

22. Has the weather of any given summer any influence on the abundance or movements of the fish in the following year?

23. Have the weather and winds from March to June any influence on the movements of the fish and their abundance in the Gulf of Maine (Cape Cod to Nova Scotia) during the summer months?

24. When, where, and in what depth of water do mackerel spawn?

25. Are they as readily caught by hook and line or with purse-seines during the spawning season as at other times?

WASHINGTON, D. C., March 18, 1887.

125.—REPORT OF SHAD DISTRIBUTION FOR 1886.

By MARSHALL McDONALD.

The work of shad propagation and the production of the young for distribution was conducted on the Potomac River at Fort Washington and Central Stations, on the Susquehanna at Battery Station and by the steamer Lookout, and on the Delaware River by the steamer Fish Hawk. Shad for distribution were contributed as follows:

Battery Station, Susquehanna River.....	43,776,000
Central Station, Potomac River.....	28,151,000
Steamer Fish Hawk, Delaware River.....	21,018,000
Steamer Lookout.....	310,000
Total.....	93,255,000

The aggregate number of fry actually planted was 92,679,000. In this distribution liberal plants of shad fry have been made in the Potomac, the Susquehanna, the Delaware, and other tributaries of Chesapeake and Delaware Bays. The following is a summary by river basins of shad distributed during the season of 1886:

River basin.	Received from station.	Actually planted.	Lost in transit.
Tributaries of Narragansett Bay.....	2,534,000	2,534,000	.....
Tributaries of Long Island Sound.....	832,000	749,000	83,000
Hudson River.....	2,312,000	2,312,000	.....
Delaware River.....	21,618,000	21,618,000	.....
Tributaries of Chesapeake Bay.....	52,923,000	52,835,000	88,000
Tributaries of Albemarle Sound.....	1,990,000	1,990,000	.....
Streams draining into the Atlantic south of Albemarle Sound.....	4,288,000	4,183,000	105,000
Mississippi River and minor tributaries of the Gulf of Mexico.....	4,758,000	4,758,000	.....
Colorado River, Gulf of California.....	1,000,000	850,000	150,000
Columbia River basin.....	1,000,000	850,000	150,000
Total.....	93,255,000	92,679,000	576,000

The localities at which the plants were made, the streams in which they were made, and the number of fish included in each deposit are given in the following table:

Record of distribution of shad from Central Station, Washington, D. C., and from Battery Station, Havre de Grace, Md., season of 1886.

CENTRAL STATION.

Date.	Stream stocked.	Tributary of—	Place of deposit.	Fish shipped.	Died in transit.	Planted.
1886.						
Apr. 24	Potomac River.....	Chesapeake Bay.....	Little Falls, Md.....	918, 000		918, 000
25	do.....	do.....	do.....	364, 000		364, 000
27	Rivanna River.....	James River.....	Charlottesville, Va.....	534, 000		534, 000
28	Rappahannock River.....	Chesapeake Bay.....	Rappahannock Station, Va.....	340, 000		340, 000
28	Rapidan River.....	Rappahannock River.....	Rapidan Station, Va.....	341, 000		341, 000
29	Occoquan River.....	Potomac River.....	Woodbridge Station, Va.....	579, 000		579, 000
30	Rappahannock River.....	Chesapeake Bay.....	Near Fredericksburgh, Va.....	730, 000		730, 000
May 1	Mattaponi River.....	York River.....	Near Milford Station, Va.....	391, 000		391, 000
1	North Anna River.....	Pamunkey River.....	C. & O. Junction, Va.....	391, 000		391, 000
1	Fork of Shenandoah River.....	Potomac River.....	Near Waynesborough, Va.....	557, 000		557, 000
2	Acquia Creek.....	do.....	Near Quantico, Va.....	389, 000		389, 000
2	Accokeek Run.....	Acquia Creek.....	Brooke's Station, Va.....	200, 000		290, 000
2	Rivanna River.....	James River.....	Near Charlottesville, Va.....	700, 000		700, 000
3	Appomattox River.....	do.....	Near Mattoax, Va.....	379, 000		379, 000
3	Monocacy River.....	Potomac River.....	Near Frederick Junction, Md.....	603, 000		603, 000
3	Patuxent River.....	Chesapeake Bay.....	Laurel, Md.....	609, 000		609, 000
3	Shenandoah River.....	Potomac River.....	Waynesborough, Va.....	200, 000		200, 000
3	Rapidan River.....	Rappahannock River.....	Rapidan, Va.....	629, 000		629, 000
4	James River.....	Chesapeake Bay.....	One mile above Boshers' Dam, Va.....	380, 000		380, 000
5	Occoquan River.....	Potomac River.....	Bristoe, Va.....	531, 000		531, 000
5	Chickahominy River.....	James River.....	Hunslett Station, Va.....	310, 000		310, 000
7	Pamunkey River.....	York River.....	Near White House Station, Va.....	385, 000		385, 000
7	Mattaponi River.....	do.....	Near Milford, Va.....	367, 000		367, 000
8	Dan River.....	Roanoke River.....	Two miles from Danville, Va.....	329, 000		329, 000
9	Chickahominy River.....	James River.....	Fives miles from Ashland, Va.....	316, 000		316, 000
10	Colorado River of the West.....	Gulf of California.....	The Needles, Colo.....	1, 000, 000	150, 000	850, 000
10	Cheat River.....	Monongahela River.....	Three miles from Rowlesburgh, W. Va.....	356, 000		356, 000
11	Chattahoochee River.....	Appalachicola River.....	West Point, Ga.....	370, 000		370, 000
12	Stony Creek.....	Nottoway River.....	Near Stony Creek Station, Va.....	364, 000		364, 000
13	Meherrin River.....	Chowan River.....	Near Belfield, Va.....	415, 000		415, 000
14	do.....	do.....	1½ miles above Belfield, Va.....	314, 000		314, 000
15	do.....	do.....	Near Margarettsville, N. C.....	300, 000		300, 000
15	Fontaine's Creek.....	do.....	do.....	40, 000		40, 000
16	Savannah River.....	Atlantic Ocean.....	Augusta, Ga.....	301, 000	30, 000	271, 000
16	Nottoway River.....	Chowan River.....	Near Stony Creek, Va.....	228, 000		228, 000
17	Monongahela River.....	Ohio River.....	Two miles from Fairmont, W. Va.....	281, 000		281, 000
21	do.....	do.....	Near Fairmont, W. Va.....	210, 000		210, 000
21	Housatonic River.....	Long Island Sound.....	Birmingham, Conn.....	832, 000	83, 000	749, 000
22	Will's Creek.....	Potomac River.....	Cumberland, Md.....	532, 000		532, 000
22	Rapidan River.....	Rappahannock River.....	Rapidan Station, Va.....	259, 000		259, 000
23	Neuse River.....	Pamlico Sound.....	Goldsborough, N. C.....	200, 000	20, 000	180, 000

	24	Tar River.....	Pamlico Sound.....	Two miles above Rocky Mount Station, N. C.....	448,000		448,000
	25	Youghiogheny River.....	Monongahela River.....	Connellsville, Pa.....	991,000		991,000
	26	Mattawoman Creek.....	Potomac River.....	Mattawoman Station, Md.....	463,000		463,000
	26	Quantico Creek.....	do.....	1½ miles from Quantico, Va.....	548,000		548,000
	27	Patuxent River.....	Chesapeake Bay.....	2½ miles from Mariborough, Md.....	528,000		528,000
	28	Hudson River.....	Atlantic Ocean.....	Catskill, N. Y.....	921,000		921,000
	31	do.....	do.....	Albany, N. Y.....	1,036,000		1,036,000
	31	Taunton River.....	Narragansett Bay.....	Dighton, Mass.....	1,034,000		1,034,000
June	3	Catawba River.....	Santee River.....	Near Morganton, N. C.....	365,000		365,000
	4	Crab-Tree Creek.....	Neuse River.....	Near Raleigh, N. C.....	374,000		374,000
	5	Acquia Creek.....	Potomac River.....	2½ miles from Quantico, Va.....	370,000		370,000
	8	Hudson River.....	Atlantic Ocean.....	Catskill, N. Y.....	355,000		355,000
(*)		do.....	do.....	Cold Spring Harbor, N. Y. †.....	1,586,000		1,586,000
(*)		Potomac River.....	Chesapeake Bay.....	Fort Washington, Md.....	3,154,000		3,154,000
		Total.....	.....	.....	29,737,000	283,000	29,454,000

BATTERY STATION.

	1886.						
Apr.	25	Susquehanna River.....	Chesapeake Bay.....	Near Station, Md.....	25,000		25,000
	26	do.....	do.....	do.....	1,421,000		1,421,000
	27	do.....	do.....	do.....	2,431,000		2,431,000
	27	do.....	do.....	do.....	325,000		325,000
	28	do.....	do.....	do.....	860,000		860,000
	28	Northeast River.....	do.....	P. W. & B. R. R., Md.....	500,000		500,000
	29	Susquehanna River.....	do.....	Near Port Deposit, Md.....	1,055,000		1,055,000
	29	Bush River.....	do.....	Bush Station, Md.....	500,000		500,000
	29	Elk River.....	do.....	Elkton, Md.....	500,000		500,000
	30	Susquehanna River.....	do.....	Near Station, Md.....	50,000		50,000
	30	Gunpowder River.....	do.....	P. W. & B. R. R., Md.....	500,000		500,000
	30	Northeast River.....	do.....	do.....	500,000		500,000
May	1	do.....	do.....	do.....	500,000		500,000
	1	Patapsco River.....	do.....	Near Relay Station, Md.....	500,000		500,000
	1	Bush River.....	do.....	Bush River Station, Md.....	600,000		600,000
	1	Elk River.....	do.....	Elkton, Md.....	600,000		600,000
	3	Susquehanna River.....	do.....	Above Harrisburg, Pa.....	1,621,000	48,000	1,573,000
	3	do.....	do.....	Near Station, Md.....	1,952,000		1,952,000
	5	do.....	do.....	do.....	804,000		804,000
	6	Palmer River.....	Narragansett Bay.....	Near Providence, R. I.....	1,500,000		1,500,000
	6	Susquehanna River.....	Chesapeake Bay.....	Near Station, Md.....	1,245,000		1,245,000
	8	Chester River.....	do.....	Near Chestertown, Md.....	500,000		500,000
	9	Columbia River.....	Pacific Ocean.....	Wallula Junction, Wash.....	1,000,000		300,000
	9	Willamette River.....	Columbia River.....	Albany, Oreg.....		150,000	550,000
	9	Patuxent River.....	Chesapeake Bay.....	Odenton, Md.....	650,000		650,000
	11	do.....	do.....	Laurel, Md.....	500,000		500,000
	11	Gunpowder River.....	do.....	P. W. & B. R. R., Md.....	600,000		600,000
	11	Bush River.....	do.....	do.....	300,000		300,000

* At sundry dates.

† Sent to Fred Mather to hatch and deposit.

‡ In addition to the fish, 585,000 eggs were shipped, hatched in transit, and are included in the 850,000 planted in Columbia and Willamette Rivers.

Record of distribution of shad from Central Station, Washington, D. C., and from Battery Station, Havre de Grace, Md., &c.—Continued.

Date.	Stream stocked.	Tributary of—	Place of deposit.	Fish shipped.	Died in transit.	Planted.
May 11	North-east River	Chesapeake Bay	Bull's Mount, Md.	1,500,000		1,500,000
12	Elk River	do	Elkton, Md.	300,000		300,000
12	North-east River	do	P., W. & B. R. R., Md	300,000		300,000
12	Susquehanna River	do	Near Station, Md.	1,500,000		1,500,000
12	Broad River	Congaree River	Columbia, S. C.	750,000		750,000
12	Saluda River	do	do	750,000		750,000
13	Monongahela River	Ohio River	Grafton, W. Va.	250,000		250,000
13	Sassafras River	Chesapeake Bay	Ordinary Point, Md	1,000,000		1,000,000
15	Chester River	do	Crumpton, Md.	600,000	40,000	560,000
15	James River	do	Clifton Forge, Va.	250,000		250,000
15	Susquehanna River	do	Near Port Deposit, Md	370,000		370,000
16	Ocklockonnoe River	Gulf of Mexico	S., F. & W. R. R., Ga.	750,000		750,000
16	Withlacoochee River	do	do	750,000		750,000
16	Brandywine River	Delaware River	Wilmington, Del	450,000		450,000
17	Cheat River	Monongahela River	Rowlesburgh, W. Va	300,000		300,000
18	Nanticoke River	Chesapeake Bay	Seaford, Del	450,000		450,000
19	Wicomico River	Tangier Sound	Salisbury, Md	450,000		450,000
19	Chester River	Chesapeake Bay	Millington, Md	600,000		600,000
20	Patuxent River	do	Patuxent, Md.	540,000		540,000
22	West Fork River	Monongahela River	Clarksburgh, W. Va	300,000		300,000
24	Susquehanna River	Chesapeake Bay	Near Columbia, Pa	900,000		900,000
25	do	do	Near Port Deposit, Md	750,000		750,000
26	do	do	Peach Bottom, Pa	836,000		836,000
26	do	do	Marietta, Pa	1,500,000		1,500,000
27	Nanticoke River	do	Seaford, Del	977,000		977,000
28	Susquehanna River	do	Conowingo, Md.	500,000		500,000
31	Deep River	Cape Fear River	Moncure, N. C.	1,100,000	55,000	1,045,000
31	Monongahela River	Ohio River	Fairmont, W. Va	200,000		200,000
June 1	Susquehanna River	Chesapeake Bay	Safe Harbor, Pa	550,000		550,000
1	do	do	Tide's Eddy, Pa	500,000		500,000
2	do	do	Above Havre de Grace, Md	100,000		100,000
5	do	do	do	228,000		228,000
7	do	do	Near Station, Md	429,000		429,000
9	do	do	do	472,000		472,000
10	do	do	do	208,000		208,000
12	do	do	do	481,000		481,000
13	do	do	do	256,000		256,000
	Total			43,776,000	293,000	43,483,000

EGGS FOR EUROPE.—In addition to the distribution covered by this table, 50,000 shad eggs were sent from Battery Station to Mr. H. C. Mercer, of Doylestown, Bucks County, Pennsylvania. Mr. Mercer had arranged to sail for Europe on the North German Lloyd steamer Eider April 28, and expected to reach Hüningen, Alsace, in ten days. He wished to take some shad eggs with him, and try to reach the Danube before they perished. He proposed to keep down the temperature of the eggs as much as possible while on board the steamer, by the use of ice. On April 27, 1886, Mr. Grabill forwarded the eggs to him. When he reached Southampton he found many of them dead, and the remainder died before he reached Bremen, to his great disappointment.

STOCKING THE COLORADO.—An attempt to acclimate shad in the Colorado River of the West, and to establish fisheries on the Colorado, Gila, and other tributaries of the Gulf of California, was commenced by the deposit of 983,000 fish in 1884 and 998,000 eggs in 1885, and was continued the present season by a deposit of 850,000 eggs, thus making a total of 2,831,000, all of which were deposited at The Needles. These plants are considered sufficient to determine whether the waters present such conditions as will assure the establishment of a run of shad in the streams tributary to this gulf. The evidence of success will be looked for in the capture of mature shad in the season of 1888, or possibly of male or buck shad in 1887. It is not proposed to prosecute this experiment further.

STOCKING THE COLUMBIA RIVER.—An unsuccessful attempt was made in 1886 to transfer shad from the Atlantic to the Pacific coast. Detentions on the way consumed so much time that the fry were all lost. In order to guard against loss occasioned by delay *en route*, the present year arrangements were made to send eggs as well as fry. Car No. 3, with J. F. Ellis in charge, was detailed for the purpose. The car was equipped with tanks for storing and a steam-pump for circulating the water. Two stands of McDonald jars, with specially designed glass aquaria for collecting and holding the fry, completed the equipment of the car as a moving hatchery. The car left Havre de Grace May 9 with 1,000,000 young shad, 200,000 eggs on trays, and 385,000 eggs in the McDonald hatching-jars. Mr. E. M. Robinson went on board to take charge of the hatching. The fry were transported with a loss of 50 per cent, while the eggs on trays were all lost. The 385,000 eggs in jars hatched and were planted in the Willamette River, with a loss of less than 10 per cent. The success of this experiment has so important a bearing upon the methods of our work, and points out such possibilities, that Mr. Ellis's report relative to the incubation and hatching of the eggs on the way is given.*

WASHINGTON, D. C., March 1, 1887.

* May 9, 1886. The 585,000 eggs arrived at the car at 2.20 p. m., 200,000 of which were put on trays in an ice-box. The other 385,000 came to the car in two Wroten buckets, and were put in four McDonald jars at 3.30 p. m. The pump was then started and a

slow motion given to the eggs. At 8.25 p. m. on May 6th 210,000 of these eggs had been taken, and 175,000 at 9.30 p. m. on May 7. The temperature of water at Battery Station when the eggs were taken was 56 degrees; the temperature of water in car was 60 degrees. Took on fresh water at York, Pa., at 10 o'clock p. m., from engine-tank, using our suction-hose and pumping about 30 minutes. Pumped the water through the ice-coil during the night, so the temperature was brought down to 58 degrees. Took on fresh water at Altoona, Pa., and after that pumped water from engine-tank three times each day.

May 10. The temperature was from 58 degrees to 60 degrees. The eggs worked nicely, with only a small loss. About a dozen or so of those taken on the 6th instant hatched this afternoon. The eggs look rather light in color, and the fish can be seen moving lively in the eggs. One jar of eggs went over in the aquaria last night; replaced them in jar at 6 o'clock a. m.

May 11. The temperature was from 56 degrees to 58 degrees. Only a few more fish hatched out, as the fall in the temperature of the water seemed to retard them. They all look well, and are developing slowly.

May 12. Got on a little alkali to-day; this did not seem to have any effect on the eggs. Those taken on the 6th instant are hatching to-day. Temperature of water 58 degrees. The fish look well, and have a large sac. Those taken on the 7th instant are almost ready to come out, and a few hatched before night. Worked all the dead eggs off and measured those left in jars; found the loss on the 210,000 eggs taken May 6 to be 10 per cent, and the loss on the 175,000 eggs taken May 7 to be 8 per cent. This would make an average loss of 9 per cent. We lost very few, if any, after this. The eggs were hatching slowly this evening. The water in tanks got a little low, so the pump was used to get some air into the water. The air-bubbles attached themselves to the young fish and turned them head down; also collected around the jars and aquaria. This caused some trouble, which was overcome a little by keeping the lower tanks as full of water as possible.

May 13. The eggs of the 6th instant are hatching rapidly; temperature of water 58 degrees. The fish look healthy and strong, with large sacs. Those of the 7th are hatching slowly. Put up at 11 a. m. 25,000 fish in five cans, and 25,000 more at 5.30 p. m. The air-bubbles were still troubling the young fish a little, so took them from aquaria as fast as hatched.

May 14. Almost all the eggs of the 6th instant hatched to-day. The temperature of water went down to 56 degrees this morning. This retards the eggs of the 7th a little. The air-bubbles in the water seem to collect on some of the eggs, making them come to top of jar; so can give them but very little motion or they will go over in the aquaria. This air-bubble has been the only difficulty we have had to contend with, which seems strange, as the air-pump has not been in use on the trip. The air also collects on the shells and causes them to come to the top, when they can be easily skimmed off. Removed the young fry from the collecting aquaria to transportation cans as fast as they were hatched. Planted 25,000 of these fish in the Columbia River, at Wallula Junction, at 11.30 to-night. They were in fine condition.

May 15. The car arrived at Portland at 10.30 this morning. All the eggs of the 6th were hatched, and those of the 7th hatched rapidly all day, the temperature of water gradually going up to 62 degrees. The air-bubbles entirely disappeared this morning. The car was taken to the Willamette, at Albany, at 9.30 p. m., and the young fry planted at 11.30 p. m. The eggs did not quite all hatch to-day, so ran the pump up to 10 o'clock May 16, at which time all the eggs had hatched, with a total loss of 9 per cent. The experience of this trip makes it safe to recommend the shipping of eggs instead of the young fry on all long trips, as this is perhaps the most difficult trip in the country. The water is very cold, going as low as 44 degrees in a great many places. The alkali, too, is very strong. I think without doubt this car can take 2,000,000 eggs to any stream in the United States, and hatch them in as good condition as they come from the hatcheries, and with as small a loss.