F I S H E R I E S R E S E A R C H B O A R D

O F C A N A D A

MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No. 375

Title

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The Great Need for the Improvement of Soft Bottoms.

For the collection of spat or for the subsequent growth of oysters, clean, firm bottoms are necessary. The bottoms must be firm enough to prevent the sinking of shells or oysters with consequent complete loss, and should be firm enough to prevent even that partial sinking which leads to the production of an elongated shape in the oysters or to the loss of small spat by smothering.

Especially in Canadian waters where we are at the northern limit of the oysters' range, suitable temperatures are to be found only in sheltered waters. Here, where quiet water allows fine silt and organic material to settle, soft muddy bottoms are much more prevalent than in more exposed situations where fine material is kept in suspension and can settle only in limited areas where eddies or deep holes provide shelter. As a result a high proportion of the bottoms in the Canadian Atlantic areas where oysters are found are too soft to support shells, or oysters. The hard bottoms are limited to a narrow shore zone where wave wash allows only sand and coarser, firmer mud to remain, to oyster beds or accumulations of the shells of dead

oysters and mussels which have developed chiefly along the shore zone and best in situations where there is some current and consequently where the bottoms would be kept free of the softest mud, and to very limited areas of rock ledge. Much of the shore zone is exposed to heavy ice in winter and as a general rule one can wade at low tide to bottoms in which one sinks a few inches. The greater part of the bottom of the sheltered bays and "rivers" in our waters, where conditions are favourable to the growth of oysters, is of very soft mud. It is a usual condition to be able to shove a two- or three-inch stake as much as five feet into the bottom by hand without the aid of a maul of any kind. It is estimated that in Bideford river, Malpeque bay, over 80% of the area sufficiently deep to be out of reach of the ice is of bottom of this kind.

The surface layers of these soft bottoms are usually very soft indeed - so soft that it is difficult to feel with a stake or oar when the surface is touched. It can readily be realized that oysters or cultch with spat soon sink into such bottoms and are lost. The mud consists of fine silt with a strong admixture of organic material leading to a black colour and a strong smell of decay. There is usually a thin surface layer where the colour is, in the case of Bideford river, red - the colour of the surrounding soil.

There is reason to believe that these bottoms, except for their softness, are suitable for the production of oysters. In spat collecting experiments spat was obtained on shells in

the deepest part of the river. The shells were in wire bags which were kept from sinking entirely by spruce boughs. These parts of the bags which were buried and became stained black showed, of course, no spat; but spat appeared and grew well until late autumn immediately above the line of the staining. This has been noted regularly wherever cultch has become partly buried. It has further been noted that when clusters of small oysters from the shore were planted in Percival river in 1928 on soft bottoms the oysters above a definite mud mark on the clusters had survived and grown well to the autumn of 1929.

Methods of improvement. These soft bottoms can be improved by the addition of a variety of materials but with many the improvement is slight and temporary. With materials such as shells or coarse gravel, crushed stone, etc., spaces are left between the materials added through which the very soft surface mud can ooze up. The addition of shells has been tried in many instances where the bottom was somewhat soft, although in no case where the bottom was as soft as those described above. In all these cases the mud in the course of time worked up through the shells which were eventually partially or completely covered, except in instances where there was a firm bottom under a soft surface (such as an old oyster bed) and enough shells were added to rest on this firm substratum and keep the surface shells above the mud. This involves the waste of a large quantity of shells which are of value for use in spat collecting and of which there is by no means an unlimited supply.

It was evident in these trials that where the mud was really soft it was necessary to add some material which would

form a continuous layer over the surface with no breaks through which the soupy surface mud could ooze up, allowing the firm material to sink. In seeking for such a material it was noticed that in many places on shores in the zone of transition from sand to mud a tough bottom which has been called "muddy sand" is to be found. It consists of a mixture of sand and fine mud and becomes so tough that when one steps on a place where such material overlies soft mud the surface layer of "muddy sand" must crack at some distance from ones foot to allow sinking. It was thought that this tough mixture might be produced over the surface of soft muddy bottoms by the addition of a layer of sand.

Experiments with adding a layer of sand to soft muddy bottoms.

1. Trial area covered in 1930. In the summer of 1930 an area 25' square was selected where the mud was as soft as could be found. The area was at the junction of Sheagh's and Grant's creek at the head of Bideford river, being at Station 2001 of the Biological Board, and in Division 206, Section F, Subsection 1 on the chart of oyster leases in Malpeque bay. The accurate ranges determining the area are as follows:

Centre of area. Birch tree on Paugh's shore and door of W.Ray Paugh's garage.
Paugh's point at high tide and peak of Wm.Grant's house.
North edge. In line with fence on Russel Ellis' land.
S.W.corner. In line with fence on Paugh's shore.

The depth of water over the area is about six feet at an extreme low tide. The mud was very soft, having a light, thin surface layer difficult to feel with a pole, and it was possible without very great effort to push a pole into the bottom five feet by hand alone.

To this area about 250 bushels of sand were added at the end of July 1930. This was spread as evenly as possible and would make a layer approximately 6" thick. The sand was obtained from a near-by point and the work of four men for one day was used, the sand being shovelled from the sand-bar to a scow and from the scow to the water. The sand was damp or wet and it was found that little of it floated away, practically all sinking directly.

The sand at first felt loose on the bottom suggesting that shells or oysters planted on it would become sanded over. In the course of time it became firmer and by the late autumn was no longer loose. It was at first easy to push a pole through the sand but it became more and more difficult. This process continued throughout 1931 when the area was examined a few times. It was thought advisable to leave it for some time before attempting to use the area for spat-collecting or for planting oysters as the fate of the sand would be obscured and it was feared that the mud would still work through. In 1932 the area when examined in July was still in good condition and had not deteriorated. It was only with some difficulty that a pole could be pushed through the layer of sand into the soft mud below, although when the latter was reached the pole could easily be pushed down four or five feet. The surface felt sandy but was not loose. It was considered that it was quite sufficiently hard to support shells or oysters, and that similar bottoms would be judged to be good firm bottoms if found occurring naturally. It is, of course, realised that examination of such bottoms under water is difficult and reliance can be placed only on the feel of the bottom

to prodding and on the appearance of samples of the material brought up with tongs or some other sampling method.

On August 2nd, 1932, 175 bushels of shells were placed on the area with a view to the collection of spat. This quantity would make a layer averaging about 4" in thickness. After the addition of this layer the bottom felt definitely hard and would compare favourably in its resistance to a pole with many oyster beds. The shells have at the date of writing received a "set" of spat. It is intended to leave the shells and spat on the area to test the ability of the area to support the shells and to make the young oysters survive. It is relaized that the layer of shells is somewhat thick and if the "set" is found to extend to the lower shells some will be removed. It was by mistake that as many shells were spread as it is important to know whether good results can be obtained with fewer shells and, consequently, less expense.

2. Use of sand in improving old oyster beds.

In a number of instances in the course of cleaning and improving old shell beds by the Department of Fisheries in Bideford river, sand has been used. In a number of instances it was found that when the mussels were removed a thin layer of thin mud was left which it was very difficult to remove as it would readily slip through the teeth of tongs or the bag of dredges and the process of stirring it up to be carried away by the currents was slow. In these instances sand was added with effects similar to those described above. The mud was rendered firm - approaching as well as could be judged the consistency of the muddy sand on the shores. In

other instances sand was used to harden the surface of mud accumulated in the cuts left by digging shell mud. It was found to be effective in these cases also.

3. Experiments with sand on mud started in 1932.

Three areas of the same size and bottom condition as that spread with sand in 1930 were selected in 1932 and spread with varying quantities of sand in the period August 5th to 11th. The details of these areas which lie close to the 1930 area (in Division 206, Section D) are as follows:

a. 25' square, spread with 350 bushels of sand making a layer approximately 9" thick, Ranges: South corner of Bideford Lodge dance hall in line with W corner Robt. MacKinnon's barn gives North corner of area: Birch (now dead) on Paugh's shore in line with SW corner of W.Ray Paugh's house gives centre. Sides of area approximately parallel to shore. Depth about 7' at low tide.

b. 25' square, spread with 235 bushels of sand making a layer approximately 6" thick. Ranges: Birch on Paugh's shore in line with SW corner of W.Ray Paugh's house gives W side of area. Fence of Russel Ellis' land at N end of birch bush gives S side of area. Depth about 7' at low tide.

c. 25' square area, spread with 115 bushels of sand making a layer approximately 3" thick, Ranges Ellis' point at high tide in line with Dawson's house gives somewhat to NE of centre; S side of Bideford lodge gives diagonally through centre. Depth about 7' at low tide.

These areas were spread with sand to find out the relative merits of the various quantities used. The sand has not as yet mixed with the surface mud to attain its greatest firmness and still feels somewhat loose. It is not possible, therefore, to judge the results as yet. It is intended to make trials of thinner coatings of shells or other cultch on these areas next season. Present indications suggest

that the 6" layer is going to give the same result as previously, that the 9" layer will be firmer but probably not sufficiently much so to be worth while and that the 3" layer is barely sufficient.

The cost of spreading sand.

The cost of spreading sand, of course, depends on the nearness of the supply, the cost of labour and equipment and what method is used. It may be estimated on the basis of other operations involving sand. Indication of the cost to those not being able to afford expensive equipment may be made from the fact that in the case of the areas spread with sand in 1932 one man was able to move over 100 bushels per day from the shore to the area using a dory and shovel only. It might be possible to reduce this cost with large scale operations and the use of a scow, dump carts, etc.

On the basis of 100 bushels per day a man could cover an acre with a 6" layer (17,000 bushels) in 170 days. This suggests a cost with this method of about $350 per acre with present rates of wages. For the man who has seasonal employment and free time this cost would be considered less and might involve no expenditure of money. Considering the present demand for oyster ground this might not be a paying proposition but on the other hand it might pay very well, especially when one considers that an acre can be made to yield over 100 barrels of oysters (and in some cases at least 200) per year.

There is a further possible value in this method of improving ground. This lies in the improvement of soft spots

in existing hard areas or shell beds, leading to much more convenient working of the whole.

Further questions yet to be investigated in this connection.

Further questions arising in connection with the improvement of soft bottoms by sand include:

How will the method work in deeper water? It is suggested that the trials be extended to deeper water where higher quality oysters could be produced. The size of the experimental area would have to be increased to offset the greater spreading of the sand as it falls through the water. The question of using greater depths is important both from the point of view of the quality of the oysters produced and the available area.

The use of bottoms intermediate between the very soft bottoms in these trials and natural sandy bottoms. It is presumed that the intermediate bottoms would not need as much sand. It is suggested that some method of measuring the penetrability of bottoms be used and various bottoms tried with various quantities of sand.

What quantities of shells are needed to make use of these improved bottoms? This question will be investigated next year.

Can the bottoms be spread with shells almost immediately after the sand without loss of shells?

These and other questions lead away from the central subject but are connected with it. It is believed that further investigations are of great potential practical importance.

Summary.

1. The need for successful and economically practicable methods of improving soft bottoms is reviewed, pointing out that only a small proportion of the bottoms are hard in the Canadian Atlantic oyster areas where suitable hydrographic conditions are found only in very well sheltered waters.

2. A trial area spread with six inches of sand in 1930 over the softest bottom which could be found yielded in 1931 and 1932 a bottom quite sufficiently firm enough to support shells and oysters. A surface layer was developed through which a pole could be pushed with difficulty into the soft mud beneath. When 4" of shells were spread the result compared favourably with many natural shell beds. A "set" of spat was obtained on the shells.

3. The cost is not more than $350 per acre, and the work can be done at this cost using dories and shovels only, if the supply of sand is close.

4. Proposed further investigations are outlined.

This work was carried out by the writer, in charge of Atlantic oyster investigations for the Biological Board of Canada, the expenses being borne by the Department of Fisheries "Oyster Culture" appropriation.

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Sept. 1st, 1932.