XVIII.—REPORT ON SHAD-HATCHING OPERATIONS.

A—OPERATIONS IN 1872.

MYSTIC BRIDGE, CONN., *July* 27, 1872.

SIR: Having received your order to stock rivers west of the Alleghanies with shad-fry, I left New London, July 1, at 2.45 p. m., accompanied by Aaron Anderson, foreman of the Poquonnoc Fish Company. Mr. E. S. Sanford, vice-president of the Adams Express Company, had very kindly furnished us with a letter of introduction to his messengers and agents, expressing his warm interest in the success of our enterprise, and requesting them to furnish us with all needed facilities for the safe transportation of the fry. This letter secured for us many favors, not only from his subordinates, but from all the companies through whose hands we passed. Many thanks are due to these companies and their messengers for their courtesies and timely aid.

We met Dr. William M. Hudson, of Hartford, chairman of the Connecticut fish commissioners, at Springfield, Mass., at 6 o'clock, *en route* for Hadley Falls, where we were to take in the fry. Dr. Hudson has taken the warmest interest in the project of stocking western waters with shad from its conception, and has done everything in his power to make it a success. The Connecticut commissioners have the use of the hatching-boxes of the Massachusetts commissioners, and their permission to use the shad-fishery for hatching purposes after the legal fishing is closed. Last year over 60,000,000 of shad-spawn were hatched at this place, and turned into the river. Mr. C. Smith, who has had charge of the hatching-boxes for several years, informed us that the shad were not only increasing in number, but in size. He had taken many shad this season weighing seven pounds, and upward. The season was a week or more later than last year, but there was every indication that the parent-fish would be more numerous, and a larger number of fry be turned into the river.

Our apparatus for transporting the fish was ten eight-gallon cans, furnished with handles, a large colander with very fine mesh, for the purpose of changing the water without disturbing the fry, a few water-pails, and a thermometer to gauge the temperature.

July 2.—We were up with the dawn preparing for our fish. The fry were taken directly from the hatching-boxes and put in the cans about two-thirds filled with river-water. The number of fry was estimated by Mr. Smith at 2,000,000. The thermometer stood at 78°, which indicated a continuance of the heated term which had prevailed for several days. We left the Holyoke Station at 6.22 a. m. The water was about 76°.

We took in ice at Springfield, and left for Albany at 9 o'clock. We reached Albany at 1.20 p. m., the thermometer indicating 96° in the shade. By occasional additions of ice-water the temperature in the cans had been kept down to about 76°. By way of experiment we took from the hatching-boxes a considerable number of ova not yet hatched, or just in the process of hatching, thinking they might bear transportation better than the fry. The loss was much greater among the ova than among the fry. Our cans were transferred to the Albany and Susquehanna road. We had a complete change of water at this point, and thorough cleansing of the cans by pouring the water from one can to another, and throwing away all sediment. We secured a fresh supply of ice, and left about 3 p. m. The water is very good along the line of this road, and we found no difficulty in making frequent changes, and in keeping the temperature down to 70°. At one watering-tank, near Binghamton, the water was at 55°, quite too cold for the fry.

July 3.—The fish passed the night safely. We reached Salamanca at 5.30 a. m. As the Alleghany River touches the railroad at this point, and this seemed to be the best place for stocking the Ohio, we left here three cans estimated to contain 400,000 fry, in charge of the ticket-master, who promised to see them immediately put into the river. The Erie trains form close connection here with the Atlantic and Great Western, and we left in a few minutes for Akron, Ohio, on our way to Indianapolis, where we had determined to make our next large deposit of fry. We reached Kent, Ohio, at 4.15, and as the Cuyahoga River was near the depot, we put in a few fry at this point. At Akron we were troubled to get good water. We drove a considerable distance to the canal, and secured enough to give the fry a change. The heat had reached 96° in the cars during the day, and the fish had suffered considerable loss.

July 4.—We reached Indianapolis a little too late for the last morning train to Saint Louis, and this involved a delay of ten hours. As the fry suffer much more in standing still than in transit, we concluded to make sure of a large stock in White River, and poured the contents of three cans into that stream, a little below the railroad bridge, in the suburbs of the city. We estimated the number at 400,000. We now had but a single can left and changed the water several times during the day. We determined to make an experiment with the remaining fry to see how far they could be carried. We thought if we could carry them across the plains and plant them in the Platte at Denver, it would be demonstrated that all the streams in the country can be furnished with shad fry. The experience would be worth all it cost, even if we failed. We left Indianapolis at 8 p. m., with fresh water and plenty of ice. The heated term had passed, which was very much in our favor.

July 5.—We left Saint Louis at 8.25 a. m., with a partial change of water and a fresh supply of ice. We took in a supply of Mississippi water from the hydrant, but it did not seem to agree with the fish so

well as the water we brought along from Indianapolis. The weather had grown cold during the night, and the water showed a temperature of 65°. This was cooler than suited the fry, and some of them perished. They grew more lively as the heat increased. At Washington and at Hermann, Mo., where the cars stopped a few minutes, we made small deposits of the fry, in the Missouri River. At Kansas City we found that we had ice and water enough to last another day in case we could not obtain it along the road. We left on the Kansas Pacific at 11.10 p. m., for Denver.

July 6.—We took in a fresh supply of ice at Brookville, and found good water at Wilson's Station, thirty-nine miles farther west. We now felt quite confident of getting some of the fry into the Platte in good condition. We are indebted to the officials of the Kansas Pacific Railroad for many courtesies.

July 7.—We met a train off the track about 7 in the morning, which delayed us over an hour. We reached Denver about 9.30 a. m., and in a few minutes had the joy of seeing Connecticut River shad swimming in the waters of the Platte. They were lively and headed up stream. We estimated the number of fry planted at this point at 2,000. As the Platte is fed by mountain streams full of trout, there can be little doubt that the fry will thrive in its waters.

I think the trip, so favorably ended, establishes the following conclusions:

1. Shad-fry in any desirable numbers can be planted in every barren stream in the country.

2. That all the larger branches of the Mississippi, the Missouri, and the Ohio Rivers can be stocked with shad next year at small expense.

3. That, as the numbers put into a stream in any shipment of fry depends upon its nearness to the source of supply, it would be desirable another season to hatch shad upon the Potomac, which is a days' journey nearer the west. From this point the distribution might begin as early as the first of June, to be followed by fish from the Hudson and the Connecticut Rivers later in the season.

Very respectfully, yours,

M. CLIFT.

Hon. SPENCER F. BAIRD,
United States Commissioner of Fisheries.

ROCHESTER, *July* 19, 1872.

DEAR SIR: My men have returned from Saint Paul. They had good luck, having placed about 25,000 young shad in the Mississippi River, two and a half miles above Saint Paul.

The shad put into the Alleghany River were deposited at Salamanca. Future observation must determine as to the return of any of these fish, though my experience assures me that they will come back if possible.

I have hatched 7,500,000 this year, and have put 200,000 above the Troy dam, in the Hudson; 50,000 in Oneida Lake, one of the tributaries of Oswego River that empties into Lake Ontario; 70,000 in Lake Champlain, which empties into the Saint Lawrence at Saint Ridges; and 50,000 in the Genesee River. The balance I placed in the Hudson.

Last year I put 15,000 young shad in the Genesee River, and now I can take at the mouth of the river, in Lake Ontario, twenty at a haul with a twenty-rod seine. These are over 7 inches long now, and we will see what we will see another year. I am very much interested in these experiments.

Yours,

SETH GREEN.

Prof. S. F. BAIRD,
United States Commissioner of Fish and Fisheries.

B—OPERATIONS IN 1873.

1.—THE SAVANNAH, NEUSE, AND ROANOKE RIVERS.

1873, *April* 20.—Arrived at Augusta, Ga.

April 21.—Went up the Savannah prospecting. Prospects very poor. Got back to Augusta at 4 p. m.; went down the river about four miles to a fishery. Two boats fishing; each boat caught one male fish.

April 22.—Went seven miles up the Savannah, from Augusta to Pitman's fishery; staid two days and two nights, and got no ripe fish; catching from three to eight fish a day.

April 24.—Moved three miles down the river, from Pitman's fishery, to Heckle's fishery; staid three days; caught no ripe shad; have not seen two shad alive at one time since we have been on the Savannah; shad selling for from 60 cents to $1.25 each in market.

April 28.—Received a telegram to go to New Berne, N. C.

April 29.—Arrived at New Berne, N. C.

April 30.—Spent the day getting ready to go up the Neuse River.

May 1.—Went up the Neuse fourteen miles above New Berne, to Cowpen's landing, at Vaughn's fishery; fished with seine at night; caught ten shad, none ripe, several of them spawned out.

May 2.—Caught five shad, none ripe. Temperature of water, a m., 64°; p. m., 65°.

May 3.—Caught eight shad, none ripe. Temperature of water, a. m., 68°; p. m., 67°.

May 4.—Caught twelve shad with seine, none ripe. Fished with skim-net along the shore; caught nine male shad. Temperature of water, a. m., 66°; p. m., 67°.

May 5.—Fished with skim-net; caught eight fish, two ripe; 50,000 spawn. River rising. Temperature of water, a. m., 62°; p. m., 65°.

May 6.—River rising. Could not haul seine. Caught three male shad with skim-net. Temperature of water, a. m., 63°; p. m., 64°.

May 7.—River reported rising. Forty miles up the river caught two shad with skim-net, both spawned out. Temperature of water, a. m., 63°; p. m. 63°.

May 8.—Water so high could not fish. Temperature of water, a. m., 63; p. m., 66°.

May 9.—River rising. No fishing. Temperature of water, a. m., 65°; p. m., 67°.

May 10.—River rising. No fishing. Temperature of water, a. m., 66° p. m., 66°.

May 11.—River rising. No fishing. Temperature of water, a. m. 66°; p. m., 67°. Spawn beginning to hatch in boxes.

May 12.—River raising, no prospects for more spawn. Temperature of water 65° a. m.; 67° p. m.

May 13.—Turned loose 45,000 young shad in Neuse River. Pitchkill, about twenty-four miles above New Berne on the Neuse, is the best place for shad-hatching that we could hear of.

May 14.—Received a dispatch to go to Weldon, N. C., on the Roanoke.

May 15.—Arrived at Weldon, N. C. They were catching some rock-fish, but no shad. The Roanoke very high but falling.

May 16.—Catching good many rock-fish. Shad do not run with rock. No chance of getting any shad till river falls.

May 19.—Got no ripe fish up to date. Got two ripe rock-fish; 110,000 spawn.

May 20.—River rising; no ripe fish. Temperature, of water a. m., 68°; p. m., 70°.

May 21.—River rising; caught no ripe fish. Temperature of water, a. m., 68°; p. m., 69°.

May 23.—River rising; caught no ripe fish. Turned loose 100,000 young rock-fish. Same principle hatches them that hatches shad.

May 24.—Fish slides all under water, but we caught no ripe fish.

May 25.—Caught a great many rock; none ripe.

May 29.—Did not catch any ripe fish up to date. River rising very fast. Took the 4 p. m. train to Washington.

May 31.—Went to the Rappahannock River from Washington. Shad fishing all done and nets hung up.

In order to build up the rivers that we operated upon there must be a close time of two days in each week before they can ever be restocked artificially, or in any other way. The lower end of the rivers are so completely barricaded with nets that the fish are nearly all caught before they get to the spawning grounds. The rivers are so nearly depopulated that there is scarcely any fishing done in the upper part of the rivers, and there would not be any done if it was not for the enormous prices they get for what few fish they do take.

SETH GREEN.

Table of shad-hatching operations at Augusta, Georgia, 1873, by Seth Green.

Date.	Temperature of water.		Fish taken.	Ripe fish.	Eggs taken.	Young fish turned into the river.	Remarks.
	A. M.	P. M.					
	°	°					
Apr. 21	.....	.....	2	.....	.....	.....	
Apr. 22	.....	.....	3	.....	.....	.....	
Apr. 23	.....	.....	8	.....	.....	.....	
Apr. 24	.....	.....	.....	.....	.....	.....	
Apr. 28	.....	.....	.....	.....	.....	.....	Left Augusta for New Berne.

No ripe shad were taken. Shad were selling in market at from 60 cents to $1.25.

Table of shad-hatching operations at New Berne, N. C., 1873, by Seth Green.

Date.	Temperature of water.		Fish taken.	Ripe fish.	Eggs taken.	Young fish turned into the river.	Remarks.
	A. M.	P. M.					
	°	°					
May 1	.....	.....	10	.....	.....	.....	
May 2	64	65	5	.....	.....	.....	
May 3	68	67	8	.....	.....	.....	
May 4	66	67	21	.....	.....	.....	
May 5	62	63	8	2	50,000	.....	
May 6	63	64	3	.....	.....	.....	
May 7	63	63	2	.....	.....	.....	River rising.
May 8	63	66	.....	.....	.....	.....	River too high for fishing.
May 9	65	67	.....	.....	.....	.....	Do.
May 10	66	66	.....	.....	.....	.....	Do.
May 11	66	67	.....	.....	.....	.....	River too high for fishing; spawn beginning to hatch.
May 12	65	67	.....	.....	.....	.....	River rising.
May 13	.....	.....	.....	.....	.....	43,000	
May 14	.....	.....	.....	.....	.....	.....	Received dispatch to go to Weldon, N.C.
Average	64.6	65.6					

Table of shad-hatching operations at Weldon, N. C., 1873, by Seth Green.

Date.	Temperature of water.		Fish taken.	Ripe fish.	Eggs taken.	Young fish turned into the river.	Remarks.
	A. M.	P. M.					
	°	°					
May 15	.....	.....	.....	.....	.....	.....	Arrived at Weldon; river very high; no shad being taken, but some rock-fish.
May 16	.....	.....	.....	.....	.....	.....	No shad taken; water too high.
May 19	.....	.....	.....	*2	110,000	.....	
May 20	68	70	.....	.....	.....	.....	River rising.
May 21	68	69	.....	.....	.....	.....	
May 23	.....	.....	.....	.....	.....	*100,000	Hatched same as shad.
May 24	.....	.....	.....	.....	.....	.....	Fish-slides under water.
May 25	.....	.....	.....	.....	.....	.....	Took many rock-fish not ripe.
May 29	.....	.....	.....	.....	.....	.....	Left for Washington, as the water was too high for fishing and no ripe shad had been taken.

* Rock-fish.

2.—THE DELAWARE RIVER.

BLOOMSBURY, N. J., *July* 12, 1873.

DEAR SIR: The undersigned having been honored by you with the appointment to the position of deputy United States commissioner for the purpose of collecting information concerning the food-fishes of the United States, and of superintending their transportation to western waters, would most respectfully submit the following report of his proceedings, reserving all observations and deductions for a future and more detailed report:

Your letter notifying me of my appointment was received on the evening of Monday, May 26, and I had the pleasure of reporting to you at Washington on the morning of May 28. At 11 p. m. of the same day I started for Weldon, N. C., where I arrived at 10 a. m. the following morning. Here I found Messrs. Holton and Green, who had for some time been endeavoring, though without success, to obtain ripe shad for the purpose of artificial impregnation. In this they had utterly failed from two causes, both entirely beyond their control. First, the method here employed in catching the fishes renders it almost impossible to obtain at the same time males and females in a ripe condition. The fishes are captured by means of a piece of apparatus called a slide, which is so arranged that in passing up stream the fish is caught by a rapid current and thrown upon a board platform, where it almost instantly dies. From all quarters I heard of the zeal and energy displayed by Messrs. Holton and Green in their efforts to obtain ripe shad, but spite of all their efforts they were entirely unsuccessful. However, important and interesting experiments were made with the rock-fish, and over one hundred thousand young were hatched and placed in the river. Secondly, as is well known, the Roanoke is liable to sudden and severe freshets; at the period of my visit the water of this river was about fifteen feet above its ordinary level, and residents of Weldon informed me that a few days previous it had risen 32 feet in twenty-four hours. As there seemed to be little use in retaining Messrs. Holton and Green at this point, I telegraphed you suggesting that they be at once recalled. On receiving a concurrent answer they at once set about their preparations for departure. On inquiry at the express-office it was found that the cost of forwarding the hatching-boxes would about equal their value, and upon Mr. Emry kindly offering to give them storage-room free until next season his kind offer was accepted.

Leaving Weldon at 4 p. m. we arrived in Washington the following day at 4.30 a. m., and I reported to you my arrival at 10 a. m.

Desiring to ascertain the condition of the shad in the river Delaware, I, at your request, telegraphed to the following persons, proprietors of fisheries on that river: B. P. Howell, M. D., Woodbury; A. J. Scarborough, Lambertsville; W. M. Hutchinson, Delaware Station. The answers received from all these persons showed conclusively that the sea-

son for ripe shad upon the Delaware River had not as yet arrived; Mr. Scarborough stating (which statement was afterwards shown to be correct) that but few ripe shad would be taken until after the close of the fishing season, (June 10.)

On the evening of May 28, accompanied by Mr. Holton, I started for Fredericksburgh, Pa., where we arrived at 3 a. m. We found the fishing season over, but obtained valuable and interesting information from Messrs. W. H. Smith and C. Rowley. No net-fishing is carried on at Fredericksburgh, and but few coarse fishes are taken at that point with the hook and line; in the lower portion of the river, however, large numbers of shad, sturgeon, rock-fishes, and herring are taken with seine, gill, and stake nets. The stake-nets are regarded as detrimental to the fishing interests, as many shad and herring escape from them severely injured and many taken are eaten by the eels, it frequently happening that hundreds of heads with back-bone attached are found in the nets of a morning. Mr. W. H. Smith has fished the river for the past eight years, his fishing-ground being some thirty-five miles below Fredericksburgh, within tide-water; he has taken during the past season about 3,000 shad and 6,000 herring, (alewives.) He estimates the number of shad sold in Fredericksburgh during the season at 10,500; this, however, is but a small portion of the catch. He commenced fishing about the 15th of March and finished May 20; during the last week of fishing noticed a number of ripe shad and frequently heard them "washing."

Mr. E. Rowley has fished for twenty years, except during the war. His fishery is located at Fallervale, twenty miles below Fredericksburgh. He corroborates the statements of Mr. Smith. Has noticed no ripe shad during the past season. Commenced fishing about March 20, and "hung up his net" May 26. There are no laws, as far as he is aware, regulating the fisheries of the Rappahannock. His fishery is a night-fishery, using a net 318 yards in length. Has heard shad "washing" in tide-water. Thinks the spawning season in this river is from April 15 to May 15.

We returned to Washington the same evening, arriving at 7.30 p. m.

On Monday, June 2, I visited the United States establishment for shad-hatching, situated at the lower end of Long bridge, operated by Messrs. Mason and Welsher. I found that during the past week very few ripe shad were met with, but that upon the afternoon of June 1 about 250,000 spawn had been taken. These, on examination of the boxes, showed to be in very fine condition, the percentage of unimpregnated spawn being very slight. A large number of spawn had been prematurely let loose by the breaking away, in consequence of a sudden storm, of a boom placed above the boxes for the purpose of breaking the force of the waves, which are sometimes so high as to upset the boxes. The fishing, June 1, commenced at 1.30 p. m., and continued until midnight. No ripe shad were taken after 9 p. m.

On the morning of Tuesday, June 3, I left Washington for Trenton, N. J., in company with Messrs. Holton and Green, having been ordered

by you to make a careful examination of the shad-fisheries of the Upper Delaware, and to find a suitable location for shad-hatching operations. We arrived at Trenton about 3 p. m. The next morning we visited Scudder's Falls, about seven miles north of Trenton. Through the courtesy of the Hon. Charles Hewitt, president of the Trenton Water-Power Company, we were enabled to make a thorough examination of the river at this point. Harvey's Island fishery has been fished during the present season by Mr. Aaron Pidcock. He reports the catch as very small, not more than half that of last year. He believed that the great run of shad had not as yet commenced; would be happy to give us every attention in his power, but believed that we would be able to do much better higher up the river. His fishery can only be operated in low water, and a rise of even a few feet would render it useless as a shad-hatching station.

Several days were now devoted to the examination of the fisheries in the vicinity of Lambertsville; over a dozen were examined, and finally it was decided to encamp at Lower Black's Eddy, situated in Bucks County, Pennsylvania, about twenty-six miles below Easton, and the same distance above Trenton. The fishery at this point is both a high and low water fishery, so that operations need not be suspended. A telegraph-station and post-office were within a short distance, and every facility, including free use of the nets and ground, was afforded by Mr. Samuel Farrel, proprietor of the fishing-grounds. The camp was named Camp Baird, in honor of yourself. The first spawn was taken June 12, the last June 27. We moved into camp June 14, and struck our tents June 29. For a detailed account of number of fishes captured and spawn taken, see the tabular statement. Being called to my home on June 20, I received yours of June 18, stating that you would be in New York City upon the following day. Wishing to obtain from you further orders, I repaired to New York, and received from you instructions concerning the transportation of spawn to the Monongahela River.

I returned to camp on Monday, June 23, and on the afternoon of June 24 started for Greensburgh with 15,000 young shad.

The following are my notes of the journey: Fishes shipped from Camp Baird at 5.30 p. m., temperature of air 64°, water 63°; reached Easton at 6.40 p. m., changed water; left Easton at 8 p. m, air 60°, water 63°; left Bethlehem at 8.40 p. m., air 60°, water 64°; left Allentown at 9.20 p. m., air 60°, water 63°; changed water; left Alliance at 10 p. m., air 60°, water 63°; left Reading at 10.30 p. m., air 68°, water 62½°; left Harrisburgh at 12.10 p. m., air 70°, water 64°; left Mifflin at 2 a. m., air 63°, water 60°; changed water; left Altoona at 5 a. m., air 66°, water 62°; left Blairsville at 7.08 a. m., air 67°, water 64°.

We arrived at Greensburgh at 8.15 a. m., and at once transferred the fishes to a small stream known as Jack's Run, situated upon the outskirts of the town. I was accompanied upon the trip by Mr. William Scwartz, of Point Pleasant, who afforded most valuable assistance. The

fishes reached their destination in good order, the low temperature of the night being greatly in their favor. Though furnished with an ample supply of ice, through the kindness of Mr. A. H. Lee, of Allentown, its use was not necessary, the temperature of the water never exceeding 65°.

I returned home via Pittsburgh, Harrisburgh, and Reading, arriving at camp June 28. Here I found all operations suspended. The erection of a dam by the Delaware and Raritan Canal Company at Bull's Island, with a chute of only 25 feet, had completely stopped the ascent of shad. A number of spent fishes upon their way down the river were taken, but the ascending spawners had disappeared. Upon my giving my assent, camp was broken June 29. Messrs. Holton and Green left for home on the following day. I remained until July 1, when I also left.

Such, sir, is a synopsis of my proceedings while in your employ. I have made numbers of observations upon the food-fishes of our rivers, which, with information obtained from various sources, I hope to present in a future supplementary report. A small collection of the fishes of the Delaware was obtained, and arrangements made for a more complete set.

I am, sir, respectfully yours,

J. H. SLACK, M. D.

Prof. S. F. BAIRD,
Portland, Me.

Report of shad and shad-spawn taken at Camp Baird, 1873.

Date.	Shad taken.	Ripe females.	Spawn taken.	Temperature of water.		Young shad turned into the river.	Remarks.
				A. M.	P. M.		
				°	°		
June 10	10	.....	.....	.....	.....	.....	All males.
11	19	.....	.....	.....	.....	.....	
12	15	1	15,000	.....	.....	.....	
13	10	1	15,000	72	76	.....	
14	7	2	35,000	72	74	.....	
15	.....	.....	.....	71	75	.....	Sunday.
16	8	2	40,000	72	77	.....	
17	21	2	25,000	74	80	.....	
18	7	2	20,000	74	81	28,000	
19	12	4	65,000	76	83	.....	
20	3	1	30,000	76	82	.....	
21	17	5	105,000	75	81	35,000	
22	.....	.....	.....	75	80	.....	Sunday.
23	11	2	50,000	73	74	.....	
24	1	.....	.....	72	72	.....	Severe storm; 15,000 shipped.
25	7	2	35,000	70	77	30,000	
26	12	4	50,000	70	77	100,000	
27	9	1	10,000	72	79	.....	
28	.....	.....	.....	75	81	.....	
29	.....	.....	.....	76	77	140,000	Sunday.
30	.....	.....	.....	.....	.....	100,000	
	169	29	495,000	73.2	78	433,000	
				75.6		15,000	
Total of young shad, including those put into Monongahela River						448,000	

REMARKS ON REPORT.

Percentage of loss, about 13 per cent.

Average temperatures: a. m., 73.2°; p. m., 78°; total average 75.6°. Percentage of ripe shad to fish taken, 17⅙; average number of spawn per fish, 17,069.

3.—REPORT ON THE TRANSFER OF SHAD FROM THE HUDSON RIVER TO THE SACRAMENTO.

By Livingston Stone.

Charlestown, N. H., *December* 1, 1873.

Sir: I beg leave to present herewith a report of my operations in carrying live shad from the Hudson River to California, and in procuring the eggs of the Sacramento salmon for distribution into various waters of the United States.

I have the honor to be, your obedient servant,

LIVINGSTON STONE.

Hon. Spencer F. Baird,
United States Commissioner of Fish and Fisheries.

REPORT.

On the 9th of June, 1873, the day after the loss of the California aquarium car in the Elkhorn River, Nebraska, I received at Omaha a telegram from you, instructing me to return East with my men, and take a load of live shad to the Pacific coast. As soon as was practicable I reported to you at Washington, and immediately after began preparations for the overland journey with the shad. Your instructions were to procure the supply of shad from Mr. Monroe Green, at the New York State Hatching-Works, at Castleton, on the Hudson. Accordingly, when everything was ready I proceeded to Mr. Green's camp with my two assistants, Mr. Willard T. Perrin and Mr. Myron Green. Mr. Monroe Green had a sufficient number of shad on hand at the right age for the journey, and at about 5 o'clock on the afternoon of the 25th of June we left the shad-hatching camp for the Castleton railroad-station, with eight cans, containing in all eighty gallons of water and 40,000 shad. Mr. Welsher, of Seth Green's force, accompanied us as far as Omaha. We reached Albany safely, and left that city at 1.40 p. m., on the New York Central Railroad, going west.

In carrying live shad, it is considered necessary to give them a change of fresh water every two hours. We accordingly took on reserves of water, for the purpose of making these changes at Albany, Utica, Syracuse, Rochester, Buffalo, Dunkirk, Erie, Painesville, Cleveland, Illyria, Edgerton, Elkhart, and South Bend, arriving at Chicago Friday morning, June 27, with the fish in good order. The temperature of the water

when it was put into the cans was 70° Fahrenheit, and we kept it at about that temperature till we reached Chicago.

I ought to remark here that the main points in carrying living shad are: (1) To make constant and regular changes of water; (2) To keep the temperature even, not letting the water fall below 62°, or rise above 75°; (3) To avoid all sudden changes of temperature in the cans; (4) To avoid introducing impure, alkaline, or other unsafe water upon the fish.

I remarked that we kept the temperature of the water about 70° till we reached Chicago. The morning of our arrival here, however, was very hot, indeed, the thermometer indicated about 100° in the shade, and it was with great difficulty that the water could be kept down to a safe point without producing too sudden a change of temperature, but by making several changes in quick succession we succeeded in keeping the water from rising above 74°, and a little after noon left Chicago for Omaha, the fish being in good condition. From Chicago to Omaha we took on water at La Porte, Bellow's Station, Bureau, Tiskilwa, Rock Island, Davenport, Kellogg, Casey, and Avoca, reaching Omaha about noon.

During the previous night, on our way from Chicago, we had succeeded in bringing the water down to 68°, but before reaching Omaha it was again to 72°. Mr. Welsher left us at Omaha, and returned to Castleton, N. Y., his care and experience having contributed very much to the success of the expedition so far.

We left Omaha at 3 p. m., on the Union Pacific Railroad, the train being several hours behind time. The fish were still as fresh as when they left the Hudson. There were now but four days between us and the Sacramento, and we took courage. Owing to the scarcity of suitable water in the long reach of alkali country before us, I considered it necessary to take on larger reserves of water at the few places where the water could be depended upon. I accordingly procured at Omaha a thirty-gallon tank which had been recovered from the wreck of the aquarium car, and obtained permission from Mr. C. B. Havens, the train-dispatcher of the Union Pacific Railroad, to stop the train at the Elkhorn River, long enough to allow us to fill our tank from the Elkhorn. The water which we took from this river proved to be the best for the shad that we found on the road, although very roily and so hot (bringing the thermometer up to 84°) that it ate up our ice-supply very fast. About 8 o'clock Saturday evening we took on several hundred pounds of ice at Grand Island, Neb., but as we climbed the Rocky Mountains the air grew colder and we did not need much ice. During the night the temperature of the cans fell steadily till morning. Just before daylight we took on a small reserve of water at Big Spring, Neb. This water was cold and clear, and brought down the temperature of the shad still lower. At sunrise the thermometer indicated 67° to 68° in the cans, and remained at about that point till 6 o'clock Sunday afternoon, when we reached Laramie, and took on fifty gallons of Laramie River

water. The Laramie reserve had a temperature of 62°, and the night being very cold, the water in the cans dropped down to 66°. We built a hot fire, however, in the stove of the express car, and kept the temperature from going any lower. We obtained a small supply of water at Evanston, Utah, and as we descended Weber Cañon, approaching Ogden, the weather grew warm again, and the anxiety we felt about the water getting too cold was removed. We reached Ogden at 5.30 p. m., Monday, June 30, and laid in a large reserve of water from Weber River, which was very good, though roily. Here we left 5,000 of the shad in charge of Mr. Rockwood, of Salt Lake City, for the benefit of Great Salt Lake.

We had previously passed through very cold weather, and at Bryan, on the Rocky Mountains, there was even a slight flurry of snow, but on leaving Ogden Monday evening the air grew still colder, the temperature of the cans dropped to 65°, and there was no stove in the car to warm the air or heat water with. The air grew colder and colder, and it soon became obvious that some unusual means must be resorted to to keep up the temperature of the water in the cans. By telegraphing ahead for hot water, and by heating an iron in the engine furnace, and plunging it into a vessel of water, we managed, by incessant labor all night, to keep the cans from going below 62°, but it was a close struggle. The secret of the difficulty was, that the warm water which we obtained we could not depend on sufficiently to introduce it into the cans, and only ventured to utilize its heat by placing a smaller vessel of good water in the large pail of hot water, and letting it remain till it became warm. Daylight and the warmer atmosphere that followed were never more welcome than they were on Tuesday morning as we emerged into them, finding ourselves about fifty miles over the Nevada line, with the shad in fine order, and now only five hundred and fifty miles from Sacramento. We had been changing the water a little oftener than every two hours night and day up to this time. We now began to change the water almost every hour, and felt quite hopeful of success. By utilizing the hot water which we obtained in various ways, and by constant exertion, we were enabled from this time to keep the temperature of the cans at a safe distance from the minimum limit of safety, and taking on another large reserve, both of hot and cold water, at Humboldt, at 7 o'clock Tuesday evening, July 1, we passed the night safely, and found ourselves the next morning within the limits of California, on the western slope of the Sierra Nevada, with all the shad in first-rate condition, and only seven hours' run to Sacramento City. At 9 o'clock Wednesday morning we took on a small supply of water at Alta, Cal., and reached Sacramento City four hours and a half afterward, with the shad as fresh and lively as when they were taken from the shad-hatching boxes on the Hudson. At Sacramento City we met S. R. Throckmorton, esq., chairman of the California State fish commission, and Mr. John G. Woodbury, the State fish-warden, who expressed themselves wholly satisfied with the appearance of the young fish. We

took on 30 gallons of Sacramento River water here, and a large supply of ice, and at twenty minutes past two we left Sacramento, on the California Pacific Railroad, which runs up the Sacramento Valley, for Tehama, where it was thought best to deposit the shad. We reached Tehama just after dark, and at ten minutes past nine on Wednesday evening, July 2, 1873, we placed our 35,000 shad in the Sacramento River, near the village of Tehama, just above the railroad bridge, in the presence of Mr. Woodbury and several citizens of Tehama, the whole expedition, from beginning to end, having been an entire success.

Below will be found a list of the places where we procured supplies of water, and also a table indicating the changes of temperature in the water which contained the shad.

We took on water east of Omaha, at Albany, Utica, Syracuse, Rochester, Buffalo, Dunkirk, Erie, Painesville, Cleveland, Illyria, (well-water,) Edgerton, Elkhart, South Bend, (bad lime-water,) Chicago, (Rock Island Railroad depot,) La Porte, Bellow's Station, Bureau, (rain-water,) Tiskilwa, (spring-water,) Rock Island, (good,) Davenport, (from Mississippi River,) Kellogg, Carey, Avoca.

West of Omaha we took on water at—

	Gallons.	Temperature.	Character of water.
Elkhorn River	50	84° F.	Roily.
Big Spring	10	58° F.	Clear.
Laramie River	50	62° F.	Clear.
Evanston, (spring-water)	10	57° F.	Clear.
Ogden, (Weber River)	50	60° F.	Roily.
Humboldt Station, (spring-water)	50	65° F.	Clear.
Alta	20	60° F.	Clear.
Sacramento	20	Warm.	Muddy.

The temperature of the cans was as follows:

Hudson River water, 70°.

Albany to Chicago, 70°, 74°.

Chicago to Omaha, 74°, 68°, 72°.

Omaha to Laramie, 72°, 70°, 69°, 67°.

Laramie to Ogden, 67°, 66°.

Ogden to Humboldt, 66°, 62°, 66°, 70°.

Humboldt to Sacramento, 70°, 68°, 66°, 67°.

Sacramento to Tehama, 67°, 70°.

Sacramento River water at Tehama, 74°.

In concluding this account of the journey with the shad, I will say that the water was changed every one or two hours, night and day, from 6 o'clock p. m. on Wednesday, June 25, to 9 o'clock p. m. on Wednesday, July 2, being about 105 times for each of the eight cans, or equivalent to changing the water of one can 840 times.

I will also add that a careful estimate was made of the number of shad that died on the way, and it was found to be about 400, or 1 per cent. of the whole.

4.—ON SHAD-HATCHING OPERATIONS BY THE COMMISSIONERS OF THE STATE OF MAINE.

BANGOR, ME., *August* 6, 1873.

DEAR SIR: You ask me for data, particulars, &c., of our shad-hatching experience this year. The awakened interest in fish-culture in our State has made such calls upon our time, has kept us so continually occupied, that we were able to make but little anticipatory preparation before we were called to the field of operation. Our experiments were not rich in results of great numbers of fish, but in valuable experience for our future guidance not contained in any of our books on pisciculture. We were governed in our time of commencing by the operations of the Massachusetts commissioners at Andover, as from them we were to learn the mode of procedure. This necessarily delayed our operations at Bowdoinham until the 15th June. Further delays in obtaining the requisite material for boxes, the changes required by practical use making all those constructed useless in waters where there was no current, consumed so much time that when all was ready the season was passed, and none but spawned shad could be obtained. The opinion was arrived at that all the shad required as spawners could be obtained at Bowdoinham between the 10th and last of June. The great obstacle presented in the path of progress to every attempt to bring about rapidly the restoration of fish to our waters, is the system of patenting every result of simple experience in practical work, and thus establishing a toll on every road to success. Conclusions as obvious and unavoidable as that "twice 2 is 4" have been the subject of claims for letters-patent until one can scarce use a bit of charcoal as a disinfectant lest he be in extricably involved in a lawsuit, upon the claim that the wood was only charred and not carbonized.

If this was exhibited only in placing a moderate royalty on every mode, or article, or implement, so patented, the tax would be readily paid; but, as in our case, the demand is now so exorbitant as to amount to prohibition. The sum demanded of us for one of these patents was two-thirds of the entire appropriation of the State of Maine for our whole department. We succeeded, most fortunately, in constructing a hatching-box that, while it infringed upon no patent, gave all the requisite motion of the eggs in the box, so necessary to the successful hatching of shad-spawn in a *current*. At Bowdoinham there was no current to move the eggs in the boxes; the short, chopping wave at the ebb and flow of the tide gave simply an up-and-down motion, while the wind with its added force projected the waves into our boxes and washed out the eggs. A new form of box was adopted, a simple parallelogram, with a bottom of wire netting. The boxes were floated within a plank frame as a sort of breakwater; this was a success, so far as hatching was concerned, but the mesh of the wire netting was too large, and our fish escaped as fast as hatched. This brought us to the end of the season, as no more shad that had not spawned were to be had. The num-

ber of shad hatched, according to an estimate made by Mr. Commissioner Stanley, and coincided with by his assistant, Mr. Brown, was 100,000. The United States commissioner, Professor Baird, afterward very opportunely supplied us with 100,000 shad-fry from Hadley Falls, on the Connecticut, which were planted in the Penobscot at Mattawamkeag. The possibility of obtaining shad-spawn from Massachusetts so much later in the season than with us, would seem to indicate that the habits of the shad are the reverse of the salmon. The earliest spawning of the salmon is at the head-waters of the river, the latest run of fish always spawning lower down the river. Our inference here may not be correctly deduced, as our experiments were at the mouth of the Kennebec, where the fish are probably turned back from their native spawning-grounds by the Sprague's Dam at Augusta, and cannot follow out their instincts. The shad at Topsham, also, were found all spawned. These later fish never could have ascended much higher than Brunswick, owing to the natural obstructions in the river.

E. M. STILWELL.