SUPPLEMENT

TO THE

51ST ANNUAL REPORT OF THE FISHERIES BRANCH
DEPARTMENT OF NAVAL SERVICE

1916-17

OFFICIAL REPORT

UPON

LOBSTER CONSERVATION IN CANADA

BY

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Being the results of Investigations carried on under the Biological Board, with the aid of Officers instructed by the Department of Naval Service during the season of 1916

OTTAWA
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1917

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Frontispiece.

View of some thousands of lobster traps placed along the shore at the close of the fishing season, the property of Messrs. Burnham and Morrill, lobster canners, Bay View, N.S.

ACKNOWLEDGMENTS.

In carrying out his scheme of investigation, which is really a continuation and extension of the work commenced at Long Beach, St. Mary's Bay, N.S., in 1914, the author desires to warmly acknowledge the great interest taken by Mr. G. J. Desbarats, C.M.G., Deputy Minister of Naval Service, Ottawa, and the valuable assistance which he was the means of furnishing during the progress of the researches. The Superintendent and staff of the Bay View Hatchery, under instructions from the Deputy Minister, gave indispensable aid, especially in the construction of the lobster rearing apparatus, before the regular hatching operations were fully under way. This assistance they rendered without, I understand, any remuneration excepting their regular pay from the Department and it involved a considerable amount of manual labour. The Department placed at the service of the Biological Board the Hatchery Buildings, wharf, etc., and supplied without cost power for the apparatus used, and live steam for heating purposes.

2. The Biological Board is under obligation to Professor W. T. MacClement, D.Sc., of Queen's University, for five weeks' exacting labour in supervising the construction of the rearing apparatus, and the retaining pounds under the wharf of the hatchery.

3. Mr. A. B. Dawson, B.A., Acadia University, of Uig, P. E. Island, a post-graduate student of Harvard University, and one of the biologists employed by the Board, assisted me in every way possible, especially in estimating the output of the living fry from the hatchery, and in operating the lobster-rearing apparatus.

RECOMMENDATIONS.

1. That the Biological Board, through its Executive Committee, should confer with the Deputy Minister of Naval Service upon a scheme for conducting an educational campaign among lobster fishermen and canners with a view to securing their co-operation with the Department in conserving the lobster industry.

2. That the proposal be considered favourably for utilizing the southwest end of the Long Beach pond or the Fourchu Lobster pond, Cape Breton, to enable experiments with lobsters to be made on a large scale.

3. That the question be considered officially for establishing a uniform close season for lobsters including the months of June, July, August, and September, for every part of the coast of the Maritime Provinces.

4. That if the step be adopted by the Department of closing the Bay View Lobster Hatchery for the season of 1917, the establishment be handed over to the Biological Board for the purpose of continuing the rearing experiments with lobster fry.

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LOBSTER CONSERVATION IN CANADA.

PART I.

LOBSTER INDUSTRY DECLINING.

It is impossible to make reference to the numerous special returns and reports on the Canadian lobster fishery published from time to time, but it is quite clear from a perusal of these reports, and similar ones in the United States that every local lobster fishery from Delaware to Grand Manan, and on to Labrador, is passing through, or has already passed through, one of the following stages:—

1. A period of plenty with abundance of lobsters and comparatively few fishermen using simple gear, and old-fashioned boats.

2. A period of rapid extension beginning in Canada about 1870 and much earlier than this in the older regions of New England.

3. A period of real decline, though often interpreted as one of increase—a period in which there is a rapid extension of the areas fished, multiplication of traps and boats, a decrease in the size of lobsters caught, and consequently of those bearing eggs, and lastly a steady increase in price.

4. A general decrease all along the line except, of course, in the price paid by the consumer.

About 1870 the supply of lobsters along the Canadian coasts seemed inexhaustible. Thus a canner writing in 1873 of the supply of lobsters for his factories says: "The heavy gale of last August drove more lobsters ashore within five miles of my packing houses than I could make use of during the whole summer. They formed a row of from one to five feet deep and I should estimate them at an average of one thousand to every two rods of shore." Another writer commenting upon the abundance of lobsters in those early days, remarks: "In spite of their increased commercial value it is nevertheless a fact that in some of the northern parts of the gulf of St. Lawrence good marketable lobsters are used to manure the field."

But twenty years afterwards the tune had changed. People had begun to realize that the supplies of lobsters were not inexhaustible, and that if they wished to conserve the continuance of the canning industry they must at least take some steps to replenish waters that at one time teemed with millions of large lobsters. And so it came about that the first lobster hatchery was erected at Bay View, near Pictou, in 1891. What might be fairly described as a mania for the artificial hatching of commercial and game fish spread over the country, and found expression in demands upon the Government for the erection of various kinds of hatcheries. Accordingly we see to-day hatcheries for trout, salmon, whitefish, lobsters, shad, and pickerel. Whether these have all justified their existence remains to be seen; but this at least may be said of the lobster hatcheries, that notwithstanding all the millions of fry which they are reported to have poured into our coastal waters for the past twenty-five years, the supply of lobsters is steadily on the decline.

Nothing bears out this statement so well as Mr. Venning's report summarizing the proceedings of the Marine and Fisheries Committee's report in the year 1909, and including very full statistics from 1897 to 1908 regarding the lobster industry, which statistics I am able to present up to and including last season's returns, thanks to officers of the department.

Now if we look at the annual catches measured in one-pound cans of canned lobster, or in pounds live-weight, and divide by the total number of traps, we shall, of course, find the catch per trap, and the following table demonstrates the results:—

TABLE showing yearly pack, number of traps, catch per trap, etc.

Year.	1-Pound Cans.	Traps.	Pounds live lobsters.	Catch per trap in 1-lb. cans.	Catch per trap live lobsters.	Total catch per trap.
				Lbs.	Lbs. per trap.	
1897	11,130,554	1,156,352	25,183,100	9·6	22·0	31·6
1900	10,548,290	1,382,935	18,914,000	7·6	14·0	21·6
1901	10,056,604	1,363,512	16,419,500	7,7	12·0	19·3
1902	9,350,121	1,221,236	14,203,400	7·6	11·0	18·6
1903	10,604,218	1,205,006	10,663,900	8·8	8·8	17·6
1904	10,762,288	1,288,997	11,104,800	8·3	8·6	16·9
1905	10,497,624	1,239,651	15,392,400	8·4	12·0	20·4
1906	10,104,764	1,268,866	10,137,000	7·9	7·9	15·8
1907	10,660,530	1,340,711	9,749,000	7·8	7·0	14·8
1908	10,911,498	1,477,623	9,837,300	7·3	6·6	13·9
1909–10	9,071,600	1,458,585	10,394,700	6·2	7·1	13·3
1910–11	8,788,512	1,504,872	11,001,200	5·8	7·3	13·1
1911–12	10,007,136	1,469,192	11,082,300	6·8	7·5	14·3
1912–13	9,005,568	1,590,966	8,537,900	5·6	5·3	10·9
1913–14	7,992,592	1,617,195	10,089,700	4·9	6·2	11·1
1914–15	7,723,296	1,596,538	8,682,400	4·8	5·0	9·8
1915–16	7,822,368	1,371,774	11,932,900	5·7	8·7	14·4

1. One conclusion to be drawn from these figures and one which must be level to the comprehension of even the dullest of men is that an industry in which the catch per trap falls from 31.6 pounds to 14.4 pounds, less than one half of what it was nineteen years before, is certainly a failing industry.

2. Another conclusion, so clear that he who runs may read, is that the yearly sea crop of lobsters varies in much the same way as our land crop of wheat does. Mother ocean and mother earth never produce the same yield for two years in succession. An abundant harvest from the land or an abundant harvest from the sea in any one year does not necessarily mean an abundant harvest the next. There are ups and downs in both. I have often been asked why the catch of lobsters was greater in 1915-6 than in 1914. As well ask me why the harvest this year was less than last. Man may modify the conditions which give him his annual yield of grain by cultivating the soil, but the harvest as a whole will depend upon cold and warmth and rainfall, none of which man can control. In any year, let there come a few degrees of frost, a scanty fall of rain, or the blight of rust, and our wheat fields are ruined. This is common knowledge to every farmer; but every fisherman seems to think it wonderful that the lobster crop should vary from year to year. Run your eye down column 7 in the above table. You see the annual catch per trap varies from year to year just as the yields of bushels of wheat per acre do. One variation is no more wonderful than the other. The sea-harvest is less under man's control than the land-harvest; but we may be quite sure that the varying temperature of sea water, and the varying food supply for the fry are as potent in the production of a variable crop of lobsters as temperature and rainfall are for a variable crop of wheat. We can easily conceive how an unusually severe winter, with the increased production of ice floes, the lowered temperature of sea water continued late into spring, would tend to kill not alone the live adult lobsters but also the eggs and fry, so that a few years afterwards when we might naturally expect the normal yield of adults, it would be found that a small catch would be reported.

Again reverting to the gale in 1873 which threw up a windrow of millions of dead lobsters for five miles along the New Brunswick coast,* who can fail to see that six years later the usual crop of half grown lobsters would be lacking, just because the mothers had been killed in vast numbers six years before. Similarly, who has not heard or read of partridges dying by hundreds as the result of a great snow-thaw, followed by severe frost, so that it was impossible for the birds to obtain their usual shelter under the frozen snow. Thus we see how Nature sometimes limits the harvest from the sea as well as the harvest on land.

3. A third proof that the supply of lobsters is declining is furnished by the following statistics from the last report of the Fisheries Branch of the Department of Naval Service:—

Areas in which Canneries are operated.	No. of canneries operated in 1900.	No. operated in 1915 and 1916.
St. John, Annapolis, Kings	2	0
Digby, Charlotte	21	14
Lunenburg, Queens, Shelburne, Yarmouth	59	51
Halifax, Guysborough, Richmond	74	42
Cape Breton, Victoria	33	32
Cumberland, Colchester, Pictou, Antigonish, Inverness	100	88
Restigouche, Gloucester, Northumberland, Kent, Westmorland	225	151
Kings, Queens, Prince, P.E.I	246	172
Magdalen Islands, Quebec	159	73
Total operated	919	623

That 296 canneries have ceased operations since 1900 is a very significant fact. No one will believe that they would have been closed, or converted to other uses if the supply of lobsters had been plentiful. It is quite true that some canneries ceased operations as a result of their owners combining with other owners. By reducing the number of canneries the operators reduced their running expenses. Then again the live lobster trade has tended to reduce the number of canneries especially in south-western Nova Scotia; but after making every allowance for these two circumstances, the fact remains that the chief reason for closing these 296 canneries lay in the declining lobster supply—a decline that to all appearances is bound to go on until the lobster industry ceases to be profitable.

4. A fourth set of facts which point clearly to the decline in the lobster industry is the diminishing size of the adult lobsters, especially in Northumberland straits. Many years ago the adult lobsters were all large. They are still large in Passamaquoddy bay, but around all sides of Nova Scotia full grown ones are comparatively rare. This is amply proved by Mr. Halkett's "Tabulations of Lobster Measurements" during the past summer. Look, for example, at the three following tables which are based upon these measurements. Off Shag Harbour, Shelburne County, the total lengths of 200 lobsters were 1,937 inches, or an average of 9·68 inches each. At Shemogue, New Brunswick, 204 lobsters measured 1,609 inches, or an average of 7·8 inches, and at Pictou, Nova Scotia, the average was 7·7 inches. The average in Passamaquoddy bay, judging from those obtained for the mating experiments, at St. Andrews, N.B., last summer, must have been nearly 14 inches.

Now experience shows that the first effects of overfishing is a reduction in the size. This is true of the halibut grounds in the Pacific. The older grounds there now yield only relatively small fish. The trawls of traps in Northumberland straits,

*See "Notes on the Natural History of the Lobster," by Professor Prince, p. 1, Suppt. No. 1, 29th Ann. Rep. Dept. Marine, Fisheries Branch, 1896.

operating in shallow water have enabled the fishermen there to catch all the large lobsters, so that if fishing goes on at its present rate we may confidently expect diminishing size of lobsters with a corresponding decrease in the percentage of berried females. We cannot exterminate any sea-fish, but we may overfish easily enough, capturing at first the largest size, then the medium-sized ones, until finally the only remaining ones are those so small that it will not pay to fish for them. So will it be with lobsters.

TABLES OF LOBSTER MEASUREMENTS, 1916.

TABLE 1—Off Shag Harbour, Shelburne, N.S.

Length in inches.		Number.		Total inches.
6⅝	×	2	=	13
6⅞	×	2	=	13⅝
7	×	1	=	7
7¼	×	4	=	29
7⅜	×	9	=	67⅜
7⅝	×	9	=	69¾
8	×	11	=	88
8¼	×	11	=	90¾
8⅜	×	12	=	102
8⅝	×	11	=	96¼
9	×	12	=	108
9¼	×	15	=	138¾
9⅜	×	9	=	85⅜
9⅝	×	12	=	117
10	×	10	=	100
10¼	×	4	=	41
10⅜	×	14	=	147
10⅝	×	6	=	14⅜
11	×	8	=	88
11¼	×	4	=	45
11⅜	×	8	=	92
11⅝	×	2	=	23⅜
12	×	5	=	60
12⅛	×	3	=	36⅜
12⅜	×	4	=	50
12⅝	×	2	=	25⅛
13	×	3	=	39
13⅛	×	2	=	26⅛
13⅜	×	1	=	16⅜
14	×	1	=	14
14⅛	×	1	=	14⅛
14⅜	×	1	=	14⅜
15⅛	×	1	=	15⅛
Total, lobsters..		200	Total.	1,927

Average length, 1 lobster = 9·68 inches.

TABLE 2—Shemogue, Westmorland Co., N.B.

Length in inches.		Number.		Total inches.
6	×	4	=	24
6¼	×	5	=	31¼
6⅜	×	9	=	58⅜
6⅝	×	13	=	87⅜
7	×	21	=	147
7¼	×	15	=	108¾
7⅜	×	19	=	142⅜
7⅝	×	15	=	116¼
8	×	29	=	232
8¼	×	13	=	107¼
8⅜	×	16	=	136
8⅝	×	9	=	78¾
9	×	9	=	81
9¼	×	10	=	92½
9⅜	×	8	=	76
9¾	×	2	=	19½
10	×	1	=	10
10¼	×	2	=	20½
11	×	1	=	11
11¼	×	1	=	11¼
11¾	×	1	=	11¾
12	×	1	=	12
Total, lobsters..		92	Total.	1,609

Average length, in inches, 7·8.

TABLE 3—Off Skinner's Reef, Pictou, N.S.

Length in inches.		Number.		Total inches.
6¼	×	3	=	18¾
6⅜	×	2	=	13
6¾	×	11	=	74¼
7	×	14	=	98
7¼	×	11	=	79¾
7⅜	×	9	=	67½
7⅝	×	12	=	93
8	×	9	=	72
8¼	×	3	=	24¾
8⅜	×	5	=	42½
8¾	×	1	=	8¾
9¼	×	2	=	18½
9⅜	×	1	=	9⅜
10	×	3	=	30
10¼	×	2	=	20½
11	×	1	=	11
11¼	×	1	=	11¼
11¾	×	2	=	23½
Total lobsters..		92	Total.	716¼

Average length, in inches, 7·7.

TABLE 4—Long Beach Pond, Digby Co., N.S.

Mr. A. B. McKay, M.A., who was in charge of Long Beach Pond last summer, measured all the lobsters that were received there during the season. The following measurements, made during the first three weeks of May, are typical of those made throughout the open season:—

May	5.	12	lobsters,	total	lengths	163	inches.
"	10.	9	"	"	"	122½	"
"	13.	28	"	"	"	371½	"
"	17.	33	"	"	"	447½	"
"	20.	35	"	"	"	460¾	"
"	22.	57	"	"	"	768	"
		174				2,233¼	"

Consequently the average length of one lobster is 13½ inches nearly, showing clearly enough that greater depth of water and greater difficulty of fishing has rendered it impossible to overfish the outer waters of the Bay of Fundy and St. Mary's Bay to the same extent as Northumberland Straits.

Nor do we get any comfort from the report of the Shell Fish Commission of 1913. Writing of the present condition of the lobster industry the Commissioners say: "The wonderful productiveness of the Canadian shores is such that the lobster industry is still carried on on a vast scale, and the total money value of this fishery is greater than ever, but in the opinion of the best informed persons the resources are being so seriously trenched upon that unless effective measures for restoring the lobster supply are taken without delay the industry must ere long cease to be profitable. The annual returns, though showing a very large increase in the money value, are really misleading, *because while the supply of lobsters is declining* the price has so materially advanced that the total value is greater to-day than at any previous period" —$4,571,014 for the year 1911-12. Enough probably has been said to show that in the lobster fishery we have passed the period of plenty, passed the period of rapid extension, and are now in the period of real decline, with increasing prices. In illustration of this latter point, it is worth noting that in 1859, two cents was the price of a five pound to a twenty-pound lobster, whereas during the past summer (1915) three-pound lobsters were retailed in New Brunswick at $1 each

DECREASE IN BERRIED FEMALES.

It is not merely the decrease in the annual pack that causes most concern to the friends of conservation. It is the decrease in the relative numbers of females which carry eggs. How radically this percentage has changed in recent years may be seen from the following report which has been kindly furnished me by Dr. Hugh M. Smith, the United States Commissioner of Fisheries at Washington, D.C.:—

LOBSTERS taken in Massachusetts.

Year.	Number of lobsters above 10½ inches.	Total Females,	Egg-bearing lobsters.	Percentages.
		Assuming that that half of the total are females.		
1888	1,740,850	.....	.....	
1889	1,359,645	679,842	61,832	9·0
1890	1,612,129	.....	70,909	
1891	1,292,791	.....	49,973	
1892	1,107,764	.....	37,230	
1893	1,149,732	.....	32,741	
1894	1,096,834	.....	34,897	
1895	956,365	.....	34,343	
1896	995,396	497,698	30,470	6·0
1897	896,273	.....	23,719	
1898	720,413	.....	19,931	
1899	644,633	.....	16,470	
1900	646,499	.....	15,638	
1901	578,383	289,196	16,353	5·0
1902	670,245	.....	.....	
1903	665,466	.....	.....	
1904	552,290	.....	13,950	
1905	426,471	213,235	9,865	4·6
1907	1,039,886a	519,943	10,348	2·0
1908	1,035,123a	.....	9,081	
1909	1,326,219a	.....	11,656	
1910	935,365a	.....	7,857	1·6

a Number of lobsters above 9 inches.

Dr. Smith is careful to state, in a communication which accompanied these statistics, that in all probability the number of berried females was greater than given in the report, for the reason that some fishermen were careless in reporting accurately their full catches. For purposes of comparing the proportion of berried females in United States waters with that in Canadian waters, the Biological Board asked the Department of Naval Service to collect similar statistics to those obtained from Dr. Smith, and an official of the department was detailed to do this work, Mr. Halkett, of the Fisheries Branch. He carefully prepared the statistics, which undoubtedly represent the facts, and these facts are not reassuring. The tables setting forth these results give the places visited, the dates, the number of males and females observed, and the number of berried females. As far as Canadian waters are concerned, in 1916 the berried females are seen to stand just about where the Massachusetts waters did in 1906. Unless stringent conservation measures are adopted, therefore, we may look forward ten years and see our lobster industry as depleted as the American one was in 1906.

OUTSTANDING FEATURES.

1. The outstanding feature in Dr. Smith's statement is the steady decline in the number of lobsters caught from 1888 to 1905. In 1907 there is a sudden rise because the legal length was reduced from 10½ inches to 9; but thereafter just as surely as in previous years, the catch again begins to fall.

2. But perhaps the most disturbing feature is the steady reduction in the number of berried females, showing that the supply of lobsters is being cut off at its very source. In last year's report I quoted a statement of Vinal Edwards' to the effect that about 1890 he had found 63·7 per cent of the females off No Man's Land, U.S., carrying eggs. When we read a report, therefore, like Dr. Smith's showing a reduction in percentage to 1·6 per cent we may well be alarmed.

TABLE showing Number of Lobsters Examined, April-August, 1916.*

Date.	Name of Place.	No. males.	No. females.	Berried females.	Remarks by A. P. Knight.
1916.					
April 24th	Tommy's Beach, N.S.	56	58	0	
" 25th	Tommy's Beach, N.S.	26	27	0	
" 28th	Little River, N.S.	23	17	0	
May 2nd	Whale Cove	25	28	0	
" 3rd	White Cove	26	19	1	Eggs of 1915.
" 5th	Tiverton	9	20	0	
" 15th	Lunenburg	36	35	1	Eggs of 1915.
" 17th	Port Mouton	50	39	3	Eggs of 1915.
" 20th	Shag Harbour	46	54	0	
" 22nd	Shag Harbour	88	112	0	
" 23rd	Shag Harbour	39	69	2	Eggs of 1915.
" 24th	Shag Harbour	171	158	0	
" 26th	Cape Sable Island	68	98	0	
" 30th	Lobster Bay, W. Pubnico	82	73	0	
June 2nd	Cape St. Mary's	66	86	0	
" 6th	Mink Cove	34	25	1	Eggs of 1915.
" 10th	Little River	24	28	0	
" 12th	Little River	14	10	0	
" 15th	Ostrea Lake	16	14	0	
" 16th	Jeddore	169	191**	6	Eggs of 1915. First eggs of season observed by Mr. Halkett to be hatching out.
" 20th	Pope's Harbour	6	6	0	
" 24th	Pugwash	366	352	50	
" 28th	Skinner's Reef	56	36	1	Eggs (1915.)
" 29th	Pictou Island	24	39	1	Eggs certainly new.
July 10th	Northport	111	110	10	1 new, 9 old 1915.
" 13th	Shemogue, N.B.	108	96	5	Eggs (1915.)
" 17th	Dupuis Corner	50	27	1	1 old.
" 19th	Cormierville	133	105	0	
" 20th	Chockfish River	139	119	1	New.
Aug. 1st	Cape Traverse, P.E.I.	157	158	1	New.
" 2nd	Cape Traverse, P.E.I.	134	112	2	Last eggs seen hatching 1 old 1 new.
" 4th	Brae Harbour	164	108	1	New eggs.
" 5th	Rocky Point	135	85	1	New eggs.
" 7th	Brae Harbour	207	118	3	New eggs.
" 9th	West Point	325	274	5	New eggs.
" 10th	Brae Harbour	156	106	3	New eggs.
	Totals	3,333	3,013	100	3·2%

* From Mr. Halkett's report to the Department.

** The larger number of these 191 females had all hatched off their eggs according to Mr. Halkett. Their swimmerets showed traces of the adhesive secretion left after the eggs have hatched out. The appearance of the swimmerets showed a gradation from the normal in some females to the partially hatched in others.

Some interesting points in the report above referred to are:—

(1) The percentage of berried females south of Nova Scotia 1·2 per cent, is less than that of Massachusetts in 1910, namely 1·6 per cent. North of Nova Scotia including the Straits of Northumberland, our percentage is only 4·2; but even this is sufficiently high to attract the south shore fishermen to fish in the richer waters of Northumberland Straits year after year.

It will be noted that our average for the whole coast is only 3·2 per cent; but what would a farmer think of a flock of 100 hens only 3·2 per cent of which lay eggs? Or of a herd of 100 cows only 3·2 per cent of which bore calves. It is not likely that there

can be any lengthened future for the Canadian lobster industry when only 3·2 per cent of the mothers extrude eggs each year.

(2) The first hatching eggs were found on June 16, but Mr. Halkett could not say whether there might not have been females that had hatched off all their eggs previously to this date. It would be impossible for any man to be certain that among all the females caught during April, May and the first half of June, there were none which had borne and hatched out their eggs, because as soon as females have cleaned their abdomen after hatching, they resemble commercial lobsters and in fact become commercial lobsters. The change at this season from a berried to a commercial female may take place in a week or ten days.

(3) The catch of 50 berried females at Pugwash, June 24, calls for special notice. Here the percentage of berried females rose to 14, a most unusual thing. How is it that such a large number suddenly made their appearance? On questioning fishermen and canners I found that they generally gave one of two explanations,—(*a*) Either the locality is a favourite spawning ground to which the females resort, or, (*b*) else it is the habit of females for three or four days towards the end of June to come out from their burrows in unusually large numbers to hatch their eggs.

At such times they are trapped in large numbers. The latter explanation seems to be the better one, as it is unlikely that during a whole summer's fishing only one spawning area should have been by chance found, if such special spawning areas exist. All the canners whom I consulted upon the subject were perfectly familiar, it is interesting to observe, with the fact of a large catch of "Eggy school lobsters," as they called them. The catch occurs about the end of June every year. It occurs in like manner off the Massachusetts coast.

That this "eggy school" makes its appearance about the same date each year requires explanation, and the explanation would seem to be that the female lobster knows when her eggs are ripe for hatching, and then leaves her burrow. How does she know that her eggs are ripe? We know that hairs on the human body are organs of touch. Any one can convince himself of this fact, who will simply take a pencil and touch the hairs, not the skin, on the back of the hand. Similarly in many other animals the hairs are sensitive to touch. One can readily understand, therefore, how the softening of the tenacious secretion which fixes the eggs to the hairs on her swimmerets may give the first intimation to the mother lobster that her eggs are ready to hatch. As the majority of mothers lay their eggs about the same time in August, so a majority of mothers will hatch their eggs 10½ months later, and thus we come to see that an "eggy school" of lobsters merely means that an unusual number of berried females leave their burrows to hatch their eggs at the same time of the year and get caught in the fishermen's traps.

4. Another set of facts which will be referred to later is, that after August 1, the proportion of males to females varies in a marked degree. Up to this date the ratio was found to be 100 males to 105 females, but after this date the ratio changed to 100 males to about 70 females. Where had the other 30 per cent of the females disappeared to? Were they moulting and hiding?

5. The fifth circumstance which calls for notice in the statistics given above is that all the eggs found by Mr. Halkett in August were new eggs, or eggs of 1916, whereas most of the eggs observed in May and June were old eggs or those of 1915. It looks therefore as if the open seasons along our coast had been fixed without having regard to the spawning, shelling and hatching habits of the lobster. One is accustomed to think of fishing laws and regulations being framed for the purpose of conserving our fisheries more especially during the breeding season; but it is manifest that the open and close seasons for lobster fishing in Canada have been framed for other purposes altogether. The Shell Fish Commission of 1913 realized clearly enough the desirability of a universal and simultaneous close season applicable to all the waters of the Atlantic shores of Canada, and also the desirability of one universal fishing season, for they mention both such seasons on page 33 of their report.

A Natural Close Season.

The researches carried on under the Biological Board during the summers of 1914, 1915, and 1916 point clearly to the necessity of a close season extending at least from June 1 to September 30, if the lobster areas are not to be depleted and the industry rendered unprofitable within the next few years. As pointed out elsewhere in this report, hatching begins probably early in June and lasts until the middle of August. In many lobsters, hatching is followed by shelling. What percentage of females cast their shells following hatching we do not know; but it is known that for six or eight weeks afterwards they are quite defenceless and unfit for human food. Also it is known that from the end of June until well into September, egg-laying is going on. Should not the laws and regulations, therefore, which are intended to protect the lobster in its hatching, its moulting, and its egg-laying habits cover the period from June 1 to September 30 ? Let the other eight months of the year constitute the open season, and during that open season let there be such strict enforcement of the law that no fisherman shall have seed lobsters in his possession. If this is done, a great advance shall have been made in conserving the lobster industry in Canada.

The objection to trapping during June is easily understood. Everyone who has seen a fisherman hauling his traps in this month must have noticed thousands of eggs dropping off the abdomen of those females which were carrying ripe eggs, sometimes even before they are touched by the fisherman, always, when they are being removed from the traps. The bottoms of fishermen's boats carrying lobsters to the canneries are frequently covered with thousands of ripe eggs. The loss of fry in this way is very great, and the loss would all be saved if the month of June were included in the close season.

PART II.

REARING LOBSTER FRY.

At the end of last season the Biological Board decided to abandon further experiments at Long Beach pond, and to remove such parts of the apparatus as were still serviceable to Bay View, five miles from the town of Pictou, Nova Scotia. This location was chosen because of the higher temperature of the water, and because it was here that the first lobster hatchery in Canada was located in 1891. It was

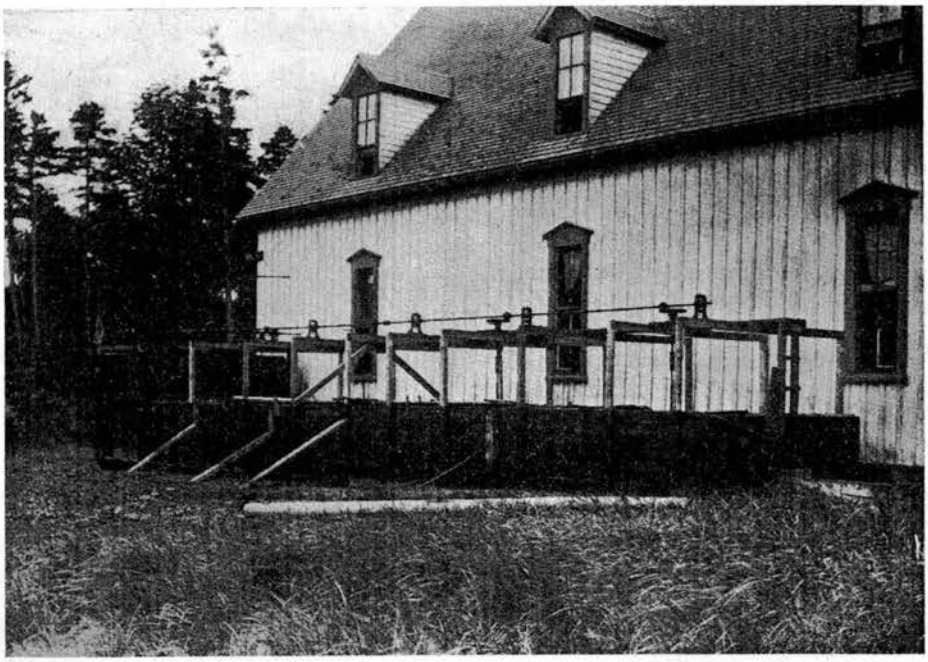


Fig. No. 1.—Bay View Lobster Hatchery from the east. Alongside the main building are the rearing boxes constructed and operated under the Biological Board of Canada. The shafting, paddles, etc., supported by the superstructure, are driven by a small steam engine located within the hatchery.

naturally thought that the two operations of lobster hatching and lobster rearing might be mutually helpful, and so indeed they proved to be. The Department of Naval Service furnished the Board *gratis* with motive power, live steam, and fresh sea-water, and the Board's staff of biologists were at hand to aid the hatchery staff with any advice which they might need in carrying on the work of the hatchery.

It was pretty certain that one cause of the failure to rear fry to the crawling stage in 1914, and again in 1915, was the cold water of St. Mary's bay. The low temperature (average 59° F.) delayed development and allowed ample time for the rapid multiplication of diatoms upon the fry, with the result that they died in large numbers. Under the circumstances Professor Macallum, F.R.S., Secretary-Treasurer of the Board, suggested that warm water should be used in 1916. As a result of the adoption of this suggestion this year, not more than 100 diatoms were observed upon

any one larva ecdysis, and these diatoms never interfered with either their swimming or feeding.

This then was the chief departure in our operations in 1916 from those of the two previous years. The change, however, necessitated others. In the first place, we could no longer have our rearing boxes immersed in the sea-water. If we did, there would be an immense loss of heat from the warmed water of our boxes to the surrounding water of the sea. The boxes, therefore, had to be placed upon land, and close to the hatchery, so as to be convenient to steam power and to the fresh running sea-water.

In the second place, we had to reduce the depth of water in our boxes. The weight of water in boxes 10 feet by 10 feet, by 3 feet 9 inches deep would be so great that no ordinary deal boards would stand the strain. Accordingly the depth of water was reduced to about 2 feet 4 inches. Even with this reduction the pressure caused bulging of the sides and bottom, with the result that in place of each box being water-tight in relation to the other, the joints opened sufficiently to allow our fry to pass from one box to another.

A third change in our apparatus was in the water supply. Whereas in the two previous years, fresh sea-water was drawn in through large openings in the bottom of our boxes and forced out through equally large openings in the sides, this season we were compelled to supply water to our four boxes through iron pipes which conveyed the water from the hatchery tank. It is true that we had a small tank of our own between the big tank and our boxes, but it was for the purpose of warming the cold sea-water up to any desired temperature. The warming was done by passing live steam through a coil of pipes which were placed in the bottom of the small tank. The average temperature maintained was about 68 F. The revolving paddles in each box were continued in use this season, but not for the purpose of supplying a current of fresh sea-water to the fry. The object was rather to keep the fry in motion so as to prevent cannibalism, and to aërate the water by exposing a fresh surface to the oxygen of the air. The only change in paddle movement was a reduction in speed from about nine revolutions per minute to about six. It had seemed to me in our two years' previous experience that nine revolutions produced a current which tumbled the fry about to an unnecessary extent, and without any corresponding advantage. Last year the refuse food, the fry casts, dead fry, algae, and other material entering our boxes, were all passed out through the side windows with the water which left our boxes. This year a different arrangement had to be made. A faucet was placed in the bottom of the boxes about the centre. Each could be opened at pleasure, and the refuse passed out as soon as it appeared to have accumulated beyond a point that might prove poisonous to the fry. The flow of water to the fry under this new plan was a subject about which we had no information.

We started operations by supplying each box with a stream of water which allowed about nineteen pints of sea-water to enter and leave every minute. Towards the end of the season Mr. A. B. Dawson carried out an experiment on this subject and made the following report:—

"At Bay View the question was raised: were the larval lobsters receiving sufficient fresh water or was the high death-rate partially due to a deficiency in the supply? The question was a vital one, but work on it was neglected till late in the season and only one experiment was attempted. One specimen of a fourth-stage larva was placed in a hatching jar containing a pint of water. Due to the large size of the jar, which was seven inches in diameter, the surface of the water exposed to the air was great in comparison with the volume. The jar was kept at the ordinary room temperature of the hatchery, which varied according to the changes in the weather. No attempt was made to replace the water lost by evaporation. Food, consisting of cooked egg, was added every two or three days and the uneaten fragments were allowed to accumulate at the bottom of the jar. Under these conditions the

lobster lived four hours less than three weeks. That is, the animal survived for 300 hours in a pint of water, which was necessarily considerably reduced by evaporation and had become more or less foul by decaying particles of food.

According to careful measurements the four rearing boxes, which at first contained 20,000 first-stage larvæ, received on an average 77 pints of water a minute, or 1,386,000 pints in 300 hours; 70 pints for a single individual. This experiment would indicate therefore that the water supply to our boxes was ample, since death came to the subject of the experiment supplied with one pint, only after a period of 300 hours.

Other and more accurate experiments along these lines suggested themselves, but on account of the lack of the necessary time had to be postponed."—(Sgd.) A. B. DAWSON.

Mr. Dawson's conclusion is corroborated by the observations of all who have worked on lobster's eggs and on newly hatched larvæ. I have frequently seen a dozen or more fry live for a week or longer in less than a half-pint of water, and without the water being changed.

On the 9th of July into two of our boxes, fry were transferred from the fry tanks of the hatchery. Two days later 10,000 more fry were placed in the other two boxes, making 20,000 in all; that is, 5,000 in each box. The second 10,000 were fry from our own stock of mother lobsters, of which we had 61 in a compartment under the hatchery wharf. Whatever the reason may have been, these latter fry appeared stronger and more vigourous than those from the hatchery jars. At any rate, more of them survived to the fourth stage. All received the same quality of food, and all were kept at the same temperature, and the only apparent reason for the differences in vitality was that the aëration of the water in our boxes was better than in the hatchery jars. As soon as our first batch of fry was seeded into our boxes, routine work was established and went on as in previous years. The kind of food (scrambled eggs), quantity fed, and times of feeding, were all the same. The fry passed through their first moult in about seven days, their second in about four days, and their third in about four days; and on July 22 we counted out 800 fourth-stage fry, or about 4 per cent of the 20,000 with which we started operations.

This is rather a poor showing as compared with the 40 per cent output reported at Wickford. It is, however, equal to that at Port Erin, Isle of Man, where the manipulation is largely by hand, and where the output has ranged around an average of 4 per cent for the years 1911-1915.

It happened that Professor Macallum visited our plant the day we distributed our first batch of fourth-stage fry in the sea. In thinking over the heavy mortality which our fry suffered not only at Bay View, but at Long Beach pond in the two previous years, he suggested that perhaps the next advance in lobster rearing lay in the direction of better feeding. He thought that a possible cause of the great mortality lay in the fact that the fry were fed exclusively on cooked food. It is quite true that some of the fry might get some vitamines from the plankton of the sea water, or from eating their fellow fry, but if not, then the absence of the growth-promoting substances to be found only in raw food would in time prove fatal. By the addition of minced crab, or clam, to the food, Dr. Macallum thought better results might be achieved. We shall test this matter next season.

SECOND BATCH.

A second batch of 5,000 fry was placed in box 4 on July 24, and a second batch of 5,000 in box 3 on July 26. On the 28th, it was observed that some first stage fry were in boxes 2 and 1, indicating that on account of the continued weight of water, the partitions between the boxes had given way and allowed some of the fry to escape from

the boxes, 3 and 4 into boxes 1 and 2 in which some 3rd and 4th stage fry of our first batch were confined.

It is well known that cannibalism increases with the age of the fry and accordingly it was no surprise to find the younger fry growing fewer in boxes 3 and 4, because just as they migrated to boxes 1 and 2, they were devoured by the older fry or so-called "Sharks," inhabiting these boxes.

On the 29th, 4 per cent of the first batch were transferred to the sea. The few remaining of the second batch of fry in box 4 had all moulted by the 30th, taking 5 and 7 days to do so. On the 31st about 1,500 fry were placed in box 1. By August 2nd a few of the second batch in box 4 were in the 3rd stage. From this date onward to the 14th when the machinery was stopped, there was nothing to report except steadily diminishing numbers from causes which we could not understand.

No doubt cannibalism played some part in their disappearance; but it is likely that the kind of food, or possibly the absence of the natural kind of food, was a factor in their rapid disappearance. Plankton feeding has been tried at the Port Erin laboratory, Isle of Man, but apparently without much success, because as already stated, only an average of 4 per cent of their fry has hitherto been reared to the crawling stage.

Our second batch ended with 17 fry in the 4th stage and 135 in the 3rd. This out of some 11,000 or 12,000 larvæ.

PART III.

MATING EXPERIMENTS.

As 1916 is the third season during which mating experiments have been carried on, it seems proper to review the results before planning for a continuation of these experiments.

About the 10th of June, 1914, there were placed in a small pound off St. Mary's bay, N.S., 47 females and 15 males all known as "commercial lobsters," because the females when caught in fishermen's traps have no berries upon them. The pound was made of wooden slats about 4 feet long by 3 inches wide and 1 inch thick, placed about one inch apart. The area enclosed was 20 feet by 10 feet; the bottom was muddy; and the animals were fed regularly.

On the 12th of August they were dipped up to see what condition they were in. To our surprise it was found that 36 per cent of the females had extruded eggs. By the end of September the percentage had risen to 64 per cent. On the 7th of April the following spring, thirty females, representing the 64 per cent, were all found alive in the latticed compartment with a full complement of eggs upon them. While Dr. Herrick (quoting from Vinal Edwards' "American Lobster," 1895) reports 12 per cent as the percentage of berried females caught in fishermen's traps along the Massachusetts coast, in Canada careful inquiries among both canners and fishermen of the bay of Fundy area elicited the information that only about 1 per cent of the female lobsters carry eggs. It was clear, therefore, that as a mere matter of accident we had increased the percentage from 1 per cent to 64 per cent. Two questions accordingly presented themselves for investigation: (1) How is it that 99 per cent of our female lobsters in the open sea carry no eggs, and (2) how is it that when males and females are brought together in a small pen, as high a percentage as 64 per cent are found to carry eggs?

Reverting to the thirty females which wintered in our pound, it may be noted in passing that they all hatched their eggs normally during the last week of June and the early part of July, and that nine of the thirty again extruded eggs in July-August, 1915.

As to the mating experiments of the season of 1915, it may be remarked that they were not so successful as were those of 1914. Only 40 per cent extruded eggs and over half of these were unfertilized.

One reason for this was undoubtedly the lack of males. During the early part of the summer we had only one male to serve fifty-one females. Later on, we were fortunate in securing twenty-five more males, but half of them died by accidental poisoning with the "Indian Red" paint on the inside of their pen. Moreover, many of the remaining ones were undersized—9 to 9½ inches in length. But perhaps the main cause of the poor results lay in the fact that the large majority of the females had been retained in the pound over winter and had suffered much in general health. Few of them had moulted and their "shells" were covered with a dark brown algal growth that I have always seen upon lobsters in lengthened confinement in a muddy pound, but never upon lobsters that are taken directly from the open sea.

In 1916 the Board authorized an extension of the experiments to two additional areas on the maritime coast, namely, St. Andrews, N.B., and Pictou, N.S., on the Northumberland straits. The extrusion of eggs at the three localities was 26 out of 105 females at St. Mary's bay; 8 out of 22 females at St. Andrews, and 14 out of 21 at Pictou, or, roughly speaking, 25 per cent, 36 per cent, and 66 per cent respectively.

How do these percentages compare with the percentages on females caught in lobster traps in these same areas? Fortunately we were able to make some approximation to an answer to these questions through some investigations which, under instructions from the Department of Naval Service, Mr. Halkett, an officer of the Fisheries Branch, was detailed to carry out. He spent the summer of 1916 going out with the fishermen at various points along the coast and compiling statistics as to the total males, total females, and percentage of berried females caught in the lobster traps. He carried on the work during the open seasons in the different districts in Nova Scotia and in the straits of Northumberland, and his results may be considered to be fairly typical of the conditions prevailing in the open sea, so far as such conditions can be gauged from the catches in the traps of the fishermen.

From the returns thus secured, and printed elsewhere in this report, it is clear that the percentage of female lobsters carrying eggs, taken in traps, varies from less than 1 per cent in the bay of Fundy area (which may be said to include St. Andrews and St. Mary's bay) to 4·2 per cent in Northumberland straits; whereas mating lobsters in artificial compounds in these same areas shows an increase over these figures of 2,500 per cent at St. Mary's bay, 3,600 per cent at St. Andrews, and 1,600 per cent at Pictou.

THE EXPERIMENTS AT LONG BEACH, N.S.

The Biological Board is indebted to Mr. D. A. Mackay, M.A., for furnishing the details of the breeding experiments at Long Beach. During May and June, Mr. Mackay supervised the reception, detention, feeding, and distribution of 745 berried lobsters that had been purchased from fishermen and confined in the retaining pounds at Long Beach pond until the end of the "open" season, June 16. During July and August he supervised our mating experiments and sent on to me at Pictou from week to week samples of the eggs which were extruded.

The lobsters were confined in five different pens or compartments, four of them being rearing boxes exactly like the rearing boxes of the Wickford plant, only that the sides consisted of lattice work. The fifth pen was latticed also, but it rested upon the bottom of the pond with about 3½ feet depth of water at low tide. The boxes were numbered for convenience in keeping our records. In box 1 were placed twenty females and ten males; in box 2, twenty-four females and twenty-four males; in box 3, twenty-four females and eighteen males; in box 4, twenty-two females and 6 males and in box 5, the one which rested on the bottom, 20 females with no males.

On the 25th of August, when Mr. Mackay ceased making observations, the berried females obtained from each box stood as follows: Box 1, four females; box 2, four females; box 3, six females; box 4, five females, and box 5, seven females, or 26 in all out of 105 (5 having died in confinement) or about 25 per cent. It will be noted that the pen with no males in it gave the largest number of berried females. Only one of the seven females in it carried unfertilized eggs. It is clear that no conclusion can be drawn from these meagre experiments as to the proportion of males and females that should be placed in any pen so as to secure the maximum of berried females. As six out of the seven females in box 5 bore fertilized eggs, it is evident that the sperm cells for the fertilization of the eggs must have been deposited in the receptaculum seminis of the females before they were caught. It may be, of course, that the sperm cells which fertilized the eggs of the 19 in the other boxes were also deposited in the receptacula of the females when they were in the open sea, and that no copulation at all took place in the pens.

EXPERIMENTS AT ST. ANDREW'S.

The mating experiments at St. Andrew's were supervised by Dr. A. G. Huntsman, the Curator of the Biological Laboratory there.

The car in which the lobsters were confined was a floating one similar to those used by fishermen. It was 16 feet long by 10 feet wide, and 3½ feet deep, and subdivided into 8 compartments each 5 feet by 4 feet by 2½ feet, inside measurements.

On June 18, 24 females and eight males were placed in the car—3 females and 1 male in each compartment. They were all commercial lobsters. Dr. Huntsman examined the car on August 8 and found that two of the females had "disappeared." Of the remaining 22, seven had extruded eggs. On the 23rd of August they were again examined when it was found that 1 more had extruded eggs, making 8 out of 22, or nearly 36 per cent.

The females were all large, those which spawned ranging from 14 to 16 inches in length; those which did not spawn measured from 13 to 15 inches. These measurements are in sharp contrast with those at Pictou where the lobsters are all comparatively small, averaging only 7·7 inches, due no doubt to excessive fishing with bull trawls.

As to spawning by compartments, it was found that there was a single female with eggs in each of five compartments on August 8, and in one compartment there were two with eggs; from one of the five compartments, the berried female was removed and an unberried female put in; one of the females in this compartment had extruded eggs by August 23. All the eggs were fertilized.

THE BAY VIEW EXPERIMENTS.

The mating experiments at Bay View were under my supervision. Twenty-five males and twenty-five females were put into a compartment measuring about 10 feet by 18, the depth of water ranging from four to eight feet with the rise and fall of the tide. The bottom was made of boards but it was partly covered with sand and stones. Whether the character of the bottom had anything to do with promoting mating and egg-laying is difficult to say. Further experiments are necessary to decide this point. At Long Beach this season the pen in which the largest number of females extruded eggs had a stony bottom and in 1914 the pen in which our first mating experiments took place had a muddy bottom. It looks, therefore, as if the natural sea bottom, whether stony or muddy, promoted egg-laying as indeed one might expect. The other four compartments at Long Beach as well as the 8 pens at St. Andrew's had board bottoms.

At Bay View, two of the original 25 females "disappeared" from the pen, and 2 died. Fourteen of the remaining 21 extruded eggs, making the percentage of females carrying eggs in this pen 66 per cent. All the eggs but two were fertilized. The percentage of females carrying eggs in the open sea as determined by fishermen's traps during the month of June was 4·2 per cent. During the last 10 days in August the percentage was only 2½ per cent; and during the last four days in September the percentage had risen to 5·6 per cent.

RELATIVE NUMBERS OF THE SEXES.

Any attempt to estimate the value of lobster mating or lobster breeding in pens inevitably brings up the question of the relative numbers of females which naturally carry eggs on the sea bottom. We have unfortunately no direct knowledge of the relative numbers of males and females in the open sea. When lobsters were abundant as in the sixties and seventies, it would have been possible to determine more accurately than now the proportion of males to females, as well as the percentage of berried ones; but to-day with greatly reduced numbers scattered over wide areas the determination is more difficult. We are dependent upon the lobster trap for our inferences, and the lobster trap gives widely varying numbers in different areas as may be seen by reference to the following table of catches:—

Place and Date.	Males.	Females.	Of which were berried.	Ratio of males to females.	Percentage of berried females.
Unnamed place, June 1st to 30th, 200 yards from shore	84	98	3	100 116	3·0
Bay View, June 23rd, 24th and 27th, Inside fishing	1,764	1,052	45	100 60	4·2
Bay View June 23rd, 24th, 27th, Outside fishing	1,112	1,148	48	100 103	4·1
Unnamed place, August 1st to 30th, 200 yards from shore	110	42	3	100 38	7·1
Last 10 days August, Bay View, Inside fishing	1,279	817	14	100 63	1·7
Last 10 days August, Bay View, Outside fishing	460	319	14	100 69	4·4
Bay View, Sept. 27th to 30th inclusive, Inside fishing	181	104	9	100 60	8·0
Bay View, Sept. 27th to 30th inclusive, Outside fishing	350	233	10	100 66	4·3
*(1) Mr. Halkett's catches	3,333	3,013	100	100 93	3·06
(2) Mr. Edwards' catches	1,313	1,344	168	100 103	12·0

*Mr. Vinal Edwards' Woods Hole catches and Mr. Halkett's are included for the sake of comparisor but in these there is no distinction between "outside" and "inside" fishing.

Fishermen at Bay View designate three miles off shore as "outside," and anything inside the three miles as "inside" or "inshore" fishing. Also, anything deeper than five fathoms is always designated outside as a rule; less than five fathoms is inshore, but there is no hard and fast rule as to depth in distinguishing inside from outside.

Are we to accept these figures as representing approximately the true proportion of males to females upon the sea bottom? If we are, then one inference is that there are more males than females, close along the shore as compared with the numbers out at sea. If on the average, males and females are equal in number, then it would be interesting to discover how it is that "inshore" there are only about 60 or 70 females to 100 males. Where are the other 30 per cent or 40 per cent of females? If present on the bottom with males, why did they not enter the traps? Were they hiding in their burrows? Had they cast their shells, and were they soft-shelled and afraid to venture out? These questions all await answers in the future.

Referring again to Mr. Halkett's figures for August 1 to August 10 along the south shore of Prince Edward Island, it will be observed that the males numbered 1,115 to 789 females or a ratio of 100 males to 70 females. The statistics, therefore, for "inside" fishing the end of June, at the end of August, and at the end of September at Bay View, all corroborate those obtained at Prince Edward Island, namely, that within 3 miles or less from shore and in shallow water the males outnumber the females in the ratio of 100 to between 63 or 70; whereas offshore in deeper water the ratio stands about 100 males to 100 females. What these variations in numbers mean it is difficult to say, but one thing is quite clear, the females do not migrate "inshore" to the same extent as the males. This general migration towards shore in the summer and offshore in autumn has of course been long known; but why should not the sexes remain equal?

Perhaps the most interesting result in the September fishing tests was the discovery that of 50 males and 50 females placed in two mating pens the 30th August, 13½ per cent of the females had extruded eggs by 30th September; whereas in the open sea the percentage on August 30 was only 2½ per cent and at the end of September 5·6 per cent, and this too notwithstanding the fact that one of our pens gave way at

one corner and allowed some of our mating animals to escape. The efficacy of mating in this instance is clear enough.

NUMBER OF BERRIED FEMALES.

Undoubtedly the percentage of females carrying eggs varies greatly along both the Canadian and the American shores, and this is a very important matter when we come to estimate the value of mating. If the lobster traps give us a true idea of the lobster population on the bottom of the sea, then the efficacy of mating is beyond all dispute; but if there are in the open sea many more berried lobsters than are revealed by traps, then there may be little or no efficacy at all in mating in pens. Manifestly, therefore, it is of the highest importance to gather as much information as possible regarding the lobster population on the ocean bottom.

BIENNIAL EGG-LAYING.

It cannot be admitted that the theory of biennial egg-laying with moulting in the alternate years can have any reasonable bearing upon our mating experiments. Because, in the first place the theory has never been shown to be founded upon facts. On the contrary, we have had females in confinement both in 1915 and in 1916 which did extrude eggs for two years in succession. Moreover, Mr. T. Anderton, the superintendent of the Marine Fish-hatchery, Portobello, New Zealand, reports annual spawning by 11 out of 15 lobsters in 1911, nineteen out of 21 in 1910, and twenty-three out of 23 in 1909. In addition to contradictory facts like these, the theory is faced with the further difficulty of explaining how it happens that 50 per cent of the females are not carrying eggs if they spawn every second year. Of course, those who believe in annual spawning have the greater difficulty still of explaining how it happens that 100 per cent of the females are not carrying eggs. A believer in biennial spawning who criticizes our mating experiments by saying that the 26 females out of the 105 at Long Beach would have spawned anyway whether in pens or in the open sea, would be bound to explain why there were not 52 of them with eggs in place of 26. Similarly, he would have to explain how it was that only 8 extruded eggs at St. Andrew's in place of 10. At Bay View he would be met with the greater difficulty still of explaining how it came about that 14 spawned out of 21, when according to his own theory only half of the 21 should have done so. The fact is that the theory breaks down completely upon even a superficial examination, and it is high time that it were discarded altogether.

A SIMPLE EXPLANATION.

A comparison of the decreasing numbers of any of our wild land animals with the decreasing numbers of lobsters will show that over-shooting on land produces similar results to over-fishing in the sea. In both, man is the destructive agent. He clears the land and shoots the game. The numbers of the adult animals dwindle, and of course, the numbers of young also. As the animals decrease, the survivors become more and more widely scattered, and mating less frequent whether the animals be deer, partridge, or ducks. So it is with lobsters. The statistics kindly furnished me by United States Fish Commissioner Dr. Hugh M. Smith, shows this beyond all question, and for our Canadian waters, Mr. Halkett's figures do the same. As the lobsters become more widely separated, mating becomes less frequent with the result that there are fewer females carrying fertilizd eggs. Moreover, if the eggs which are extruded are not fertilized, they will "go bad" and drop off sooner or later, thus greatly reducing the percentage of berried females.

On the assumption that the catch of berried females in lobster traps represents approximately the proportion of berried females on the sea bottom, the efficacy of mating in pens as a means of conserving the lobster industry may be fairly claimed to have been demonstrated by our three seasons of experimentation. To say the least, the results thus far amply justify further experiments on a larger scale, and if the results prove as satisfactory as those already achieved mating will far surpass either lobster hatching or lobster rearing as a means of conserving the lobster industry.

PART IV.

LOBSTER SANCTUARIES.

What can we do to stay the decline of our annual lobster harvest? The initiative has been taken by the Government, and it is too late now to talk about leaving the problem to either the lobster fishermen or the canners. The former do not yet realize that their industry is declining, and that it can only be saved from becoming unprofitable by united action on their part; while most of the latter know perfectly well that the industry is waning, but before their profits reach the vanishing point they may be trusted to either close up their factories altogether, or sell them to less experienced operators. The fact that 296 canneries have ceased operation since 1900 tells its own tale.

What is to be done? It is useless to look to the hatcheries as a means of replenishing our depleted waters. Rather are they agencies of destruction than of conservation, if the Bay View hatchery is to be considered a fair type of the work they do. We must therefore look elsewhere for succour—but where? If fishermen would voluntarily agree to return all berried females to the sea, a great deal might be accomplished towards postponing the evil day; but the greedy and the lawless would render this method of conservation of no avail, by not obeying the law, just as they have not obeyed it in the past.

Nor can it be said that lobster rearing plants are likely to be more effective than hatcheries. At the end of three years' experimentation, the best results are 4 per cent out of our first batch of 20,000, and 13 per cent out of our second batch of 11,500. Even if we had succeeded in rearing 40 per cent of our fry, which is the percentage reported from Wickford, Rhode Island, the success of a rearing plant is not by any means demonstrated. For, just as we know nothing about the number of fry that will grow to maturity from the operation of a hatchery, so we are equally ignorant of the numbers which will grow to maturity from the operations of a rearing plant. The best that can be said in favour of lobster rearing is that more of the fry are *likely* to become adults than are the fry of a hatchery. But that is not saying much. How many will actually grow into adults no man knows, and consequently we shall always be in the dark as to whether the rearing plant gives any adequate return for the expense of building and operating it.

The lobster industry is a huge one, the annual catch in Canada being estimated at from 70,000,000 to 90,000,000, according to an authority quoted by the Canadian Shellfish Commission in their report of 1912-13. Assuming Professor Herrick's estimate to be correct, that one adult lobster only grows to maturity from 15,000 eggs, it follows that by either natural or artificial means of conservation no fewer than about 1,200,000,000,000 of eggs would be required each year to make good the annual loss of adults. Where are so many eggs to come from? Certainly not from our fourteen Canadian hatcheries, because they furnish according to Government returns only about 760,000,000, not the one-thousandth part of what would be required to replenish the annual destruction. Let it be remembered too that this estimate of 760,000,000 fry as the output of all our hatcheries is far higher than it should be. Probably 100,000,000 is nearer the mark and if so, they do not furnish the ten-thousandth part of the fry that are required to keep the industry where it is today.

These figures are referred to not because they are considered important and convincing but because they serve to emphasize the huge scale upon which conservation must be planned if conservation is to avail anything. As well attempt to stay a city's

conflagration with a squirt as try to conserve the lobster industry with the petty output of either hatcheries or rearing plants.

The destruction is on a huge scale, restoration must be equally huge. The problem is not impossible of solution? In stemming the tide of destruction we must aim at doing big things and the two biggest things are (1) to increase the production of eggs, and (2) to care for the berried mothers. We may well emphasize the protection of berried lobsters because canners and fishermen alike affirmed this summer that they had never seen spawn-bearing lobsters so scarce. If so, we may look for a small pack of lobsters six years from now.

Coming back to our problem, the question is how can we increase the production of eggs, and how can we protect the berried females on a scale big enough to cope with the annual destruction by canners and fishermen. Certainly not by mating on the petty scale on which our experiments have been carried on during the past three summers. Little enclosures 10 feet by 20 feet with a couple of dozen females impounded in them are well enough for demonstration purposes, but cannot achieve anything as conservation agencies. But prohibited and protected bays of several square miles of area—lobster sanctuaries—in short, well stocked with thousands of full-grown lobsters would in a few years make a great difference in the annual catch. It cannot be too clearly understood that by sanctuaries I do not mean lobster pounds of small areas enclosed by costly walls. I mean large natural bays or harbours if possible with narrow entrances which are to be set apart by Government specially for lobster culture.* Take for example the area from which the Bay View hatchery is supposed to draw its supply of eggs. Elsewhere in this report will be found the data upon which it has been estimated that about 30,000 spawn lobsters should have reached the seven canneries in the Bay View area during last spring. Whether this number actually did reach the canneries is not at present under discussion. The important point is that there were 30,000 berried lobsters whose eggs should have been carefully conserved by both canners and fishermen. If we accept the estimate that every berried female 10 inches long carries at least 10,000 eggs, we see that the 30,000 mothers should have furnished 300,000,000 eggs for the Bay View hatchery. How is it that only 71,000,000 reached the hatchery? Can it be that three quarters of the eggs were either "brushed" into the sea or put into the boiling pots of the factories? It would be interesting to see this mystery cleared up. But aside from that, the big question is what should be done with these 30,000 females. Some of the fishermen realizing the serious condition of the industry have petitioned the Government to close the hatchery, and propose to return all berried lobsters to the sea. Returning the spawn lobsters to the sea just where and as they were caught would not be a wise move, because the same mothers would be caught over and over again, and this would entail serious labour and loss of time upon the fishermen. It would, I think, be wiser for the hatchery launch to gather up all these mothers and place them in Bay View harbour as a sanctuary and protect them from all poachers. The mothers would hatch out 300,000,000 fry, a decided gain over the 15,000,000 fry turned out by the hatchery last summer.

Naturally enough, the fishermen who would surrender the 30,000 mothers would like to be paid commercial prices for them, say 30 cents each, but no Government could afford to pay out $9,000 per annum for spawn lobsters in one small area. A conservation policy must be a general policy, applicable alike to every accessible area of the Canadian coast, and it would cost the enormous sum of about $400,000 annually to purchase all the berried females that are caught along our Canadian coast. If these berried lobsters are to be returned to the sea when and as they are caught the fishermen must be willing to donate the berried lobsters to the Government as their contribution towards conserving the future of their industry. The Government, on its part, should patrol the prohibited bays and protect the lobsters until the eggs have hatched out.

* It is interesting to note that the Canadian Lobster Commissioners favoured spawning lobster reserves (lagoons, coves, etc.) in their report in 1898, p. 33.

That would be conservation on a big scale, but even this would not be big enough to make good the estimated catch of 1,470,000 lobsters in the Bay View area.

Lobster mating is another agency that promises well and that can easily be operated on a vast scale, if found efficacious. I am not, however, prepared to advocate lobster mating on any large scale at present. Experiments have not been carried on long enough or on a sufficiently large scale. Considering the necessarily small way in which they have been carried on during the past three years, the results show an increase of eggs ranging from 1,600 per cent to 3,000 per cent. The efficacy of mating in small pens 10 feet by 20 feet has been clearly demonstrated by the Biological Board. What is needed now is demonstration on a larger scale. Two or three large areas like the southwest end of Long Beach Pond, N.S., should be used next summer. If 1,000 males and 1,000 females were placed in such a sanctuary for July, August and September we should know whether mating is likely to be a success or not when tried on a larger scale. If the Baker pond, Cape Breton, is suitable (it may easily equal Long Beach) then it, too, should be pressed into service as a mating sanctuary for next summer. With the results of mating 4,000 or 5,000 lobsters before us next year, we should be in a position to know more definitely whether we may look with confidence to mating on a large scale as a conservation agency for the future.

But let us proceed slowly. As pointed out in my report of last year, there is great danger of excessive mortality if sanctuaries are too small in proportion to the numbers of lobsters which are confined in them. Confinement and restraint of movement press heavily upon nearly all wild animals. Thus the death rate among lobsters long confined in Long Beach pond was high. The U. S. has had a similar experience. In the Fisheries Service Bulletin, issued at Washington for June, 1916, page 4, under the heading "Lobster Culture in Maine," we are told that of 17,808 berried lobsters placed in Pemaquid pound, Maine (area ⅔ acre), in the summer of 1915, only 12,910 were alive in April of 1916. The editor adds, "this heavy loss, amounting to nearly 29 per cent, and the comparatively poor results in egg collections, can only be accounted for by the severe weather conditions to which the stock was subjected during the early part of the winter." In my judgment, a portion at any rate of this serious loss may fairly be credited, not to the severe winter, but to the close confinement of a large number of animals in an area much too small for their comfort and health. That this conclusion is a fair one is evident from the fact that the annual loss in the Pemaquid pond varies from 15 per cent to 30 per cent. These facts show that our lobster sanctuaries must be carefully selected—neither too small nor too large. They should be sufficiently large to accommodate a large number of mating stock, and should be chosen only after careful examination by an expert biologist. If too small, the stock will suffer, if too large the expense of looking after them and especially of capturing and examining them at the end of the season would be very great.

The duty which lies nearest to our hand now is to bridge the gulf that exists between mating in a pen 10 feet by 20 feet and mating in a bay as large as Bay View harbour—6 miles long by 1 mile wide. If it were proved by experiment during the next two seasons that commercial lobsters enclosed in an area of one or two acres, extruded from 16 to 30 times as many eggs as are found in the open sea, then the Government might safely set apart a number of large bays as lobster sanctuaries, stock them with the largest males and females that can be found, and reasonably expect in a few years to stem the tide of destruction. The cost of one such experiment would range from $1,600 to $1,800. But the cost must be met and the experiment must be tried before it would be safe to conclude that a large bay or sanctuary for mating lobsters would necessarily be successful. The principle of a National Park on land for the conservation of our forests and wild game is clearly the principle upon which we must try to conserve our lobster industry.

PART V.

GENERAL REPORT UPON THE OUTPUT OF BAY VIEW LOBSTER HATCHERY FOR 1916.

I made a detailed examination into the numbers and condition of the eggs and fry in the Bay View Hatchery during the season of 1916, with the co-operation of the Department of Naval Service (Fisheries branch).

From the point of view of the conservation of the lobster industry the output of living fry from the hatchery is far from satisfactory. The superintendent tells me that

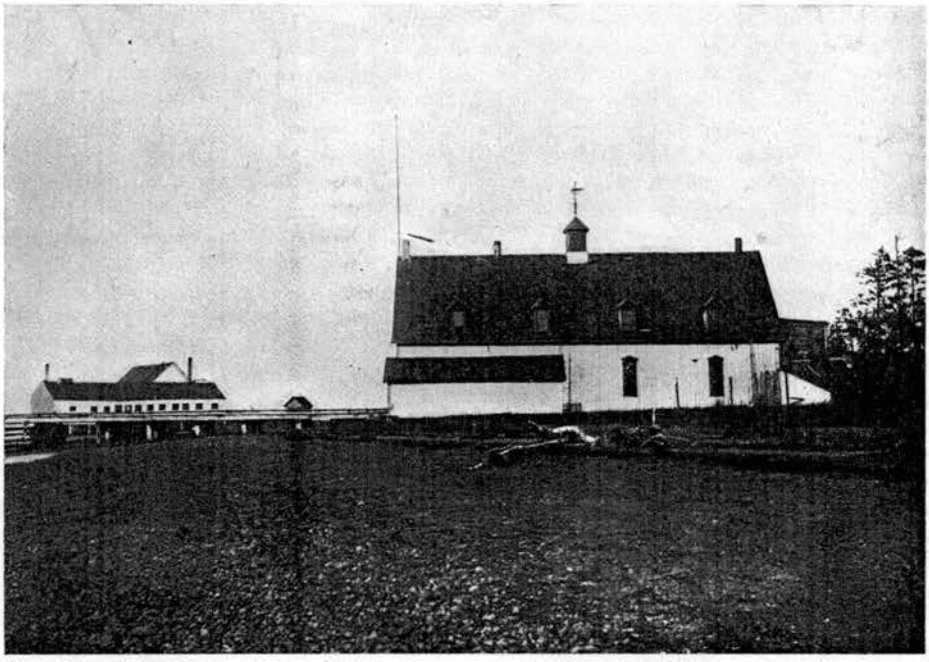


Fig. No. 2.—Bay View Lobster Hatchery from the west. In front of the building is seen the white boat-house. To the left is the wharf and the buildings in the distance are Burnham and Morrill's lobster canning factory.

he took in this season, 288 quarts of spawn; that this spawn was put into 214 hatching jars representing a possible 71,000,000 of fry, if all the fry hatched out.

Basing my estimate upon facts and considerations to be submitted later on, I judge that not more than 15,000,000 fry were returned alive to the sea. A much smaller estimate could easily be defended when all the circumstances are considered in connection with the age of the spawn; its removal from the mother at the canneries; its transportation to the hatchery; its treatment in the hatching jars, and the distribution of the fry in the sea.

PURPOSE OF THE HATCHERY.

The Bay View Hatchery is intended to conserve the eggs of the berried lobsters which are received at seven lobster canneries within a radius of some seven or eight

miles from the hatchery. Each fisherman using as many "traps" as he can manage, (fig. 3) brings his catch to the canning factory each forenoon. The females which carry eggs, (about 4·2 per cent in this area) are sorted out from the rest; the eggs are removed from the body and the lobsters then transferred to the boiling pot and canned. The Fisheries Department pays the canner for the eggs, and the canner pays the fishermen for the mother lobster. A fisherman, therefore, who is within the bounds of a cannery suffers no pecuniary loss, whereas his brother who fishes outside the bounds of a cannery does suffer loss, because he is required by law to return his berried lobsters to the sea without being paid for them.

Each forenoon two employees of the hatchery, in a gasolene launch, transport the eggs from the seven canneries (in shallow trays contained in a box) to the hatchery, some of them a distance of about twenty miles. The eggs are deposited in the launch between 12 and 1 p.m., and are landed at the hatchery between 5 and 6 p.m.

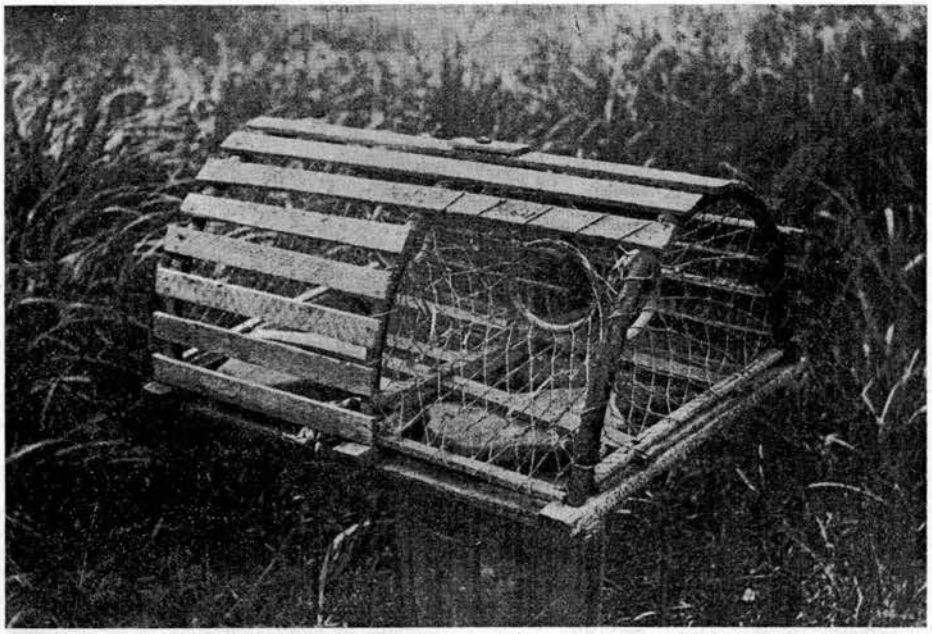


Fig. 3.—Parlour Lobster Trap. Note the two "ring" entrances to the vestibule, one at the end, the other at the side. Another ring opening leads from the vestibule to the "parlor" from which the escape of lobsters is impossible, unless a slat comes off or the netting gives way.

On arrival at the hatchery, they are transferred to hatching jars, similar to those shown in figure 4. The hatchery superintendent is authorized under printed instructions to put "from two to three quarts of eggs" into each jar, and sea-water is kept running into and out of the jars, as long as fry continue to hatch out. Employees are instructed to keep stirring the eggs with a wooden spoon, night and day, so as to prevent them from becoming massed together and suffocating each other—an operation rendered necessary partly by the fact that too many eggs are placed in each jar.

At the end of several days or weeks, depending upon the age of the eggs and the temperature of the water, the fry hatch out and pass from the jars along small sluiceways into large tanks (figure 5) in which they remain usually not longer than twenty-four hours. From the tanks they are siphoned into pails and then transferred to the gasolene launch in barrels. The launch transports them to different areas in Northumberland straits, where they are siphoned into the sea.

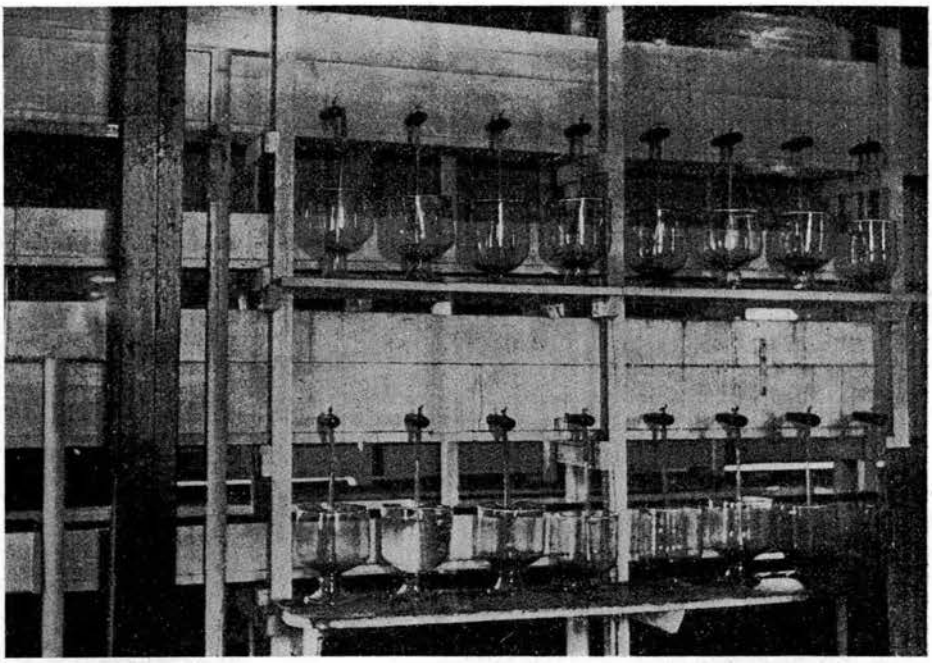


Fig. No. 4.—Bay View Lobster Hatchery. View of sixteen hatching jars. From a tap above a stream of sea-water flows into each jar passing down a central glass tube to the bottom, and then flowing up to find exit by an overflow lip at the side. The effect of this flow of water from the bottom is to prevent the eggs from massing together and suffocating the unhatched fry.

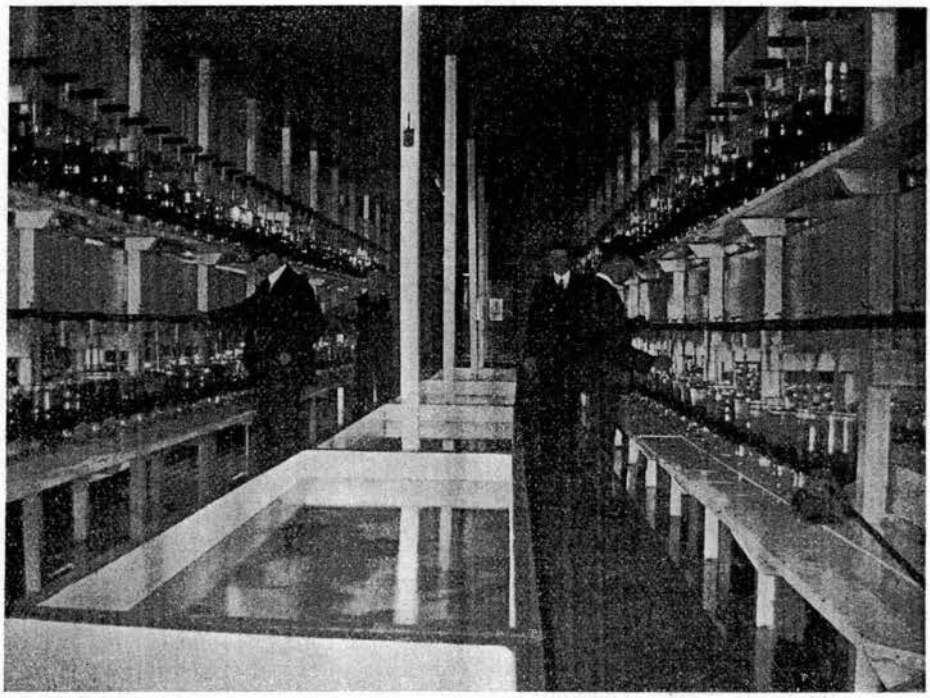


Fig. No. 5.—Bay View Lobster Hatchery. Interior view showing a "battery" of hatching jars (two long tiers) on each side. The retaining tanks for newly hatched lobster fry occupy the middle of the hatchery.

CAUSES OF DEATH.

Here then are some seven or eight operations and conditions that inevitably determine the number of living fry which can be distributed from a hatchery:—

1. Mixing new eggs, that is, eggs of 1916 with old eggs, or those laid in 1915.
2. The care given to the mother lobsters by the fishermen, followed by the care with which the eggs are scraped from the mother.
3. The storage of the eggs in fresh or in stale sea-water from the time they are removed from the mother until the launch comes for them.
4. The care exercised in their transportation in trays and boxes while on the way to the hatchery.
5. The care and attention bestowed upon the eggs, while they are in the hatching jars.
6. The quality of the water which is pumped to the hatchery jars from the sea.
7. The number of eggs placed in each jar in proportion to the volume and flow of water.
8. The length of time the fry remain in the tanks, and the manner in which they are cared for, also their transportation out to sea, and their distribution therein.

Let us consider these various operations in some detail and in the order indicated above.

1. *Loss through mixing eggs.*—That the fishermen would bring to the canneries some lobsters bearing eggs, of 1915-16, and other lobsters bearing eggs of 1916-17, is exactly what any one would expect, who has even an elementary knowledge of the natural history of the lobster. By all odds the majority of females "lay eggs," or more correctly speaking, extrude eggs, between the 15th of July and the 20th of August, in our climate. But while this is true of the majority, it is also true that quite a number extrude eggs during the latter part of June and probably a larger minority still extrude their eggs during the latter part of August, and well into September. In other words, the total egg-laying season extends from about June 15, till probably September 15.* Diagrammatically, it may be represented as follows:—

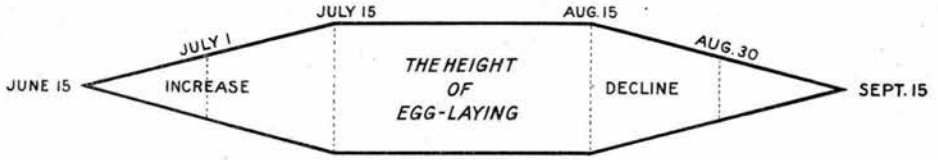


FIG. 6

Now, it is the early eggs of June, possibly of May, that are brought to the hatchery and are mixed with those which will soon hatch out, and which of course were laid the previous year. The spring eggs will not hatch out at all this season and represent a dead loss.

Evidence that old eggs (1915) were mixed with new eggs (1916) at the Bay View Hatchery was first noted by Professor MacClement about the middle of June, and the fact was pointed out to the men on the hatchery launch. Furthermore, Mr. A. B. Dawson examined on three different days (June 23, 24, and 27), 5,076 lobsters brought to Burnham and Morrill's canning factory by twenty-three fishermen. Of the total females, 2,107, only 93 carried eggs, or 4·2 per cent, and among these 93, there were 15 which bore newly extruded eggs. These eggs went into Bay View Hatchery and helped to swell the volume of unhatched and dead eggs.

The evidence of the hatchery jars themselves corroborated the evidence of the two observers referred to. On my arrival at the hatchery on July 7, the superintendent

* See Appendix, in which evidence is submitted to show that more lobsters extrude eggs in September than in either July or August.

brought me samples of the last eggs delivered at the hatchery, viz., those of June 28 or 30. Eggs of this date were selected for examination, because I am informed that the general experience at the hatcheries is that the latest eggs to be received are those from which fewest fry hatch out.

Examination of these eggs under the microscope showed that between 10 per cent and 15 per cent of them were eggs extruded this spring (1916) and were really eggs of this season, whereas the eggs collected earlier this season were those which had been extruded in 1915. Here then lay the first cause for the failure of the hatcheries to turn out a full percentage of living fry. Of course no one who recognizes the difference between the ages of the eggs would expect the two kinds to hatch at the same time, any more than he would expect eggs under a hen for two weeks to hatch at the same time as eggs under her for two days.

If the hatching is to be successful then the two kinds of eggs must be kept separate. In fact lobsters carrying newly extruded eggs should not be taken to the canneries at all, and of course, the eggs should not be removed. Placing them in the hatching jars along with the eggs of 1915-16 merely helps to kill the good eggs of 1915-16, and increases the destruction of the eggs which normally will not hatch out until 1917.

LOSS BY CARELESS HANDLING.

2. In the removal of the eggs from the mother lobster, three points should be emphasized. First, the mother lobster should either be towed to the cannery in a specially constructed car through which fresh sea water passes so that her eggs are always in sea water, or she should be kept under sea-weed and shaded from the sun's rays.

Eggs are delicate structures. A warm wind will dry and kill them, while rough handling will injure the baby lobster inside. Hence, the second point is that the eggs should be gently and carefully handled, when being scraped from the abdomen of the mother.

Thirdly, there must be absolute cleanliness of the scraper (spoon), the hands of the operator, the vessel into which the eggs are scraped, and the seawater contained in the vessel, otherwise the spores of fungi will get among the eggs and cause loss after they reach the hatching jars.

Lastly, plenty of fresh seawater should be supplied to the eggs every half hour, until they are transferred to the hatchery launch.

LOSS THROUGH DIRT.

3. The trays and boxes in which the eggs are kept on their way to the hatchery cannot be kept too clean. After transferring the spawn to the hatching jars, the trays and boxes should be thoroughly scrubbed with clean soap and water, and rinsed in boiling hot water so as to remove all traces of eggs, that may have been dirty or may have died. Drying the trays afterwards in the sun is a good way of insuring cleanliness.

On the journey to the hatchery, fresh seawater should be gently poured over the trays every half hour, and the boxes should be shaded from the direct rays of the sun. It would be a simple matter by means of a pump driven from the launch engine, to have a gentle stream of fresh sea water play over the eggs in the trays during the whole journey.

LOSS IN THE HATCHERY JARS.

4. The care of the eggs while in the hatchery jars must be unremitting, both night and day, if success is to be achieved. In the first place, little more than a pint of eggs should be put into a jar. If more than a quart is used, the mere weight of the eggs

at the top of the mass tends to smother the ones lower down. Besides, too many eggs act as a filter and make the sediment which is pumped in through the water pipes accumulate at the bottom of the jars. Any day during the latter part of the hatchery season, one could see a quarter of an inch or more of red mud, sand and organic matter lying below the eggs. So discoloured and murky was the water at times that it was impossible to see the bottom of our rearing boxes, only two feet deep, or to see the adult lobsters in our compartments, only three to four feet deep under the wharf.

While better results could probably be attained by purer water, it must not be inferred that this was the chief cause of the high death rate among the eggs. It was not. A much more important cause as already pointed out was the excessive number of eggs placed in the hatching jars. This very excess retained minute animals and plants below and throughout the close mass of eggs. Ultimately these organisms played havoc with the spawn. Towards the middle of July, dozens and dozens of minute "animalcules" could be seen with the naked eye at the bottom of all the hatching jars, and at the end of the season the sense of smell proved that each jar contained a putrefying mass of dead eggs.

The variety and number of these organisms are surprising and may be judged from the following list of diatoms and other forms found in tow netting from one tap of Bay View Hatchery for 12 hours. The determination of genera and species was made by Miss Fritz, under the supervision of Professor Willey, of McGill University.

Name.	No.	%
Pleurosigma affine	78	26
" *angulatum*	30	10
" *balticum*	2	2/3
" *fasciola*	5	1 2/3
Skeletonema costatum	87	29
Nitzschia sigma	12	4
" *sigmoidia*	2	2/3
" *longissima*	6	2
" *closterium*	2	2/3
Coscinodiscus radiatus	6	2
Actinoptychus undulatus	2	2/3
Rhizosolenia hebetata	3	1
Rhabdonema arcuatum	2	2/3
Chaetoceras decipiens	1	1/3
Melosira (?)	30	10
Licmophora	1	1/3
Navicula (?)	10	3 1/3
" (?)	6	2
Peridinium	11	3 2/3
Ceratium	2	2/3
Cyttarocylis	2	2/3
	300	

LOSSES IN THE TANKS.

6. Attention must also be given to the fry after they have left the jars and are being collected in the retaining tanks. Whenever a sufficient number has collected they should be distributed. There are serious objections to allowing fry to remain even a few days in the tanks. There is death through cannibalism, death through lack of food and death through muddy water. In our rearing boxes, which are at least three times the size of the hatchery tanks, the death-rate during the first week is very high, even although we feed them every two hours. The death-rate in the hatchery tanks must be equally high, hence the necessity for distributing the fry two or three times a day, whether many or few are hatching out.

LOSSES IN DISTRIBUTION.

7. Lastly as regards distribution, it is doubtful whether there is not considerable loss of life during the transportation of the fry from the hatchery to where they are planted,

especially if the journey is far. The barrels used at Bay View for this purpose are the ordinary 31½ gallon ones. As many as 5,000,000 fry are reported as being carried in one of these barrels at one time,—a number which would certainly cause suffocation and death among the fry, especially if the stale water was not removed and fresh seawater supplied during the journey. It would be a very simple matter to work a small pump from the engine and thus furnish a continuous stream of fresh water to the barrel. The same pump could be used for supplying fresh seawater to the eggs on their way to the hatchery.

LOSS IN CLOSING HATCHERY.

To understand how a loss may occur in closing, one must remember that the egg-hatching season extends, at Bay View, from about June 15 to August 15. The earliest hatching at Jeddore, N.S., was found to be June 16, and we had females hatching in our compartments at Pictou as late as August 17. There are, no doubt, females which hatch their eggs outside of these dates, but they are few in number. We may therefore represent the egg-hatching season by a diagram similar to the egg-laying one, figure 6, but occurring a month or six weeks earlier.

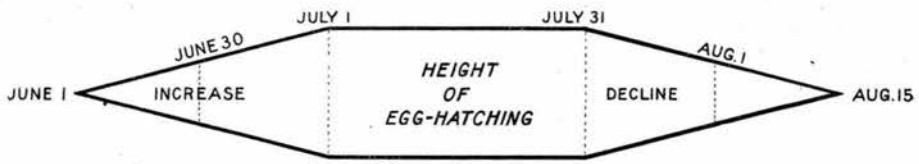


FIG. 7

The beginning of hatching, the rate of increase, its maximum, its decline will depend upon the egg-laying period of the previous year, and to a considerable extent upon the temperature of the water. In a cold spring, when the ice remains long in the straits, the egg-hatching will begin later and end later. To make the matter clearer, let us try to follow the history of eggs that are spawned late in any season, say September 30. They are carried by the mother over the winter for 10½ months, or if the water remains cold, for 11 months. A cow, a ewe, or a mare carries a single egg which develops into a calf or a lamb or a colt, inside of the animal's body for a fixed number of weeks or days. Somewhat similarly a mother lobster carries her thousands of eggs on the outside of her body, and hatches them out in due time also. If they are extruded late in any season, they are due to hatch out late the next season, August 1, or it may be August 15. Consequently if the hatcheries are ordered closed at the same date every year, it will happen that in a late season many unhatched eggs will have to be destroyed. At Bay View this year the order to close did not affect the output of fry at all, for the simple reason that the last 42 jars of eggs had all rotted in the hatchery jars and were all emptied out on July 17, whereas the order to close did not come into effect until July 20.

CLASSIFICATION OF EGGS.

The length of the egg-hatching season, about June 1 to August 15, may have a direct bearing upon the loss of eggs, though I had no opportunity of testing the matter. For, during this period of eight or ten weeks, there are eggs of different ages hatching out on different days throughout the period, simply because they were laid at different dates 10½ or 11 months before. In the hatchery the early hatching fry leave behind in the jar, the egg-capsule, and along with it the epidermis of their first

moult. I do not forget that a portion of this matter passes away in the running water. Enough of it remains in the jars to assist in causing trouble. Decomposition of both membranes takes place with resulting chemical compounds, which must be poisonous for eggs which hatch later in the same jar. The bad effects are aggravated by additional organic matter, which enters with the water.

To prevent the ill effects of mixing eggs of different ages they should be classified on the basis of age, as was recommended, it is interesting to observe, in a bulletin issued by the department twenty-five years ago (1892). Into one set of jars should be placed all eggs that would hatch early, into another sea of jars should be placed all eggs that would hatch later, and so on, until there were at least three sets of jars, each set with eggs of about the same age. In this way all eggs of the same age would hatch about the same time and consequently there would be few late hatching eggs in jars that were poisoned by the decomposing membranes of the early hatching ones. As well might a farmer sow a field with wheat, some of it May 1, some of it June 1, and some July 1, and expect it all to ripen at the same time, as to expect all eggs taken at random from different females to hatch out about the same time.

ESTIMATE OF DEAD EGGS.

As already stated, an estimate of 15,000,000 of living fry would be an outside one for the output of the hatchery this season. A more conservative estimate based upon actual count of living fry in the hatching jars, as compared with the dead ones, and based also upon an inspection of the number of fry swimming in the tanks on different days, might easily reduce the output to 10,000,000 or 12,000,000.

It might be of interest to give some of the details of the microscope examinations made by Mr. Dawson and myself, the second week of July, on eggs received at the hatchery at different dates.

In contrast with the deplorable condition of the eggs of June 28 and 30, already referred to, those of May 21 and 22 were fairly satisfactory. Sample jars of these collections were also furnished me by the Superintendent. About a dozen different egg-masses from different lobsters were removed from a jar and separated into individual eggs, or into small masses, by tearing them apart with dissecting needles. They were then stirred about thoroughly in a wash basin, so as to give a fairly uniform collection from different mother lobsters. The eggs were then divided into four equal portions—all four as alike as possible. One of these four portions was selected as typical of the whole collection, and every egg in this quarter portion was counted. Then every dead egg in this same portion was counted, and the percentage of dead eggs determined.

The following counts were typical of others:—

Sample 1.	17	eggs		0	bad	ones.
" 2.	77	eggs,	of which	7	were	bad.
" 3.	50	"	"	3	"	"
" 4.	100	"	"	8	"	"
" 5.	125	"	"	9	"	"
" 6.	143	"	"	14	"	"
" 7.	196	"	"	15	"	"
" 8.	135	"	"	10	"	"
Total....	843	"	"	66	"	"

The percentage of bad eggs here, about 8 per cent, would represent not recently extruded eggs, because there would be few, and, perhaps, none of these on May 21. Rather would it represent mature eggs which had died through carelessness in the canneries, or in transportation, or in the hatchery.

Mr. Dawson's examinations, made subsequently to my earlier ones, show a progressive increase in the number of dead eggs. For example:—

Sample	1.	397	eggs,	of	which	61	contained	dead fry.
"	2.	111	"	"		41	"	" "
"	3.	66	"	"		17	"	" "
"	4.	150	"	"		120	"	" "
"	5.	260	"	"		60	"	" "
"	6.	70	"	"		115	"	" "

An average of about 30 per cent of dead eggs.

On July 12 another examination of the hatchery eggs was made. On this occasion the superintendent was left free to select eggs from any of the 145 jars remaining in the hatchery. Counted samples of the eggs which he brought me showed that 30 per

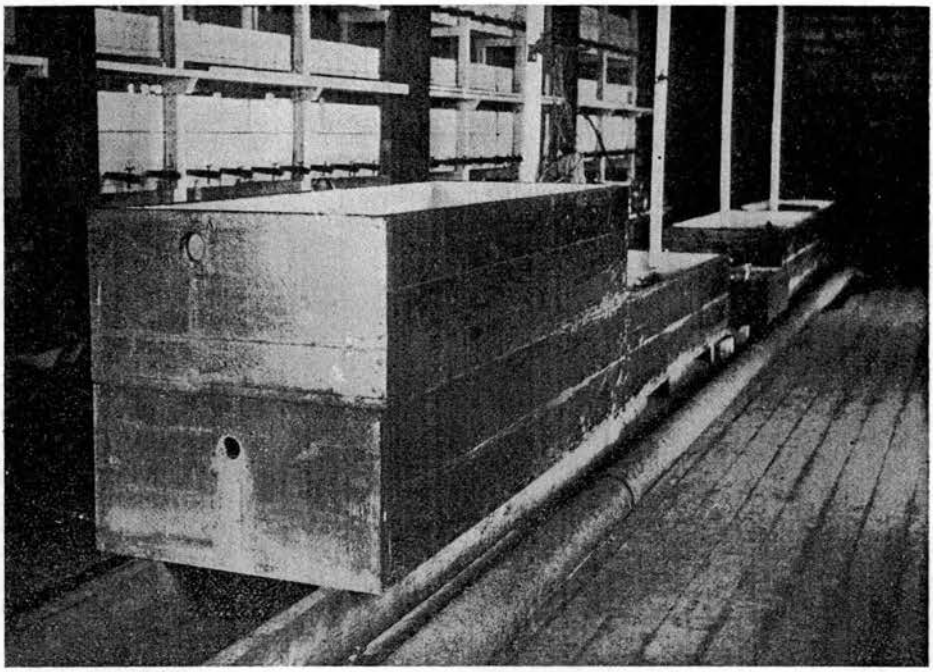


Fig. No. 8.—Four of the tanks into which newly hatched fry pass. All were disconnected from the water-supply at the end of the season. On the left one tank is seen placed upon another. While the fry are swimming in these tanks a close estimate can be easily made of the numbers which hatch out from day to day.

cent of the eggs were dead, whilst another sample of eggs, which I chose at random for myself, showed a loss of 23 per cent in dead eggs.

Four days later the hatchery was again visited. As it was getting near the end of the hatching season there were only forty-two jars in operation. A careful examination of samples from a number of these jars, in fact, a selection of the best egg-clusters that could be found, showed that at the most only 20 per cent of the eggs contained living fry. Unfortunately, it was not possible to save this remnant. They were so completely tied up, the living with the dead, that there was no possibility of saving any of them. Only two jars showed living fry swimming in the water above the eggs.

Fungus growths were visible on the surface of the eggs and showed more abundantly under the microscope. Immense numbers of "animalcules"—(Protozoa,

cyclops and sand-fleas) were attached to or were moving about freely among the living and the dead eggs. Young barnacles and mussels were found attached to the inside of the jars and glass tubes, of such a size that no one would credit their dimensions if he had not actually seen the animals.

If the whole 42 jars of July 16 could have been examined under a microscope—hand-picked, as it were—so as to separate the living from the dead, possibly a million fry might have been saved, but as matters stood at that date, no power on earth could have saved this remnant out of the possible 7,000,000 fry represented in the eggs of these 42 jars.

ESTIMATE OF LIVING FRY.

To estimate the number of living eggs in a jar is a difficult matter, and requires considerable training in the use of the microscope. To estimate the fry swimming in a hatchery tank is much simpler, and can be learnt by any intelligent person who has had a season's instruction and practical experience in a hatchery.

One method of estimating the number of fry in the tanks is based upon our experience in counting living fry at Long Beach pond, in 1914 and 1915. In our operations there it was necessary to actually count with the assistance of an automatic counter every one of the fry which we put into our large rearing boxes (10 feet by 10 feet by 4 feet deep) filled with water to within three inches of the top. In counting 5,000, 6,000, 8,000, 10,000 into such boxes, the eye soon came to form a standard of comparison, by which a very close estimate of the number of fry in a box could be made without counting. Moreover, at Long Beach, we had the experience of watching daily the diminishing number of fry in our boxes, and at the end of the rearing period —17 days—we again counted with the aid of the automatic counter our remaining living fry.

With such experience as this to guide us, a mere glance at the hatchery tanks from day to day convinced us beyond any reasonable doubt that there were not more than from 10 to 12 millions of fry hatched out at Bay View this season.

PUBLIC REPORT.

But a superintendent must not depend upon an inspection of his tanks for his estimate when he has to make a public report upon the number of fry which he plants in the sea. He must base it upon an actual count. By stirring the water so as to distribute the fry uniformly throughout the tank, and placing a cheese-cloth partition across the middle, then a second partition across the middle of one half, and if the fry are very abundant, a third partition across the quarter, the actual number of fry, in one-quarter, or one-eighth of the tank, can be counted and the number thus obtained can be used as a basis for estimating the number of fry in the whole tank.

Furthermore, the estimate made in this way may be checked by measuring the dead eggs remaining in the hatchery jars when all hatching has ceased, and then converting the measured volume into numbers, in exactly the same way as quarts of incoming spawn are converted into numbers of eggs, only, of course, the units will differ.

An effective check upon the accuracy of the estimates that may be based upon the two foregoing methods is furnished by the daily use of the microscope. As already pointed out, when I first visited the hatchery, the number of dead eggs varied in different samples between 8 per cent and 15 per cent. As time went on, however, the percentage gradually increased until within a few more days it reached 30 per cent. Then as the poison (bacteria, fungus, and "animalcules") spread still more widely among the eggs, the percentage of dead eggs increased, until on July 16 there remained alive less than 20 per cent and these contained in only 42 jars. These three methods carefully and consistently applied will give a very close estimate of the output of living fry from any hatchery.

TWO BATCHES OF EGGS.

There is yet a fourth way in which the output of Bay View hatchery may be gauged. A fisherman, whom we shall call Mr. "A," sold a lot of 61 berried females to the Biological Board for experimental purposes. About the same time he sold another lot of berried females to the Logan and Murdock cannery. Let me narrate very briefly the fate of the eggs of these two lots of lobsters. The spawn on the females that went to the canning factory was scraped off in the usual way, was transferred to the launch and conveyed to the jars in the hatchery. The spawn on the females which Mr. "A" sold to the Biological Board (approximately 600,000 eggs) was not removed at all, the mothers being simply confined in a wooden pen under the hatchery wharf.

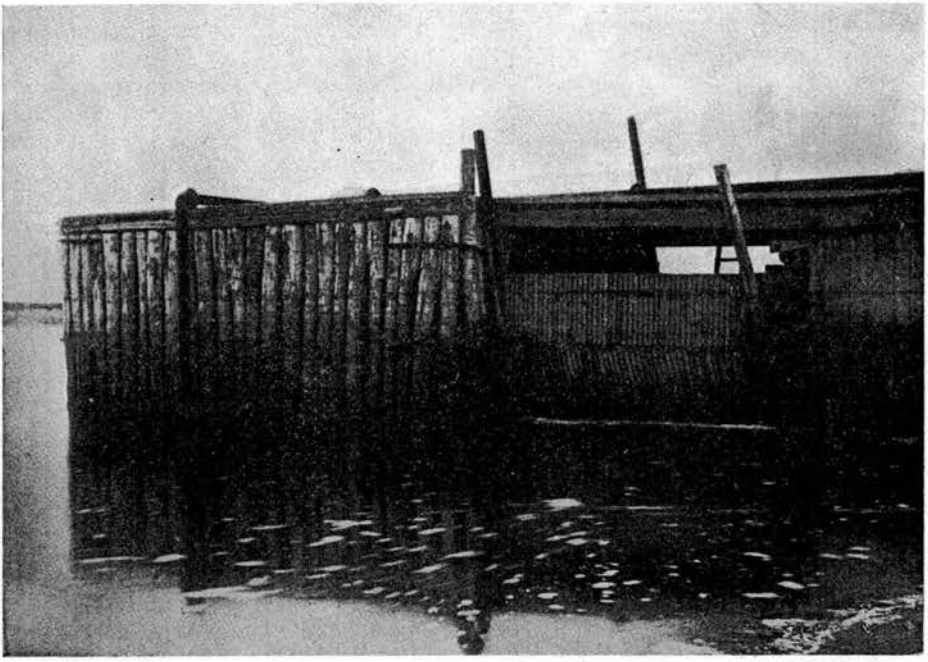


Fig. No. 9.—Side View of the end of the Hatchery Wharf showing the latticed pens for mating and berried lobsters and admitting a tidal flow of water. Near the end of the wharf may be seen the intake pipe which supplies sea-water to the hatchery jars and rearing boxes.

Here then were two sets of spawn, both sets obtained from lobsters that were caught by the same fisherman, and on the same fishing grounds. So far as known, the fisherman took equally good care of both sets of lobsters while they were in his possession. The outer end of the intake pipe which supplies water to the hatchery eggs was not more than twenty-five feet away from where the Board's berried lobsters lay under the wharf. [See fig. 9.] The water, therefore, supplied to both sets of eggs was exactly alike in quality. The quantity was abundant for both and the temperature alike for both. The hot weather, that is, the temperature of the air, had nothing whatever to do with the different fate of the two sets. How was it then that on the 17th of July every egg in the hatchery set was dead and hatching operations closed, while in the other set the 240,000 eggs remaining, on 40 per cent of the females under the wharf, were all alive and healthy? These mother lobsters continued to hatch out fry and distribute them in the sea for more than a month after the hatchery set were dead. And this brings up the question of the value of a hatchery as a conservation agency compared

with the simple method of requiring fishermen to put all berried lobsters back into the sea.

TWO POLICIES.

Conservation by requiring fishermen to return all berried females to the sea dates back to 1873. Conservation through the agency of hatcheries dates only from 1891, when the first building for this purpose was erected at Bay View. No attempt has yet been made so far as I know to estimate the relative efficacy of the two methods. I may be permitted therefore, to break ground on the subject, it being understood, of course, that my comparison is based solely upon facts which came to my knowledge during this summer.

To make the comparison clear, it will be necessary to calculate the number of berried females that are delivered at the seven canneries. The data for this come partly from the returns to the Government and partly from the canners themselves. According to Government returns the catch of lobsters canned in each of the seven establishments from which Bay View draws its supply of eggs is as follows:—

McLeod and Stewart	634	cases.
Fred Magee, West End, Pictou Island	1,497	"
" East End, "	844	"
Burnham and Morrill	437	"
Logan and Murdock	740	"
Geo. W. Atkins	559	"
W. Smith & Co	313	"
Total	5,024	cases weighing

48 pounds each, or a total of 241,152 pounds of meat.

Now, in two canneries it is known that the average weight of green lobsters required to make 1 pound of meat varies from 3·9 to 4·1; it follows, therefore, that it would require 940,493 pounds of newly caught or green lobsters to make the 241,152 pounds of meat.

The next step in the calculation is to ascertain the average weight of a single green lobster. This was done by Mr. A. B. Dawson. He examined 2,269 fresh male and female lobsters on the 24th June, and found that they weighed 1,446 pounds, so that the average weight per lobster was ·64 pounds. Mr. Halkett found (see appendix) that 860 lobsters weighed 600 pounds or 0·7 pound each lobster.

The third step in the calculation was to find the total number of lobsters that reached all the factories, and this of course was found by dividing the total weight of green lobsters 940,493 by 0·64 giving 1,470,000 lobsters; or using 0·7 as the weight of a single lobster 1,343,000.

Now assuming—an assumption backed up by all the statistics that have been collected in Canada—that half of the 1,470,000 lobsters are females and that only 4·2 per cent of these females carried eggs, we reach the conclusion that between 28,000 and 30,000 berried females reached the canneries of the Bay View area in 1916. (That is females 735,000, of which take 4·2 per cent, approximately 30,000.)

Outside of the bounds of a hatchery, the law is that these 30,000 females must be returned to the sea. Inside of the bounds of a hatchery, the law requires the canner, and the canner requires the fisherman, to scrape the eggs off and pass them over to the hatchery officials. The question then which the scientist has to answer is: which of these two methods of conserving the lobster industry is the better one? To my mind the comparison stands thus:—

(a) *Conservation in a Hatchery.*

1. The eggs are scraped off and sent to a hatchery and the 30,000 mothers are boiled and canned, so that we have 30,000 dead mothers.

2. These 30,000 dead mothers will lay no more eggs of course.

3. Of the 71,000,000 eggs sent to the hatchery, about 85 per cent died, so that we must face a further loss of 60,000,000 dead fry or eggs.

4. It costs $2,500 annually to run the hatchery, so that here is a further serious pecuniary loss.

(b) *Conservation by Returning Berried Lobsters to the Sea.*

1. We have a straight gain of 30,000 living mothers.

2. These 30,000 living mothers will, many of them, produce more eggs in future years.

3. The 30,000 whether confined in pens as the Board confined theirs, or liberated in the open sea, would in accordance with our observations, both at Long Beach and at Bay View, hatch out almost every egg, so that we must credit this method of conservation with 71,000,000 living fry.

4. The 30,000 living mothers and the 71,000,000 living fry do not cost the country one cent.

Perhaps it should be again stated that this comparison is limited to the Bay View hatchery for the summer of 1916. No criticism is here made of other hatcheries. It is quite possible too that others achieve better results if the staffs are more intelligent and better qualified men.

FURTHER OBJECTIONS TO HATCHERIES.

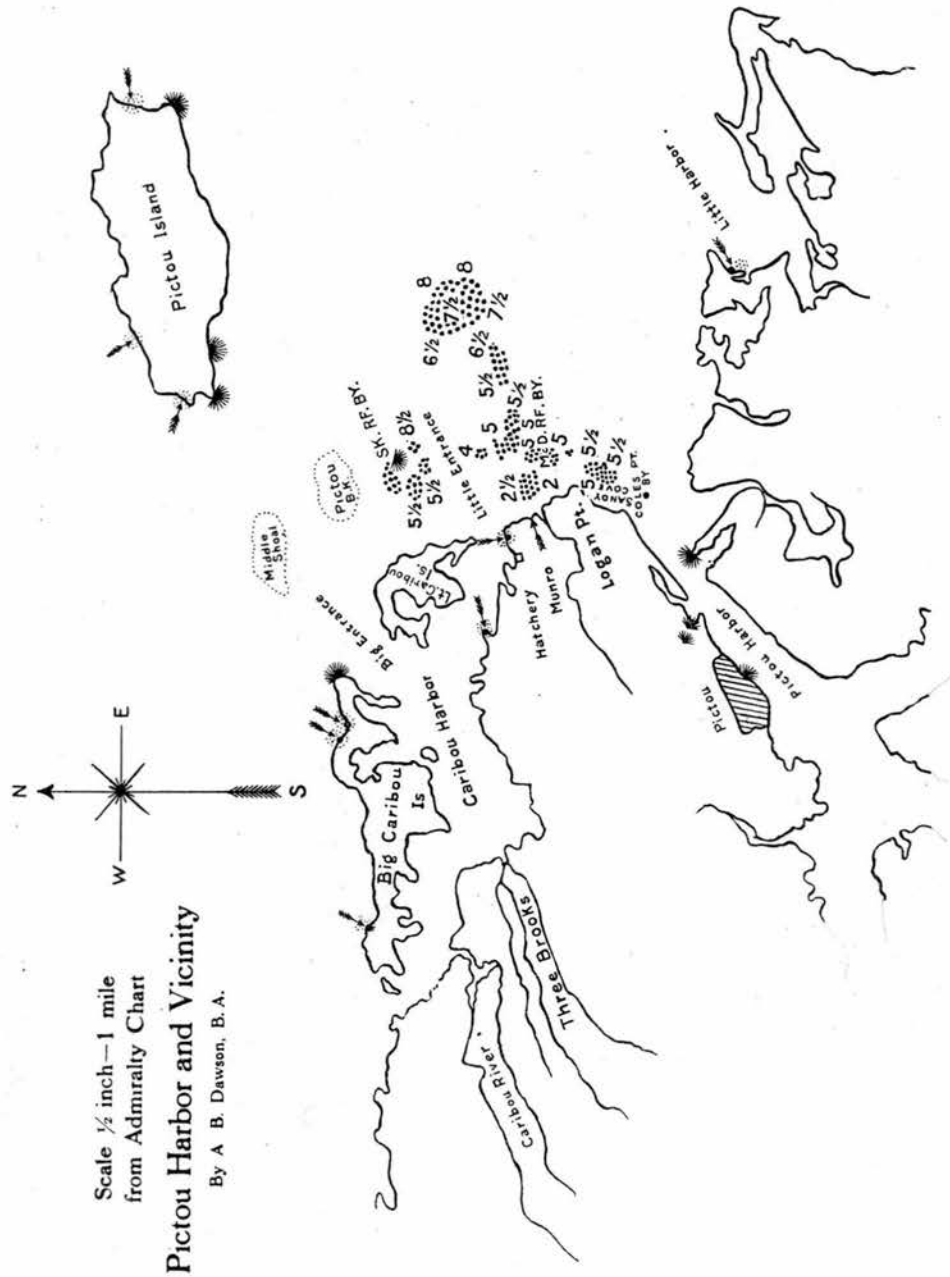
A very old criticism and one directed against the hatchery service almost from their inception was that many of the fry when deposited in the sea were soon devoured by fish. As already explained the fry are taken out in a launch some distance from shore and siphoned into the sea. As the internal diameter of the hose (used as a siphon) is about an inch, the fry are forced into the sea in such numbers that they give a cloudy appearance to the water. That this appearance attracts the attention of fish (like cunner) is undoubted, because they have been seen devouring the fry. No doubt some of the fry escape, but the loss must nevertheless be considerable. This objection to the hatchery method of conservation is specially serious inasmuch as it comes at the very end of a lengthy and expensive process. It need scarcely be stated that no hatchery staff can be held responsible for this loss. It is simply one that must be reckoned with in weighing the value of this method of conservation.

In this connection we must also take into serious consideration the conclusion reached by Professor Herrick as to the number of fry that grow into adults in the sea. His reasoned conclusion is that only one fry out of 15,000 or possibly 5,000 ever reaches maturity. If we apply this conclusion to my estimate of the output of Bay View hatchery this year, say 15,000,000, we can expect only $\frac{15,000,000}{15,000}$, or 1,000 adult lobsters from this season's operations. As the expense of running the hatchery is about $2,500 per annum, not including either interest on capital or any allowance for depreciation in building or equipment, it follows that each mature lobster, grown from hatchery fry, costs the country $\frac{\$2,500}{1,000}$, or $2.50.

Professor Herrick's estimate may be right or wrong; no man knows; but we do know that the number of adult lobsters that grow from hatchery fry is an utterly unknown quantity. Although this is undoubtedly true, still no one would be foolish enough to say that the hatcheries are valueless. They do contribute an indefinite something towards the conservation of the industry, but the question is "How much do they contribute, and do they contribute enough to make it worth while for the

country to run them?" How long would any business man continue to run a factory whose output he did not know and could not check?

No doubt the hatcheries could be made to do more effective work if the employees are given some elementary scientific training; but I do not see how the output in fry can ever equal the simple plan of returning the berried lobsters to the sea and allowing them to hatch their eggs in a natural way.



APPENDIX.

RECORDS OF LOBSTER FISHING DURING THE LAST TEN DAYS OF AUGUST, 1916, FOLLOWED BY A SIMILAR RECORD FOR FISHING DURING THE LAST FOUR DAYS OF SEPTEMBER, 1916.

Carried on by A. P. Knight under a permit issued by the Hon. J. D. Hazen, Minister of Naval Affairs, for the purpose of determining the lobster population on the bottom of the south shore of Northumberland straits, near Pictou, N.S.

Map from an Admiralty chart modified by A. B. Dawson, B.A.

The records for August were made by Andrew Halkett, Esq., and A. B. Dawson, B.A. The records for September, by Andrew Halkett, Esq.

All the lobsters in the August fishing were returned to the sea, excepting 50 males and 50 females, which were retained in our pens for mating purposes during September. At the end of September all of these which remained in the pens were liberated excepting 5 berried females; and all of those caught in the September fishing were returned to the sea, excepting 18 berried females. The 23 berried females are confined in the pens under the wharf to see whether they will live and carry their eggs through the winter.

Date. — Bull Trawl.	Location.	Fathoms.	Total No. males	Total No. females	Berried.	Remarks on Ecology, etc.
8 traps, Aug. 21.....	3 miles off Munroe's shore.....	8	31	14	0	1 Caprella.
6 traps, Aug. 21.....	2 miles off Munroe's shore.....	7	14	10	1	1 crab in trap. The berried female had a new shell.
8 traps, Aug. 21.....	¾ mile NE. of McDonald's reef buoy.....	6½	19	10	0	4 crabs in traps.
6 traps, Aug. 21.....	Off MacKay's house boat ¾ mile.	3	21	7	0	4 crabs.
8 traps, Aug. 22.....	3 miles off Munroe's, on rock bottom.....	8½	33	27	1	Few crabs. Berried female had an old shell.
*7 traps, Aug. 22.....	2 miles off Munroe's, on rock bottom.....	5½	32	20	0	Brown Algæ, Bryozoa, Cunner.
6 traps, Aug. 22.....	Off Graham's reef ½ mile.....	2½	13	6	0	1 Gammarus.
8 traps, Aug 22.....	Off Graham's reef 1½ miles. Rock bottom.....	6½	25	14	0	
9 traps, Aug. 22.....	McDonald's reef ¼ mile NE. Rock bottom.....	5	21	8	1	Isopods. Few crabs. Female recently hatched.
10 traps, Aug. 22.....	Sandy cove ½ mile off. Rock bottom.....	5	60	29	0	Crabs. 1 male with dense algæ growth on carapace.
10 traps, Aug 23.....	Sandy cove ½ mile off, on mud..	5	64	24	1	Berried female with old shell. Few crabs.
9 traps, Aug. 23.....	McDonald's reef buoy ½ mile NE., rock bottom.....	5	24	13	1	Limpet.
8 traps, Aug. 23.....	Off Graham's reef on sand.....	4½	33	13	0	Caprella.
7 traps, Aug. 23.....	Logan's house over Factory Pt. Rock bottom.....	5½	38	20	2	
6 traps, Aug. 23.....	Off Graham's reef ½ mile. Rock bottom.....	2½	18	12	0	

*The sea water temperature off Munroe's on this occasion was 64° F.

Date. — Bull Trawl.	Location.	Fathoms.	Total No. males	Total No. females	Berried.	Remarks on Ecology, etc.
10 traps, Aug. 24.....	Sandy Cove 1 mile of hard, mud	5½	72	64	0	1 Mysis, 1 Caprella.
6 traps, Aug. 24.....	½ mile E. of McDonald's reef, soft mud.....	5½	35	23	0	
8 traps, Aug. 24.....	Outside, rock bottom.....	7	39	22	0	
8 traps, Aug. 24.....	Outside, rock bottom.....	7	27	10	2	Caprella. Neither female had moulted recently, shown by shell.
7 traps, Aug. 24.....	Logan's house over Factory Pt., rock.....	6½	35	24	0	
8 traps, Aug. 24.....	½ mile NE. of McDonald's reef, rock.....	5	15	9	1	1 Asterias. The berried female had a new shell.
10 traps, Aug. 24.....	Skinner's reef.....	5½	59	30	0	Laminaria, Fucus, Dulse on traps.
10 traps, Aug. 25.....	Skinner's reef.....	5½	63	61	0	9 crabs in 1 trap.
7 traps, Aug. 25.....	"Outside", rock bottom.....	7½	27	17	1	Female had old shell.
8 traps, Aug. 25.....	Outside, rock bottom.....	7½	32	19	0	
8 traps, Aug. 25.....	Outside, rock bottom.....	7½	28	28	1	Berried female had an old shell.
7 trawls, Aug. 25.....	Logan's house, over Factory Pt., rock.....	6½	33	23	0	
10 traps, Aug. 25.....	1 mile off Sandy Cove, hard mud	5½	72	43	1	Female with old shell.
9 traps, Aug. 26.....	½ mile outside Skinner's reef, rock	8½	11	6	0	Sculpin.
†10 traps, Aug. 26....	½ mile S. Skinner's reef, rock....	5½	54	39	1	Cunner. Berried female with new shell.
7 traps, Aug. 26.....	"Outside", rock bottom.....	8	22	13	0	
††8 traps, Aug. 26....	Outside, rock.....	8	28	17	1	Berried female with old shell. Crepidula on rostrum.
8 traps, Aug. 26.....	Outside, rock.....	8	13	14	0	1 Nassa.
7 traps, Aug. 26.....	Inside, Logan's house over Factory Pt., rock.....	6½	19	20	2	1 scallop, 1 berried had new shell.
11 traps, Aug. 26.....	1 mile NE. off Sandy Cove, hard mud.....	5½	64	46	0	
10 traps, Aug. 28.....	1 mile off Sandy Cove.....	5½	77	44	1	Female (berried) had a new shell.
11 traps, Aug. 28.....	Skinner's reef, S. ½ mile.....	5½	54	24	0	Sponge.
7 traps, Aug. 28.....	Outside.....	7½	17	8	2	Both berried females had old shells.
8 traps, Aug. 28.....	Outside.....	8	11	11	0	1 sculpin.
9 traps, Aug. 29.....	Skinner's reef.....	5½	4	2	1	Berried female had old shell.
9 traps, Aug. 29.....	Skinner's reef.....	5½	48	29	0	Rock eel. Sea urchin
11 traps, Aug. 29.....	Skinner's reef.....	6	55	36	0	1 sculpin.
7 traps, Aug. 29.....	Outside.....	7½	10	11	0	30 cunners.
8 traps, Aug. 29.....	Outside.....	8	11	10	0	
8 traps, Aug. 29.....	Outside.....	7½	19	9	1	Berried female with old shell.
8 traps, Aug. 29.....	Logan's house, over Factory Pt.	6½	11	6	0	
7 traps, Aug. 30.....	Logan's house, over Factory Pt.	6½	23	13	0	
8 traps, Aug. 30.....	Outside.....	7½	4	6	1	Berried female with old shell.
7 traps, Aug. 30.....	Outside.....	8	14	7	0	42 cunners.
7 traps, Aug. 30.....	Outside.....	7½	22	11	1	Berried female with old shell. Growing in around were barnacles, mussel and hydrozoa.
9 traps, Aug. 30.....	Skinner's reef.....	6	17	7	0	

†The sea water temperature was 64° F.
††The sea water temperature was 64° F.

Date. — Bull Trawl.	Location.	Fathoms.	Total No. males	Total No. females	Berried.	Remarks on Ecology, etc.
9 traps, Aug. 30.....	Skinner's reef.....	5½	39	32	0	
11 traps, Aug. 30.....	Skinner's reef near buoy.....	6½	37	36	1	Berried female had old shell.
6 traps, Aug. 31.....	Outside.....	7½	13	7	0	
7 traps, Aug. 31.....	Outside.....	7½	24	9	0	20 cunners.
7 traps, Aug. 31.....	Outside.....	7½	16	17	1	Berried female had old shell.
8 traps, Aug. 31.....	Outside.....	8	19	18	2	Both berried females had old shells.
			1,739	1,136	28	According to Mr. Dawson's observations.
			1,738	1,130	28	According to Mr. Halkett's observations.

RESULTS of re-setting of lobster traps at Bay View, N.S., during the last four days in September. (Tables compiled by Mr. A. Halkett).

27TH—AFTERNOON.

	Traps.	Males.	Females.	Remarks.
Bull trawl 1.—About 1½ miles off Caribou Island. 4½ fathoms when sounded....	1	4	4	
	2	3	2	
	3	4	1	
	4	6	4	
	5	3	2	
	6	3	3	
	7	1	3	One a seed lobster.
	8	4	3	
		—28	—22	
Bull trawl 2.—About 1 mile off Caribou Island. 3½ fathoms when sounded.	9	3	2	One a seed lobster.
	10	4	1	
	11	5	2	
	12	0	0	Broken lathe. A crab (included below) and a cunner.
	13	2	0	
	14	4	1	Trap with 2½ in. dia. entrances. A crab (included below) and some 9 cunners.
	15	3	3	
	16	4	2	
	17	4	1	
	18	3	1	A crab (included below) and a flatfish.
		—32	—13	
		60	35	There were in all in the traps some 43 crabs (*Cancer*) including the few mentioned above.
		=	95	

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RESULTS of re-setting of lobster traps at Bay View, N.S., during the last four days in September. (Tables compiled by Mr. A. Halkett)—*Con.*

28TH.—MORNING.

	Traps.	Males.	Females.	Remarks.
Bull trawl 1.—4½ fathoms when sounded.	1	4	4	
	2	4	2	One a seed lobster.
	3	0	0	Door of trap open.
	4	3	1	
	5	2	1	
	6	3	3	One a seed lobster
	7	0	0	Door of trap open.
	8	4	1	
		—20	—12	
Bull trawl 2.—4 fathoms when sounded.	9	1	4	
	10	1	3	
	11	3	2	One of the males with barnacles on had not moulted.
	12	0	0	Broken lathe.
	13	5	2	
	14	1	1	Trap with 2½ in. dia. entrances. Some 8 cunners.
	15	5	1	
	16	4	3	One a seed lobster
	17	3	1	
	18	5	1	A seed lobster.
		—28	—18	
Bull trawl 3.—5 fathoms when sounded.	19	3	2	
	20	3	4	
	21	7	5	
	22	4	4	
	23	3	2	
	24	5	2	
	25	1	2	
		—26	—21	
		74	51	There were in all the traps some 42 crabs (*Cancer*).
		= 125		

28th.—AFTERNOON.

Bull trawl 1—About 1 mile NW. off Skinner's Reef Light Buoy. (The traps had been shifted.) 5 fathoms when sounded.	1	7	4	One a seed lobster.
	2	3	0	
	3	1	2	
	4	4	3	
	5	4	1	
	6	5	0	
	7	3	3	
	8	4	2	
		—31	—15	
Bull trawl 2.—3½ fathoms when sounded.	9	8	3	
	10	4	1	
	11	3	2	
	12	2	5	One a seed lobster.
	13	6	3	
	14	3	0	Trap with 2½ in. dia. entrance.
	15	3	5	
	16	4	2	
	17	2	1	
	18	6	0	
		—41	—22	
Bull trawl 3.—4 fathoms when sounded.	19	6	2	One a seed lobster.
	20	7	4	
	21	4	3	
	21	4	3	
	22	5	3	One a seed lobster.
	23	5	1	
	24	3	2	
	25	2	2	
		—32	—17	
		104	54	There were in all in the traps some 25 crabs (*Cancer*).
		= 158		

RESULTS of re-setting of lobster traps at Bay View, N.S., during the last four days in September. (Tables compiled by Mr. A. Halkett)—*Con.*

29TH.—MORNING.

	Traps.	Males.	Females.	Remarks.
Bull trawl 1.—5 fathoms when sounded.	1	3	3	
	2	2	1	Dogfish, female.
	3	2	1	
	4	2	3	
	5	2	1	
	6	2	1	A seed lobster.
	7	x	x	Trap lost.
	8	3	2	One a seed lobster.
		—16	—12	
Bull trawl 2.—5 fathoms when sounded.	9	3	0	
	10	6	2	
	11	3	6	
	12	8	3	
	13	2	4	Trap with 2½ in. dia. entrances Two crabs.
	14	9	1	
	15	9	1	
	16	4	2	
	17	4	3	
	18	4	0	One of those males had not moulted very long. Eel pout.
		—52	—22	
Bull trawl 3.—5 fathoms when sounded.	19	6	7	
	20	6	6	
	21	5	2	
	22	4	7	
	23	0	2	One a seed lobster.
	24	6	3	
	25	3	3	
		—30	—30	
		98	64	There were in the traps in all some 30 crabs (*Cancer*) including the 2 mentioned above.
		=162		

29TH.—AFTERNOON.

Bull trawl 1	1	4	1	
	2	4	2	
	3	5	3	
	4	2	1	
	5	4	1	
	6	2	4	
	7	x	x	Indicating the trap which was lost.
	8	0	0	Door of trap open.
		—21	—12	
Bull trawl 2	9	4	1	A seed lobster.
	10	5	6	One a seed lobster.
	11	9	1	
	12	5	1	
	13	2	0	Trap with 2½ in. dia. entrances. Four cunners.
	14	6	1	
	15	5	2	
	16	4	1	
	17	1	2	
	18	2	2	
		—43	—17	
Bull trawl 3	19	4	2	
	20	4	6	
	21	4	2	
	22	5	3	
	23	4	1	
	24	5	5	One a seed lobster.
	25	3	3	One a seed lobster.
		—29	—22	
	‡	1		
		94	51	There were in all in the traps some 18 crabs (*Cancer*).
		=145		

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RESULTS of re-setting of lobster traps at Bay View, N.S., during the last four days in September. (Tables compiled by Mr. A. Halkett)—*Con.*

30TH.—MORNING.

	Traps.	Males.	Females.	Remarks.
Buli trawl 1	1	6	2	
	2	x	x	Indicating the trap which was lost.
	3	2	3	
	4	7	2	
	5	4	2	
	6	4	3	
	7	0	1	Door of trap open.
	8	2	3	
		—25	—16	
Bull trawl 2.—6 fathoms when sounded.	9	1	2	
	10	7	2	
	11	1	7	One a seed lobster.
	12	3	2	
	13	3	3	Trap with 2½ in. dia. entrances.
	14	8	5	
	15	7	1	
	16	6	3	
	17	2	3	
	18	3	1	
		—41	—29	
Bull trawl 3	19	6	5	
	20	5	5	One a seed lobster.
	21	6	3	One of the males had not moulted long.
	22	4	6	
Traps lifted and taken in.	23	1	1	Door of trap open.
	24	4	6	
	25	3	2	
		—29	—28	
		95	73	There were in the traps in all some 21 crabs (*Lancer*).
		= 168		

30th.—RELIFTED AND TAKEN IN BY NOON.

Bull trawl 1	1	0	0	
	2	x	x	
	3	1	1	
	4	1	1	
	5	0	0	
	6	0	1	
	7	0	0	
	8	4	3	
		— 4	— 3	
Bull trawl 2	9	0	1	
	10	1	1	
	11	1	0	
	12	0	2	
	13	0	1	2 cunners. 2½ in. dia. entrance traps.
	14	0	0	Door of trap open.
	15	0	1	
	16	1	0	
	17	x	x	Another trap lost.
	18	0	0	Door of trap open.
		— 3	— 6	Crabs, if any, included in above.
		7	9	
		= 16		

RECAPITULATION.

	Males.	Females.	[Seed.]	Total.
Sept. 27th. Afternoon	60	35	[2]	95
" 28th. Mornirg	74	51	[4]	125
" 28th. Afternoon	104	54	[4]	158
" 29th. Morning	98	64	[3]	162
" 29th. Afternoon	94	51	[4]	145
" 30th. Morning	95	73	[2]	168
" 30th. Re-lifted by noon	7	9	.....	16
	532	337	[19]	869

1916—	Pounds.	Lobsters.
September 27, afternoon	68	93
" 28, forenoon	32	45
	100	138
September 28, forenoon	57	76
" 28, afternoon	43	56
	100	132
September 28, afternoon	73	98
" 29, forenoon	27	39
	100	137
September 29, forenoon	80	120
" 29, afternoon	20	30
	100	150
September 29, afternoon	79	110
" 30, forenoon	21	25
	100	135
September 30, forenoon	100	158*

Average number of lobsters per 100 pounds in above 600 pounds—141⅔, thus:—

100	pounds.	138	lobsters.
100	"	132	"
100	"	137	"
100	"	150	"
100	"	135	"
100	"	158	"
600	"	850	"

Average weight ·7 pounds for each lobster.

*Includng one seed lobster to make the full weght.

ERRATUM SLIP.—Official Report on Lobster Investigations, 1917, by A. P. Knight, M.A., M.D., F.R.S.C., etc.

Page 5, line 8 from bottom, in place of 10 read 100.
Page 7, second paragraph, insert "in" between the words "while" and "each".
Page 8, Table VII, Insert a line between the 5th and 6th horizontal rows of figures. The last row represents totals.
Page 10, Table VIII, make headings clear as follows :

6″ females.		7″ females.		8″ females.		9″ females.		10″ females.		11″ females.		12″ females.		13″ females.		14″ females.	
Total females.	of which carry eggs.	Total females.	of which carry eggs.	Total females.	of which carry eggs.	Total females.	of which carry eggs.	Total females.	of which carry eggs.	Total females.	of which carry eggs.	Total females.	of which carry eggs.	Total females.	of which carry eggs.	Total females.	of which carry eggs.
717	2	1355	10	1088	45	584	57	246	22	120	12	61	9	19	2	3	1
·27% of 6″ females carry eggs.		·81% of 7″ females carry eggs.		4·1% of 8″ females carry eggs.		9·7% of 9″ females carry eggs.		8·9% of 10″ females carry eggs.		10% of 11″ females carry eggs.		14·7% of 12″ females carry eggs.		10% of 13″ females carry eggs.		33% of 14″ females carry eggs.	

The lobsters come from 30 different districts along the Atlantic coast.