

XXIV.—REPORT ON THE PROPAGATION OF SCHOODIC SALMON IN 1880-'81.

By CHARLES G. ATKINS.

1.—GENERAL SUMMARY.

The only important changes or improvements in the fixtures at this establishment this season were the construction of two short aqueducts at the old house in the woods and the beginning of a new house at a cove on the west side of the lake close by the dam. The latter was at first intended to be used as supplementary to the other two houses, but it has proved so useful and to possess such facilities that it may yet become our headquarters.

This has been, on the whole, the most prosperous season we have experienced. We caught 2,171 Schoodic salmon of uncommonly large size; 1,473 were females (an unusually large proportion), and 1,427 of these yielded 2,326,740 eggs, an average of 1,630 each, twice the yield common ten years ago. There has been an increase in the vigor and hardiness of the embryos as developed in the hatching houses, due, possibly, in part, to the greater health and vigor of their parents, but probably in greater degree to the better treatment, the greater supply of water, and its better aeration secured by our new facilities. Resulting from this was a greater degree of success in the transportation of the eggs shipped and in their subsequent hatching and rearing, and a marked improvement in the vigor of the fry hatched from the reserved eggs. The new house in which the latter were hatched stands on a hillside, and affords abundant facilities for aerating the water, which we so much needed at the old house. I expect this increased vigor of the young to tell on the future supply of adults in the lake.

The losses sustained during the development of the eggs were only such as ordinarily occur here. As determined by count or careful measurement, they amounted to 218,240, or 9 per cent., reducing the entire stock to 2,108,500. The 25 per cent. reserve still further reduced the number available for shipment to 1,581,500. *Pro rata* division gave the subscribers the following shares, viz: The United States, 527,000; Maine, 124,000; New Hampshire, 124,000; Massachusetts, 310,000; Connecticut, 496,500. All of these were shipped except 10,000

out of the share of Maine, and 30,000 donated to Maine by the United States, which were retained to be hatched for private parties to whom they had been allotted.

The shipment of spawn was made between January 10 and March 28. All were packed in wet bog moss inclosed in dry moss or leaves, in capacious wooden boxes. They were transported on a sled or "pung" to Princeton, 12 miles, and after a stay of a night, thence on the rack of a sleigh 28½ miles further, to Forest Station on the European and North American Railway. Severe weather was often encountered, but only in one instance, or at most in two, does there appear to have been any injury done to the spawn.

The subsequent development and growth of the eggs were very generally satisfactory.

Further details of operations are given in the subjoined notes from my diary, and the tables of "spawning operations," "shipment," and "transportation" of spawn.

2.—DIARY.

Grand Lake Stream, 4th November, 1880.—Arrived from Bucksport at 9 p. m. last night, having come through in one day.

Mr. Munson and Mr. Ripley have been at work steadily since my former visit. The aqueducts are all done and in working order. The nets have been maintained at the head of the canal and at the old coffer-dam near by, 270 feet above the driving dam, but no attempt has been made to put in pounds or take any fish. From time to time considerable numbers of them have been seen above the nets, sometimes coming down in heavy schools to the nets. M. told me last night that he had seen no nests made anywhere, but had not looked yesterday. Had looked often before that.

No fish have got into the stream or canal except on one occasion. On the night of October 2, Forbes watched till half-past twelve o'clock, and then went to bed. During the night some one came and plugged up two of the aqueduct logs that Cavanagh had bored, and then took our boat, went to the canal net, cut it down from top-line, inclusive, in one place 4 feet, and in another a boat's length away, 5 feet, and then passed on down the canal letting the boat drift down to the bridge. The net straightened out on the bottom flat, and let fish freely down over it. Munson examined the canal and thinks sixty or seventy ran down at that time. From that date on, Forbes has watched all night long and has, he says, been over by boat to the canal net about once an hour.

The lake has risen, M. thinks, about 4 inches from the lowest stage, now standing at 1 foot 10 inches.

November 4.—I find on examining that several salmon nests have been commenced on the bar above our nets.

We begin to-day early to put in the pounds, very nearly as on last year's plan. We got three of the pounds ready for fish, and they began

to come in before the work was done. They came in very freely in the evening.

November 5.—As usual, the most of the fish came in in the early part of the night. This forenoon we got in the remaining pounds and in the afternoon commenced taking spawn.

The fish taken last night are remarkable for size, and are fully up to the average of former years in plumpness and health. This is the evidence of the eye, and so far as the measurement goes, it bears out this conclusion.

November 6.—Not so good a run last night as the night before. The size of the fish is, however, fully up to the first. I went down to the bark-mill and examined the whole length of the canal. Counted thirty-four Schoodic salmon, probably nearly half females. There may have been some that escaped me, but I do not think there are forty in all in the canal. I think they are making nests a little more than two-thirds of the way down. It is possible that some fish get through our net now from time to time, where it goes round the main pier, for Ripley and Munson have found some holes in it.

Just above the dam I saw this afternoon three females spawning, and six to ten males fighting over them; one little yearling or bi-yearling, with bars. Below the dam I looked the gravels and rapids over carefully and found no evidence of salmon having been there this year. Nor anywhere below the dam could I see nest or fish, except one male fish in old channel at head of saw-mill flume.

It does not follow that these fish at the dam and below escaped through our net, for it may be that they have lain below our nets all the season.

I have seen two yearling or bi-yearling salmon—one at the dam, one at the pounds; the latter showed the bars and spots plainly, but was, I think, fully 8 inches long. The new nets of which our pounds are this year largely built will hold a fish of this size.

November 7.—The run of salmon last night was smaller than either of the other two nights, probable not over 100. The rain continued with a southerly wind all night. Between 6 and 7 a. m. we drove the fish into third pound. During the forenoon others came in, more in number, Munson thinks, than during last night. These were driven through with the others into pound 3, and so was another good drive late in the afternoon. In the evening I stood for an hour quite still by the weir, watching for fish to enter, but only four came in during that time. I saw two females spawning just outside the entrance within 10 feet of me; those that came in and others that lingered about did not manifest any fear of me; I think they did not see me. Forbes says that last night the fish all about, both within and without our pounds, were very quiet; to-night he says they are much less so.

Munson put a whole net around the pier.

At the hatching house I find that Mr. Munson has the water from the

west aqueduct running into the troughs, and it is strongly colored, but not roily—a good deal of it. Temperature of water of both aqueducts 48°, of spring water 46°.

We looked at a number of the trays of eggs already in the house, and selecting one appearing to contain about average number of eggs Munson and I counted them out with spoons. They counted 2,087. This calls for an increase of estimated number of eggs. The tray was more than covered.

In taking eggs I do not think we have thus far exercised due care in the agitation of the eggs and milt to secure contact. We took, as the record shows, pretty heavy panfuls of eggs before washing off, and we did not agitate constantly enough to suit my idea. I think I shall establish it as a rule never to have the eggs in a pan more than two layers deep. Perhaps one layer would be better. Then as soon as one layer was impregnated they could be turned out into another pan, and when several of these have been collected thus together we could weigh them, thus avoiding frequent weighings.

In former years we have used every male that came to hand. This year I have begun the practice of putting all poor looking and small males directly over into the final pound. It is convenient to pass out all less than 19 inches in length. That would leave us plenty for use this year. But I have not thus far followed this or any other strict rule.

November 8.—A large run of fish yesterday, a small one during the night, and another large one to-day. Both these days have had clear weather, so that in these instances the salmon have run into our inclosures best in daylight and clear weather.

We have from the first, each day (except Sundays), handled over the fish taken the previous twenty-four hours, and immediately taken the spawn of those ripe. We have in no case up to date counted or assorted any of the fish caught until we took them in hand for spawning.

November 9.—They have not been scowing bark down the canal for some time, much to our satisfaction; but to-day they began again, and we must lower the net for them. I saw an eel in the second pound last night, and several nights ago I saw one of large size outside the entrance of the first pound. Have begun the building of a little jetty from the west bank, just above mouth of Ripley's Brook, to keep the water of the brook from mingling with that of Grand Lake in the pool that supplies our aqueduct. I shall merely throw out a narrow mole of earth and face it with stones—two or three days' work.

November 10.—Overhauled the main pound. Find exactly the number of full females that we put there. Don't think any of them have laid any eggs, though there have been a good many attempts at digging in the pounds. The greater part of the females are still unripe; the most of them very hard.

I have now one man all the time ready to take the pans of eggs im-

mediately from the spawn-takers, to stir them up thoroughly, and then immediately weigh them and wash them off.

November 11.—At the old hatching house I find temperature in the troughs 43°; of the west aqueduct, 41°; of the spring, 46°; of the north aqueduct, 44°. In the west aqueduct we get highly-colored water. It is unfiltered, but we propose to fill up the large collecting tank with gravel to form a filter.

November 12.—In old hatching house I find fifth faucet running two-fifths of a quart per second—6 gallons per minute—and for four troughs 30 gallons per minute. This includes the spring and the west aqueduct, the brook not having been admitted and the east aqueduct being temporarily shut off on account of roily water. The east aqueduct is delivering 7½ gallons per minute. Total for whole house, 37½ gallons per minute. There was a half inch of rain last night, and the brooks around the hatching house are running full. The fish taken now are almost wholly females, which indicates that the run is drawing to a close.

We have taken now (7 p. m.) from 417 females, say, 760,000 eggs; 759 females on hand will yield, say, 1,200,000; total, 1,960,000. I think we have a good prospect of catching 400 more fish, of which 324 females will yield, say, 480,000, making total for the season (estimate) 2,440,000.

November 16.—I calculate our trough capacity thus:

At old hatching house:

Eight troughs, at 80,000 each	640, 000
Two troughs, at 100,000 each	200, 000
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	840, 000

At new hatching house:

(Already in use) two troughs, deep, at 360 M. .	720, 000
(To be fitted to-day) two troughs, deep, at 320 M. .	640, 000
(To be brought from old house) one long shallow trough (10 inches, nine stacks).....	180, 000
(To be brought from old house) one short shallow trough (6 inches, 6 stacks)	120, 000
	<hr/>
	1, 660, 000
	<hr/>
	2, 500, 000

To fit these out we need 34 deep frames; on hand, 27; the remainder supplied by repairing three frames and making four new ones. We have in the new house and in the storehouse, including those in use, 882 trays, with capacity of 1,646,000 eggs, proper allowance having been made for covers. The hatching trays with oblong meshes have not yet been brought into use, but shall have to use them.

I am reckoning 2,000 eggs per tray. Have had three trays (appearing to contain average) counted, and have got the following results: First tray, 2,087; second tray, 2,040; third tray, 2,025. I think it would

be safe to reckon 2,030 per tray; that would increase our estimate 1½ per cent.

We have now by our original reckoning, 1,574,000 eggs; on a basis of 2,030 per tray we should add 23,610—making 1,597,610.

Blodgett counted the eggs of a large female on yesterday's record and found 1,950.

Munson tells me of having discovered a copious spring about half a mile back from the old hatching house; the water from it flows in the other direction, and he thinks the land is "too flat" to bring it to the hatching house.

Now that we are threatened with a very large crop of eggs, I am beginning to consider the facilities existing within our reach for the hatching out of the 25 per cent. reserve. The trough-room in the old hatching house will hardly suffice for the hatching of 300,000; indeed I think 250,000 quite enough; that is what we had last winter. We could put in extra troughs on the floor so as to accommodate, say, another 100,000 or 150,000 by occupying the aisles. But this would be very inconvenient, and it would be much better to put all the extra troughs outside the present building, under a temporary roof. It would also be practicable to put in a house near the east spring.

But after all is it desirable to hatch these fish out here in the woods? The carrying them out to the stream is a laborious job, and very unpleasant in fly and mosquito time. It goes on so slowly, too, that when we have a large number of fish we can hardly get them out in season except by putting on an extra force, and that would necessitate the employment of a less careful man than Munson. Munson says that he brought them all out last year by hand in tin pails pretty nearly full, I suppose holding two gallons of water each. In each pail he took, he guesses, about 500 and made eight trips per day. Thus with two pails a trip it would take 500 trips and over sixty-two days to carry out the 500,000 young fish which we hope to turn out next spring.

I am anxious to save part of this labor and risk, and am thinking of putting in a hatching house, cheap and temporary, near Forbes' Cove, into which I can lead the water near at hand; and also the spring back of Calligan's house if at some future time it appears worth while.

November 17.—To-day we overhauled pound 5, containing the unripe fish on hand from catchings previous to to-day. We took a large quantity of eggs. Having now spawned all but 154 of our females, we are going to proceed immediately to boat the spent fish up the lake. This evening made a beginning by taking up two boat loads (one trip) to a point on the west shore nearly opposite Half Moon Island. They were turned out on a shore of cobblestone. We have discussed carrying them to Mayberry Cove, and all think it would be a fine place to let them out, but apparently it is too far.

Last year the fish were all taken up on the other shore and let loose near Munson's Island. Munson tells me of a deep cove, where part of

the fish were turned out and where he afterwards saw traces of their having scratched about. He thinks they do not linger on a rocky shore, but do on a sandy shore. I think that on a shore of proper grade, say fine gravel (or coarse sand, like Mayberry Cove), the fish might find bottom on which they might be satisfied to finish their digging for the season, instead of returning to the stream. The men got back this trip a little after 11 o'clock.

November 18.—This morning quite a number of fish in the outer pound, and among them undoubtedly some of those that were carried up late last night. We know them by their abraded noses, which a great many of the males had.

November 19.—Sent up four boat loads of fish to-day.

November 20.—Sent up four boat loads of fish to-day.

November 22.—Windy and cold. The ice has prevented our doing anything at boating fish since 20th. Have not given up hopes of being able to do something more in that direction, but don't expect to get any more good fish. Have therefore lifted the nets around the first and second pounds, and let all the fish hereafter coming in escape.

November 23.—Lake closed last night for half a mile up.

November 24.—This morning I heard the ice cracking and snapping about 4 a. m., and after. This did not attract my attention at first, but when it did I merely supposed that the saw-mill had been started at an early hour, and had, as usual, drawn down the water near our house. But between five and six o'clock it occurred to me to go down to the stream and look. I found the water very low, and could hear no sound of rushing water from the dam. I ran up to the dam and found that all the gates (seven, and all open) were clogged up with anchor ice so that no water could be perceived running through. We immediately turned to with shovel and pick and soon had the water running again. This was similar to the jam of two years ago. I thought then that the ice all formed above and merely came down with the wind, but I am sure that in this instance the ice must have formed in the gates or close above them, for there was a sheet of ice across above at the old coffer-dam and nearly all the way as far as we could see. Apparently the water did not cease to run in our hatching troughs, and no harm was done.

November 25.—Lake frozen almost as far as we can see. All the fish on hand (say 500) let loose. Nets all submerged (except the cross-net, to prevent fish running down to the dam and the canal net). They were so frozen to stakes and encumbered with ice that I could not hang them on stakes as I had intended, so sunk them and kept them down with the chains and stones to thaw out.

November 26.—I find at old hatching house 20.33 gallons of water per minute. Of this the north aqueduct furnishes 4.28 gallons; west aqueduct, 6.00 gallons; old spring, 10.05 gallons. Temperature of water in the hatching troughs 41°. Tested the Widdifield thermometer in use there, and found the mercury to sink $\frac{1}{2}$ degree below the mark at freez-

ing point. Plunged it in snow and water. The long Wilder thermometer in use now at the house is just right at 32° F. The oil-testing thermometer of Widdifield also shows $\frac{1}{2}$ ° below the 32° mark. The latter will hereafter be used at the stream-hatching house.

November 27.—Dragged the nets, except cross-net, out of water, and hung up in spawning-shed.

November 30.—Left for Bucksport early in the morning.

January 7, 1881.—Returned from Bucksport yesterday. The new hatching house at Forbes' Cove is boarded, roof shingled, single upper floor laid, upper windows in. S. S. Sprague and George Macartney have been at work at it most of the time since I left, and at that time I had had perhaps \$15 worth of work done on excavation. The water appears to be in fair supply, and the little pool under the rock, near the corner of the hatching house, has not frozen over at all.

At the old hatching house the water is getting very low. The measurement to-day gives 8.919 gallons per minute. Of this I find by measurement that the north aqueduct yields 1.875 gallons (or say 1.919), and of the remainder I judge from temperatures that the brook gives one-seventh and the main spring six-sevenths (say one gallon and six gallons per minute. In the rough, one gallon, six gallons, and two gallons). Temperature of main spring to-day, 42°; of north aqueduct, 39°; of brook water, 35°; of water in troughs, 41°. All the eggs are apparently doing well. I looked at several lots from both upper and lower ends of trough, and could distinguish no difference. All the embryos that I saw were strong, with good color and well marked veins. They are all fit to ship, but I think the oldest can wait two or three weeks safely. I shall, however, try to send some away immediately, for we have so many that we must send in two or three batches, first clearing the house, and then bringing out another lot from the stream to develop, and finally a third batch. I hardly dare to bring out next time as many eggs as we have now in the old house (855,000), for I am not satisfied that it is safe with 9 gallons of water—the present limit.

This afternoon Mr. Munson turns some of the earliest eggs, preparatory to picking out unfertilized. He performs the operation thus: He brings the stack to the table, capsizes them into a long, shallow pan of water, pours them from this pan into a common milk-pan, and then pours them from milk-pan to milk-pan five times, holding the pan about 8 inches high each time. He says this is sufficient, according to his observation, and does not injure the good eggs. [I find subsequently that there is quite a percentage in some of the trays of unfertilized eggs remaining clear after this operation, and think it would be better to have the pan held 1 foot high each time, but Mr. Munson thinks these instances were on trays turned by some one else than himself.] After turning, the eggs are replaced on the trays and remain a day or two, when they are picked over. Those turned to-day will be picked tomorrow and packed Monday.

January 10.—To-day began packing. Packed lot 1 (except 2,000 kept for hatching), all of 2 and 3, and 64,500 out of lot 4. Sent away 50,000 to Grand Falls, N. B.

So far as I am able to see, these eggs are in prime order. The fish are not very large—apparently not very near hatching (not so near as I expected to find them, but perhaps as near as I ought to expect; last year the record showed lot 1 was half hatched February 23, and all out March 1). The veins show well, and those at lower end of trough appear as good as any. I have seen no prematurely hatched fish; scarcely any defective ones. All in this house are ready to ship; not much difference in their stages of development, to be sure; only six days difference in their ages.

The picking of eggs has been every three days in the old house and every six days in the stream house.

The eggs in the stream house are very backward. The trunk of the fish can be discerned by close examination, but that is all; not near coloring yet.

January 11.—The packing proceeded to-day until near 2 p. m., when we had three cases ready, all of which went to H. J. Fenton, Windsor, Conn. The first was a 50-thousand case packed with dry moss; the second and third were 80-thousand cases and packed with dry leaves. We have in all cases 3 inches space around the inside boxes.

January 13.—Munson and Macartney worked yesterday all day at "turning" the eggs in the old house and turned $17\frac{1}{2}$ trays. To-day they and Forbes worked all day at picking them (and a few others) over; =400,000 turned by two days' work and picked by three days' work; and only one of these men is an adept.

The results of picking pretty satisfactory. For instance, lot 7, estimated originally at 276,000, picked to-day 12,700 = 4.6 per cent., but some lots much worse.

On 12th in packing I observed just two collapsed eggs in lot 4; no others.

On 11th we shut off water from faucet 1 in old house and shut off most from faucet 2, which feeds now only the remnant of lots 1 and 5 and part of lot 6, not over 20,000 in all.

We measured the volume of water and found 8.103 gallons per minute, which showed a falling of one-eighth, or $12\frac{1}{2}$ per cent., since 7th.

The weather is mild to-day and cloudy, with indications of speedy rain.

At stream hatching-house Blodgett finds 109 gallons per minute. This is the highest head, the head trough being nearly full. When saw-mill is running the amount of water is less. This all runs through without seriously disturbing the eggs.

January 18.—The packing of spawn is waiting until I receive Professor Baird's schedule, which I expect to-morrow. All the eggs in the old house have been picked and are all ready. None have been carried

out from the stream yet. The eggs in the stream house very backward. One day last week a man dropped one tray, and out of it Mr. Munson has since picked 1,800, which shows that they are very tender.

January 19.—Having the unimpregnated eggs picked out ahead as far as lot 12 (and all but 1½ stack of that), Munson, Forbes, and Macartney began packing this morning for shipment. During the day they put 195,000 into the packing-boxes, and put 130,000 of these in the cases.

I got Professor Baird's schedule to-day and immediately began to fill it.

January 20.—Yesterday evening I took a deep (3¼-inch) packing-box and filled it with damp moss and put it out in the wood-shed of the old hatching-house on an empty three-quarter-inch case, covered it with an empty packing-box, and left it from 8 p. m. till 8 a. m. to-day. Meanwhile the temperature at dwelling-house was +7° all night, and at shed on the top of this box the thermometer stood at 9° at 8 a. m. On opening, I found that the moss was frozen into a solid mass on top and sides and a little on bottom; by careful measurement, .85 inch on sides, 1.2 inch on ends, 1.6 inch diagonally at corners, one-quarter inch on bottom, and five-eighth inch on top. The moss was from under the bench, the same that we are using constantly in packing eggs; was fully as damp as average; received no extra water; was pressed in hard, much harder than we press with eggs. Had a three-fourths-inch board under it and a one-fourth over it (packing-box bottom). The sides were three-eighths inch thick, ends a little over one-fourth, bottom one-fourth; temperature of moss originally about 35°.

Up to to-day we have used for outside packing only leaves, except in the case sent to Mr. W. H. Barber, Grand Falls, N. B. But to-day we used moss only and packed eight small cases.

To-day I tried the temperature of moss under the table and found it 35°. Also temperature of heap of dry moss up aloft, and found it 37°. The moss was all gathered on a bog on the south side of Princeton road, about 1½ miles out. The dry was dried by spreading out on the open ground near our dwelling-house, after hauling green from the bog. The bog near our hatching-house used to furnish our moss, but we pulled it all over, and the new growth is still too short for use.

I am going to try comparative efficacy of leaves and moss for outside packing. Would like also to try cat-tail-flag down, if I could find enough of it.

In packing the eggs sent to-day we put snow on moss under each layer of spawn—light, dry snow, grated or scattered on. We got on from 1 pint to 1 quart in each deep box (10,000 eggs). Besides this the eggs were rinsed off, before packing, in the coldest water at our command (from brook end of bulkhead, temperature 35°).

January 24.—Packing again to-day. We find now and then a bursted shell, but few.

Last Saturday we packed up, out of lot 7, one deep and one shallow

packing-box, making about 15,000 eggs in all, in the same style as usual for shipment, and let them stand in the back part of the room. I suppose there the temperature stood at about 34° or 35° , and that they were as wet as those sent away. This a. m. we opened them and found that they have kept well, except that about 10 per cent. of them have shrunk some and are indented on the side; a few were burst. Not likely to send these away again without some picking. We took out what shrunken ones we could see after turning them out into pans of water. Those taken out, numbering about 1,000, we place upon a tray to keep and hatch. After several hours in the water they seem to have about all swollen out to original size. During the first hour in water but few of them swelled out completely. These weak shells have a greater transparency than the others. I have not yet perceived anything inferior in the appearance of the embryo. So far as I have examined, they appear of good size, good color, and with strong veins.

After the plump eggs (from which the shrunken ones had been taken out) had been in water a few hours they were packed up again and went to McDonald, whose package was made up from lots of 8 and 9.

I do not think this shrinking is due to the water being exhausted by an overstock of eggs. Were this so, the eggs at the upper ends of the troughs would be good and those at the lower ends bad. However, to test this, I have packed up two small trays from lot 9, of which 5,000 same from the lower stack, in trough 8, and the other 5,000 from upper stack, in trough 9. These are appropriately marked and stand in the back part of the hatching-house.

I also overhauled three boxes put up to test modes of packing against cold. They were packed Saturday afternoon and left in the hatching-house till near 10 p. m., when I put them outdoors on the tops of some old hatching troughs arranged right side up, so that the air had access to them on all sides except merely the edges of the sides of the trough. These were packed as if containing eggs for shipment. Inside were trays full of wet moss, and around them 3 inches of dry protecting material, one of dry sawdust, one of dry leaves, and one of dry moss. The first (with sawdust) was a good deal frozen—I think an average of three-eighths of an inch from all sides into the inside moss. In the other two the frost had penetrated, as near as I could judge, an average of not over three-sixteenths of an inch from all sides—in some places a good deal less, of course—this average including the edges and corners, where the frost had penetrated much deeper. I cannot say surely that there is any difference between the dry moss and leaves. If eggs had been in these boxes they would not have frozen, but part of those in the sawdust would.

These boxes were put outdoors Saturday at 10 p. m., temperature then being $+14^{\circ}$. Next morning temperature was $+11^{\circ}$. As soon as the sun was high enough the boxes were put under a shed, in the shade, but were brought out again after sundown, temperature $+11^{\circ}$; at 7

next morning it was $+2^{\circ}$. So I should say that the average temperature for the whole 36 hours was about $10\frac{1}{2}^{\circ}$ F., or, that being $21\frac{1}{2}^{\circ}$ below freezing, I may call it ($21\frac{1}{2}$ by $36 =$) 774 degrees of frost. I think I can say that these packages would protect eggs against 1,000 degrees of frost. I am surprised that there should be no showing in favor of dry moss over leaves, and also that sawdust should have done so well compared with them. One of these boxes I had packed in p. m. in same manner with dry moss, and put out in same place at 4.45 p. m.

January 25.—This p. m., at 2.15, I took in and opened the box put out at 4.45 p. m. yesterday. I find that the inside moss is frozen on top about one-eighth of an inch. Without examining further, the boxes were repacked and put out again. This had been out for $21\frac{1}{2}$ hours. Temperature at 7 this morning was -2° ; same at 10 a. m.—say an average of about 0 for $21\frac{1}{2}$ hours. Eggs would not have been reached by the frost had the box contained them. Quite a number of the shrunken eggs picked out of lot 7 have been hatched—weak fish. Lot 1 has not yet begun to hatch.

January 26.—This p. m. Munson carried out from stream to old hatching house eight deep stacks of eggs, making sixteen common stacks, or about 320,000 eggs. They are all out of lot 13. They have just reached the stage of sensitiveness; no color in the eyes yet. We handled them very carefully. They were hauled out on the "toboggin."

January 27.—This morning measured water at the old house. It is all flowing in the fourth and fifth faucets, only those troughs being now occupied by eggs.

I find of this the north aqueduct furnishes 1.67 gallons per minute. Temperature of bulkhead 40° ; that is from main spring. Temperature of north aqueduct, $37\frac{1}{2}^{\circ}$.

Last Monday, 24th, we packed a box with wet moss inside, dry moss outside, and put it out at 4.45 p. m.; examined it next afternoon on the top (see that day's notes) and found frost had penetrated about an eighth of an inch, or a little less. It was then put out again and left. To-day I take it in at 9 a. m., and open and examine it all through. I find frost has penetrated on top about one-half inch, and on bottom about three-eighths of an inch; outsides about three-eighths of an inch; in corners $1\frac{1}{2}$ to 2 inches. Had there been eggs in this box the top layer of upper box and bottom of lower box would probably have been frozen, and the corners of other boxes a little, enough to make three layers in all, or a loss of 7,500 out of 35,000 eggs. The temperature meanwhile has been: Monday, 7 a. m., $+2^{\circ}$; Tuesday, 7 a. m. -2 ; Wednesday, 7 a. m., $+12\frac{1}{2}$; Thursday, 7 a. m., -1 ; and the days have been cold throughout.

January 30.—On the 24th I packed up in two shallow packing-boxes (5,000 each) two selections of eggs from lot 9—5,000 from lower stack of trough No. 8, and 5,000 from upper stack of trough No. 9. They were packed as for shipment, and placed on the shelf on the back (west) side of the old hatching house. To-day we unpacked them and put them

into trays again. We found some indented, but by no means so many in either of these lots as in those of lot 7, packed for two days, on 22d and 24th, nor were they so seriously indented as those.

Without doubt the indented eggs were most abundant in those from lower end of trough. We picked out 300 of the indented and put them by themselves as lot 27. The eggs from lower end of trough are numbered 25; those from upper end, 26. Lot 24 consists of the shrunken (indented) ones of lot 7 that were picked out from those picked for experiment on 24th. So far as this goes it rather indicates that the water, after passing through a good many stacks, has lost part of its nourishing powers, and from this cause the shells are weak; but this single experiment is by no means sufficient to settle the question, for there may have been, even in this case, some other difference in the eggs, or some difference in the packing, that would account for it. I think these were packed better than on 22d. Don't know about the pressure. I am inclined to think dryness most favorable to indentation, and that great pressure may favor it some. As to exhaustion of water, this presents the worst case in our house, lot 25 being from lower stack of fullest trough, which also had the smallest supply of water. I have directed that in refilling the house fewer eggs be put in this than the other troughs.

February 1.—Returned to Bucksport, leaving W. H. Munson in charge of the Schoodic station.

The remaining shipments of eggs, amounting to 792,000, were made by Mr. H. H. Buck and Mr. Munson in March, after which Mr. Munson conducted alone the hatching of the 25 per cent. reserve, and the planting of the fry in Grand Lake, which was brought to a very successful issue in June.

TABLE I.—Record of spawning operations, Grand Lake Stream, 1880.

Date.	Remarks on the fish used.	Fish at first hauling.						Females spawned.	Females re-spawned.	Eggs.			Remarks.
		Total.	Males.	Females.						Estimated number.	Lot.	Impregnation.	
				Unripe.	Ripe.	Spent.	Total.						
1880. Nov. 5	Caught between 4 p. m. of 4th and 9 a. m. of 5th.....	294	176	84	35	0	118	35	.....	55,000	1	P. et	
6	Respawning of yesterday's fish.....								35	10,000	2		
8	Caught since 9 a. m., 5th.....	117	57	53	7	0	60	7	.....	12,000	3		
8	Respawning of yesterday's fish.....								7	2,000			
	Caught from 8 a. m. of 6th to 6½ a. m. of 8th.....	454	178	185	90	1	276	90	.....	207,000	4		
	Caught from 6½ a. m. to 4 p. m. to-day....	378	114	210	48	4	262	48	.....	28,500	5		
9	Respawning of yesterday's fish.....								134				
9	Caught from 4½ p. m., 8th, to 6½ a. m., 9th.	1,241	525	532	180	5	716	180	178	314,500			
10	Respawning yesterday's fish.....	102	33	59	10	0	69	10	.....	16,500	6		180 females yield 314,500 eggs, averaging 1,747 each.*
	Caught last night.....	183	34	138	18	3	159		11				
	Rehanding all previously unripe.....								18	278,000	7		
	Caught to-day, 6½ a. m. to 5 p. m.....	88	20	33	33	2	68		172				
	Caught this evening, 5 to 8 o'clock.....	21	5	12	4	0	16		33	52,000	8		
11	Respawning.....								4				
									229	43,000	9		
11	Caught from 8 p. m., 10th, to 4 p. m., 11th.	1,675	617	774	245	10	1,022	417	416	702,000			
12	Respawning.....	83	14	43	25	1	69	25	.....	36,000	10		417 females yield 1,983 eggs each.*
	Caught from 3 p. m., 11th, to 9 a. m., 12th.	92	13	61	18	2	79	10	25				
	Caught to-day, 9 a. m. to 8.25 p. m.....	66	8	44	13	1	58	13	.....	49,000	11		
13	Respawning.....												
	Caught from 8.25 p. m., 12th, to 7 a. m., 13th.....	62	5	44	12	1	57	12	29	456,000	12, 13		
	Overhauling part of those previously unripe.....								279				
	Caught from 7 a. m. to 8.30 p. m., 13th....	45	9	21	14	2	37	14	.....	20,000	13, 101		
15	Respawning.....								395	63,000	14		
	Caught from 8.30 p. m., 13th, to 10 a. m., 15th.....	100	18	41	38	3	82	38	.....	51,000	15		
	Rehanding of fish previously unripe.....								151	217,000	16		
17	Respawning.....								189				
	Caught from 7 a. m., 16th, to 7 a. m., 17th.	30	12	12	5	2	18	5	.....	420,000	17		
	Overhauling all of reserve.....								285				
	Caught from 8.35 a. m. to 4 p. m., 17th....	5	2	0	2	1	3	2	.....			

19	Respawning							292	67,000	18	
18	Caught from 4 p. m., 17th, to 7 a. m., 19th.	2,129	698	1,040	370	23	1,431	1,257	2,087,000		1,257 females yield each 1,660 eggs.*
	Overhauling unripe	31	0	8	23	0	31	23			
20	Respawning								38	19	
	Caught from 7 a. m., 19th, to 7 a. m., 20th.	5	0	2	3	0	5	3	79,000	20	
	Rehandling fish before unripe							48			
22	Respawning								48		
	Rehandling fish before unripe							46	73,000	21	
	Caught from 7 a. m., 20th, to 4 p. m., 22d.	6	0	3	3	0	6	3			
23	Respawning								60	22	
	Rehandling fish before unripe							8	16,000		
25	Rehandling, &c.—There remain 5 unripe fish, which are turned free							1	2,000	23	
		2,171	698	1,053	399	23	1,473	1,427	2,392	*2,332,000	1,427 females yield each 1,634 eggs.*

* These are the estimates made at the time the spawn was taken from the fish. Subsequent measurements and calculations changed some of these figures and reduced the total to 2,328,740 eggs. According to these revised estimates the average yield of eggs is 1,630 for each female.

TABLE II.—Shipment of Schoodic salmon eggs from Grand Lake Stream, Maine, January and March, 1881.

Date.	Consignee.	Address.	Final destination.	For whose use.	Number of eggs.			cases. do. or do.
					Belonging to State.	Donated by United States.	Total.	
1881.								
Jan. 10	W. H. Barber	Andover, New Brunswick	Grand Falls, N. B.	Canadian Government	50,000		50,000	1
11	H. J. Fenton	Windsor, Conn.	Poquonock, Conn.	Connecticut Commission	207,500		207,500	1
19	do	do	do	do	80,000		80,000	1
	E. G. Blackford	Fulton Market, New York	Roslyn, L. I.	New York Commission		25,000	25,000	1
	E. J. Anderson	Trenton, N. J.	Bloomsbury, N. J.	New Jersey Commission		25,000	25,000	1
20	B. F. Shaw	Anamosa, Iowa	Anamosa, Iowa	Iowa Commission		25,000	25,000	1
	D. B. Long	Ellsworth, Kans.	Ellsworth, Kans.	Kansas Commission		25,000	25,000	1
	J. G. Portman	Pokagon, Mich.	Pokagon, Mich.	Michigan Commission		25,000	25,000	1
	H. R. Miller	Wheeling, W. Va.	Romney, W. Va.	West Virginia Commission		25,000	25,000	1
	Seth Weeks	Corry, Pa.	Corry, Pa.	Pennsylvania Commission		15,000	15,000	1
	N. E. Fairbank	Chicago, Ill.	Walworth, Wis.	N. E. Fairbank		20,000	20,000	1
	L. Luppelman	Fremont, Ohio	Toledo, Ohio	Ohio Commission		5,000	5,000	1
	B. B. Redding	San Francisco, Cal.	San Francisco, Cal.	California Commission		25,000	25,000	1
24	Col. M. McDonald	Lexington, Va.	Lexington, Va.	Virginia Commission		25,000	25,000	1
	Wm. Griffith	Louisville, Ky.	Louisville, Ky.	Kentucky Commission		25,000	25,000	1
	H. H. Cary*	Atlanta, Ga.	Morganton, N. C.	North Carolina Commission		10,000	10,000	1
	M. Metcalf	Battle Creek, Mich.	Battle Creek, Mich.	M. Metcalf		10,000	10,000	1
	S. G. Worth	Morganton, N. C.	Morganton, N. C.	North Carolina Commission		5,000	5,000	1
	C. A. Johnston	Columbia, Miss.	Columbia, Miss.	C. A. Johnston		2,000	2,000	1
25	T. Hughtlett	Druid Hill Hatchery, Baltimore, Md.	Baltimore Md.	Maryland Commission		25,000	25,000	1
	James Duffy	Marietta, Pa.	Marietta, Pa.	Pennsylvania Commission		15,000	15,000	1
	H. W. Mowry	Oak Lawn, R. I.	Oak Lawn, R. I.	H. W. Mowry		5,000	5,000	1
	P. H. Christie†	Bloomsbury, N. Y.	Bloomsbury, N. J.	New Jersey Commission		5,000	5,000	1
	E. A. Brackett	Winchester, Mass.	Winchester, Mass.	Massachusetts Commission		70,000	70,000	1
March 7	W. E. Sixty	Denver, Colo., care of Daniel Witter.	Brookvale, Colo.	Colorado Commission		10,000	10,000	1
	R. O. Sweeney	Saint Paul, Minn.	Saint Paul, Minn.	Minnesota Commission		25,000	25,000	1
8	H. J. Fenton	Windsor, Conn.	Poquonock, Conn.	Connecticut Commission		62,500	62,500	1
	F. C. Hewey	Phillips, Me., care T. L. Page.	Rangely, Me.	Maine Commission		50,000	50,000	1
	E. A. Brackett	Winchester, Mass.	Winchester, Mass.	Massachusetts Commission		130,000	130,000	3
9	George Jelliffe	Westport, Conn.	Westport, Conn.	Connecticut Commission		110,000	110,000	3
	A. H. Powers	Plymouth, N. H.	Plymouth, N. H.	New Hampshire Commission		99,000	99,000	3
	J. M. Haven	Rutland, Vt.	Rutland, Vt.	C. H. Barber		5,000	5,000	1
14	Fred. Mather	25 Hill street, Newark, N. J.	Paris and Berlin.	Paris Acclimatization Society and Deutsche Fischerei Verein.		40,000	40,000	1
15	T. Hughtlett	Druid Hill Hatchery, Baltimore, Md.	Baltimore, Md.	Maryland Commission		30,000	30,000	1

	S. G. Worth.....	Morganton, N. C.....	Morganton, N. C.....	North Carolina Commission.....	20,000	20,000	1	
	Thomas Morrison.....	Morrison, Colo.....	Morrison, Colo.....	W. R. Scott.....	5,000	5,000	1	
18	Silas Woodson.....	Saint Joseph, Mo.....	Saint Joseph, Mo.....	Missouri Commission.....	10,000	10,000	1	
21	E. A. Brackett.....	Winchester, Mass.....	Winchester, Mass.....	Massachusetts Commission.....	110,000	110,000	1	
22	George Jolliffe.....	Westport, Conn.....	Westport, Conn.....	Connecticut Commission.....	38,500	38,500	1	
	A. H. Powers.....	Plymouth, N. H.....	Plymouth, N. H.....	New Hampshire Commission.....	25,000	25,000	1	
24	E. M. Stillwell.....	Bangor, Me.....	Bangor, Me.....	Maine Commission.....	14,000	14,000	1	
28	H. G. Parker.....	Carson City, Nev.....	Carson City, Nev.....	Nevada Commission.....	10,000	10,000	1	
	Total.....				1,044,500	497,000	\$1,541,500	48

* Originally intended to be used in Georgia, but reshipped from Atlanta to North Carolina.

† This package, after going to Verbank and not being called for, was ordered to New Jersey.

‡ This lot was repacked in New York by Mr. Fred. Mather, in his method, for transportation to Europe.

§ In addition to the numbers here appearing, there were retained at Grand Lake Stream, to be hatched, the 25 per cent. reserve, amounting to 527,000; also, to be hatched for other parties, from the share of Maine, 10,000; from the share of the United States, 20,000; total retained, 567,000; making, with the above number shipped, a grand total of 2,108,500.

TABLE III.—Transportation of Schoodic salmon eggs, shipped from Grand Lake Stream in January and March, 1881.

Date of shipment.	Consignee.	Final destination.	Number of eggs.	How packed.	Time en route.		Arrived at final destination.	When unpacked.	Condition on packing.	Number died at transportation station.
					Hours.	Miles.				
1881.										
Jan. 10	W. H. Barber	Grand Falls, N. B. ...	50,000	Wet moss inside, dry moss outside.	97	2101	Jan. 14, 3 p. m. ...	Jan. 14, 3.30 p. m. ...	Very good	30
11	H. J. Fenton	Poquonock, Conn. ...	207,000	Outside, 1 case dry moss, 2 cases dry leaves.	78	502	Jan. 14, 10 a. m. ...	Jan. 14, 9 p. m. ...	Good	788
19	do	do	80,000	Outside, dry leaves ...	77	502	Jan. 22, 3 p. m. ...	Jan. 22, 8 p. m. ...	Two per cent. of eggs indented.	384
	E. G. Blackford	Roslyn, N. Y.	25,000	do	140	6401	Jan. 24, 3 p. m. ...	Jan. 25, 10 a. m. ...	Very good	132
	E. J. Anderson	Bloomsbury, N. J. ...	25,000	do	122	7001	Jan. 24, 12 m. ...	Jan. 24, 4 p. m. ...	In very good condition.	47
20	B. F. Shaw	Anamosa, Iowa	25,000	Outside dry moss; inside, moss and snow.	119	1,607	Jan. 25, 11 a. m. ...	Jan. 25, 1 p. m. ...	Very good	30
	D. B. Long	Ellsworth, Kans. ...	25,000	do	178	2,095	Jan. 27, 6 p. m. ...	Jan. 28, 8 a. m. ...	Good	Not 1/4
	J. G. Portman	Pokagon, Mich.	25,000	do	98	1,289	Jan. 24, 3 p. m. ...	Jan. 24, 4 p. m. ...	do	53
	H. R. Miller	Romey, W. Va.	25,000	do	141	1,005	Jan. 26, 9 a. m. ...	Jan. 26, 11 a. m. ...	Very good	337
	Seth Weeks	Corry, Penn.	15,000	do	102	972	Jan. 24, 7 p. m. ...	Jan. 24, 8 p. m. ...	Good	73
	N. K. Fairbank	Walworth, Wis.	20,000	do	146	1,483	Jan. 26, 4 p. m. ...	Jan. 26, 4 p. m. ...	In good condition ...	18
	L. Leppelman	Toledo, Ohio.	5,000	do	96	1,158	Jan. 24, 12 m. ...	Jan. 24, 2 p. m. ...	Good	5
	B. B. Redding	San Leandro, Cal. ...	25,000	do	281	3,818	Jan. 31, 6 p. m. ...	Feb. 1, 7 a. m. ...	Not very good condition.	2,075
24	Col. M. McDonald	Lexington, Va.	25,000	Outside, dry moss; inside, moss and snow or snow-water.	123	1,363	Jan. 29, 4 p. m. ...	Jan. 29, 5 p. m. ...	Good	100
	William Griffith	Louisville, Ky.	25,000	do	117	1,400	Jan. 29, 8.30 a. m. ...	Jan. 29, 11 a. m. ...	Good; moss quite wet.	60
	E. H. Cary	Morganton, N. C. ...	10,000	do	458	2,1001	Feb. 12, 1.30 p. m. ...	Feb. 12, 4.15 p. m. ...	Eggs all dead	10,000
	M. Metcalf	Battle Creek, Mich. ...	10,000	do	115	1,221	Jan. 28, 4.30 p. m. ...	Jan. 29, 9 a. m. ...	Good, except bottom tray, which was frosty	60
	S. G. Worth	Morganton, N. C. ...	5,000	do	170	1,515	Jan. 31, 12.30 p. m. ...	Jan. 31, 3.55 p. m. ...	Good	80
	C. A. Johnston	Columbia, Miss.	2,000	do	(1)	2,0101	(1)	(1)	Package not called for; all perished and express charges returned on C. G. A.	2,000
25	T. Hinglett	Baltimore, Md.	25,000	do	93	805	Jan. 29, 8.45 a. m. ...	Jan. 29, 11.30 a. m. ...	Good	100
	James Duffy	Marietta, Pa.	15,000	do	118	723	Jan. 29, 10 a. m. ...	Jan. 29, 1 p. m. ...	Very good	32
	H. W. Mowry	Oak Lawn, R. I.	5,000	do	114	4501	Jan. 29, 7 p. m. ...	Jan. 30, 8 a. m. ...	do	17
	P. H. Christie	Bloomsbury, N. J. ...	5,000	do	527	7001	Feb. 17, 8.15 a. m. ...	Feb. 17, 10 a. m. ...	Eggs all dead and decomposed.	5,000
	E. A. Brackett	Winchester, Mass. ...	70,000	do	651	369	Jan. 27, 7 p. m. ...	Jan. 28, 8 a. m. ...	Fair	618
Mar. 7	W. E. Sisty	Brookvale, Colo.	10,000	Outside, dry moss; inside, moss and snow.	190	2,548	Mar. 15, 12 m. ...	Mar. 15, 1 p. m. ...	Good	200
	R. O. Sweeney	Saint Paul, Minn. ...	25,000	do	144	1,789	Mar. 12, 1.35 p. m. ...	Mar. 13, 2 p. m. ...	do	46

8	H. J. Fenton	Poquonock, Conn.	62,500	do	74	502	Mar. 11, 12 m.	Mar. 11, 4 p. m.	do	22
	F. C. Hewey	Bangely, Me.	50,000	do	96	3001	Mar. 12, 12 m.	Mar. 12, 2 p. m.	do	40
	E. A. Brackett	Winchester, Mass.	130,000	do	67	389	Mar. 10, 6 p. m.	Mar. 11, 9 a. m.	do	1,180
9	George Jelliffe	Westport, Conn.	110,000	do	74	570	Mar. 12, 3 p. m.	Mar. 12, 4 p. m.	do	140
	A. H. Powers	Plymouth, N. H.	99,000	do	51	515	Mar. 11, 3 p. m.	Mar. 11, 5 p. m.	do	112
	J. M. Haven	Rutland, Vt.	5,000	do	78	5251	Mar. 12, 3 p. m.	Mar. 12, 3 p. m.	do	2
14	Fred. Mather	Paris, France	20,000	do	(1)	3,290			No report received	
	do	Berlin, Germany	20,000	do	(1)	3,840			do	
15	T. Engleitt	Baltimore, Md.	30,000	do	(1)	805			do	
	S. G. Worth	Morganton, N. C.	20,000	do	147	1,515	Mar. 21, 1 p. m.	Mar. 21, 5 p. m.	Very good	37
	Thomas Morrison	Morrison, Colo.	5,000	Moss with snow inside, dry moss outside.	265	2,583	Mar. 25, 7 p. m.	Mar. 26, 3 p. m.	Excellent	50
16	Silas Woodson	Saint Joseph, Mo.	10,000	Moss and snow inside, dry moss outside.	164	1,847	Mar. 22, 12 m.	Mar. 23, 10 a. m.	As good as could be.	25
21	E. A. Brackett	Winchester, Mass.	110,000	do	91	389	Mar. 24, 6 p. m.	Mar. 25, 9 a. m.	Not good; part of the eggs were frozen.	2,361
22	George Jelliffe	Westport, Conn.	36,500	do	121	570	Mar. 29, 2 p. m.	Mar. 29, 3 p. m.	Good	42
	A. H. Powers	Plymouth, N. H.	25,000	do	98	515	Mar. 28, 3 p. m.	Mar. 28, 4 p. m.	Very good	36
24	E. M. Stillwell	Bangor, Me.	14,000	do	49	137	Mar. 28, 2 p. m.	Mar. 28, 3 p. m.	Good	(1)
28	H. G. Parker	Carson City, Nev.	10,000	Outside, 4 1/2 inches moss and snow; inside, moss and snow.	214	3,5401	Apr. 6, 11.15 a. m.	Apr. 6, 12 m.	do	20

