XX.—REPORT OF OPERATIONS CONNECTED WITH THE PROPAGATION OF WHITEFISH (COREGONUS ALBUS) AT THE NORTHVILLE STATION, NORTHVILLE, MICH., FOR SEASON OF 1880–'81.

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PREFACE.

A brief notice of the hatchery, together with its immediate surroundings and facilities for the work under consideration, may properly precede an account of the work of the season.

The Northville hatchery was built by the late N. W. Clark, its nucleus being collected from a similar establishment formerly located at Clarkston, Mich., thirty miles distant. The latter building was torn down and removed, together with the appurtenances of fish-hatching contained therein, to its present site during the summer of 1874, and the erection of a building double the size and capacity of its predecessor immediately begun.

A description of the hatchery as then completed and of its surroundings will suffice in the present instance, as no material changes were made until August, 1880, at which time the United States Fish Commission assumed control. Under their direction many needed improvements have been made and some new features added, which will be noticed in the proper place. The hatchery as built and as it now remains, is a one-story frame structure, 80 feet in length by 30 in width, containing a 9 by 11 office in front, also an 8 by 30 tank-room in the rear. Its interior arrangements were designed more especially for the accommodation of the hatching appliances to be used therein, viz: hatching troughs and the "Clark" hatching box. No new apparatus was introduced, neither was its capacity increased previous to the present season. The main or hatching room was provided with three parallel tanks, each 50 feet in length and uniformly 9 inches in depth. One tank was 42 and either of the others 28 inches in width, the larger being divided into 96 and each of the others into 64 compartments for the reception of the boxes, making a total capacity of 224 hatching boxes. Although as many as 75,000 eggs of the whitefish can be brought forward successfully in each of these boxes, usually but 48,000 have been incubated therein, it being possible to hatch a greater percentage with less trouble and expense when the latter number is not exceeded. Of the eggs of *Salmo fontinalis* or *Salmo iridea* not more than 24,000 should

be placed in each box to obtain the best possible results. A description of the "Clark" hatching-box is given in Report of United States Commissioner of Fish and Fisheries for 1872-'73, pages 583 and 584.

The hatchery is located at the foot of a gentle slope of land, and ascending this declivity about 200 feet we find issuing forth within a circle of a hundred feet numberless little springs which furnish in the aggregrate about 175 gallons of water per minute. A public highway running directly in front of the hatchery and between it and the spring, by intercepting the flow of water from the latter, serves incidentally as a dam, thereby creating a pond having an area of one-eighth acre, averaging 4 feet in depth and extending back a few feet beyond the spring area, thus incorporating the whole of the latter. The surface of this spring pond is 7 feet above the level of the hatchery floor, which gives an ample fall of water. This spring, called the upper spring to distinguish it from a second one underneath the hatchery, is the sole feeder of the spring pond, and not only furnishes all the water used in the hatchery, but a considerable excess for which other avenues of escape have been provided; but the demand for water to develop eggs of the whitefish in the hatchery is not supplied directly from the spring pond, as the temperature of the latter during the hatching season is sufficiently warm to bring forth the fry earlier than is usually deemed desirable. The temperature of the water at its immediate source is 47°, never fluctuating more than a small fraction of a degree, while in the spring pond it is variable, depending, of course, on the temperature of the atmosphere; but, owing to the constant and abundant influx of spring water, is kept warmer than is desirable for incubating eggs of the whitefish, except during brief periods of extremely severe weather. The average temperature of the spring pond, then, through the winter season will approximate 43°, which would bring forth the fry in from 80 to 90 days, or about the 1st of February. Aside from the consideration of the existence of food for the young fishes at the period indicated, about which there may be no uncertainty, the advisability of allowing a too rapid development of the embryos may be considered questionable from the fact that when brought forward in this manner they suggest prematurity, shown by their vague and shadowy outlines, which present a decided contrast as compared with the fruit of 120 to 150 days' incubation, the latter having black and fully developed forms, evidently better fitted to survive or escape the vicissitudes necessarily attending their infantile period.

At the time of the construction of the hatchery no information concerning the temperature of the spring pond during the winters season could be obtained, no record having been made; however, as it was known to contain but little ice even in the most severe winters, steps were taken with a view to aid in securing the desired reduction in temperature. The water must be exposed still further to the influence of cold winter air; an artificial pond must be arranged, and into this must

be drawn barely enough water to supply the actual necessities of the hatchery. Accordingly a pond 12 feet wide by 100 long was constructed on a narrow plateau situated across the road diagonally from the spring pond, and running nearly parallel with the hatchery. The surface of the plateau is nearly level with the spring pond, and thus the requisite fall of water is maintained. A trunk fitted at its mouth with an adjustable gate runs under the road and conveys the water to the cooling or ice water pond, as it is called.

With the limited amount of water used in the hatchery up to the present season, and consequently the comparatively small quantity of water to be cooled, this pond proved equal to the requirements. The first severe weather of November coated it with ice, which soon increased to several inches in thickness, and remained until the following March. Water which issued from the earth at a temperature of 47° was thus reduced to an average temperature of 35°. The good results obtained by the use of this cooling pond have been substantially the same each succeeding season up to the present, when, as operations were to be conducted on a much larger scale, and as the Chase jars, requiring a greater volume of water than the hatching-boxes, were to be introduced, it was thought to be inadequate. Subsequent events verified the prediction, and the additional measures adopted in the premises will be alluded to again.

The trout ponds at the station, six in number, and constituted in one series, are situated immediately in the rear of the hatchery, and are supported by a spring yielding 200 gallons of water per minute, located directly beneath the hatching room. They have contained at various times since their construction Brook trout (*Salmo fontinalis*), McCloud River trout (*Salmo iridea*), California salmon (*Salmo quinnat?*), Lake trout (*Salmo namaycush*), and Grayling (*Thymallus tricolor*), but at present are occupied exclusively by the first two varieties named, the latter being the property of the United States Fish Commission.

A feature of both the upper and lower springs, and which indicates that their origin and conducting strata are far beyond surface influences, is their uniformity of flow and temperature; even the "oldest inhabitant" failing to remember any perceptible increase or diminution in their yield. They are perpetual fountains, inasmuch as they are uninfluenced by protracted droughts, while the variance of temperature between the extremes of winter cold and summer heat is less than one degree.

The amount of water furnished by the lower spring, all of which now runs through the ponds in use, is abundantly ample to sustain a second series, while the waste from the upper spring could be utilized by supporting a third series of ponds.

It will be readily perceived, then, that these springs, both as to their relative position and fecundity, are peculiarly fitted for trout propagation and culture on an extensive scale; but for whitefish work of sufficient magnitude to demand the use of more than half the product of the

upper spring, the reduction and maintenance of the temperature of the water to that degree of coldness necessary to delay the hatching until early spring is a work not easily accomplished, evidenced by the results of the season just closed. If it is considered immaterial whether whitefish are hatched and planted in February or in April, then a more suitable locality would be difficult to find; for with an adequate quantity of ova to consume the entire yield of the supplying spring the water would, even against the adverse influences of the ice-water pond as now used, be still warm enough to bring forth the fry as early as February, thereby shortening the season by two or three months, with its attendant expenses.

PREPARATORY WORK.

During the month of August, 1880, instructions were received from United States Fish Commissioner Prof. Spencer F. Baird for the prosecution of the work of propagating whitefish at the Northville station for the season of 1880–'81. As provisions were made for conducting operations quite extensively, preparations commensurate with the contemplated extent of the work were essential. Preliminary work, then, was immediately begun, and consisted for the most part of the following: Cleaning and enlarging the spring pond; devising and introducing some plan of drawing the surplus water immediately from its source at the head of the pond, instead of from the foot, as had previously been done; enlarging ice-water pond; providing increased facilities in the way of conducting pipes and trunks for conveying the water from the spring pond to the ice-water pond, and from thence to the tank room; repairs to the hatchery and a thorough overhauling of the appliances of the hatching and tank-rooms; providing increased facilities for carrying spawn; and, finally, the construction and arranging of feeding troughs and equipping the same with the Chase hatching jars.

The object, of course, of drawing all the waste water from that portion of the pond fed directly by the spring or springs was to obtain the minimum quantity of spring water to be cooled, allowing only enough of the latter to mingle with the pond to maintain it against the counter draught of the ice-water pond for consumption in the hatchery. The plan originally intended to secure these results contemplated a division of the spring pond into two sections by the erection of a wall or dam, thus separating the spring area from the remainder. With the springs thus cut off and confined within the smallest possible space, provisions for drawing from them the actual quantity needed and also for the disposition of the surplusage could be easily made. But a careful inspection of the premises and a complete investigation of the character of the bottom of the pond disclosed the fact that this plan could not be carried out save at an expense greatly in excess of the estimates, and it was, therefore, abandoned and substituted by a simple arrangement, the

results of which proved quite satisfactory. An open trough, resting on stilts driven just beneath the surface of the water and drawing from the upper or spring-fed part of the pond, was laid the entire length of the pond. This being the only exit allowed for the discharge of the superfluous water, the entire waste was thus drawn from the immediate vicinity of the springs.

The dimensions of the ice-water pond were then increased to 150 feet in length by 18 feet in width, with its boundary maintained by a wall of masonry backed up on one side of the pond by the natural elevation of the ground, on the other by a layer of clay of sufficient thickness to prevent leakage. The trunk from the spring pond discharges into an open, shallow trough, which carries the water to the farther end of the ice-water pond for the purpose of cooling as much as possible by exposure to the air while in transit, the two conductors for the tank room tapping the opposite end of the pond. The additional precautionary measures adopted for cooling the water were thought to be sufficient, but, as a result of the increased work of the season, the demand of the hatchery required fully one-half of the product of the spring, and, notwithstanding the unusual severity of the winter, it was found necessary at times to use considerable quantities of ice in the tank room to keep the temperature of the water down to the desired point. The cooling-pond rendered efficient service, but did not fully meet anticipations.

The repairs to the hatchery included a new roof and new floors for the hatching and tank rooms. A small temporary apartment was arranged in one corner of the hatching room adjoining the office, which was occupied as a sleeping room by one of the employés during the hatching season. This precaution was adopted upon the supposition that the sleep of the occupant would be interrupted as quickly by the cessation of the noisy monotony of running water in the hatching room as by the sudden intrusion of noise under ordinary circumstances.

One double row of hatching boxes were removed, and replaced by a tier of tanks for feeding the hatching jars. These tanks, three in number, are placed one above the other, and consequently occupy but little more floor room than a single row of hatch boxes; they are uniform in size, viz, 40 feet long by 15 inches wide and 14 inches deep, the top one being fitted with 50 and the middle one with 56 No. 8 faucets, or 106 altogether. The jars rest on narrow shelves placed crosswise of the tanks, one shelf sufficing for two jars, one at either end, the water entering the top tank feeding the upper rows of jars, which, in turn, supply the middle tank, from which the lower rows of jars are fed, the water from these emptying into the bottom tank, which, at present, serves only as a conductor for the waste water. The five rows of hatching boxes remaining were thoroughly examined, and given the needed repairs, in the way of caulking &c. Some of the wire trays were repaired, while others were supplied with new screens entire, and all were given a coat of asphaltum varnish. The picking trough was lengthened to 50 feet.

For carrying the spawn, nine boxes, each containing 20 canton flannel trays 16 inches square, were made, also one large can for the same purpose. This can is 24 inches high by 16 in diameter, cylindrical in shape, and filled with a system of wire trays fitted around a central tube, funnel-shaped at its mouth, through which the water is introduced and conducted to the bottom of the can before being freed, the bottom of the tube having a conical flange attachment to diverge the water, which then flows upward through the trays of eggs (or fish) and out of the ventricle provided near the top of the can. It is undoubtedly superior to the boxes for carrying spawn, but is much more expensive, and, when in transit, requires extra attention as to frequent changes of water.

The Chase hatching jars, 100 of which had been ordered of the Dorflinger Glass Company, White Mills, Pa., had not yet arrived October 20, although advices of their shipment September 29 had been received. Considerable uneasiness was felt on account of their non-arrival, as the anticipated time for using them was near at hand, and steps were at once taken to locate their point of detention. They finally arrived October 28, without the loss of a single jar or tube by breakage, and were placed in position as soon as possible. A full head of water was turned on to search out any leaks or disclose any defects that might exist in the trunks, tanks, &c., and in time to make any needed repairs or changes before eggs were received. The preparatory work was now soon completed—none too soon, however, as subsequent events will show—and everything placed in readiness for the reception of spawn.

SPAWN-GATHERING OPERATIONS.

While the preceding operations were making, a visit to the "Bass" Islands of Lake Erie, viz, North Bass, Middle Bass, and Put-in-Bay was made in the early part of September for the purpose of arranging for the privilege of collecting whitefish eggs from the catch of the leading pound-net fishermen. Usually, it is "first come first served"; but, in the present instance, several net-owners were found who were quite unwilling to allow their eggs to be taken for the benefit of the United States Fish Commission, preferring to give them to the Ohio State commission, whose work, being more of a local character, would naturally include deposits of fry in their vicinity. A sufficient number, however, cheerfully offered to co-operate in the work.

While on this trip I engaged the services of Mr. P. Wiers and Mr. S. W. Downing, residents of North Bass Island, and experienced spawn-takers, to assist in that work during the season.

A second visit was made to the islands October 25 and 26, to complete the preliminaries and note the condition of the fish, which were then being caught in considerable numbers. Many of the large females showed indications of early spawning, while several ripe males were found—always reliable evidence that ripe fish of the opposite sex will soon

appear. Instructions were left with Mr. Wiers to keep a close watch, and report by telegram the first appearance of mature spawners.

Meanwhile, correspondence with some of the leading fishermen of Alpena elicited information from which the conclusion was reached that large numbers of eggs of the whitefish could be secured at that point, although no precedent for this conclusion had been established by previous operations of private parties or State commissions. The fishermen, too, here, unlike many at the islands, were not only willing but anxious to render all reasonable aid to the State and United States commissions in their efforts to propagate the whitefish.

Large numbers of the lake trout (*Salmo namaycush*) are also caught at this point, but the fishermen, claiming they are a deadly enemy of the whitefish, a much more valuable fish, strenuously object to, and will not permit, so far as they have the power to prevent, the collection of their spawn for the purpose of perpetuating the species. But this claim of the fishermen is not supported by the investigations of the late Mr. J. W. Milner (Report of United States Commissioner of Fish and Fisheries, 1872–'73, pages 38 and 39), and it is altogether probable that the destruction of the young whitefishes to any great extent by the trout exists only in the imaginations of the fishermen. Nevertheless, the opposition of the latter, including the boat and net employés, as well as proprietors, is an element to be conciliated by the spawn-gatherer, as the net-lifters have it in their power, and with but little effort on their part, to greatly increase or decrease the numerous difficulties against which the operator must always contend under the most favorable circumstances, it being an easy matter to carelessly or accidentally (?) overturn the pans or pails of spawn when throwing the fish from the pound-nets into the small open pound-boats, or likewise equally as easy to assist by throwing the spawners near the operator and avoid covering the same with subsequent "dips" of other kinds of fish.

Notwithstanding the favorable outlook for collecting spawn of the whitefish at Alpena, it was thought best not to place too much confidence or reliance in this direction, as its remoteness and inaccessibility as compared with the Lake Erie islands were sufficient reasons for depending mainly on the latter to furnish the desired supply. Accordingly but one man was stationed at the former place, Mr. A. W. Root, who was instructed to engage the aid of one or more assistants, as circumstances might require.

At the time of the first visit to this place, November 3, the gill-netters were catching many whitefish, but no ripe spawners were found. Leaving operations here under the immediate supervision of Mr. Root, I returned to Northville, arriving November 6. Arrangements were made with the porters of the Bay City line of boats to receive the boxes of spawn of Mr. Root and deliver the same to messengers previously sent on to meet them at Bay City, who would of course bring them on to Northville with all possible dispatch. While at Alpena word came

to Northville from Mr. Wires, at North Bass Island, that he had taken eggs from six fish October 31. On receipt of this Mr. Bower repaired to the islands as quickly as possible, equipped with pails, pans, dippers and four of the carrying cases for eggs, arriving November 3.

As will be seen by referring to the subjoined table, the number of eggs secured by Wires and Bower up to November 6 amounted to nearly two and one-half millions. They were then conveyed to the hatchery by boat and rail in charge of Mr. Bower, leaving the islands at 11 a. m. and arriving at Northville 7 p. m. same day. Eggs were in prime condition when deposited in the hatching boxes the following morning.

At 4 a. m., November 8, I started for the islands, accompanied by assistants Bower and Donnelly, arriving at 12 m. The results of each day's efforts for the season of procuring the ova at the islands will be found in the special table of spawn-taking operations. All eggs were taken by what is known as the dry method, wherein impregnation is accomplished by mixing the spermatic fluid undiluted with the eggs before water is added.

Notes and instructions to spawn-takers and those having the care of spawn included the following:

Take eggs only from ripe fish, *i. e.*, those yielding their eggs by a gentle pressure of the hand on the anterior of the abdomen, including, of course, those from which the eggs are oozing.

Reject the entire yield of any female when more than 3 to 5 per cent. of her eggs are spotted or milk-white when taken; likewise throw aside all females bearing broken eggs.

Do not try to force all the eggs from each female manipulated, but only those which can be extruded by a gentle pressure or stroking of the abdomen, each stroke commencing just forward of the pectoral fins and extending towards the ventricle, releasing the grasp about midway between these two points. This will, however, expel nearly all the eggs if the fish is in the proper condition.

The manipulation of the male is a pinching or stripping process, but the female should be neither pinched nor stripped, the process or operation consisting of a slow, gentle, and crowding movement upward and forward with the whole hand adapting itself to the natural curve of the belly.

Hold the vent of the female as near the bottom of the pan or receiving vessel as possible, as the eggs are very soft and tender when first taken, and may be injured by dropping.

Incline the fish to an angle of about 45 degrees; the eggs will then naturally settle towards the orifice and require less pressure for expulsion. The males, however, should not be held in this position, as in many instances the vital fluid will not stream directly into the pan, but cling to the fish and follow down to the end of the tail, mixing with slime and water before dropping, wasting the entire yield of the male sometimes, as many will furnish but a few drops, which may not find

their way into the pan at all. This loss can be obviated to a certain extent by holding the male in a horizontal position, when the result of each titillation will usually be driven directly into the pan. When there is an abundance of ripe males the observance of this precaution is not material; but when there is a scarcity—frequently the case—the saving of every particle of this fluid is of great importance, as each drop may represent the future life of thousands of fishes.

If the first or any subsequent ejection of milt from any male is streaked with blood, cast him aside.

Not more than one large or two small females should be handled before using the males. It is a good plan to alternate one or more males with each female, adding milt to the eggs as soon as possible after they are taken, having a few of the former selected and placed within easy reach before manipulating the latter. No definite rule can be given as to the number of males to be used for each female, owing to the great variance of yield in both sexes; still it is evident that a sufficient quantity of the male principle has been mixed with the eggs if, when the pan is tilted, a milky coating is seen crawling on the bottom, for, when used as freely as this it seems impossible that any eggs could have escaped contact with the spermatic fluid, all that is necessary to accomplish impregnation. A feather or the tail of a fish—nothing harsher—should be used in mixing the milt and eggs. The same end may also be secured by swaying the pan, but the first plan is preferable, as a complete diffusion of the milt can be effected in much less time.

After thoroughly fertilizing the eggs allow them to stand three to five minutes before adding water; then add about a half dipperful and mix with a feather or by tilting and swaying the pan. But do not delay the addition of water much beyond the time specified, as a portion of the eggs will, if neglected but a short time, adhere to the pan and collect in twos, threes, and bunches, subsequently requiring considerable extra labor for their separation. Continue to add water as before at intervals of five minutes until the pan is nearly full; then pour off, rinse the eggs well through two or three waters, and transfer to one of the large pails previously filled with fresh water, filling no pail, however, more than half full of eggs, giving them an hourly change of water thereafter—oftener if practicable, the oftener the better—until removed to the floating boxes or carrying cases. As soon as water is given the eggs they immediately begin to absorb it with greater or less greed, depending on the temperature of the water—the warmer the water the more rapid the process—the impregnated eggs, also, absorbing water more readily than the unimpregnated. This absorption of water also causes them to swell proportionate to the quantity so imbibed, and harden gradually, growing firmer for several hours. They may be deposited in the floating boxes any time after being thoroughly washed, but should not be placed on trays for at least four to six hours, by which time they will become sufficiently hardened to spread in single layers. A greater depth than

this would at this juncture distort many of the eggs on the bottom layer; but when they are eight or ten hours old, so to speak, they may be transferred from the water to the trays and arranged two or three layers in depth.

Spread with a feather and always tilt the tray for a moment or two to drain off any water that may remain. The eggs should be damp, but not saturated—in short, should never remain in contact with water not subjected to frequent changes or aëration.

Guard well your air temperature, never allowing eggs on trays to get below 30°; 28° will prove fatal to them. On the other hand, although they will live for several hours on trays at a temperature of 60°, they are imperiled at this point and should be removed to a cellar or some cool place, or surrounded by ice. If circumstances make any of these subterfuges impracticable, then return them to the floating boxes to remain until cooler weather. The nearer they can be kept down to 33°, in air or water, the better.

Of course strict compliance with some of these hints is not necessarily essential so far as the well-being of the eggs is concerned; for instance, changing the eggs from the pans to a pail or larger vessel is not necessary, although it is quite important that they should be taken in a pan or shallow dish for obvious reasons; but a considerable saving of time is effected by concentrating into fewer vessels, no more time being consumed in changing the water in a pail of 250,000 eggs than in a pan of 50,000, while the former will occupy less room and is less liable to be overturned by the fishermen in the prosecution of their work, and also to lose its contents by the lurching of the boat in a heavy sea.

Again, a fixed routine cannot always be observed in regard to the treatment of the eggs while on the pound or tug boat. For example, in fair weather, with the boat quiet, an active operator, with an abundance of fish, will often have six or seven pans containing eggs in different stages of progression scattered about; but in a heavy sea, with the boat tossing violently, only the pan receiving the eggs, and this held with the greatest difficulty while manipulating the fish, can be used. In such cases the eggs may be transferred at once to a pail or larger vessel, which may have to be secured to its place.

It will be seen, then, that no accurate or specific rules can be given (or observed) for every contingency likely to arise, for many times the operator will meet with annoyances and difficulties not anticipated, and which, to overcome, will require expedients his own ingenuity must suggest; while the extent to which any given instructions may be violated must be determined by his knowledge of the requirements of the case. It is well to bear in mind, however, that the sooner the fish are used after taken from the water, the greater the percentage of impregnation to be obtained; that the greater the care with which the eggs are handled and the more frequent the changes of water, the smaller the percentage of loss; and that the nearer the eggs are kept at a tempera-

ture of 33° in air or water, but not lower in air, the farther their removal from danger. Knowing that good results depend largely upon the near observance of these "first principles," the operator must be governed accordingly, remembering that the object of taking eggs is to *hatch fish;* that fish can be hatched only from *live, impregnated eggs*, and therefore it is better, under all circumstances, to strive not so much to see how *many* but how *well* they can be taken and taken care of. A half million eggs secured in this way will produce more fish than a million carelessly taken and indifferently cared for.

FLOATING BOXES.

The floating boxes referred to in the following tables are a simple contrivance for retaining the eggs for a short time at the spawning grounds, and are usually made of the following dimensions: Twenty-four inches in length by fifteen in width and twelve in depth, having a screen-wire bottom, and wide boards fastened edgewise to the ends to insure their floating. For the safety of the eggs they should be placed in harbors, or some suitable place protected from violent storms or heavy seas. In the present instance they were floated under the docks, whence they were not subjected to the force of sharp seas, and yet were sufficiently influenced by the smaller waves and tide-currents to give the eggs constant changes of water. As the presence of dead (or unimpregnated) eggs is not specially hazardous to the others, previous to fungus growth, and as this growth seldom, if ever, appears on eggs less than seven days old, and usually ten to twelve—depending, of course, on the temperature of the water—their removal during this period is not material, and for this reason the floating boxes are found very convenient for retaining the eggs until a sufficient number for shipment has accumulated, requiring no special care in the mean time.

Record of spawn-taking operations conducted at the Bass Islands, Lake Erie, from October 31, 1880, to November 20, 1880, in charge of Seymour Bower.

Date.	Temperature.		Wind.		No. pounds visited.	Owner of pounds.	Fish caught.			Ripe whitefish used.		No. eggs obtained.	By whom taken.
	Air.	Water.	Direction.	Intensity.			No. of whitefish.	No. pounds of herring.	No. pounds of other fish.	Males.	Females.		
	°	°											
October 31	48	47	W.	Gentle	4	Jasper Snide	170	1,800	150	15	6	120,000	Peter Weirs.
November 1	40	46	W.	High	2	do	50	500	75	3	2	40,000	Do.
November 2	45	46	S.E	Gentle	4	do	445	1,800	100	25	10	200,000	Do.
November 3 (a. m)	48	47	E.	do	3	Stone & Fox	170	1,500	50	15	10	200,000	Do.
November 3 (p. m)	48	47	E.	do	4	Jasper Snide	450	4,000	300	60	30	600,000	Weirs & Bower.
November 4	45	47	E.	do	4	do	360	1,500	200	45	21	420,000	Do.
November 5	50	47	S.E.	Fresh	4	do	225	1,600	225	100	45	900,000	Do.
November 6	40	45	N.W.	High	None.								
November 7	42	45	W.	do	None.								
November 8	45	46	S E.	Fresh	3	Jasper Snide	600	3,500	500	140	50	1,000,000	Weirs & Downing.
November 9	48	47	E.	Gentle	3	do	200	1,200	775	24	15	300,000	Do
November 9					4	Morrison & Delichy	650	4,000	500	80	31	620,000	F. N. Clark.
November 9					10	A. Dolar	1,000	6,000	1,000	52	15	300,000	F. L. Donnelly.
November 10	40	45	S.E.	High	3	Jasper Snide	100	1,400	300	15	10	200,000	Weirs & Bower.
November 10					2	Morrison & Delichy	300	1,500	250	45	25	500,000	F. N. Clark.
November 11	40	43	S.W.	High	2	do	200	1,000	150	18	10	200,000	F. L. Donnelly.
November 12	33	42½	N.W.	do	None.								
November 13	33	42	S W.	Fresh	3	Jasper Snide	400	7,600	600	44	30	600,000	Weirs & Bower.
November 13					4	Morrison & Delichy	200	1,500	300	20	9	180,000	F. L. Donnelly.
November 13					3	Wm. Brandow	175	1,200	200	21	16	320,000	S. W. Downing.
November 14	31	40	W.N.W.	High	2	Jasper Snide	150	5,400	200	15	8	160,000	Weirs & Bower.
November 14					4	Morrison & Delichy	200	1,000	150	16	9	180,000	F. L. Donnelly.
November 14					3	Wm. Brandow	150	800	100	12	5	100,000	S. W. Downing.
November 15	30	37	N.W.	High	3	Jasper Snide	130	3,100	75	13	10	200,000	Weirs & Bower.
November 15					4	Morrison & Delichy	220	2,000	150	17	12	240,000	F. L. Donnelly.
November 15					3	Wm. Brandow	180	1,600	300	18	11	220,000	S. W. Downing.
November 16	32	38	W.	High	None.								
November 17	21	35	W.	do	3	Jasper Snide	500	15,000	500	42	35	700,000	Weirs & Bower.
November 17					4	Morrison & Delichy	220	3,000	300	20	14	280,000	F. L. Donnelly.
November 17					3	Wm. Brandow	240	4,000	400	20	13	260,000	S. W. Downing.
November 17					1		75	1,200	100	14	10	200,000	L. Carpenter.
November 18	18	34	N.W.	High	None.								
November 19	16	32½	S.W.	do	3	Jasper Snide	800	17,000	200	18	15	300,000	P. Weirs.
November 19					4	Morrison & Delichy	225	6,500	125	7	5	100,000	F. L. Donnelly.
November 19					1	W. Brandow	50	1,400	110	6	4	80,000	S. W. Downing.
Total					100		8,335	103,600	8,385	940	486	9,720,000	

Diary in connection with the preceding table.

October 25.—Weirs examined fish at Snide's pounds. Ripe males numerous, but no ripe females.

October 26.—Fish handled as before. No appreciable difference to be seen.

October 27.—Examined about 1,000 whitefish, lifted from seven pounds. Milters plenty, and large females softening.

October 28.—Pounds not lifted; high winds.

October 29.—Abundance of ripe males, but no ripe spawners.

October 30.—Females getting quite soft.

October 31.—Six ripe females found. About two males caught to one female, and nearly half of them ripe. Eggs placed in floating boxes.

November 1.—High westerly winds, in consequence of which only two of Mr. Snide's pounds lifted. Eggs obtained were placed in floating boxes.

November 2.—Very pleasant day. About one in fifteen of the females ripe. Eggs deposited in floating boxes.

November 3.—Warm and pleasant. Three pounds visited in forenoon by Weirs, and four in afternoon by Weirs and Bower, the latter of whom arrived from Northville at 12 m. The best day of the season for operations, as lake was very calm. Eggs secured in good shape and well milted. Those taken in the forenoon were placed with those previously deposited in the two floating boxes on hand. Eggs obtained in the afternoon exceeding the numbers on hand, it was feared that injury might result from having them too deep in the floating boxes; accordingly two more boxes were hastily improvised, the eggs, however, being allowed to stand in the pails six hours, with changes of water every forty minutes, becoming almost perfectly hardened before being transferred thereto. But when all were taken up for shipment, no noticeable difference was apparent between these and the others that had been deposited in the boxes immediately on arrival of the pound boat at the dock, and while the eggs were yet quite soft.

November 4.—Eggs obtained to-day were retained in pails six hours—water changed ten times—and then spread in double layers on the flannel trays for shipment. A narrow margin of flannel was left unspread, so that eggs did not come in contact with the tray frames, and the trays were thoroughly sprinkled or immersed before receiving the eggs—precautions that were observed with all subsequent shipments from this point.

November 5.—Eggs taken to-day, after standing seven hours, with hourly changes of water, were, together with those in the floating boxes, transferred to the carrying cases, the next day being regular boat day for Detroit. Eggs were dipped from the floating boxes with a small tin strainer into a pail partially filled with water, then transferred in like manner to the trays, being held in the strainer until pretty well drained,

and still further drained after spreading, by tilting the tray and inserting a knife blade between the flannel and frame at the converging corner—a routine adopted with all shipments.

November 6.—Lake so boisterous that no pounds were lifted. Eggs on hand, nearly two and one-half million, taken to Northville in charge of S. Bower, leaving the island (North Bass) at 11 a. m., and arriving at Northville at 7 p. m., without special incident.

November 7.—Still blowing too hard to lift pounds. Weirs made six floating boxes.

November 8.—Best day of the season thus far, as regards number of eggs taken. Plenty of ripe fish of both sexes. Eggs consigned to floating boxes. Clark and Donnelly arrived at Put-in Bay, and Bower returned to North Bass. Five floating boxes sent from latter place over to Put-in Bay.

November 9.—Large numbers of eggs obtained to-day. All placed in floating boxes. A few spent females found.

November 10.—Heavy wind and rain storm, nearly destroying one of Mr. Snide's pounds. Nevertheless, five pounds were visited at the two islands. Mr. Clark came over to North Bass on Sandusky boat, bringing with him in pails and cases all eggs that had been obtained at Put-in Bay, nearly a million and a half, those collected same day in pails, and remainder, gathered the day previous, in cases. The following morning the cases contained nearly three millions ready for shipment, those in pails and in the floating boxes at North Bass having been placed therein in the meantime.

November 11.—Blustering wind and heavy sea prevented Detroit boat from landing at North Bass, and the Sandusky boat ran no farther north than Put-in Bay, five miles distant, thus necessarily deferring the intended shipment of eggs. No pounds lifted at North Bass. At Put-in Bay Messrs. Morrison & Delichy lifted two pounds near shore, off the leeward side of the island, and Mr. Donnelly succeeded in gathering a few eggs, which were deposited in floating boxes.

November 12.—Very high wind; no boats to North Bass, nor no pounds lifted. The trays of eggs were removed from the cases, sprinkled by pouring water through the strainers previously alluded to, thoroughly drained, and then replaced in the cases; all in excellent condition, apparently, in the warehouse at dock. Temperature of room, 33°.

November 13.—Detroit boat stopped at North Bass and eggs were conveyed to Northville in charge of Mr. Clark. Ten pounds visited altogether to-day. At North Bass, Mr. Snide's pounds not having been lifted for three days, a heavy catch of fish was secured, the great bulk of which, however, were herring. About 100,000 eggs were taken after boat had reached dock, the fish used having been out of water about thirty minutes. From another pound boat a female and two males, out of water forty-five minutes, were used. The eggs in these instances swelled as rapidly as those known to be thoroughly fertilized,

thus showing a good impregnation. The fish, though, were not yet dead, as the air was down to 33°, in which temperature they will hold their vitality much longer than in air at 45° to 60°. However, a good percentage of impregnation can be obtained with a live male, if female has been dead three or four hours; but, if the case is reversed, a very small percentage will be fertilized. All eggs gathered to-day were deposited in floating boxes.

November 14.—High wind and frequent squalls. Plenty of ripe females, although about one in four is spent; but males, not spent, are quite scarce. Probably about one in six of the females yet unripe. Eggs consigned to the floating boxes.

November 15.—As milters were in the minority, the experiment of using a less quantity of milt was tried. The eggs were crowded from one large and one small female and the milt from two small males immediately mixed with them; they were then set aside and treated the same as those known to be sufficiently milted; about 10 per cent. died within twelve hours. There were about 50,000 eggs to be impregnated with not more than six drops of milt—enough, perhaps, under favorable circumstances, but the males used in this instance had been dead a few moments, or long enough so that the milt, instead of being emitted in jets, as usual, had become sufficiently hardened to be expelled only in drops or clots, which required considerable stirring with the eggs to effect a complete solution and diffusion.

November 16.—Snow-squalls and cold westerly winds. Lake rough; no pounds lifted. Messenger arrived from Northville, via Sandusky, with empty egg cases.

November 17.—Best day of the season as regards number of eggs obtained; over one and one-half million secured from all sources. Eggs on hand at North Bass taken to Put-in Bay in the evening and placed in warehouse at dock; temperature of room 28°; cases covered with blankets.

November 18.—Temperature of room this morning 25°; temperature inside the cases, 31°; eggs unharmed, though many were incased in a thin shell of ice, which, upon being taken in the hand, would roll from the egg, leaving it moist and perfect in form. Mr. Bower proceeded to Northville, via Detroit, having in charge nearly three and one-half million eggs arranged in six cases. No pounds lifted to-day.

November 19.—Wind high and very cold. Boat and rigging coated with ice. Eggs in pans soon freeze; frequent changes of water and motion of boat prevented ice from forming in the pails.

November 20.—One pound lifted at North Bass, but lake was so rough and boat so icy that no eggs were taken.

November 21.—High winds, no pounds lifted. Ice forming in the lake.

November 22.—Fishing practically stopped; fishermen taking up nets as fast as possible and d—(enounc)—ing the weather and season in very vigorous language. Many nets destroyed. Navigation from islands, via Detroit, closed.

Eggs on hand, except those at Kelley's Island, brought on to Northville by Bower via Sandusky November 25. Eggs at Kelley's Island, taken by Carpenter, brought to Northville November 27, by F. L. Donnelly. Eight inches of ice in Sandusky Bay on November 24, and navigation suspended except with the Eagle, a boat designed especially for breaking ice, and which was making daily trips to the islands. It may be stated in this connection that fishing at the islands is confined almost entirely to pound nets, set within a mile of shore.

AT ALPENA.

No record of the spawn-gathering work at this place having been kept by Mr. Root, it is, of course, impossible to furnish a table or daily record of observations and operations. Suffice it to say, however, that Mr. Root, with but little assistance, obtained five million and sixty thousand eggs, a much greater number in proportion to the days of actual work than was secured at the islands of Lake Erie, a result due partly to the greater numbers of whitefish caught at Alpena, and partly to the eggs being taken mostly from gill-net fishing, by which method the fish are taken into the boat one at a time, thus affording the operator an opportunity to examine each fish as fast as taken from the net, a privilege necessarily inadmissible with the pound-net, where the fish are cornered and scooped in as rapidly as possible. However, although in the pound-boat many desirable fish may be lost sight of or covered up with the hundreds of smaller fish caught in a pound-net, and thereby escape examination, yet on the whole the pound-net is the best field for operations, as the fish are always alive, fresh, and uninjured, and consequently their eggs will invariably turn out better than those from gill-nets, in which the fish are found exhausted, frequently injured, and sometimes dead—all caused by their violent struggles to free themselves from the mesh of the net—and which is also a fruitful source of spent fish, the efforts causing many of the females to emit their eggs. But on the other hand, again, a greater number of eggs can usually be secured daily from gill-nets than from pound-nets; that is, when the former are set in gangs of two to five miles—many extend this length at Alpena—as it gives the operator from six to twelve consecutive hours' labor, whereas the pound-net is generally lifted in less than an hour, and one boat rarely visits more than four or five pounds daily.

CONCLUDING REMARKS IN CONNECTION WITH THE SPAWN-TAKING OPERATIONS.

The fishing industry of Alpena, a rapidly growing city now having population of seven thousand, is a very important one, second only to its lumbering interests. The bulk of the catch is secured by gill-nets, many gangs of which are set on the reefs from five to thirty miles out; a number of pound-nets, however, are located inshore and off the adjacent islands.

The eggs of the whitefish at this point, as also the fish themselves, present a decided contrast when compared with those from Lake Erie. Eggs from the former place are a bright orange color when first taken; from the latter a pale straw color.

The Alpena fish average larger in size than those from Lake Erie, while their difference in appearance is so marked that New York and Philadelphia dealers detect their source at sight, and make, as I am credibly informed, a difference of a cent a pound in favor of the latter. Just why this commercial discrimination is made against the Alpena fish is not easily understood, unless we charge it to the distinction in their external characteristics being taken advantage of for speculative purposes, for surely the Lake Erie whitefish in no wise excel their brethren from the deep waters of Lake Huron in firmness, flakiness, or delicacy of flavor; in fact, if any difference in their table qualities exists, the epicure must decide in favor of the latter.

The Huron whitefish have dark fins, very dark backs, almost black down the spinal column, shading to a dark green at the sides, the color line extending farther down than on the Lake Erie fish, while the latter are not so highly colored in any part of the body.

Many millions of eggs can be obtained at Alpena, but the railway facilities now wanting must be supplied before there can be any certainty of delivering them to hatcheries located elsewhere, and for the reason that navigation is liable to close early and abruptly, even before gill-netters are obliged to suspend operations, as witnessed the past season, thus cutting off all communication, so far as the transportation of whitefish eggs with safety and economy is concerned, the nearest railroad point being 48 hours distant by stage. But when the much-needed railroad facilities are secured, as they undoubtedly soon will be, Alpena will present inducements for spawn-gathering hardly equaled by any other point on the lakes.

The islands of Lake Erie also furnish whitefish spawn in large numbers, but must always be subject to the same restrictions in regard to boat communication, though in a much less degree, as they are but twenty-five miles from Sandusky and sixty from Detroit; consequently, trips to these points, although often irregular or delayed at this season of the year, are seldom discontinued for any length of time.

The season now under consideration was a very disastrous one to shipping as well as fishing interests. Ordinarily the same number of men employed in collecting spawn would have secured double the number of eggs; but bad weather compelled many idle days and necessitated an early suspension of operations by the fisherman, thus forcing the spawn-gatherer to discontinue operations when the meridian line of the spawning season had barely been passed. The result of their efforts, then, should not be the standard by which calculations for future work should be made. It must not be inferred, though, that the severity of the weather was so much responsible for the deficit in the number of

eggs obtained as the brevity of the season, for it has been equaled in this respect by many of its predecessors, and probably will be by many successors. It should be understood that procuring eggs of the whitefish is invariably attended with labors, exposures, difficulties, and dangers not met with in similar work with any other kind of fish; but, owing to their great fecundity, large numbers of eggs can be obtained with adequate help. Local causes alone are responsible for the hardships frequently experienced in their procurance. The spawning season of the whitefish occurs at that time of the year when the great lakes, proverbially rough and treacherous, are seen at their worst; squalls are common, severe storms frequent, and high winds prevail. But the fisherman, as well as the spawn-gatherer, must "Make hay while the sun shines," and the little tug-boat or pound-boat often puts out in a heavy sea, the attempt appearing almost foolhardy to the ordinary landsman. Under these circumstances, with the boat tossing about so violently that equilibrium is maintained only with the greatest difficulty, spawn-taking is necessarily a slow and arduous work; but when the wind, that is strong enough to almost deluge the boat and its occupants with spray, is cold enough to convert the spray into ice, existing difficulties are magnified and multiplied, the situation becomes perilous, and the suffering from cold and exposure, from which there is no escape in the pound-boat, is intensified almost beyond physical endurance.

OPERATIONS AT THE HATCHERY.

As will be gathered from previous notes, the total number of eggs shipped to the hatchery was 14,780,000; all of which were received in prime condition with the exception of the last lot of 1,000,000 from Alpena, which were thrown away as soon as received, as but very few, if any, were free from the little white spot, the death mark. The actual number, then, deposited in the hatching boxes and jars was 13,780,000, and this is the number, of course, on which the hatching percentages are based. They were distributed as follows:

100 hatching-boxes, 6 trays each, 8,000 to the tray	4,800,000
40 hatching-jars, 150,000 to the jar	6,000,000
15 hatching-jars, 125,000 to the jar	1,875,000
10 hatching jars, 100,000 to the jar	1,000,000
1 hatching-jar, 105,000	105,000
	13,780,000

With the exception of five jars of mixed eggs, those from the Lake Huron fish were kept separate from the eggs of the Lake Erie fish, and none of the fry of the former were planted in Lake Erie or the Detroit River.

All the eggs taken at Kelley's Island (Lake Erie) were procured in one day, November 17, by Mr. L. Carpenter, who, having no floating boxes, spread them on flannel trays after keeping them eight hours with

hourly changes of water. The trays were then removed to a cellar, where they remained until November 26, when they were brought on to the hatchery via Sandusky, arriving the next day at 11 a. m. Eggs looked well when received, but some doubts as to results were felt, no record of the temperature to which they had been exposed while in the cellar having been made. They were placed in two of the Chase jars, and watched with considerable interest. The percentage of loss was no greater than the average, and the fish began hatching at precisely the same time as other eggs of the same age. The length of time that whitefish eggs of this age may be retained on trays without material injury has not been fully determined, and experiments in this direction, as well as others in regard to their treatment at this, their most critical period, were intended to have been made, after having secured the complement of eggs for the hatchery, but the season terminated abruptly and before the desired numbers had been obtained.

The regular employés of the hatchery at this time were Mr. I. Slaght, Mr. A. W. Root, and Mr. S. Bower, and the respective duties assigned to each were well performed. Mr. Slaght was given the immediate supervision of the eggs in the hatching-boxes; Mr. Root was employed as carpenter and general assistant; and Mr. Bower was intrusted with the immediate care of the eggs in the jars, and also attended the office work.

The principal and most important of the work of the hatching-room from this time on, consisted in protecting the live eggs from the fatal presence of the dead egg of confervoid growth, and from the pernicious influences of slimy coatings and sediments. Other general work included a periodical cleaning of the tanks, troughs, trays, hatching-boxes and flannel screens, to remove slimy deposits and accumulations; making shipping cases and shipments of eggs; the construction and operation of a refrigerator; confining the temperature of the water to certain limits by the use of ice and snow when necessary; repairing old and constructing new tanks, and fitting them for the reception of the fry; and finally the general distribution of the young fishes.

In the artificial propagation of whitefish, if the eggs have been taken with a greater regard for quality than quantity, and are given special care and attention under favorable circumstances until received at the hatchery, 85 to 95 per cent. may be hatched. If the eggs have been secured under the conditions just indicated, nearly accurate calculations as to the number of young fishes to be shown at the end of the season can then be made; results can be anticipated with confidence. But approximate estimates cannot always be made from the appearance of the eggs on arrival at the hatchery, their aspect at this time generally giving no clew upon which to base computations, as the fruits of prior neglect or defective treatment may not yet be apparent; neither does the unimpregnated egg exhibit any distinguishing marks visible to the unaided eye, by which its presence may be detected. The lapse of a

few days, however, will tell the story, for the greater part of the loss during the period of incubation, be it much or little, will occur within thirty days; the "good," "bad," or "indifferent" lots received at different times and from diverse sources, if kept separate, will soon be searched out. So it was in the present instance. The eggs from Alpena, although a good lot, were decimated in numbers within the time above noted, while those from the islands proved to be unexceptionably good, the loss within the time mentioned not exceeding 5 per cent. Of the total loss of a million and a half in round numbers, during the season, nearly one million died within twenty-five or thirty days.

THE HATCHING-BOXES.

There seems to be but one way to rid the hatching-boxes of the dead eggs, viz, pick them out one by one as they appear. For this purpose a shallow picking trough running parallel with the rows of hatching-boxes, and of the same length, is arranged along the side of the hatching-room facing a row of windows. The little nippers or tweezers for removing the eggs are spherical at the picking end, so that when closed they are just large enough to hold the egg without crushing it. Girls were employed for picking the eggs—as many as were needed to look over all the hatching-boxes at least once in two days.

The eggs, boxes, and trays received a weekly washing, a process accomplished with the eggs by simply agitating the tray in a tub or tank of water. The tray is then transferred to the picking trough, a clean tray fitted over it and the whole quickly overturned and immersed in a tank of clean water, when the eggs will be changed to the clean tray. The compartments containing the hatch-boxes are provided with plugs, which, being removed, the whole is quickly washed and cleansed, a waste trough underneath running the entire length of the rows of boxes.

It is of great importance that the dead egg should be removed very soon after the little white spot—the first positive evidence of its death visible to the naked eye—is apparent. This is rendered imperative from the rapidity with which confervoid growth develops on dead eggs lying motionless on the trays, and which, if undisturbed, soon reaches out from an individual egg and embraces within its deadly grasp the circle of eggs surrounding it, and these again in turn soon destroy another circle, and so on. This growth starts much quicker and creeps out faster from eggs of the whitefish than from any of the large eggs of the Salmonidæ, as *Salmo fontinalis*, *Salmo quinnat*, *Salmo iridea*, &c., and the same rule holds good with respect to eggs of the whitefish incubating in the jars, in which the morbid growth is usually delayed from five to ten days after the death of the egg, doubtless due to the constant motion imparted to the eggs by the upward current of water.

From about the tenth to the thirty-fifth day the eggs in the hatching-boxes require special attention, for not only does the greatest mortality occur during this period, but the contact of diseased growth is espe-

cially destructive to the live eggs at this time, it being the most critical period in the life of the egg, so far as the influence of confervaceous growth is concerned. During the period just mentioned, and with a temperature of water ranging from 40° to 45°, ten dead eggs scattered equidistant on a 7 by 12 tray containing 10,000 live eggs (in water) will soon accomplish the destruction of the remainder, if allowed to remain undisturbed. Eggs thus neglected are doomed.

From the thirty-fifth to the forty-fifth day the eyes of the embryo become plainly visible, and the egg from this time on may remain in contact with fungous growths much longer than previously without injury. From this time on, too, the work of caring for the eggs continually lessens.

THE HATCHING JARS.

With reference to bringing forward eggs of the whitefish in hatching boxes and applicable more particularly to the earlier stages of development, it may truthfully be said that "eternal vigilance" is the price of success. But this statement cannot be made concerning the development of embryos in the Chase hatching jar; for, while incubating in this manner, the eggs are not subjected to critical periods, and thus the necessity of a constant surveillance at certain times is obviated. Happily, too, the introduction of the jar does away with the primitive one-by-one-picking process with nippers, unavoidably a slow and tedious operation requiring the persistent patience of a Chinaman. The jar, then, greatly lessens and simplifies the work, thereby reducing the expense to a nominal figure. Safety and economy constitute its chief points of superiority over any hatching device in which the eggs are stationary, or, at best, have but very little movement; more economical, because one man having but little experience or instruction can readily care for 20,000,000 eggs; and safer because the dead eggs are separated by the natural operation of the jar as soon as confervoid growth begins. Previous to this growth, however, separation of the dead from the living eggs by any mechanical arrangement of currents or counter currents would seem to be impossible as there is no apparent difference in their specific gravity; but the spongy filaments of morbid growth, without materially increasing the weight of eggs thus affected, present a greater surface to the influence of the current which, having an upward tendency, carries and retains them either against the gate or just above the surface of the mass of eggs whence they are easily syphoned away. Unless great care, demanding considerable time, is observed, and which is not at all essential, the syphon will draw away many good eggs, and frequently good eggs will be found with the bad ones at the gate; but when all such are transferred to a separate jar, a solid layer of varying depth of the worst eggs will soon rise to the surface and can then be drawn away without disturbing the remainder.

During the early part of the season, the eggs collecting at the wire gate and those hovering over the mass of eggs were removed twice daily

and placed in a separate jar or jars, conveniently named "hospital" or "pest" jars; while later on only a daily treatment was needed, and during the last six weeks preceding the hatching season a weekly manipulation in this manner sufficed to keep the eggs in excellent shape. The "hospitals," of course, were relieved of their extraneous eggs whenever a sufficient number had collected in bunches or layers to be drawn away unaccompanied with good ones.

The wire gates were cleaned at least once a day throughout the season until the eggs began hatching, when they were removed to allow the fry and shells to float off, the supply of water for each jar being slightly decreased at this time to prevent eggs from being thrown overboard also. If the jars could be made exactly perfect, thereby compelling a uniform current of water to flow from all points of the base of the tube, the upward current might probably be so nicely adjusted as to throw off only fungoused eggs, in which event the gate and syphon could be dispensed with, thus making a complete self-picking apparatus; but the slightest imperfection in the jar or tube—found to exist in every one in use during the season—will create unequal currents, the stronger ones throwing good eggs against the gate, the weaker having strength barely sufficient to carry the light eggs to the surface but not enough to expel them; hence the necessity of a little assistance to complete the elimination, and which is undoubtedly accomplished more readily by the syphon than any other way.

NOTES, ETC.

One convenience, and probably the only one, of the hatching boxes over the jars is, that eggs in the former receiving a tri-weekly picking are nearly ready for shipment at all times, it being important of course in shipping eggs that all dead eggs should be removed; this the jar will not do; it separates only those made buoyant by confervoid growth, and the picking trough must be resorted to to complete the work; hence a few trays and nippers and the picking trough will be found almost indispensable accessories, and should be retained in the hatching room where jars have displaced the boxes.

Although the collection of eggs of the whitefish is attended with hardships seldom if ever experienced in gathering eggs from any other kind of fish, yet from the date of their introduction into the hatchery they can be brought forward with much less trouble and expense (when the jar is used) than the eggs of any other member of the salmonoids; and, furthermore, greater percentages can be hatched than from any other salmonoid, or from the shad. As compared with the latter, which are equally as well adapted to bulk methods of hatching, the difference in the temperature of water in which they are incubated must be charged with the difference in mortality, the rapidly growing fungous of the warmer water necessarily destroying a greater number of embryos. As compared with the former, over which they may have no advantage in

water temperatures, the difference in favor of eggs of the whitefish must be credited to their ready adaptability to the bulk method of hatching; for not only can eggs be developed in this way at a greatly reduced outlay of labor and expense, but it is a safe assertion to make, susceptible of proof by any one who will make a fair trial, that the jar will hatch 5 per cent. more eggs than any hatching box now in use, other things being equal. The deficit with the latter method may be charged to the frequent handling of the eggs, changing from the boxes to the picking trough and return, but more than this, to the quick thrusts of the nippers amongst the eggs when picking, and which alone unavoidably injures or kills outright throughout the season nearly 5 per cent., at a low estimate.

The average yield of eggs from the whitefish may be computed at 20,000 for each female spawner, although as many as 75,000 were taken from single specimens in two instances at the islands; but this was a very extraordinary yield, as such extreme fecundity is rarely found. Eggs on trays were estimated on a basis of 64 to the square inch and in bulk on a basis of 36,800 to the quart, this number being almost absolutely correct, having been determined by actual count of a fractional part of the quantity taken as the standard.

RETARDING EGGS.

For the purpose of experimenting with a view to retarding the development of eggs, about 10,000 taken October 31 were spread in double layers on flannel trays December 8, and the whole arranged in a small refrigerator previously charged with ice and placed in the corner of the hatching room farthest removed from the stove. No special care was given them other than to keep the chambers well filled with fine ice and to give the eggs a weekly picking and sprinkling, care being taken to thoroughly drain the trays before replacing, and also to avoid exposing the eggs to a greatly increased temperature while being picked, a work usually performed in the morning before the room had become too warm for the purpose. Very few eggs had died up to December 29, fewer probably than if they had remained in water, but of course this is simply a matter of conjecture. A record of the temperatures both inside and outside the refrigerator was made three times daily. The extremes previous to December 29 were: inside 30° and 31½°, and outside 30° and 46°. The eggs were in splendid condition on the date mentioned, when the temperature of 30° was recorded at 8 p. m.; but the next morning the temperature of the hatching room had fallen to 21°, 9° colder than the refrigerator had been subjected to, while inside, the thermometer marked 27° and the eggs were all dead. The fact that not a single live egg could be found, proves conclusively that eggs of the whitefish will not live in an atmosphere of 27°.

Meanwhile, a larger refrigerator was made, having seven chambers fitted with slides of the proper size to admit the flannel trays of the

carrying cases, thus avoiding the expense of new trays by utilizing those on hand. This was completed December 22, and the following day 1,000,000 eggs from a lot received at the hatchery November 6, were placed in chambers 1 and 2; January 5, 1,500,000 from lot received November 13, were transferred to chambers 3, 4, and 5; and the remaining chambers were filled January 12, with 1,000,000 eggs from lot received November 13. The eggs were treated the same as those in the smaller refrigerator in regard to sprinkling and picking, but the temperature inside the larger one was maintained one degree higher on an average, while 29° was the lowest limit allowed the atmosphere surrounding it. The temperature inside ranged from 31° to 34°, averaging 32°. The eggs from section one, one-half million, were removed January 10, for shipment to Iowa. Section 3, containing the same number, was likewise emptied January 13, for Kentucky and Minnesota shipments. The two and one-half million remaining were retained in their respective sections (2, 4, 5, 6, and 7) until February 1, when all were transferred to the hatching jars. A jar of eggs from section 2 began and completed hatching almost simultaneously with eggs received at hatchery, November 18, showing a retardation of twelve days. By comparison with eggs of various ages continuously developed in water, sections 4 and 5 showed a detention of ten days, and sections 6 and 7 a retardation of 9¼ days. The fry from all these were equal in vigor and development to those brought forward in the usual manner. Previous experiments in retarding eggs of the whitefish have given substantial evidence that the eggs should be taken from the water earlier in the season to secure the longest possible postponement of the hatching period.

SHIPPING EGGS.

The following table includes all shipments of eggs made during the season, except a few sample lots to Prof. S. F. Baird, Washington, D. C., Prof. S. A. Forbes, Normal, Ill., and John A. Ryder, Philadelphia, Pa.:

Eggs shipped by express.

Date of shipment.	Number of eggs shipped.	Destination.
December 17, 1880	250, 000	Fred. Mather, Newark, N. J.
December 22, 1880	500, 000	E. M. Stilwell, Bangor, Me.
January 10, 1881	500, 000	B. F. Shaw, Anamosa, Iowa.
January 13, 1881	250, 000	R. O. Sweeney, Saint Paul, Minn.
January 13, 1881	250, 000	Wm. Griffith, Louisville, Ky.
January 17, 1881	250, 000	B. B. Redding, San Francisco, Cal.
January 19, 1881	500, 000	E. M. Stilwell, Rangeley, Me.
January 22, 1881	250, 000	Wm. Griffith, Louisville, Ky.
February 3, 1881	25, 000	Mrs. H. C. Fenstermaker, Eureka, Nev.
February 5, 1881	250, 000	B. B. Redding, San Francisco, Cal.
February 12, 1881	100, 000	S. Weeks (for R. B. Wright), Corry, Pa.
Total	3, 125, 000	

All eggs prepared for shipment were subjected to a critical picking, and were spread and packed in an atmosphere ranging from 29° to 35°. The first lot, to Mr. Mather, were spread in double layers on trays of

Canton flannel with a piece of the same material corresponding in size to the inside of the tray frames spread over the eggs; the trays were throroughly soaked in water before receiving the eggs, and a narrow margin left unspread so that no eggs came in contact with the frames; the flannel covers were similarly saturated in cold water and partially wrung out, but were allowed to retain all the moisture possible without dripping; the trays were then placed one above the other in two equal lots for the two cases in which they were to be shipped, each lot resting on an inch board on which was spread a piece of wet Canton flannel, and having a second board and flannel on top for a cover (the flannel, of course, being on the under side of the cover), and all held to position by strips on the ends and sides tacked to the top and bottom boards. The packages were then removed to their respective cases and entirely surrounded with a 6-inch coating of fine, dry, hard-wood shavings, quite firmly packed in by stamping with the feet. This consignment of eggs was repacked and shipped to Germany by Mr. Mather.

The following extract from a communication from Mr. von dem Borne to the *Forest and Stream* of February 17, 1881, concisely states the condition of the eggs on arrival: "The whitefish eggs recently sent over by favor of Professor Baird arrived almost without loss. They are very healthy, and are now developing in my hatching troughs."

MAINE.—Reports from the two shipments of one-half million each to Maine are not so favorable. The first was packed precisely the same as those sent to Mr. Mather, with the exception of using trays twice as large, to carry twice as many eggs in the same number of cases, the latter being made larger to correspond. Notwithstanding the fact that "whitefish eggs" was displayed in large letters on the covers of the cases, coupled with a special request to express messengers and employés to exercise great care in handling, and to "keep this side up under all circumstances and place the case as far as possible from the stove in the car," they were evidently subjected to rough treatment while *en route*, and were probably allowed to get too warm in the car.

Commissioner Stilwell wrote, January 12, in reference to their appearance when unpacked, that "the eggs had undoubtedly been roughly handled on the route, as they had been, apparently, rolled from one side to the other, and were piled together in the corners of the trays," and that they were looking so badly that less than 40 per cent. could be saved.

The second lot forwarded to Maine, packed in one large case, arrived in better shape than the first. The following letter addressed to F. C. Hervey, to whose care this shipment was made, shows the manner of packing:

"NORTHVILLE, MICH., *January* 19, 1881.

"DEAR SIR: In accordance with instructions from the United States Fish Commission, I ship you per express to-day 500,000 whitefish eggs, and trust they will reach you in better condition than the former lot. They are packed as follows: The first ten trays on top have the flannel

coverings drawn down close to the eggs and secured by strips tacked to the tray frame. This ought to prevent rolling or accumulation of the eggs in case the box is overturned while in transit. The next five trays have moss in addition to the cloth covering; the next four are precisely the same as all were in the preceding lot sent you, and the last tray is covered with snow.

"Please note carefully the condition of the eggs in each method of covering and communicate the facts to me.

"Yours, very truly,

FRANK N. CLARK."

Unfortunately, the eggs preceded the arrival of the letter, which was forwarded the same day, and no accurate note of their precise condition was reported. It is fair to presume, however, that there was no marked difference in results, or the party opening the case doubtless would have noticed it.

The following extracts from letter of Commissioner Stanley, dated February 28, embrace the facts relative to their condition when received:

"In appearance they were in very good condition when they arrived at their destination, although they were considerably shaken up and had apparently received very rough usage on the route. After being placed in the hatching-boxes the loss has been large. I should judge by appearances now that if we can save 50 per cent. of them we will do well. * * * They must have been in good condition when packed, as I have examined them carefully and could find none but what were impregnated and well developed."

And, again, from letter of April 19, in reference to the disposition of the fry:

"Your favor inquiring about our whitefish eggs received this day. Would say we have just deposited the fry into the Mooslucmaguntic Lake, one of the Rangely chain of lakes. Both lots were placed in the same lake. Of the last lot, about 50 per cent. hatched; of the first, about 25."

IOWA.—The half million eggs to Iowa were prepared exactly the same as the first lot to Maine, except being placed in one large case instead of two smaller ones. The following from Commissioner Shaw shows their condition on arrival at destination:

"I found the whitefish eggs in fair condition on opening at Spirit Lake, except that some of them were a little matted with fungus. I was delayed two days by a very bad snow-storm, but kept the eggs in a cool place, however, and succeeded in getting them safely through. I was much surprised to see nearly 10,000 young fish hatched out the next morning after eggs were put into the water, all the more so as the water was only just above freezing. There were quite a number hatched in the box upon opening, and I am of the opinion that a portion of the eggs were a little too far advanced when shipped."

Some of the eggs being matted together with fungus indicates that they were exposed to a considerable warmth during their journey; for

eggs in the refrigerators—arranged practically the same as those intended for shipment—although exhibiting fungous growth a few days after dying, in a temperature of 32° or 33°, exerted no baleful influence on the live eggs within a much longer period than that occupied in making this shipment—due to the very slow formation of fungous growths on dead eggs out of water, in the temperature above noted.

From the reports of the careless handling and treatment which the cases of eggs had evidently undergone at the hands of express employés, it was very obvious that but little heed was paid to the precautions conspicuously lettered on the cases; and concluding that a special order from the superintendent of the express company would be more effectual, a personal interview was held with that courteous official, Mr. J. S. Hubbard, with the result of receiving his indorsement to the following, which appeared on all subsequent shipments; and by his instructions the Northville agent was required to attach a duplicate to the way-bill accompanying each consignment:

"*To express messengers and employés:*

"You will observe the following regulations in regard to the care and handling of cases containing fish eggs:

"Place the case as far as possible from the stove in the car.

"The case must never, under any circumstances, be overturned, but kept right side up with care.

"Do not delay or detain, but forward as expeditiously as possible; but where detention for any length of time is unavoidable, as in case of accident or non-connection of trains, place the eggs in a room containing no fire.

"This order must be countersigned by Frank N. Clark, superintendent United States fish hatchery, Northville, Mich.

"J. S. HUBBARD,

"*Superintendent American Express Company.*"

"Countersigned:

_____,

"*Superintendent United States Hatchery.*"

Thereafter but one instance of carelessness in regard to rough handling of the cases was reported (second lot to Maine), but protection from too great a degree of warmth was not secured in every instance, for which, however, messengers could not be held accountable, their whole duty having been performed when the eggs were placed as "far as possible from the stove in the car," a point not necessarily removed from too great a degree of heat for the safety of the eggs.

MINNESOTA.—Eggs shipped in one case of ten trays, 25,000 to the tray, packed as usual. A communication from Commissioner Sweeney in reference to these eggs contains the following:

"The eggs came on the 15th instant and were, except two trays, in good order. These two trays were frozen, and we feared all the eggs were killed that were on them, but now they are hatching very freely, and the frosted ones seem as vigorous and forward as the others. The

outer eggs on the two frozen trays were killed, but those in the center seem all right, notwithstanding they were frozen or caked together."

It will be seen from this that a little freezing is not so disastrous as overheating.

Later on, Superintendent Watkins reported on the disposition of the fry as follows:

"January 25, deposited in White Bear Lake, Ramsey and Washington Counties, 80,000 whitefish fry; January 29, deposited in Minnebonka Lake 100,000; February 8, deposited in Gervais Lake 50,000; total, 230,000. Some of the trays were frozen around the edges when received; loss, including the frozen ones, 20,000."

KENTUCKY.—First lot packed precisely the same as the one forwarded to Minnesota same day (January 13). The following is from letter, dated January 15, from Wm. Griffith, President of Kentucky Board of Fish Commissioners:

"The whitefish eggs arrived yesterday, and were placed in troughs at hatch-house yesterday evening. My man has just reported to me that the eggs opened in better condition than any lot he has ever before received. He reports 293 dead eggs, and the embryo moving, and thinks they will soon commence hatching."

Again, from same source, January 17:

"A messenger just in from hatch-house reports all the whitefish eggs dying. These eggs were received Friday, the 14th instant, at noon, and were placed in troughs at hatch-house late same evening; water, 38°. They appeared in splendid condition Saturday, but yesterday the weather moderated, with a drizzling rain, and the temperature of the water rose to 44°. The eggs commenced dying, and this morning about two-thirds of them were dead. * * * This misfortune is to be regretted, and is a matter of great surprise to me, as my man reported that he had never opened a lot of eggs in such apparent good condition."

Again, January 22, in which the daily loss is reported, as follows:

"I herewith annex a statement of condition of the eggs from date of receipt to present time: White-fish received and opened in apparent splindid condition.

White-fish eggs received and opened in apparent splendid condition.

	Dead eggs.
January 14, temperature of water 38°	183
15, temperature of water 38°	110
16, temperature of water 44°	5,000
17, temperature of water 40°	28,000
18, temperature of water 40°	39,000
19, temperature of water 42°	55,000
20, temperature of water 44°	12,000
21, temperature of water 40°	7,000
22, temperature of water 44°	3,400
Total to date	149,693

"The eggs commenced hatching January 16, and about 10,000 are now hatched. I think we will save about 75,000 of them."

Without attempting to assign a reason for this great mortality, or whatever the cause may have been, certainly the rise in temperature from 38° to 44° cannot be charged with the loss, for this change should have produced no decided effect, except perhaps to hatch them out very freely, the eggs being quite well advanced.

A second lot of a quarter of a million equally distributed on twenty trays was forwarded January 22. The first fifteen trays were covered as usual, *i. e.*, damp canton flannel spread loosely over the eggs: On tray No. 16 the covering was drawn down so closely as to exert some pressure on the eggs, and secured to its place by cleats tacked to the frame; No. 17 was covered with flannel as usual, and the intervening space between it and the next tray above—about one-half inch—filled with moss; No. 18 had nothing whatever over it, that is, in the way of a cover; No. 19 contained a compartment 2 inches square, which was filled with eggs to the level of the frame, or about six layers deep; and No. 20, the bottom tray, was covered with flannel and one-half inch of snow firmly packed in.

The following extract from letter of President Griffith, dated January 29, shows results:

"The last lot of white-fish eggs arrived in Louisville Tuesday the 25th instant, at 8½ a. m., and at hatch house 11 a. m., same morning. Temperature of air 26°, water 41°. Packing on top of trays dry, around trays damp. Temperature of trays 48°. Eggs all in troughs at 2 p. m. In trays from 1 to 15 inclusive were 17 dead fish and 183 dead eggs; in tray No. 16 were 2 dead fish and 12 dead eggs; in 17 were 2 dead fish and 12 dead eggs; in 18 were 2 dead fish and 12 dead eggs; in 19 were 3 dead fish and 14 dead eggs; and in No. 20 were 7 dead eggs."

The loss throughout the case being merely nominal—a small fraction of 1 per cent.—and so uniformly distributed, the inference might be drawn that the manner of covering, or, indeed, the presence or absence of any cover at all, has but little bearing on the successful transportation of eggs. The principal object of a damp cover being to supply additional moisture the evidence would clearly indicate that it might be dispensed with for shipments designed to reach consignees within three or four days, the damp trays on which the eggs are spread and the eggs themselves retaining all the moisture essential.

However, although in the present instance there was no manifest difference in results due to any special feature in the cover or between the several methods and the absence of any covering, except possibly tray No. 20, covered with snow, and on which there were no dead fish and only 7 dead eggs, or a trifle over half the average, still, the conclusion can hardly be drawn that the absence or presence of a damp covering of some kind would be immaterial for eggs conveyed long journeys; and, as it can do no harm under any circumstances, and makes provision for

insuring the proper degree of moisture in the event of a delay, and as it would seem to be quite essential for the retention of requisite moisture for long journeys, it may be regarded as nominally indispensable. But snow, which in the present instance was dry and frosty when packed, and hence exercised a salutary influence by maintaining a low temperature, can hardly be considered a safe covering either for long or short journeys, for the chances are all in favor of its melting in transit, thereby completely saturating a portion of the trays and their contents, a condition which repeated experiments have shown to be deleterious or even fatal to eggs thus situated for any length of time.

Far better results were obtained from the second lot of eggs. Two hundred and sixty thousand fish were hatched from the two lots and planted as follows, according to report of President Griffith:

"White-fish fry deposited as follows: February 3, 1881, Barren River, tributary to Green River, tributary to Ohio River, near Bowling Green, Warren County, 100,000; March 5, same place, 160,000; total, 260,000."

CALIFORNIA.—The first case to San Francisco was started January 17, and contained ten trays, 25,000 to the tray, with the flannel spread securely fastened with strips same as in last shipment to Maine. They arrived in excellent shape as the following from Commissioner Redding indicates:

"The 250,000 whitefish eggs received in good condition, not to exceed 1 per cent. loss. After regulating the temperature of the water they were placed in it and within twelve hours commenced hatching out."

A second lot of 250,000 packed precisely the same as its predecessor, shipped February 5, arriving 9 days later, was almost a total loss, as the following from Commissioner Redding will show:

"The last lot of 250,000 whitefish eggs arrived a few days ago in a terrible condition. The top layers were entirely decayed, and there seemed to be hardly any life remaining in the lower eggs. All that appeared to have life have been put in the water. I do not know of any reason for this result except probably they were detained by the snow blockade and the car was kept too warm."

The following is from a subsequent communication from Mr. Redding in reference to these eggs:

"The eggs arrived on the 14th instant. * * * The messenger in the express car usually has two stoves, one in each end of the car, to keep himself warm, and the temperature is kept too high for the transportation of fish eggs."

Mr. Redding's supposition that the eggs were allowed to get too warm is undoubtedly correct.

The report of Superintendent J. G. Woodbury, San Leandro (where the State hatchery is located), contains some interesting notes, and is given in full:

"*Whitefish shipments.*—February 5, Tulare Lake, 125,000; February 10, Mountain Lake, 10,000; February 12, Merced Lake, 10,000; Febru-

ary 14, Tahoe Lake, 100,000; March 25, to Judge McShalter, Warm County, 2,500; total, 247,500.

"The temperature of the water in which the whitefish were hatched was about 54°, ranging from 51° to 56°. The first lot of 250,000 came in splendid order, better than any ever before received from the East. After being put into the water and during the hatching, also up to and including the last shipment, the loss did not exceed 1½ per cent. Most of them hatched out very soon after being put into the hatching baskets, but were vigorous and shy, and at the end of one week began to eat pounded-up crab which they were fed on. They appeared to be very fond of this, taking in their mouths pieces of the fiber a quarter of an inch long, swimming around trying to swallow it. The white meat of the crab could be seen in their stomachs through their transparent bodies.

"The last lot of 250,000 whitefish eggs arrived (being delayed, I suppose) in very bad condition, all the top layers rotten and smelling badly. Of those put into the water only a few hatched out (four or five thousand), and in a very sickly condition. These few would not eat, and at the end of three weeks they were quite attenuated, with their heads and gills covered with fungus. During the hatching and feeding time of the first lot the water was quite muddy, so much so that the little fish could hardly see their food."

NEVADA.—February 3, a case containing 25,000 eggs was forwarded to Mrs. H. C. Fenstermaker, a lady considerably interested in pisciculture, residing at Eureka, Nev.; but for some unaccountable reason no word has ever been received as to whether they reached their destination or not. Three letters of inquiry have failed to evoke any response.

PENNSYLVANIA.—One hundred thousand eggs, packed as usual, were shipped February 12 to Corry, Pa., with the following results, embraced in a communication from the Hon. Hendrick B. Wright:

"The eggs arrived safely at Corry and were hatched and the fry delivered to me on the 18th instant. I succeeded in putting some 70,000 of them in my lake in Luzerne County, Pennsylvania, so that the matter is, so far, a success. The lake where they were deposited is known as Harvey's Lake, containing about 1,000 acres, ten miles in circumference, and in places over a hundred feet deep; it is pure spring water, and about 1,000 feet above the sea level."

Two small packages, each containing about 500 eggs, were sent by mail to Mr. John Ryder, Academy of Sciences, Philadelphia, but eggs were all dead when received by Mr. Ryder.

The results of shipping eggs of the whitefish the present season, as well as of moving them much greater distances in previous seasons, have demonstrated beyond a doubt that they can be transported to the most distant points of the globe with almost absolute certainty of a successful issue, provided the proper limits of temperature are guarded, and the eggs are not too far advanced when shipped. The essential conditions as to the means of securing the maintenance of the proper degree of moisture and of the admittance of air, can be so completely

satisfied in the preparation of packages of eggs for extended journeys as to render their inspection or repacking at intervening points entirely superfluous. But with many shipments, notably those by rail, it is not so easy to provide for guarding temperatures; that is, of course, when they are to be unaccompanied by a special messenger. Very rarely indeed will the eggs be exposed to a dangerous degree of coldness, and practically the opposite extreme is the only one to guard against. The clear, cold atmosphere produced by ice seems to be the best adapted to the preservation of the vitality of the embryos; hence, a roughly constructed refrigerator would answer every purpose, but would require special arrangements as to replenishing the ice at intermediate points along the route, and would also demand ample provisions for the disposition of the drips, otherwise the water slopping or draining in the car would doubtless subject the whole affair to extortionate express rates. The ice rooms of vessels, being uniformly cold, are especially suited to keep fish eggs in excellent condition; and for this reason foreign shipments can be made (from port to port) with a far greater degree of certainty of success than can those inland even for a short distance; in fact, the ordinary carrying cases used to convey eggs from the spawning ground to the hatchery, filled with eggs not too far advanced, and snugly ensconced in the ice room of a vessel, could safely be intrusted with a voyage across either ocean.

To obtain the best possible results, shipments should be made before the development of the embryo has proceeded too far, and therefore applications should be sent in earlier in the season.

DISPOSITION OF THE FRY.

The work of distributing the young fish was greatly facilitated and the expense materially lessened by the gratuitous assistance of several railroad companies, to whom acknowledgments are due, as follows: The Flint and Pere Marquette Railroad Company for special car from Northville to Bay City; special car, and round trip passes for messengers, from Northville to Ludington; hauling Michigan Central car from Detroit to Northville, and from the latter place to Wayne Junction, where connection is made with the Michigan Central Railroad; special car from Northville to Toledo (terminus of the line), and allowing car to go on to Sandusky; and conveying cans of fish in baggage car from Northville to Detroit. The Michigan Central Railroad for special car and round trip passes for messengers from Wayne Junction to Chicago. The Lake Shore and Michigan Southern for hauling Flint and Pere Marquette car from Toledo to Sandusky and return. The Chicago and Northwestern for transporting cans of fish in baggage cars from Chicago to Waukegan, and from Chicago to Milwaukee.

In addition to favors above noted all empty cans were returned gratis, and the first-named company carried all eggs over its line during spawn-gathering without charge.

Following is the table of distribution:

Date of removal from hatchery.	Hour.	Temperature of water in hatchery.	How transported.	Number of cans used.	Where deposited.	At what point.	Temperature of water in which fish were planted.	Number fish deposited.	Date of deposit.	Hour.	Messengers.
1881. Mar. 1	8 to 10 a. m.	38°; reduced to 33° in the cans before starting.	Special car.	68	Saginaw Bay ..	Bay City	° 32	2,000,000	Mar. 1	5 to 6.30 p. m.	F. N. Clark and S. Bower.
Mar. 8	...do	40°	...do	98	Lake Michigan.	Ludington	32½	2,000,000	Mar. 9	9 to 11.30 a. m.	Do.
Mar. 15	10 p. m., the 14th, to 3 a. m.	41°	...do	33	....do	Michigan City ..	32½	1,000,000	Mar. 15	7 to 8.40 p. m.	Clark, Bower, Root, and Horton. } One trip; one car.
Mar. 15	...do	41°	...do	33	....do	Waukegan	32½	1,000,000	Mar. 16	11.05 a. m. to 1 p. m.	Clark, Bower, and Horton, from Michigan City to Chicago; S. Bower, from Chicago to Waukegan. } One trip; one car.
Mar. 15	...do	41°	...do	33	....do	Milwaukee	32½	1,000,000	Mar. 16	12.15 to 2 p. m.	Clark, Bower, and Horton, from Michigan City to Chicago; Clark and Horton, from Chicago to Milwaukee. } One trip; one car.
Mar. 21	7.45 to 9.45 a. m.	41°	...do	50	Lake Erie	North Bass and Put-in-Bay Islands.	33	1,250,000	Mar. 23	1.30 to 4 p. m.	Clark and Slaght.
Mar. 30	8.30 to 9.30 a. m.	37°	Baggage car.	10	Detroit River ..	Detroit	33½	1,000,000	Mar. 30	12 to 1 p. m.	F. N. Clark.
Mar. 24	8 p. m	45°; reduced to 33° in can before shipping.	Express.	1	Cedar Lake	Crown Point, Indiana.	33	15,000	Mar. 26	9 a. m	Water not changed or aërated on the route; a few dead fish reported.
Total.	....	....	....	...	....	....	......	9,265,000			

FOOD OF THE YOUNG FISHES.

On December 31, a few hundred whitefish eggs taken November 1 were arranged in a perforated tin box, and placed in the spring pond in a temperature ranging from 43° to 45°. These began hatching January 15, and were all hatched out by January 24. The fry were then divided into two lots, one of which was removed to the lower spring near its source, where the water ranges from 45° to 47°. The others were set free in a tank in the hatchery, the water being quite variable, but averaging much colder than the spring. Those in the spring were offered no food, but those in the tank were given the privilege of partaking of shrimp (*Gammarus*) pounded to a pulp and diffused into the water two or three times daily. Specimens from both lots were, from time to time, sent to Prof. S. A. Forbes, Normal, Ill., who made a thorough microscopical examination of their stomach contents, and reported the results of his investigations as follows:

NORMAL, ILL., *March* 29, 1881.

F. N. CLARK, Esq.,
Northville, Mich.:

DEAR SIR: Having now finished work on the young whitefish sent me since February 1, I wish to make a connected statement of my observations and conclusions, to take the place of the rather confused memoranda I have sent you heretofore.

I have been carefully over the slides a second time, and think that there is little, if anything, more to be learned from them.

1. FRY FROM THE SPRING.

a. Received February 9.

One hundred specimens were examined from this lot. Only one had lately taken food, and this had eaten some filamentous algæ and a minute fragment of the parmchyma of some higher plant, with a few scattered diatoms.

b. Received February 17.

There were also one hundred in this lot of the fry. All were passed under the microscope, and food was found in but one. This consisted of a few particles of vegetable parmchyma, doubtless derived from the decaying plant structures in or about the water.

c. Received February 25.

In this lot there were but forty-two specimens. Six of these showed traces of food in the intestines, consisting almost entirely of filamentous algæ and a little vegetable parmchyma. Desmids and diatoms were observed in trivial number, associated with oscillatoria, &c., in a single specimen. Total from the spring, 242; containing vegetable food, 8; containing animal food, none.

2. FRY FROM THE HATCHERY.

a. Received February 9.

Ninety fishes were examined—all but four without result. In three, mere traces of dirt were seen in the intestine, and these were not dissected. In the fourth was a fragment of *Gammarus*.

b. Received February 17.

One hundred and eleven fry, of which seventeen had taken food. I dissected nine of these, and found fragments of *Gammarus* and nothing else.

c. Received February 25.

Ninety specimens examined. Food was found in fourteen. Four of these had eaten fragments of *Gammarus;* seven, small particles of the leaves and stems of vascular plants; two, larvæ of gnats; and one, a small *Entomostracan* (*Cypris*) entire.

d. Received March 15.

There were thirty-nine specimens in this lot, and food was visible in fourteen. I dissected nine of these, finding fragments of *Gammarus* in four, larvæ of gnats in three, and a minute vegetable fragment, a *Cyclops*, a *Cypris*, and some undetermined *Entomostracan* each in one.

Thus there were 340 fry in all examined from the hatching house, in 47 of which (14 per cent.) more or less food was discernible. Of the 35 dissected, 18 had eaten fragments of *Gammarus;* five, minute insect larvæ; four, *Entomostraca;* and eight, small particles of vegetation.

Taking these facts in connection with the appearance of teeth on the lower jaw at the time the egg-bag is entirely absorbed, I am very well satisfied that the earliest food of this fish consists of *Entomostraca*, with probably some admixture of filamentous algæ. As the gill-rakers are not developed at this early age, I don't think that any smaller objects could be separated from the water, except by accident.

The *Gammarus* "hash" evidently makes a very good substitute for the *Entomostraca*. It is, however, less nourishing, as much of the soft tissues of the *Gammari* must be lost in pulverizing the crust—a fact indicated also by the greater quantity of oil found in the intestines of those fishes which have taken *Entomostraca* entire.

Very truly, yours, S. A. FORBES.

The following, from a previous letter from Professor Forbes, is very valuable and interesting in this connection:

"An observation made to-day practically settles to my mind the earliest food of the whitefish. As you are of course aware, the adult fish is quite toothless. The young are likewise without teeth until the egg-

sack has nearly disappeared. At that time the lower jaw develops four strong, sharp canines, which curve backward and inward, forming stout hooks, two on the front of the jaw and two at the sides. It is evident that these hooks are for the seizure and retention of a living prey. Such a provision would be useless for protozoa or rotifers, or any other animals as minute as these, and the fish itself is too small to eat anything as large as an amphipod crustacean. The whole apparatus is, however, well adapted for the capture of *Entomostraca* and minute insect larvæ, and it is very probably upon these that the little fish depends for its principal food."

The egg-sac of the fry in the warmer spring water disappeared some faster than with those in the hatchery, the fish developing in size to correspond; but their growth, however, was very slight. But a few days after the absorption of the egg-sac the fish began dying, and by March 1 were all dead.

Those in the hatchery fared somewhat better. After the last lot were sent to Professor Forbes (March 14) about 40 or 50 remained, some of which lingered along until April 10, when the last one disappeared. The nourishment derived from the scant animal life found in the water, supplemented by the meager sustenance afforded by the few particles of *Gammarus* eaten, although prolonging their lives several days after the egg-sac was gone, was quite insufficient to sustain life for any length of time.

On March 18 about 200 young fish (hatched March 5), having their egg-sac nearly absorbed, were placed in a tank 2½ feet deep by 1½ in width and 4 in length, supplied with water from two one-inch spigots. These were offered *Gammarus*, as before; but as soon as the sac was entirely consumed they commenced dying quite rapidly, until only about 20 remained on the 25th of April. These had grown a trifle in length, but were quite attenuated. A change of diet was then tried with better results to date (May 25) and prospectively. Liver and kidney, chopped into very fine particles, was substituted for the *Gammari*. The chopping process of preparing the food seems to be much better than pounding (the only way practicable with the *Gammarus*), as a minute subdivision of the mass is obtained without destroying the nutritious value of the particles by pounding out the soft tissue, leaving nothing but fiber.

The fact that *fragments* of *Gammarus* were found in the stomachs of the fry dissected by Professor Forbes would indicate clearly that their food must not be too impalpable before the gill-rakers are developed. This is corroborated by the conduct of the little fellows when fed the *Gammarus* "hash." They would invariably attack the larger particles first—those quite too large to be swallowed; these would be held by the mouth of the fish for a second or two, then spewed out and almost immediately seized again—an operation that was repeated until the particle had subsided to the bottom of the tank; then the smaller par-

ticles, more perfectly held in suspension by the water, would be taken in the mouth as before, and many of these they succeeded in swallowing.

At the present writing (May 25) eight of the twenty specimens fed on liver and kidney since April 25 remain. Seven of these have attained lengths varying from ¾ to 1¼ inches, while one has grown to fully 1½ inches in length.

From the fact that the fry in the spring, being deprived of animal food, lived but a short time after the consumption of the sac, and also from the fact that a portion of those supplied with animal food are to-day alive and growing, the evidence is clearly established that animal life is absolutely essential for their subsistence in early life, whatever the adult fish may feed upon.

SUMMARY.

Number of eggs deposited in hatching boxes and jars		13,780,000
Number of eggs shipped	3,125,000	
Number of fish distributed	9,265,000	
Loss	1,390,000	
		13,780,000

Expenses of the work, including repairs to hatchery and ponds, and expenses of distribution of fry	$4,003.35
Less inventory of property on hand paid from above amount	459.80
	$3,543.55

Comparing the number of eggs shipped and fish distributed with the number of eggs procured, it will be seen that the average percentage brought forward was, approximately, 90, and the average cost per million, $286.

Record of temperature observations made at Northville, Mich., from November 1, 1880, to April 1, 1881, by S. Bower.

Date.		Temperature of—						Wind.						Condition of—			
Day of week.	Day of month.	Air, 8 a. m.	Water, 8 a. m.	Air, 1 p. m.	Water, 1 p. m.	Air, 5 p. m.	Water, 5 p. m.	Direction, 8 a. m.	Intensity, 8 a. m.	Direction, 1 p. m.	Intensity, 1 p. m.	Direction, 5 p. m.	Intensity, 5 p. m.	Sky, 8 a. m.	Sky, 1 p. m.	Sky, 5 p. m.	Water.*
		°F.	°F.	°F.	°F.	°F.	°F.										
Monday	Nov. 1	33	45	53	47½	42	45	S.W.	Gentle	W.	Strong	S.	Gentle	Clear	Lt. clouds.	Clear	....
Tuesday	Nov. 2	32	45	53	48	48	48	S.E.	do	S.E.	Gentle	S.	do	Lt. clouds.	Clear	do	....
Wednesday	Nov. 3	34	45	64	49	60	50	S.	Calm	S.E.	do	S.	do	do	Cloudy	Cloudy	....
Thursday	Nov. 4	50	48	56	50	60	50	S.	Gentle	S.E.	do	S.	do	Cloudy	Rain	do	....
Friday	Nov. 5	56	50	53	51	48	52	S.W.	do	S.W.	do	W.	Strong	do	Cloudy	do	....
Saturday	Nov. 6	34	46	32	44	32	44	N.	do	N.W.	Fresh	W.	do	do	do	do	....
Sunday	Nov. 7	28	38	34	40	33	42	W.	Strong	W.	do	W.	Gentle	Clear	Clear	Clear	....
Monday	Nov. 8	34	42	40	43	40	42	W.	Gentle	W.	Gentle	W.	do	do	do	do	....
Tuesday	Nov. 9	38	42	52	48	50	48	W.	Calm	S.	do	S.	do	do	Lt. clouds.	Lt. clouds.	....
Wednesday	Nov. 10	44	46	48	47	56	48	S.	Gentle	S.E.	do	S.E.	do	H'vy cl'ds.	Cloudy	Rain	....
Thursday	Nov. 11	38	46	38	45	40	44	S.W.	Fresh	W.	Strong	W.	Strong	Cloudy	do	Cloudy	....
Friday	Nov. 12	32	39	33	39	30	40	W.	Strong	W.	Fresh	W.	Very gentle	do	do	do	....
Saturday	Nov. 13	26	38	38	39	36	42	W.	Gentle	W.	Gentle	S.W.	Gentle	do	do	do	....
Sunday	Nov. 14	33	38	44	40	36	42	S.W.	do	S.W.	do	S.W.	do	do	do	do	....
Monday	Nov. 15	22	35	26	38	25	38	W.	do	W.	Fresh	W.	Fresh	do	do	do	....
Tuesday	Nov. 16	26	36	32	38	26	38	W.	Fresh	W.	do	W.	Gentle	do	do	do	....
Wednesday	Nov. 17	16	34	22	36	26	38	W.	do	W.	do	W.	Fresh	do	do	Clear	....
Thursday	Nov. 18	6	36	19	37	14	38	W.	Gentle	N.W.	do	W.	Strong	Clear	Clear	do	....
Friday	Nov. 19	0	36	22	38	13	38	W.	do	N.W.	Gentle	W.	Gentle	Lt. clouds.	do	Cloudy	....
Saturday	Nov. 20	7	36	20	38	18	38	W.	do	N.W.	Fresh	W.	Strong	Clear	Cloudy	Clear	....
Sunday	Nov. 21	6	34	10	34	1	35	W.	Strong	W.	Strong	W.	do	Cloudy	do	do	....
Monday	Nov. 22	−10	34	15	36	8	37	W.	Fresh	W.	do	W.	Fresh	Clear	do	Cloudy	....
Tuesday	Nov. 23	2	37	22	37	24	38	W.	Gentle	W.	Gentle	S.W.	Gentle	do	Clear	do	....
Wednesday	Nov. 24	15	37	22	38	21	38	S.	do	S.W.	do	S.W.	do	Cloudy	Cloudy	do	....
Thursday	Nov. 25	14	38	22	38	18	39	S.W.	do	N.E.	do	N.E.	do	do	Clear	do	....
Friday	Nov. 26	0	38	29	38	25	38	S.E.	do	S.E.	do	E.	do	Clear	do	do	....
Saturday	Nov. 27	16	38	32	39	26	39	S.W.	do	S.W.	do	E.	do	Cloudy	Cloudy	do	....
Sunday	Nov. 28	22	38	22	39	30	39	S.W.	do	S.W.	do	S.W.	do	do	do	do	....
Monday	Nov. 29	21	39	30	39	18	39	W.	Strong	W.	Strong	W.	Strong	Clear	do	do	....
Tuesday	Nov. 30	2	37	28	39	25	39	W.	Gentle	W.	Fresh	W.	do	do	do	do	....
Wednesday	Dec. 1	26	39	28	40	27	40	W.	do	N.W.	Gentle	W.	do	Lt. clouds.	do	do	....
Thursday	Dec. 2	29	39	29	39	26	39	N.W.	do	N.W.	do	N.W.	Gentle	do	do	do	....
Friday	Dec. 3	19	38½	30	40	28	39	S.W.	do	S.W.	do	S.W.	do	Cloudy	Clear	Clear	....
Saturday	Dec. 4	15	38½	38	40	31	38	W.	do	S.W.	do	S.W.	do	Clear	Cloudy	Cloudy	....

Sunday	Dec. 5	26	42	38	40	38	38	S.W.	Fresh	W.	Strong	W.	Strong	do	do	do	
Monday	Dec. 6	12	34½	28	35	15	35	N.W.	Strong	W.	Gentle	N.W.	Gentle	Cloudy	do	do	
Tuesday	Dec. 7	9	32	12	34	6	35	N.W.	do	N.W.	Fresh	N.W.	do	do	Clear	Clear	
Wednesday	Dec. 8	8	33½	16	36	6	37	N.W.	Gentle	N.W.	Gentle	N.W.	Fresh	do	do	do	
Thursday	Dec. 9	10	36	16	38	15	38	N.W.	do	N.W.	Fresh	N.W.	do	do	do	Cloudy	
Friday	Dec. 10	10	38	15	38½	20	38½	W.	do	W.	do	S.W.	do	do	do	do	
Saturday	Dec. 11	12	38	31	38½	30	39	N.W.	do	W.	do	W.	do	Clear	Lt. clouds	do	
Sunday	Dec. 12	34	39	36	40	32	41	W.	do	S.W.	do	S.W.	Gentle	Cloudy	Cloudy	do	
Monday	Dec. 13	30	40	33	40½	28	41	N.W	do	W.	do	W.	do	do	do	do	
Tuesday	Dec. 14	33	41	35	41	34	40	S.W.	do	W.	do	W.	Fresh	do	do	do	
Wednesday	Dec. 15	30	40	33	40	30	39	W.	Fresh	W.	do	W.	do	Clear	do	do	
Thursday	Dec. 16	22	38	24	38	28	38	NW.	Gentle	N.	do	N.	do	Lt. clouds	do	do	
Friday	Dec. 17	21	37	25	37	36	37	W.	do	N.	do	N.	do	H'vy cl'ds	do	do	
Saturday	Dec. 18	20	37	22	38	18	38	N.E.	do	N.E.	Gentle	N.	do	do	do	Clear	
Sunday	Dec. 19	20	37	20	38	24	38	N.	do	N.W.	do	N.W.	do	do	do	Cloudy	
Monday	Dec. 20	26	38	27	38	26	38	N.E	do	N.E.	do	N.E.	Gentle	Cloudy	do	do	
Tuesday	Dec. 21	23	36½	26	38	26	37	N.W.	do	N.E.	do	N.E.	do	Clear	do	do	
Wednesday	Dec. 22	20	38	27	38	27	37	N.E.	do	S.E.	Fresh	S.E.	do	Cloudy	do	do	
Thursday	Dec. 23	24	39	30	39	28	38	N.E.	do	S.E.	do	S.E.	do	do	do	do	
Friday	Dec. 24	26	38	27	38	27	38	S.E.	do	S.W.	Gentle	S.W.	do	do	do	do	
Saturday	Dec. 25	23	37	28	38	27	37	S.E.	do	E.	do	E.	do	do	do	do	
Sunday	Dec. 26	28	37	20	38	30	38	S.E.	do	N.E.	do	N.E.	do	do	do	do	
Monday	Dec. 27	26	38	20	37	6	35	S.E.	Strong	W.	Strong	W.	Strong	do	Clear	Clear	
Tuesday	Dec. 28	− 4	32	6	32	0	32	N.E.	Gentle	W.	Gentle	W.	do	Clear	Cloudy	Cloudy	
Wednesday	Dec. 29	−15	33	− 8	34	−12	32	W.	Strong	S.W.	Strong	W.	do	do	Clear	Clear	
Thursday	Dec. 30	− 5	33	7	35	− 2	35	N.W.	Fresh	W.	do	W	Fresh	do	do	Cloudy	
Friday	Dec. 31	−10	34	6	35	2	36	W.	do	N.W.	do	N.W.	do	do	do	Clear	
Saturday	Jan. 1	− 2	34	16	37	11	38	W.	Gentle	S.W.	Gentle	S.W.	Gentle	do	do	do	
Sunday	Jan. 2	− 4	36	14	37	10	37	S.	do	S.W.	do	S.W.	do	do	do	do	
Monday	Jan. 3	16	38	28	38	24	38	W.	Fresh	W.	Fresh	W.	do	Cloudy	do	Cloudy	
Tuesday	Jan. 4	20	37½	27	38	23	37½	W.	do	S.W.	do	S.W.	do	do	do	do	
Wednesday	Jan. 5	7	37½	21	38	26	38	S.W.	Gentle	S.E.	do	S.E.	do	Clear	Cloudy	do	
Thursday	Jan. 6	21	37	30	38	36	38	S.W.	do	S.W.	do	S.E.	Fresh	Cloudy	do	do	
Friday	Jan. 7	16	37	24	37	15	36	S.E.	do	S.E.	Gentle	S.E.	Gentle	do	do	do	
Saturday	Jan. 8	−11	34	16	36	4	36	N.E.	Fresh	N.E.	Fresh	N.E.	do	Clear	Clear	Clear	
Sunday	Jan. 9	12	35	20	36	18	37	N.E.	Gentle	N.E.	do	N.E.	do	Cloudy	Cloudy	Cloudy	
Monday	Jan. 10	4	35	16	37	4	37	N.W.	do	N.W.	Light	N.W.		Clear	Clear	Clear	
Tuesday	Jan. 11	−12	34½	25	36	2	36	N.W.	do	E.	Gentle	N.W.		do	Cloudy	do	
Wednesday	Jan. 12	2	35	30	36	26	37	N.W.	do	N.E.	do	N.E.		Cloudy	do	Cloudy	
Thursday	Jan. 13	32	37	29	36	12	36	S.W.	do	S.E.	do	S.W.		do	do	do	
Friday	Jan. 14	− 9	32	2	33½	− 7	34	W.	do	S.W.	Fresh	W.		Clear	Clear	Clear	
Saturday	Jan. 15	9	34	20	36	12	35	S.W.	do	S.W.	Gentle	S.W.		Lt. clouds	Lt. clouds	Lt. clouds	
Sunday	Jan. 16	12	36	24	36	22	36	S.W.	do	S.W.	do	S.W.		Cloudy	Cloudy	Cloudy	
Monday	Jan. 17	6	35	19	37	− 4	36	N.W.	do	N.W.	do	N.W.		Clear	Clear	Clear	
Tuesday	Jan. 18	3	35	10	35	4	35	S.E.	do	S.E.	Fresh	S.E.		Cloudy	Cloudy	do	
Wednesday	Jan. 19	−12	35½	28	37	10	36½	S.E.	do	S.W.	Gentle	S.W.		Clear	Clear	do	
Thursday	Jan. 20	6	36	14	37	20	37	N.E.	do	S.E.	do	S.E.		Cloudy	Cloudy	Cloudy	
Friday	Jan. 21	26	37	27	37	20	37	N.W.	Strong	N.W.	Strong	N.W.		do	do	do	
Saturday	Jan. 22	28	37	40	38	32	38	S.W.	Gentle	S.W.	Gentle	W.		do	do	do	
Sunday	Jan. 23	20	37	29	38	22	38	N.E.	do	N.E	do	N.		Clear	do	do	
Monday	Jan. 24	16	37	26	38	21	38	N.E.	do	N.E.	do	N.		Cloudy	do	do	
Tuesday	Jan. 25	14	37	20	37½	16	37	N.W.	do	S.W.	do	W.		do	do	do	

Record of temperature observations made at Northville, Mich., &c.—Continued.

Date.		Temperature of—						Wind.						Condition of—			
Day of week.	Day of month.	Air, 8 a. m.	Water, 8 a. m.	Air, 1 p. m.	Water, 1 p. m.	Air, 5 p. m.	Water, 5 p. m.	Direction, 8 a. m.	Intensity, 8 a. m.	Direction, 1 p. m.	Intensity, 1 p. m.	Direction, 5 p. m.	Intensity, 5 p. m.	Sky, 8 a. m.	Sky, 1 p. m.	Sky, 5 p. m.	Water.
		°F.	°F.	°F.	°F.	°F.	°F.										
Wednesday	Jan. 26	12	34½	16	34½	10	34	W.	Strong	W.	Strong	W.		Cloudy	Cloudy	Cloudy	
Thursday	Jan. 27	6	34½	6	35½	8	36½	N.W.	Gentle	W.	Fresh	W.		do	do	Clear	
Friday	Jan. 28	−6	34	16	36	10	36½	S.W.	do	S.W.	do	S.W.		Clear	Clear	do	
Saturday	Jan. 29	14	37	21	37	19	26½	W.	do	S.W.	Gentle	S.W.		Cloudy	Cloudy	Cloudy	
Sunday	Jan. 30	34	37½	34	38	30	38	S.	do	S.	do	S.		do	do	do	
Monday	Jan. 31	17	37	20	37½	12	36½	E.	do	E.	do	E.		do	do	do	
Tuesday	Feb. 1	6	31½	10	32	2	32½	N.E.	Strong	N.E.	Strong	N.E.		do	do	Clear	
Wednesday	Feb. 2	−24	33½	6	35	−2	35	N.E.	do	N.E.	Fresh	S.E.		Clear	Clear	do	
Thursday	Feb. 3	−10	35	7	36	6	36	N.	Gentle	N.W.	Gentle	N.W.		do	do	do	
Friday	Feb. 4	0	34½	22	36½	8	36½	N.	do	N.W.	do	N.W.		Cloudy	Cloudy	do	
Saturday	Feb. 5	−16	34½	17	36½	2	36	W.	do	N.W.	do	N.W.		Clear	Clear	do	
Sunday	Feb. 6	4	35	26	36½	16	35½	S.E.	do	S.E.	do	S.E.		do	do	do	
Monday	Feb. 7	16	36	40	35½	38	35	S.E.	do	S.	do	S.		Cloudy	do	Cloudy	
Tuesday	Feb. 8	35	36	37	36	36	32	S.	do	S.	do	S.		do	Cloudy	do	
Wednesday	Feb. 9	38	33	40	35	40	36	S.	do	S.	do	S.		do	do	do	
Thursday	Feb. 10	35	36	33	35	40	36	W.	Fresh	W.	Fresh	W.		do	do	do	
Friday	Feb. 11	30	35½	36	37	32	37½	W.	Gentle	S.W.	Gentle	S.W.		do	do	do	
Saturday	Feb. 12	32	37	34	36	26	36	S.W.	do	S.W.	do	S.W.		do	do	do	
Sunday	Feb. 13	16	35	18	35	19	35	N.W.	Fresh	N.W.	Fresh	N.W.		do	do	do	
Monday	Feb. 14	2	34	16	37	14	38	N.W.	Gentle	N.W.	Gentle	N.W.	Gentle	Clear	Clear	Clear	
Tuesday	Feb. 15	12	36	31	36½	24	36	N.E.	do	N.E.	do	S.E.	do	Lt. clouds	Cloudy	Cloudy	
Wednesday	Feb. 16	20	36	22	37	22	37	W.	Strong	W.	Strong	W.	Strong	Cloudy	do	do	
Thursday	Feb. 17	8	34½	26	35	22	35	W.	Gentle	W.	Gentle	W.	Gentle	Clear	Clear	Clear	
Friday	Feb. 18	26	35	36	35	32	36	E.	do	E.	do	N.W.	do	Cloudy	Cloudy	Cloudy	
Saturday	Feb. 19	14	36	36	38	15	38	N.W.	do	N.W.	do	N.W.	do	Clear	Clear	Clear	
Sunday	Feb. 20	0	37	36	38	18	38	N.W.	do	N.W.	do	N.W.	do	do	do	do	
Monday	Feb. 21	26	38	31	38	24	39	W.	do	W.	do	W.	do	Cloudy	do	do	
Tuesday	Feb. 22	27	26	38	39	36	38	S.W.	Fresh	S.W.	Fresh	S.W.	Fresh	Clear	do	do	
Wednesday	Feb. 23	2	40	10	37	11	38	W.	do	W.	do	W.	do	do	do	Cloudy	
Thursday	Feb. 24	2	37	24	37	16	37	W.	Gentle	N.W.	Gentle	N.W.	Gentle	do	Cloudy	do	
Friday	Feb. 25	−5	37½	20	37½	10	38	W.	do	N.W.	do	N.W.	do	do	do	do	
Saturday	Feb. 26	3	37	40	38	37	38	S.W.	Fresh	S.	do	S.	do	do	Clear	do	
Sunday	Feb. 27	40	37	43	38	42	39	S.	Gentle	S.	do	S.	do	Cloudy	Rain	Rain	
Monday	Feb. 28	20	42	26	39	18	38	W.	Fresh	W.	Fresh	W.	Fresh	do	Cloudy	Cloudy	

Tuesday	Mar. 1	−8	38	18	37	10	37	S.W.	Gentle	W.	Gentle	W.	...do	...do	...do	Clear	....
Wednesday	Mar. 2	12	33	30	36	25	38	S.E.	...do	S.E.	...do	S.E.	...do	Clear	Clear	...do	....
Thursday	Mar. 3	10	37	28	37	24	39	S.	Fresh	S.	...do	S.E.	...do	...do	...do	Cloudy	....
Friday	Mar. 4	14	36	34	39	30	40	S.W.	Gentle	S.W.	...do	S.W.	Gentle	Cloudy	Cloudy	...do	....
Saturday	Mar. 5	18	38	38	40	31	41	N.E.	...do	N.E.	...do	N.E.	...do	Clear	Clear	Clear	....
Sunday	Mar. 6	8	41	31	42	36	42	S.E.	Fresh	S.E.	Fresh	S.	Fresh	Cloudy	Cloudy	Cloudy	....
Monday	Mar. 7	18	41	42	45	40	43	W.	Gentle	W.	...do	W.	Gentle	Clear	Clear	Clear	....
Tuesday	Mar. 8	28	39½	38	45	40	44	E.	...do	E.	Gentle	N.E.	...do	Cloudy	...do	...do	....
Wednesday	Mar. 9	32	44	44	49	38	48	N.	...do	N.W.	...do	N.E.	...do	Clear	...do	...do	....
Thursday	Mar. 10	31½	42	38	47	44	46	E.	...do	N.E.	...do	N.E.	Fresh	Cloudy	Cloudy	Cloudy	....
Friday	Mar. 11	18	45	29	45	32	45	N.E.	...do	N.E.	...do	N.E.	Gentle	Clear	Clear	...do	....
Saturday	Mar. 12	20	39	28	40	34	40	S.E.	Strong	S.E.	Fresh	W.	Fresh	...do	...do	...do	....
Sunday	Mar. 13	18	38	33	39	30	39	N.W.	Fresh	S.W.	Gentle	S.W.	Gentle	Cloudy	Cloudy	...do	....
Monday	Mar. 14	33	40½	36	45	39	49	S.W.	...do	W.	Fresh	W.	Fresh	Clear	...do	...do	....
Tuesday	Mar. 15	35	40	38	44	37	43	W.	Gentle	W.	Gentle	W.	Gentle	Cloudy	...do	...do	....
Wednesday	Mar. 16	29	39½	35	45	34	44	S.W.	...do	S.W.	...do	S.W.	...do	...do	...do	Clear	....
Thursday	Mar. 17	32	40	40	44	38	42	S.	...do	S.	...do	S.	...do	Clear	...do	...do	....
Friday	Mar. 18	40	41	44	46	42	44	S.W.	Fresh	S.W.	Fresh	S.W.	Fresh	...do	...do	...do	....
Saturday	Mar. 19	45	41½	47	45	38	42	N.E.	Gentle	N.E.	Gentle	N.E.	Gentle	...do	...do	...do	....
Sunday	Mar. 20	40	41	48	42	42	42	S.	...do	S.	...do	S.	...do	...do	...do	...do	....
Monday	Mar. 21	30	41	33	42	32	42	S.	...do	S.	...do	S.	...do	Cloudy	Clear	...do	....
Tuesday	Mar. 22	28	40	36	41	34	41	W.	...do	W.	...do	W.	...do	Clear	...do	...do	....
Wednesday	Mar. 23	26	39	36	44	34	44	W.	...do	W.	...do	W.	...do	...do	...do	...do	....
Thursday	Mar. 24	33	42	40	48	37	47	S.W.	...do	S.W.	Fresh	S.W.	Fresh	...do	...do	...do	....
Friday	Mar. 25	28	44	40	50	36	46	S.W.	...do	S.W.	Gentle	S.W.	Gentle	Cloudy	Cloudy	Cloudy	....
Saturday	Mar. 26	28	42	30	46	32	47	S.	...do	S.	...do	S.	...do	Clear	Clear	Clear	....
Sunday	Mar. 27	20	38½	33	43	36	47	N.W.	Strong	N.W.	Strong	N.W.	Strong	...do	...do	...do	....
Monday	Mar. 28	30	41	42	44	40	48	N.	...do	N.	...do	N.	...do	...do	...do	Cloudy	....
Tuesday	Mar. 29	30	40	31	42	28	41	N.	Gentle	N.W.	Gentle	N.W.	Gentle	Cloudy	Cloudy	...do	....
Wednesday	Mar. 30	24	37	26	37	28	38	N.	Fresh	N.	Fresh	N.	Fresh	...do	...do	...do	....
Thursday	Mar. 31	30	38	38	40	36	40	W.	...do	W.	...do	W.	...do	Clear	...do	...do	....

[a] Spring water; always clear.

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