

85.—MEMORANDA RELATIVE TO INCLOSURES FOR THE CONFINEMENT OF SALMON, DRAWN FROM EXPERIENCE AT BUCKSPORT, PENOBSCOT RIVER, MAINE.**By CHARLES G. ATKINS.**

[In response to request of Dr. C. J. Bottemanne.]

The Penobscot salmon-breeding establishment was founded in 1872, at Bucksport, in the State of Maine, near the mouth of the Penobscot River. The location was primarily determined by the necessity of being near a supply of living adult salmon, to be used for breeders. After an exploration of the headwaters of the Penobscot, which lie mostly in an uninhabited wilderness, the conclusion was reached that the chances of securing a sufficient stock of breeders were much greater at the mouth of the river, where the principal salmon fisheries are located; but to avail ourselves of the supply here afforded we must take the salmon at the ordinary fishing season, May, June, and July, and keep them in confinement until the spawning season, which is here the last of October and first of November. As the salmon naturally pass this period of their lives in the upper parts of the rivers, it was thought essential to confine our captives in fresh water. Later experiments in Canada indicate that they will do as well in salt water, but the construction and maintenance of inclosures is much easier when they are located above the reach of the tide, to say nothing of the proximity of suitable fresh water for the treatment of the eggs. In the precise location of the inclosures several changes have been made, but they have always been in fresh water, and within convenient distance (5 to 10 miles) of the place where the salmon were captured.

In our experiments and routine work we have made use of four inclosures, which I will now describe.

No. 1.—In Craig's Pond Brook, a very pure and transparent stream, an artificial pond 40 square rods in area and 7 feet in extreme depth, was formed by the erection of a dam. The bottom of this pond was mainly a grassy sod newly flooded. About half the water came from springs in the immediate vicinity, and the rest from a very pure lake half a mile distant. The water derived from the lake was thoroughly aerated by its passage over a steep rocky bed. The transparency of the water in the pond was so great that a pin could be seen at the depth of 6 feet. This inclosure was a complete failure. The salmon placed therein were after a day or two attacked by a parasitic fungoid growth on the skin, and in a few days died. Out of 59 impounded not one escaped the disease and only those speedily removed to other waters recovered. Several, removed in a very sickly condition to the lake supplying the brook, recovered completely, from which it is safe to infer that the cause of the trouble did not lie in the lake water. Of the spring

water I have some suspicions, and should not dare to inclose salmon in it again.

No. 2.—After the failure of the above experiment an inclosure was made in the edge of an ordinary lake by stretching a stout net on stakes. This water was brown in color, and objects 4 feet beneath the surface were invisible. The bottom was gravelly and devoid of vegetation. The depth was $7\frac{1}{2}$ feet in early summer, and about 4 feet after the drought of August and September. The area inclosed was about 25 square rods in June, and perhaps half as much at the end of summer. This inclosure was entirely successful, very few salmon dying in it except those that had been attacked by disease before their introduction, and all the survivors were found to be in first-rate condition in November. This site was not afterwards occupied, because it was inconveniently located, and was exposed to the full force of violent winds sweeping across the lake, and therefore unsafe.

No. 3.—The inclosure in use for the confinement of the stock of breeding fish for the four years from 1872 to 1875, inclusive, was made by running a barrier across a narrow arm of a small lake (mentioned in official reports as "Spofford's Pond") near Bucksport village. This body of water, about 60 acres in area in the summer, receives the drainage of not more than 5 square miles of territory through several small brooks, that are reduced to dry beds by an ordinary drought. About a quarter of the shores are marshy and the rest stony. The water is highly colored by peaty matters in solution, and all objects are invisible at a depth of 2 feet. The bottom is composed mostly of a fine brown peaty mud of unknown depth. Aquatic vegetation of the genera *Nuphar*, *Nymphæa*, *Bragenia*, *Potamogeton*, &c., is abundant. The water is nowhere more than 16 feet deep in the spring, and 11 feet in midsummer. The portion inclosed is 2 feet shoaler. The inclosure occupied sometimes 8 or 10 acres, and sometimes less. The barrier was from 400 to 600 feet long, and was formed the first year of brush; the second and third years of stake-nets, weighted down at the bottom with chains; and the fourth year of wooden racks, 4 feet wide and long enough to reach the bottom, which were pushed down side by side. The brush was unsatisfactory. There were holes in it by which the fish escaped. A single net would not retain its strength through a whole season, the bottom rotting away and letting the fish out, unless before the autumn was far advanced its position were reversed, the stronger part that had been above water being placed now at the bottom. This method was therefore rather expensive and not perfectly secure. The wooden racks were costly and heavy to handle, but quite secure.

The salmon placed in this inclosure had to be carted in tanks of water overland about a mile in addition to transportation in floating cars from 3 to 5 miles; they were transferred suddenly from the salt water of the river (about two-thirds as salt as common sea-water) into the entirely fresh water of the lake. To all the supposed unfavorable circumstances

must be added the high summer temperature of the water. During August the mean was generally above 70° Fahrenheit at the bottom and several degrees warmer at the surface. Occasionally there was observed a midday temperature of 74° F. and once 76° F. at the bottom. Yet this proved an excellent place for our purpose, a satisfactory percentage of the salmon remaining in perfect health from June to November.

No. 4.—The inclosure in use since 1879 at Dead Brook, Bucksport. It is located in a gently running stream bordered by marshy ground, with a bottom in part of gravel but mostly of mud, crowded with aquatic vegetation. The water, supplied by two small lakes among the hills, is cleaner than the average of Maine rivers, but does not in that respect approach the water of inclosure No. 1. The greatest depth is about 8 feet, but in the greater part of the inclosure it is from 3 to 5 feet. The width of the stream is from 2 to 4 rods, and the portion inclosed is 2,200 feet long. The barriers to retain the fish are in the form of wooden gratings, with facilities for speedily clearing them of débris brought down by the stream.

Better results were expected from this inclosure than from No. 3, but have not been realized. The percentage of salmon dying in confinement has been greater, amounting commonly to about 25 per cent of those introduced, and this notwithstanding the salmon are conveyed to the inclosure by water carriage the entire distance (7 miles) instead of being carted in tanks. The cause of the trouble has not yet been discovered, but there is good reason for thinking that it lies in some of the circumstances attending the transfer of the fish from the place of capture, and that the inclosure itself is perfectly suited to its purpose. This view is supported by the fact that nearly all the losses occur within a few weeks after the introduction of the salmon and almost wholly cease by the end of July. If the cause of disease was located in the inclosure, we should expect it to be more fatal after a long than a short duration of the exposure of the fish to its action, and that with the smaller volume and higher temperature of August it would be more active than in June and July.

The above description will, I think, give Dr. Bottemanne a sufficiently correct idea of the character of the inclosures we have tried. There are, however, several other points to be touched upon to put him in possession of the practical results of our experience.

The facilities for the recapture of the salmon when the spawning season approaches must be considered. In the lake at Bucksport village (No. 3) we hoped at first that their desire to reach a suitable spawning ground would induce them all to enter the small brook that forms the outlet, which was within the limits of the inclosure. In this matter our expectations were but partially realized. Many of the fish refused to leave the lake through the narrow opening that was afforded them, and were only obtained by pound-nets, seines, and gill-nets, all of which involved a considerable expenditure of labor and material. The drawing

of a seine in a large body of fresh water is likely to be a serious undertaking unless the bottom has been previously cleared of snags. In this respect the long and narrow inclosure at Dead Brook possesses great advantages, since it can be swept with a comparatively short seine. However, the influx and efflux of a considerable volume of water is of great advantage in enticing the gravid fish into traps that can readily be contrived for them by any ingenious fisherman.

The existence of a gravelly bottom in the inclosure must be considered a positive disadvantage, inasmuch as it affords the fish a ground on which they may lay their eggs before they can be caught; but the danger of such an occurrence is less as the bounds of the inclosure are more contracted and the facilities for capturing the fish are better.

As to the number of fish to a given area, I think we have never approached the maximum. I should have no hesitation in putting 1,000 salmon in the inclosure at Dead Brook, which covers an area of less than 3 acres. Of course the renewal of the water supply, or its aeration by winds, is of importance here.

The capture and transport of the fish in June involves methods requiring some explanation. The salmon fisheries about the mouth of the Penobscot River are pursued by means of a sort of trap termed a "weir." It is constructed of fine-meshed nets hung upon stakes, arranged so as to entrap and detain the fish without insnaring them in the meshes. They swim about in the narrow "pound" of the weir until the retreating tide leaves them upon a broad floor. Just before the floor is laid bare, the salmon destined for the breeding works are dipped out carefully with a cloth bag or a very fine bag-net and placed in transporting cars or boats, rigged specially for the purpose, sunk deep in the water, which fills them, passing in at two grated openings above, and passing out at two others astern, and covered with a net to prevent escape. In a boat 13 or 14 feet long (on the bottom) we put 10 or 15 salmon, to be towed a distance of 7 miles. If the water is cool, twice as many can go safely, but there must be no delay. It is very important that this car be smooth inside, with no projections for the salmon to chafe on, and the gratings must be so close that they cannot get their heads in between the bars.

If conveyance overland is necessary, a wooden tank 3 feet long, 2 feet wide, and 2 feet deep, with a sliding cover, will take six salmon at a time for a mile and perhaps farther, and they may be jolted along over a rough road in comparative safety.

It has been our uniform experience that all the salmon that survived till autumn were in normal condition as to their reproductive functions, and yielded healthy spawn and milt. On two occasions we suffered serious losses of eggs. In neither instance could the loss be attributed to any defect in the inclosure, but on one occasion the conclusion was reached that the water which was well suited to the maintenance of the

fish was injurious to the eggs, rendering the shell so soft that they could not be transported safely.

With the exception of the disasters enumerated above, there has been but one that I can recall, and that was caused by the bursting of our barriers at Dead Brook under the pressure of a flood.

BUCKSPORT, ME., *April 7, 1884.*

**86.—FURTHER REPORT OF R. D. HUME'S SALMON HATCHERY,
OREGON.***

By CHARLES I. FINELY.

[From a letter to Prof. S. F. Baird.]

I have carefully liberated about 12,000 salmon fry in a little stream called Indian Creek, a tributary of Rogue River, Oregon.

Nearly all the eggs that I lost were from non-impregnation. I had to spawn the salmon too early, but I did it then for fear of losing them altogether, on account of a freshet. We had them in two boxes afloat in the water. These boxes are made of slats 24 by 10 by 6 feet. Between the 25th and 28th of August last I put into these boxes 100 salmon (50 in each box). Those that lived I left there until the 22d of November. In towing the boxes down the river one of them ran aground and a slat tore off, so that we lost 50 fish thereby. Of the other lot about half died. I think this was due chiefly to their being confined in too small a space. They got a good deal bruised before the middle of September. Mr. Hume intends to do away with the boxes and to build a large reservoir at the outlet of the hatching-house.

I spawned in all only nine females; lost two from their getting away, and let one go for want of a male. I estimated only about 30,000 eggs, and from actual count the loss of eggs was 7,000. The loss of minnows and fry was about 1,000.

The first eggs were put in the trays on the 22d of November; the first embryo was discovered on the 26th of December; and the first fish was free the 27th of January, or in sixty-six days. The last salmon hatched February 17th, or eighty-seven days from spawning. On the 10th of March we commenced fishing, and on the 7th of April let them go, all large and healthy fry. As far as I could find, I had only ten cripples, and some of these lived to become fry. I waited for Mr. Hume to come from San Francisco before turning them out. Under the circumstances, I feel much encouraged with my success.

Mr. Hume intends to make the hatchery a permanent fixture here, and to have the river stocked to its full capacity during the coming winter. We have a capacity for about 1,000,000 eggs.

ELLENSBURG, OREG., *April 27, 1884.*

* See previous report on page 88 of this volume.—C. W. S.