly enforced close season. It was ten years since there had been so heavy a shipment of oysters. The figures show that the oyster trade was of considerable importance twenty-five years ago and that it has dwindled in that period until it was in 1912 less than one-third of its extent at the beginning of the period. The need of protection is very apparent.

## CONCLUSIONS.

1. The character of the bottom is favourable to the development of oysters. There is a considerable amount of mud bottom, but there are also extensive tracts of good hard clean bottom on which it should be possible to develop good oyster areas.

2. Eel-grass is abundant throughout the shallow areas, and will demand the expenditure of labour and money in order that it may be kept in check.

3. The salinity of the water, although somewhat high, is still favourable to the production of oysters and, judging by the oysters seen during the summer, of very fine quality.

4. The temperatures are somewhat low until rather late in the summer. In this way the spatting is delayed and the season of growth during the same season shortened. The low temperature probably does decrease the rate of growth of and the number of oysters in Richmond bay, but it would appear that it improves their quality.

5. Although the identification of the diatoms, kindly undertaken by Dr. A. H. MacKay, is not yet completed, it may be here stated that there is an abundant supply of oyster food in the waters of this bay.

6. The enemies of the oyster are not yet a serious menace in Richmond bay if proper measures are taken to keep them in check. The most serious depredations are those made by man and the starfish.

7. Spatting falls short of the requirements for successful oyster growing, but this condition of affairs may be remedied.

8. Oysters have existed in Richmond bay for a very great number of years, and have been much more plentiful in former years than they are at present. This would appear to be due to overfishing.

The oyster beds of Richmond bay are in bad shape, but their condition may be remedied. There is no evidence on which one can make the statement that natural conditions bar the development of oyster production. Eel-grass and starfish present difficulties which may be successfully contended with. No good evidence was obtained that the physical conditions are more unfavourable than they have been in the past. The chief danger to oyster production is disregard for and slack enforcement of the law. The hope for the regeneration of the oyster industry as a great national asset lies in a strict and impartial enforcement of protective regulations.

## RECOMMENDATIONS.

The writer would favour the following steps as most desirable:—

1. That measures be taken to more rigidly enforce the oyster laws.

2. That a close season of at least three years be established, during which no one be permitted to take oysters from the public beds, and during which the sale of oysters taken from any bed, public or private, in the bay be prohibited.

3. That the ground between the 4-foot line and the shore be leasable to the fishermen for spatting grounds.