

XV.—THE PROPAGATION AND DISTRIBUTION OF SHAD IN 1877.

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A.—STATION ON THE SUSQUEHANNA RIVER NEAR HAVRE DE GRACE, MD.

Reference has been made in previous reports to the failure to procure a sufficient supply of shad in the southern waters of the United States to warrant the expense of establishing stations, the results having always proved greatly disproportionate to the outlay. In laying out the work for 1877, therefore, it was determined to concentrate effort upon the Susquehanna and Connecticut Rivers, with the object of obtaining a sufficient number of young fish from these two streams to meet the requirements in the way of stocking new waters. Another reason for concentration was the desire to test, during part of the season at least, the efficiency of a radical change planned and adopted by Mr. T. B. Ferguson, Maryland commissioner of fisheries, in the entire theory and practice of the hatching of shad, in dispensing entirely with the use of floating boxes of any kind whatever, such as had been hitherto considered absolutely necessary for successful work. These boxes, as the result of several years' experience, were found to answer an excellent purpose in comparatively narrow rivers, where there was a steady and continued current, but they were inadequate to the requirements in tidal waters.

As has been explained in previous reports, the floating boxes are connected in a gang by cords, the foremost one being held to its place by an anchor. During the strong tide-current there is sufficient movement of the eggs, but when the tide is slack they rest in masses upon the bottom of the boxes and in consequence suffer greatly, especially when the water is at a high temperature, unless shaken up by hand. In the event of a storm or freshet the boxes, except in the few sheltered places which are available in the region of the shad fisheries, are in great danger of being upset and the eggs and young fishes thrown out or carried away as has frequently occurred; and under the best of circumstances the exposure of the apparatus and the attendants to the elements, and the great number of boxes required to contain even a million of eggs at one time, are serious obstacles to their use when work is done on a large scale. In most tidal waters, and waters without current, as at the head of Albemarle Sound, these objections are fatal to success. It was therefore with much satisfaction that the experiments of Mr. T. B. Ferguson in the employment of an entirely

new process were observed, and a proposition to co-operate with the Maryland commission in carrying it out was most readily acceded to.

By the new method the work was to be done on floating barges or platforms, and the agitation, required for the eggs, imparted by the mechanical action of a steam-engine with its accessories. The work is prosecuted more or less under cover, and is capable of being conducted on a very large scale.

Early in the spring of 1877 Mr. Ferguson commenced his operations by borrowing from the authorities of the city of Baltimore four scows, formerly used in the transportation of stone for its piers and sea-walls. Each of these is about 60 feet in length and 20 in breadth, and one was properly fitted up with the necessary apparatus for the work, the propelling power being a steam-engine of 5-horse power, purchased by the United States Fish Commission and lent to Mr. Ferguson for the purpose. An arrangement was made with Mr. Ferguson for hatching such fish as might be needed by the United States Commission, their distribution to be under the direction of the latter. For the purpose of better accommodating the party under my direction while waiting for the production of the fish and their successive shipment to different points, one of these scows was fitted up by the United States Commission in a suitable manner, and placed in convenient relationship to a similarly arranged vessel of the Maryland Commission. The first locality visited for the shad work was situated in the Northeast River at the head of Chesapeake Bay; but for some reason this was found to be unsuitable, and the station was finally established in Spesutie Narrows between Spesutie Island and the Maryland shore, about six miles below the bridge at Havre de Grace. The actual work of shad-hatching commenced in the early part of May, and eggs were obtained at first principally from the ripe fish caught in the seines, but subsequently almost exclusively from the gill-nets. The season on the Susquehanna closed the 13th of June, up to which time there were distributed on the Atlantic side of the continent, in New England rivers, 1,477,000; in the Susquehanna River, 1,910,800; in the Southern Atlantic waters, 1,245,000; in the Mississippi and its tributaries, 1,158,000; and in the rivers of the Gulf of Mexico aside from the Mississippi, 110,000; in the Sacramento River of California 110,000 were placed, making the total number of shad distributed 6,010,800.

The accompanying tables exhibit the number of eggs taken, the number of fish hatched, and the distribution to different waters. The hatching apparatus (to be described hereafter) proved to be efficient and to possess all the superiority over the former method of the floating boxes that had been anticipated, especially in the success in hatching the eggs in waters where there was no current whatever. Another advantage not already referred to was the facility with which a cooler stratum of water could be reached when the surface was too hot for the proper development of the eggs, a condition always present when the

temperature rose above 80°. By covering the tops of the buckets by caps of wire gauze, they could be immersed to any required distance towards the bottom, where even the slight difference of heat might be enough to save the eggs. The apparatus, which was placed upon a large scow 59 feet long and 19 feet wide, consists of a shafting along the center of the scow upon which at intervals are placed irregularly formed cams which have a long and a short side. This is accomplished by making the outline of the cams two intersecting cycloid curves, which produces upon the lever following its circumference a quick fall and slow rise at the extreme end. A steam-engine is the motive power revolving the shafting and cams. To the ends of the levers are suspended cylinders of sheet-iron, from 1½ to 2 feet in diameter having a wire-cloth bottom, and within these cylinders the eggs are placed. The rise and fall in the water does not exceed 5 inches. A slow revolution of the shafting produces all the agitation in the water essential to the welfare of the eggs, a more rapid motion having a tendency to draw the eggs hard against the wire cloth. The slow rise and quick fall of the cylinders also prevents the eggs from this injury, as the effect is to throw the eggs high up as the bucket goes down, and as it comes slowly up they fall gently to the wire-cloth bottom.

B.—STATION ON THE CONNECTICUT RIVER AT SOUTH HADLEY FALLS, MASSACHUSETTS.

The work on the Susquehanna River closed on the 13th of June, and on the 26th of the month I commenced operations at South Hadley Falls, Massachusetts. We had shipped our stock of furniture in a freight car, and obtained a house in the vicinity of the fishery for the accommodation of the party; this proved to be very much more convenient in every way than a residence at the hotel over a mile from the fishery, as formerly. Seines and fishermen were at once engaged and began fishing, and the first eggs were taken on the night of the 26th. From that time until the fourth of August, eggs were taken every night, the entire number amounting to 3,161,000.

An immense raft of logs which was floated down the river over the spawning ground was a great detriment to our work, as, although the men in charge of the rafts were very obliging, in attempting to keep the logs as much as possible out of our way, still it proved to be a considerable interference with the fishing and the general success of our work.

Both at Havre de Grace and South Hadley Falls, Mr. H. J. Rice, of the Johns Hopkins University, of Baltimore, was with us, studying, by aid of the microscope, the embryological development of the shad. A portion of his conclusions having been published in the Maryland Report of Commissioner of Fisheries for the year 1877. Mr. Charles G. Atkins, of Bucksport, Me., also remained with us at South Hadley Falls during the season, making a large number of interesting and important experiments with reference to the impregnation of the eggs, and the care of the eggs and young fishes while in the hatching-boxes.

Mr. Frank N. Clark was sent on a reconnaissance to Windsor Locks, Conn., to determine the eligibility of that point as a hatching-station, but the season proved to be too far advanced for successful work. It is

It is asserted that the falls and dam constitute almost as complete an obstacle to the migration of the shad at this point as the dam at South Hadley Falls, although a law has been enacted by the State providing for a passage for the fish. A fishery has been established a few rods below which is carried on during the months of May and June. About the last week in June daily fishing is stopped, and the seine is hauled at intervals for the next two months and captures sturgeon, which are used almost entirely for local supply. During the last fortnight of regular fishing a sufficient capture of shad is made to warrant the success of a hatching-station nearly equal to that at South Hadley Falls, provided the fish are found to be ripe in this part of the river. The discovery that shad are in full spawning condition but a short distance above brackish waters in the Southern Atlantic rivers renders it probable that they are also so here. The testimony of the fishermen is to the effect that many ripe spawning fish are found in the season, and an adequate reward will probably follow the efforts of whoever attempts to propagate shad at this point.

The accompanying tables exhibit the extent of the work done here.

C.—TABLES OF SHAD PROPAGATION IN 1877.

Record of shad-hatching operations conducted at Havre de Grace, Md., on the Susquehanna River, from May 21, 1877,* to June 10, 1877.

Date.	Hour.	Temperature of—			Direction of wind.	Ripe fish.		Eggs obtained.
		Air.	Surface water.	Bottom.		Males.	Females.	
May 21	Noon	64	78	77	Change.	60	23	460,000
22	do	83	78	73	N. W.	35	18	253,000
23	do	70	75	64	N. W.†	20	10	145,000
24	do	54	69	61	N. W.	4	5	100,000
25	do	60	63	65	N. W.	3	8	140,000
26	do	76	64	67	Change.	6	4	60,000
27	do	70	65	66	S.†	25	38	417,000
28	do	69	67	66	S.	28	46	735,000
29	do	73	71	66	S.	31	23	340,000
30	do	78	73	71	S.	13	29	490,000
31	do	74	71	71	S.	7	16	332,000
June 1	do	78	74	71	S.	17	24	400,000
2	do	85	75	74	S. W.	20	27	465,000
3	do	83	77	77	S.	6	11	160,000
4	do	80	70	78	S.	6	10	145,000
5	do	76	76	77	S. W.	11	13	185,000
6	do	73	75	76	Change.	4	6	95,000
7	do	78	77	75	Change.	7	14	225,000
8	do	84	79	79	Change.	6	8	125,000
9	do	77	77	77	S.	2	4	65,000
10	do	69	76	73	S. W.	1	3	45,000
								5,384,000

* For eggs obtained previous to this date see Report of Commissioners of Fisheries for Maryland.
 †A heavy gale. ‡Calm.

Record of distribution of young shad made from May 21, 1877, to August 8, 1877.

Date of trans-fer.	Obtained from—	Place whence taken.	Number of fish actually taken.	Introduction of fish.			Transfer in charge of—
				Place.	Stream.	Tributary of—	
May 21	Maryland Commission	Harre de Grace, Md.	100,000	Saint Louis, Mo.	Mississippi		L. Fairfax.
22	do	do	100,000	Macon, Ga.	Ocmulgee		H. E. Quinn.
23	do	do	75,000	Montgomery, Ala.			I. Kumbien.
29	do	do	50,000	Sterling, Ky.	Licking		F. A. Ingalls.
30	do	do	40,000	Spesutie Narrows.	Susquehanna		United States Fish Commission.
30	do	do	100,000	do	do		Do.
31	do	do	100,000	Milledgeville, Ga.	Oconee		C. D. Griswold.
31	do	do	150,000	—, Md.	Elk		United States Fish Commission.
June 1	do	do	100,000	Topeka, Kans.			H. E. Quinn.
1	do	do	50,000	Spesutie Narrows.	Susquehanna		United States Fish Commission.
2	do	do	100,000	do	Potomac		L. Fairfax.
2	do	do	125,000	do	Bohemia		United States Fish Commission.
2	do	do	225,000	do	Sassofras		Do.
2	do	do	150,000	Cumberland, Md.	Potomac		L. Fairfax.
2	do	do	127,000	Spesutie Narrows.	Susquehanna		United States Fish Commission.
3	do	do	12,200	do	do		Do.
4	do	do	100,000	Saint Joseph, Mo.	Missouri		L. Fairfax.
4	do	do	100,000	Canton, Miss.	Big Black		F. A. Ingalls.
5	do	do	100,000	Spesutie Narrows.	Susquehanna		United States Fish Commission.
5	do	do	510,000	Denton, Md.	Choptank		Do.
6	do	do	110,000	Tehama, Cal.	Sacramento		F. N. Clark.
6	do	do	72,000	Spesutie Narrows.	Susquehanna		United States Fish Commission.
7	do	do	30,000	do	do		Do.
7	do	do	160,000	Laurel, Md.	Patuxent		C. D. Griswold.
8	do	do	50,000	Spesutie Narrows.	Susquehanna		United States Fish Commission.
9	do	do	100,000	Covington, Ga.	Ocmulgee		C. D. Griswold.
9	do	do	20,000	Spesutie Narrows.	Susquehanna.	Chesapeake Bay.	United States Fish Commission.
10	do	do	60,000	do	do	do	Do.
11	do	do	20,000	do	do	do	Do.
11	do	do	100,000	Seaford, Md.	Nanticoke		Do.
11	do	do	100,000	Salisbury, Md.	Wicomico		Do.
11	do	do	100,000	Railroad Crossing.	Pocomoke		Do.
12	do	do	100,000	Appleton, Wis.	Fox		James W. Milner.
12	do	do	30,000	Spesutie Narrows.	Susquehanna.	Chesapeake Bay.	United States Fish Commission.
13	do	do	36,000	do	do	do	Do.
13	do	do	50,000	Cockeysville, Md.	Gun Powder		L. Fairfax.
July 4	United States Fish Commission.	South Hadley Falls, Mass.	12,000	Smith's Ferry.	Connecticut.		C. G. Atkins.
4	do	do	90,000	Springfield, Mo.	James	White	F. A. Ingalls.
5	do	do	110,000	Mexico, Mo.	Salt Creek	Mississippi	C. D. Griswold.
8	do	do	90,000	Waterbury, Vt.	Winooski	Lake Champlain.	R. E. Earl.

Record of distribution of young shad made from May 21, 1877, to August 8, 1877—Continued.

Date of transfer.	Obtained from—	Place whence taken.	Number of shad actually taken.	Introduction of fish.			Transfer in charge of—
				Place.	Stream.	Tributary of—	
July 12	United States Fish Commission.	South Hadley Falls, Mass.	118,000	Tennessee	Forked Deer..	Mississippi.....	F. A. Ingalls.
13	do	do	110,000	Columbus and West Point, Ga.	Chattahoochee .....	.....	C. D. Griswold.
14	do	do	50,000	Rhode Island	Blackstone.....	.....	Rounds.
14	do	do	80,000	Fulton, Ark.	Red .....	.....	R. E. Earl.
16	do	do	110,000	Mamfordsville, Ky.	Green .....	.....	F. N. Clark.
16	do	do	145,000	Smith's Ferry	Connecticut.....	.....	C. G. Atkins.
16	do	do	110,000	Hart's Store, Va.	Dan .....	.....	H. E. Quinn.
17	do	do	207,000	Smith's Ferry	Connecticut.....	.....	C. G. Atkins.
18	do	do	50,000	Rhode Island	Blackstone.....	.....	Rounds.
18	do	do	100,000	North Carolina.....	.....	.....	J. F. Ellis.
19	do	do	100,000	do .....	.....	.....	F. A. Ingalls.
20	do	do	60,000	South Hadley Falls.	.....	.....	.....
20	do	do	100,000	Saint Paul, Minn.	Mississippi .....	.....	H. E. Quinn.
23	do	do	165,000	Smith's Ferry	Connecticut.....	.....	Clark & Atkins.
23	do	do	50,000	do	do .....	.....	C. G. Atkins.
24	do	do	75,000	New Hampshire	Merrimac.....	.....	Weber & Powers.
25	do	do	100,000	North Carolina.....	Merrimac.....	.....	C. D. Griswold.
28	do	do	50,000	New Hampshire	Merrimac.....	.....	Weber & Powers.
28	do	do	50,000	Middleboro', Mass.	Taunton .....	.....	R. R. Holmes.
30	do	do	100,000	Smith's Ferry	Connecticut.....	.....	William Smith.
31	do	do	80,000	do	do .....	.....	C. G. Atkins.
31	do	do	50,000	Bridgewater, Mass.	Taunton .....	.....	R. R. Holmes.
Aug 1	do	do	33,000	Smith's Ferry	Connecticut.....	.....	C. G. Atkins.
3	do	do	27,000	do	do .....	.....	Do.
4	do	do	14,000	do	do .....	.....	William Smith.
4	do	do	85,000	Maine	Penobscot .....	.....	H. J. Rice.
7	do	do	22,000	Smith's Ferry	Connecticut.....	.....	William Smith.
8	do	do	62,000	do	do .....	.....	Do.
			6,210,800				