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130.—REPORT OF SHAD PROPAGATION ON THE POTOMAC RIVER DURING THE SEASON OF 1885.

By MARSHALL McDONALD.

Prior to the season of 1885 the work of collecting shad eggs on the Potomac River was independently organized and under the responsible direction of an officer of the Commission, specially detailed for that service. The eggs collected were delivered at Central Station in Washington, where they were hatched and from which they were distributed to suitable waters by car and messenger service, in accordance with a program approved by the Commissioner.

In February I was placed in charge of the production of shad on the Potomac River during the season of 1885, and was instructed by the Commissioner "at the earliest possible moment to prepare the necessary plans for the same, submitting estimates of the force needed, their assignments and duties, and whatever else may be requisite to make the estimates for the expenses."

In obedience to instructions, I submitted the following program:

"*Program for the organization and conduct of shad-hatching operations on the Potomac River for the season of* 1885.

"I. THE COLLECTION OF EGGS.—It is proposed to establish the headquarters of the collecting force at Fort Washington. All eggs taken will be brought to this station and held there in circulation of water, awaiting convenience of transportation to Washington by the river steamers.

"To the equipment of the station already provided it will be necessary to add a supply tank with a capacity of twelve or fourteen hundred gallons, a steam pump and boiler, and thirty hatching jars and fixtures complete. The supply tank can be placed outside of the present building, thus avoiding the expense of additional constructions.

"The different sources from which eggs may be obtained are as follows:

"(*a*) From the fishing shores: (1) By employees of the Commission, stationed there for the purpose. (2) By the purchase of impregnated eggs at the rate of $20 per million.

"(*b*) From the gillers: (1) By the purchase of impregnated eggs at the established rate per million. (2) By employees of the Commission, equipped and detailed for the purpose.

"(*c*) From the Fort Washington seine, manned and operated by employees of the U. S. Fish Commission.

"It is proposed to have recourse to all the sources of supply above indicated, and to occupy with the collecting force the whole river from Chapman's Point to Washington. Should it be found expedient or necessary to employ the Fish Hawk on the Potomac River, it will be best to station her at Chapman's or Glymont, and assign as her field of operations all the shores and gillers below and including the Pomonkey fishing shore. The vessel should be used as an auxiliary collecting station, and the eggs taken should be shipped direct from Glymont to the Central Station, Washington.

"II. TRANSPORTATION OF EGGS.—It is not necessary or desirable that any special means of transportation from the collecting stations to Washington should be provided. The steamer Corcoran, in her daily trips to Mount Vernon, furnishes every desirable facility and convenience. The eggs should be held at the collecting stations in circulation of water from twenty-four to forty-eight hours. In this time most of the dead and unimpregnated eggs will have been cleaned off, and at this stage of development the live eggs may be transported on trays with little or no loss, and will reach Central Station in first-rate condition.

"It is important that the eggs during transit should be in the personal charge of a messenger. He may be detailed from the employees of Central Station, the detail being varied from time to time to suit the convenience or exigencies of the work.

"For the service of the collecting force there will be needed certainly one steam-launch (preferably a Herreshoff). The work of collecting eggs is very exacting and must be performed without regard to hours or weather, and since the disabling of the launch and the necessity of repairs would seriously embarrass the work if we have but a single one, I would recommend that provision be made for two. The second, when not needed otherwise, will be available for the necessary work of inspection or investigation.

"III. PROPAGATION.—All eggs obtained from the auxiliary or collecting station will be sent to Central Station for incubation and hatching.

* * * * * * *

"I respectfully submit herewith a plan of organization of the *personnel* of the work, and an estimate of the expenditures necessary to conduct the work in accordance with the program submitted.

"The entire expenditure will not exceed $6,000, and it is probable that such economy may be practiced in the organization and conduct of the work as to reduce the entire expenditure for the season below $5,000."

The program submitted was approved by the Commissioner, who authorized an expenditure not to exceed $5,000 in carrying out the plan of operations proposed.

FORT WASHINGTON STATION.

Immediately after taking charge of the work I made an inspection of the Fort Washington Station, and, after examining its facilities and convenience for the work, determined upon the erection of an additional building to be appropriated exclusively to holding the eggs in good condition until convenient to ship them. Plans for a building 16 feet by 22 feet were at once prepared, its erection contracted for, and the structure completed and equipped for work in time to receive the first eggs taken.

A steam pump, with a capacity of 100 gallons per minute, drew the water from the river and forced it into a 2,400-gallon tank, from which it was distributed to thirty of the automatic hatching-jars conveniently arranged on tables in the interior of the building.

Mr. James Carswell, who had so efficiently conducted the work of collecting for the two seasons immediately preceding, was placed in charge of Fort Washington Station, and directed to organize his force and make all necessary arrangements preliminary to occupying the station.

March 30 the shore was occupied by Mr. Carswell with four men of his force. The others were called in as the emergencies of the work required. The fishing shore was cleaned up, the seine rigged, and everything in order for work by April 5.

There being no prospect of shad in the river, the seine was not regularly fished until April 16th; only five shad were taken prior to April 20, at which date fifteen were taken, among them one ripe female, furnishing 20,000 eggs; the temperature of the river at this date being 52° Fahr. After the 20th the temperature steadily rose, reaching 60° on the 24th, when 107,000 shad eggs were obtained from the Fish Commission seine.

The following extract from Mr. Carswell's report gives a general review of the progress of the work:

"On May 4 the run of shad had greatly increased, and I was averaging 750,000 eggs per night; but on the 6th and 7th of May the largest amount for the season was secured, nearly three and one-half millions being taken on those two nights.

"Up to the 28th of May a fair average was maintained, but from this date there was a gradual decrease, and the last eggs were taken on the 6th of June, the total for the season being 22,576,000.

"The number of shad taken during the season of 1885 in the Potomac River is the smallest for a number of years."

The aggregate of 22,576,000 shad eggs obtained for the season was derived as follows:

From the Fish Commission seine	7,280,000
From Greenway fishing shore	432,000
From Moxley's Point fishing shore	4,228,000
From Ferry Landing fishing shore	2,536,000

From Pomonkey Point fishing shore	333,000
From Tent Landing fishing shore	796,000
From Chapman's Point fishing shore	1,610,000
From the gillers	5,361,000
Total	22,576,000

Interesting details showing the fluctuations in production during the season will be found in Table I.

TABLE I.—*Showing the number of shad eggs collected from the different fishing shores on the Potomac River, season of* 1885.

Date.	Fort Washington.	Greenway.	Moxley's Point.	Ferry Landing.	Pomonkey Point.	Tent Landing.	Chapman's Point.	Gillers.	Total.
April 20	20,000								20,000
April 21	25,000	15,000							40,000
April 22	15,000			15,000					30,000
April 23	75,000	25,000	10,000	35,000	12,000				157,000
April 24	107,000		45,000		14,000			75,000	241,000
April 25	66,000		70,000		48,000			85,000	269,000
April 26	288,000		72,000					34,000	394,000
April 27	102,000		45,000	35,000		56,000			238,000
April 28			136,000	28,000		56,000	56,000	193,000	469,000
April 29	179,000							42,000	221,000
April 30	28,000		12,000	10,000		20,000	56,000		126,000
May 1	100,000	42,000	35,000	242,000			65,000	119,000	603,000
May 2		49,000	45,000	95,000			14,000	252,000	455,000
May 3	175,000		56,000	95,000				220,000	546,000
May 4	163,000		98,000	160,000		91,000	222,000	105,000	839,000
May 5	126,000	140,000	84,000	462,000			250,000	490,000	1,552,000
May 6	329,000	77,000		637,000	217,000	41,000	422,000	249,000	1,972,000
May 7	55,000		14,000	109,000				85,000	263,000
May 8	399,000	21,000	191,000	375,000		112,000	98,000	133,000	1,329,000
May 9	277,000	45,000	198,000	150,000				149,000	819,000
May 10	439,000		336,000			49,000		324,000	1,148,000
May 11	536,000		424,000	28,000	42,000	63,000	20,000	420,000	1,533,000
May 12	207,000		337,000			91,000	28,000	177,000	840,000
May 13	179,000		154,000	35,000		119,000		332,000	819,000
May 14	50,000		63,000			77,000		160,000	350,000
May 15	46,000		35,000	7,000		21,000	266,000	160,000	535,000
May 16	150,000		21,000					101,000	272,000
May 17	187,000	18,000	10,000					319,000	534,000
May 18	102,000						20,000	226,000	348,000
May 19	139,000						75,000	195,000	409,000
May 20	165,000						18,000	155,000	338,000
May 21	290,000		140,000	18,000				25,000	473,000
May 22	326,000							99,000	425,000
May 23	234,000		250,000					20,000	504,000
May 24	145,000		225,000					28,000	398,000
May 25	250,000		276,000					103,000	629,000
May 26	181,000		135,000					25,000	341,000
May 27	85,000		170,000					90,000	345,000
May 28	239,000		174,000					50,000	463,000
May 29	304,000		215,000					21,000	540,000
May 30	70,000		152,000						222,000
May 31	119,000								119,000
June 1	30,000								30,000
June 2	60,000							50,000	110,000
June 3	110,000							50,000	160,000
June 4	58,000								58,000
June 5	50,000								50,000
Total	7,280,000	432,000	4,228,000	2,536,000	333,000	796,000	1,610,000	5,361,000	22,576,000

In connection with the operation of the Fish Commission seine an accurate record was kept each day. The total number of shad taken, the number of males, the number of females, the number of ripe females, the number of eggs taken and impregnated, and the temperature of the

water (in degrees, Fahr.) at the time of impregnation are shown in detail in Table II.

TABLE II.—*Record of seine hauling at the Fort Washington shore, season of* 1885.

Date.	Number of shad caught.	Males.	Females.	Ripe females.	Number of eggs taken.	Temperature of water during impregnation.	Date.	Number of shad caught.	Males.	Females.	Ripe females.	Number of eggs taken.	Temperature of water during impregnation.
April 16..	2	2	0	0	0,000	46	May 13..	106	45	61	3	179,000	61
April 17..	2	1	1	0	0,000	46	May 14..	84	33	51	1	50,000	62
April 18..	1	1	0	0	0,000	47	May 15..	60	18	42	2	46,000	63
April 19						49	May 16..	90	21	69	6	150,000	65
April 20..	15	7	8	1	10,000	52	May 17..	76	21	55	6	187,000	64
April 21..	13	8	5	3	25,000	57	May 18..	72	23	49	5	102,000	67
April 22..	28	20	8	1	15,000	58	May 19..	63	27	36	5	139,000	67
April 23..	67	34	33	4	75,000	58	May 20..	18	12	6	5	165,000	70
April 24..	28	11	17	4	107,000	60	May 21..	31	17	14	11	290,000	71
April 25..	54	30	24	3	66,000	60	May 22..	73	47	26	11	326,000	69
April 26..	39	23	16	9	288,000	61	May 23..	101	45	56	11	234,000	69
April 27..	58	24	34	5	102,000	62	May 24..	80	28	52	5	145,000	70
April 28..	31	18	13	0	0,000	62	May 25..	60	26	34	9	250,000	70
April 29..	31	15	16	8	207,000	62	May 26..	59	21	38	8	181,000	70
April 30..	47	17	30	0	0,000	63	May 27..	25	0	26	3	85,000	71
May 1...	39	18	21	2	52,000	61	May 28..	79	31	48	9	239,000	70
May 2...	30	24	6	1	48,000	61	May 29..	51	17	34	11	304,000	71
May 3...	53	33	20	5	175,000	59	May 30..	49	37	12	2	70,000	70
May 4...	108	71	37	3	163,000	61	May 31..	45	15	30	4	119,000	71
May 5 ..	111	66	45	4	126,000	62	June 1...	12	1	11	1	30,000	72
May 6...	69	25	44	12	329,000	62	June 2...	27	6	21	2	60,000	72
May 7...	100	51	49	2	55,000	61	June 3...	33	4	29	3	110,000	73
May 8...	140	92	48	14	399,000	63	June 4...	17	2	15	2	58,000	73
May 9...	47	16	31	9	277,000	62	June 5...	19	3	16	1	50,000	74
May 10..	86	46	40	14	439,000	61	June 6...	1	0	1	0	0,000	72
May 11..	105	44	61	16	530,000	61							
May 12..	61	28	33	6	207,000	64	Total ..	2,696	1,234	1,462	252	7,280,000	

A review of the record furnishes the following conclusions:

(1) That at no time during the season were the males in marked preponderance over the females.

(2) That for the entire season the number of females was considerably in excess of the number of males, the relative percentage being, females, 54.3 per cent; males, 45.7 per cent.

(3) The proportion of ripe females in the entire number of shad taken was 9 per cent; the proportion of ripe females in the entire number of females taken was 17 per cent.

(4) The average yield of eggs per ripe female was 28,888, the number ranging from six thousand to one hundred and two thousand.

Conclusion four is, probably, generally applicable to the shad in the Potomac River. Conclusions one, two, and three can be held to apply only to the Fort Washington shore. A discussion of like data obtained from other shores would possibly lead to conclusions widely different.

CENTRAL STATION.

In connection with the main work of the station, special attention was given to devising a successful method for hatching the adhesive eggs of the herring, including *Clupea mediocris*, or hickory jack. Every

form of apparatus that ingenuity could devise was used without success, and unless the failure is to be attributed to the low temperature of water prevailing during the course of the experiments (the range of temperature being 50° or below), I am utterly at a loss to explain our want of success.

The shad eggs after being taken were held at Fort Washington Station from 12 to 36 hours, and then were forwarded by the steamer Corcoran, in charge of a special messenger, to Central Station, where they were hatched, and from which they were distributed by car and messenger service.

The total number of eggs produced at the collecting station at Fort Washington, as measured at the station, was 22,576,000. Of these 21,019,000 were forwarded to Central Station, and the rest, yielding 1,000,000 fry, were hatched out at the station and planted in the Potomac at the mouth of the Piscataway River. Of the entire number sent to Washington 16,536,000 reached the station in good condition, and yielded 14,791,000 shad fry for distribution.

A separate record was kept of each lot of eggs, so as to furnish a complete history of it from the time the eggs were taken until they were distributed from Central Station. The detailed record will be found in Table IV. The time and temperature data can be relied upon as accurate only in the case of eggs furnished from the commission seine.

By reference to this table it will be seen that under precisely the same conditions of temperature, so far as recorded, the period of time from impregnation to hatching varies from a few hours to several days. It is evident that the period of incubation does not simply vary inversely to the temperature as indicated by the thermometer under which incubation proceeds, as I have been led to conclude from observations heretofore made.

The rate of development is not determined by the temperature at which impregnation takes place, since we find considerable differences in the period of incubation when the temperature of impregnation is precisely the same.

We know that in damp and cloudy weather the rate of development is slowed down, that in direct sunlight it receives marked acceleration, and to a less degree by reflected light in clear, bright weather. After all, this may be the indirect effect of increased temperature, since either the direct or reflected heat rays would pass through the flowing water without producing any sensible rise of temperature in it, but would be absorbed by the eggs and accelerate their development just as would result if the temperature of the water itself were to rise.

The earlier runs of shad habitually spawn in a lower temperature than those that come later in the season. It may, therefore, well be that a difference in the rate of development of different lots of eggs may come by inheritance.

An investigation of the conditions other than temperature which modify or influence the rate of development in the eggs of shad and other species of fish would furnish the subject of a fruitful biological study, which would probably have important practical applications.

In Table III, prepared by W. F. Page, superintendent of propagation, Central Station, will be found a very interesting summary, giving the average period of hatching under different temperatures from 53.5° to 75.5°. From this it will be seen that while there is considerable variation in the period of hatching in different jars under the same conditions of temperature, yet the average time of incubation at a given temperature is longer the lower the average temperature prevailing during incubation.

TABLE III.—*Summary of the period of incubation of* 485 *jars of shad eggs hatched at Central Station, U. S. Fish Commission, during* 1883, 1884, *and* 1885.

Average temperature (degrees of Fahrenheit) of hatching water.	Period of incubation.						Number of jars hatching at this temp't're.	Average per centage of eggs lost per jar.
	Maximum.		Minimum.		Average.			
	d.	h.	d.	h.	d.	h.		
From 53.5 to 54.5	13	16	13	16	13	16	1	99.9
From 54.5 to 55.5	13	18½	9	9	11	23⅝	6	55.3
From 55.5 to 56.5	13	23	8	½	11	23⅜	21	45.7
From 56.5 to 57.5	11	23	11	23	11	23	1	60.0
From 57.5 to 58.5	11	11	8	19	10	3	2	49.0
From 58.5 to 59.5	10	22⅓	10	10	10	15½	11	26.6
From 59.5 to 60.5	10	22	7	11½	9	10⅝	19	21.7
From 60.5 to 61.5	9	22	8	18½	9	3½	10	17.1
From 61.5 to 62.5	10	15	7	15½	9	3 1/12	23	32.7
From 62.5 to 63.5	9	12	6	6½	7	23⅝	42	39.0
From 63.5 to 64.5	8	11	6	10	7	10⅝	74	22.0
From 64.5 to 65.5	8	12	5	12	6	18½	111	24.1
From 65.5 to 66.5	7	14	4	16	6	8	72	22.2
From 66.5 to 67.5	7	8½	6	3	6	18½	3	13.6
From 67.5 to 68.5	6	12½	5	1	5	14½	15	13.5
From 68.5 to 69.5	5	22	4	20½	5	1⅝	17	8.7
From 69.5 to 70.5	6	18	4	20½	5	12⅝	33	9.1
From 70.5 to 71.5	5	18	4	10	5	5½	20	20.0
From 71.5 to 72.5	4	21	4	21	4	21	2	21.0
From 72.5 to 73.5								
From 73.5 to 74.5								
From 74.5 to 75.5	4	3	4	3	4	3	2	3.5
	13	23	4	3	8	4⅝	485	29.96

The above 485 jars represent a total of 34,323,000 shad eggs.

All who have been connected with the work of shad production have had occasion in different seasons to note the variations in the date when we first begin to get ripe eggs in any quantity, in the date at which production reaches the maximum for the season, and in the period at which the season closes. This is instructively shown by W. F. Page in Table VI. It will be seen from that table that the season of 1885 was remarkably late. No eggs were taken up to April 25. On the corresponding date in 1884 the aggregate collected was 2,246,000, and in 1883 1,365,000. The season of 1884, which yielded the largest number of eggs, terminated on May 24, while the seasons of 1883 and 1885 extended to June 8.

TABLE IV.—*Comparative statement of the number of shad eggs received at Central Station, U. S. Fish Commission.*

Date.	1883.		1884.		1885.	
	Received in past 24 hours.	Total received to date.	Received in past 24 hours.	Total received to date.	Received in past 24 hours.	Total received to date.
April 15	12,500	12,500	30,000	30,000	.....	.....
16	25,000	37,500	45,000	75,000	.....	.....
17	187,500	225,000	155,000	230,000	.....	.....
18	82,500	307,500	60,000	290,000	.....	.....
19	417,500	725,000	255,000	545,000	.....	.....
20	45,000	770,000	225,000	770,000	.....	.....
21	233,000	1,003,000	277,000	1,047,000	3,000	3,000
22	190,000	1,193,000	(*)	.....	(*)	.....
23	172,000	1,365,000	1,199,000	2,246,000	(*)	.....
24	(*)	.....	(*)	.....	(*)	.....
25	70,000	1,435,000	573,000	2,819,000	125,000	128,000
26	(*)	.....	590,000	3,409,000	205,000	333,000
27	(*)	.....	205,000	3,614,000	(*)	.....
28	40,000	1,475,000	90,000	3,704,000	550,000	883,000
29	(*)	.....	817,000	4,521,000	186,000	1,069,000
30	(*)	.....	810,000	5,331,000	210,000	1,279,000
May 1	68,000	1,543,000	508,000	5,839,000	(*)	.....
2	20,000	1,563,000	1,255,000	7,094,000	215,000	1,494,000
3	209,000	1,772,000	810,000	7,904,000	92,000	1,586,000
4	325,000	2,097,000	775,000	8,679,000	500,000	2,086,000
5	399,000	2,496,000	465,000	9,144,000	400,000	2,486,000
6	167,000	2,663,000	475,000	9,619,000	492,000	2,978,000
7	300,000	2,963,000	1,010,000	10,629,000	685,000	3,663,000
8	1,294,000	4,257,000	460,000	11,089,000	2,004,000	5,667,000
9	691,000	4,948,000	625,000	11,714,000	75,000	5,742,000
10	505,000	5,453,000	650,000	12,364,000	210,000	5,952,000
11	519,000	5,972,000	420,000	12,784,000	1,573,000	7,525,000
12	920,000	6,892,000	(*)	.....	817,000	8,342,000
13	820,000	7,712,000	835,000	13,619,000	1,086,000	9,428,000
14	342,000	8,054,000	(*)	.....	550,000	9,978,000
15	792,000	8,846,000	380,000	13,999,000	492,000	10,470,000
16	284,000	9,130,000	812,000	14,811,000	235,000	10,705,000
17	649,000	9,779,000	605,000	15,416,000	413,000	11,118,000
18	767,000	10,546,000	625,000	16,041,000	(*)	.....
19	758,000	11,304,000	520,000	16,561,000	598,000	11,716,000
20	900,000	12,204,000	580,000	17,141,000	321,000	12,037,000
21	600,000	12,804,000	245,000	17,386,000	(*)	.....
22	735,000	13,539,000	555,000	17,941,000	348,000	12,385,000
23	675,000	14,241,000	426,000	18,367,000	366,000	12,751,000
24	391,000	14,605,000	415,000	18,791,000	898,000	13,649,000
25	297,000	14,902,000	(*)	.....	(*)	.....
26	100,000	15,002,000	(*)	.....	362,000	14,011,000
27	158,000	15,160,000	(*)	.....	383,000	14,394,000
28	410,000	15,570,000	(*)	.....	588,000	14,982,000
29	294,000	15,864,000	(*)	.....	669,000	15,651,000
30	525,000	16,389,000	(*)	.....	320,000	15,971,000
31	180,000	16,569,000	(*)	.....	411,000	16,382,000
June 1	50,000	16,619,000	.....	.....	80,000	16,462,000
2	315,000	16,934,000	.....	.....	(*)	.....
3	550,000	17,484,000	.....	.....	(*)	.....
4	173,000	17,657,000	.....	.....	34,000	16,496,000
5	(*)	.....	.....	.....	(*)	.....
6	(*)	.....	.....	.....	(*)	.....
7	(*)	.....	.....	.....	40,000	16,536,000
8	105,000	17,762,000	.....	.....	(*)	.....
Total	.....	17,762,000	.....	18,791,000	.....	16,536,000

* None.

The aggregate production of eggs did not vary greatly in the three seasons, but the production of young for distribution was larger in the season just closed than in either of the preceding.

SUMMARY.

The following is a summary of the work, so far as it came under my direction:

The aggregate furnished for distribution was	20,732,000
Lost on the way	1,861,000
Actually planted	18,871,000

These were furnished as follows:

By the Susquehanna River station (Battery Station)	5,224,000
By Potomac River stations (Central Station and Fort Washington)	15,508,000
Total	20,732,000

In making the distribution care has been taken to stock liberally the Potomac, the Susquehanna, and most of the minor tributaries of the Chesapeake. Plants of 250,000 to 1,250,000 have been made in streams in Pennsylvania, Maryland, and Virginia, which it was supposed would furnish suitable nurseries for the young fry during the first summer of their life.

The aggregate of the plants in the tributaries of the Chesapeake was about	8,000,000
In tributaries of Narragansett Bay	825,000
In Hudson River	1,250,000
In tributaries of Albemarle Sound	1,500,000
In streams draining into the South Atlantic	1,475,000
In the Mississippi and minor tributaries of the Gulf of Mexico	4,325,000

The experiment of stocking with shad the Colorado River of the West, which was begun in 1884, has been continued this season, and 848,000 were sent out by car No. 2, in charge of George H. H. Moore, and planted in good condition. Should this experiment prove successful, the shad fry deposited in 1884 should reappear as mature fish in the spring of 1887 or 1888.

It is believed that the rivers of the Seattle region of Washington Territory, draining into Puget Sound, can be successfully stocked with shad, and be made to furnish profitable fisheries, the importance of which to that region can be scarcely overestimated. With the view of making the experiment, 900,000 vigorous fry were selected and sent out by car No. 2, in charge of Mr. George H. H. Moore, one of the most experienced and careful messengers of the commission. The experiment was hazardous, because the number of days required for uninterrupted transit from Washington, D. C., to Seattle, Wash., marks the limit of time during which the shad can be transported with safety. A detention of three days by the washing away of a bridge resulted in almost total loss, only 50,000 being alive when the car reached Portland, Oreg. These were planted in the Willamette River, at that point.

WASHINGTON, D. C., *September* 15, 1885.

TABLE V.—*Daily register of eggs received and fish hatched at Central Station, U. S. Fish Commission, season of* 1885.

No. of record card.	Eggs taken.		Eggs received.		Whence obtained.	Temperature of water used in impregnating the eggs.	Total number received.	Number received alive.	Number of fish produced.	Disposal of eggs while hatching.	Period of hatching.				Temperature during incubation.			Days and hours in incubating.
	Date.	Hour of day.	Date.	Hour of day.							Began.		Ended.		Max.	Min.	Av.	
											Date.	Hour of day.	Date.	Hour of day.				
		h. m.		*h. m.*								*h. m.*		*h. m.*				*d. h.*
1	Apr. 20	13 45	Apr. 20	16	Fort Washington seine	55°	5,000	3,000	None.	B 1								
2	Apr. 21	17	Apr. 22	16	do	57°	35,000	None.										
3	Apr. 21	20	Apr. 22	16	Fort Washington Station		20,000	None.										
4	Apr. 23	7	Apr. 24	15 30	Fort Washington seine	57°	70,000	50,000	40,000	B 1	Apr. 28	21	May 2	9	62	58	59.8	8 26
5			Apr. 24	15 30	Fort Washington Station		100,000	75,000	65,000	B 2	Apr. 28	21	May 3	20	62	58	59.8	
6	Apr. 24	18 30	Apr. 25	16	Fort Washington seine	60°	110,000	75,000	70,000	B 3	Apr. 29	11	May 2	16	62	58	59.8	7 21½
7	Apr. 24	20 30	Apr. 25	16	Fort Washington Station		100,000	90,000	78,000	B 5	Apr. 29	8	May 4	11	62	58	59.8	
8	Apr. 24	20 30	Apr. 25	16	do		45,000	40,000	39,000	B 6	Apr. 29	8	May 4	9	62	58	59.8	
9			Apr. 27	16	do		125,000	105,000	100,000	B 4	Apr. 30	8	May 5	10	62	58	29.7	
10			Apr. 27	16	do		115,000	105,000	100,000	B 7	Apr. 30	8	May 6	6	62	59	59.8	
11			Apr. 27	16	do		85,000	80,000	66,000	B 31	Apr. 30	8	May 6	7	62	59	59.8	
12	Apr. 26	18	Apr. 27	16	Fort Washington seine	62°	75,000	70,000	70,000	B 30	May 1	15	May 7	6	62	59	59.8	10 12
13	Apr. 26	21 30	Apr. 27	16	do	62°	130,000	115,000	105,000	B 29	May 2	6	May 5	10	62	59	59.8	8 12½
14	Apr. 26	19 30	Apr. 27	16	do	62°	195,000	75,000	75,004	B 28	May 2	6	May 7	10	62	59	59.8	10 14½
15	Apr. 27	22 30	Apr. 28	15 30	do	61°	9,000	8,000	6,000	B 10	May 2	10	May 5	10	62	59	59.8	7 11½
16	Apr. 27	19 30	Apr. 28	15 30	do	61°	95,000	80,000	72,000	B 11	May 3	8	May 7	6	62	59	59.8	9 10½
17			Apr. 28	15 30	Fort Washington Station		100,000	98,000	96,000	B 12	May 3	8	May 6	21	62	59	59.8	
18			Apr. 29	16 15	do		90,000	45,000	45,000	B 1	May 3	21	May 7	15 30	60	59	59.5	
19			Apr. 29	16 15	do		110,000	75,000	55,000	B 2	May 4	21	May 8	9	60	59	59.5	
20			Apr. 29	16 15	do		127,000	90,000	60,000	B 3	May 5	8	May 7	15 30	60	59	59.5	
21			Apr. 30	16 15	do	62.5°	120,000	None.										
22	Apr. 30	3	May 1	16	Fort Washington seine	62°	28,000	25,000	21,000	B 4	May 6	6	May 9	4	62	59	59.7	9 1
23	Apr. 29	23 40	May 1	16	do	62°	84,000	75,000	75,000	B 5	May 5	13	May 9	6	62	59	59.7	9 6½
24	Apr. 29	22 20	May 1	16	do	62°	95,000	90,000	78,000	B 6	May 5	11 30	May 9	6	62	59	59.7	9 7½
25			May 1	16	Fort Washington Station		28,000	25,000	25,000	B 7	May 6	10	May 9	4	62	59	59.7	
26			May 2	16	do		100,000	92,000	78,000	B 31	May 7	15	May 9	4	62	59	59.7	
27			May 3	16	do		705,000	95,000	85,000	B 30	May 8	6	May 11	8	62	59	60.5	
28			May 3	16	do		95,000	92,000	88,000	B 29	May 8	6	May 11	13	62	59	60.5	
29			May 3	16	do		112,000	85,000	80,000	B 28	May 8	4	May 10	14	62	59	60.5	
30			May 3	16	do		112,000	68,000	64,000	B 27	May 8	4	May 10	13	62	59	60.5	
31			May 3	16	do		77,000	70,000	60,000	B 26	May 8	6	May 9	4	62	59	60	
32	May 1	15	May 3	16	Fort Washington seine	61°	52,500	50,000	50,000	B 17	May 7	21	May 10	20	62	59	60.5	9 5
33	May 2	16 30	May 3	16	do	61°	56,000	40,000	40,000	B 18	May 8	8	May 11	11	62	59	60.5	8 18½
34			May 4	16	Fort Washington Station		119,000	115,000	100,000	B 19	May 8	5	May 11	10	62	59	60	
35			May 4	16	do		115,000	105,000	100,000	B 20	May 8	6	May 10	14	62	59	60	
36			May 4	16	do		117,000	110,000	100,000	B 21			May 10	21	62	59	60	

37	.....	.....	May 4	16	.....do.....	.....	77,000	70,000	70,000	B 22	May 8	4	May 10	14	62	59	60	.....
38	.....	.....	May 5	16	.....do.....	.....	126,000	115,000	100,000	B 1	May 8	9	May 12	6	62	60	61.3	.....
39	.....	.....	May 5	16	.....do.....	.....	113,000	105,000	100,000	B 2	May 8	9	May 12	13	62	60	61.3	.....
40	.....	.....	May 5	16	.....do.....	.....	119,000	112,000	110,000	B 3	May 8	9	May 12	7	62	60	61.3	.....
41	May 3	16 30	May 5	16	Fort Washington seine.....	61°	79,000	77,000	77,000	B 16	May 8	9	May 12	11	62	60	61.3	8 18½
42	May 3	16 30	May 5	16	.....do.....	61°	84,000	83,000	75,000	B 15	May 8	9	May 11	17	62	60	61.3	8 ½
43	.....	.....	May 6	16	Fort Washington Station.....	.....	120,000	91,000	80,000	B 4	May 9	17	May 13	8	62	60	61.6	.....
44	.....	.....	May 6	16	.....do.....	.....	116,000	107,000	92,000	B 5	May 9	15	May 13	13	62	60	61.6	.....
45	.....	.....	May 6	16	.....do.....	.....	120,000	84,000	60,000	B 6	May 9	19	May 13	6	62	60	61.6	.....
46	.....	.....	May 6	16	.....do.....	.....	114,000	100,000	80,000	B 7	May 9	15	May 13	7	62	60	61.6	.....
47	.....	.....	May 6	16	.....do.....	.....	92,000	90,000	80,000	B 10	May 9	19	May 13	8	62	60	61.6	.....
48	.....	.....	May 6	16	.....do.....	.....	63,000	57,000	57,000	B 11	May 9	21	May 12	7	62	60	61.6	.....
*49	.....	.....	May 6	16	Fort Washington seine.....	62°	62,000	58,000	43,000	B 12	May 9	15	May 12	7	62	60	61.6	.....
50	.....	.....	May 6	16	.....do.....	62°	103,000	98,000	95,000	B 13	May 9	15	May 13	13	62	60	61.6	.....
51	.....	.....	May 7	16	Fort Washington Station.....	.....	120,000	60,000	50,000	C 11	May 11	7	May 14	8	62	61	62—	.....
52	.....	.....	May 7	16	.....do.....	.....	128,000	95,000	85,000	C 12	May 11	9	May 15	7	62	61	62—	.....
53	.....	.....	May 7	16	.....do.....	.....	112,000	70,000	55,000	C 13	May 11	10	May 15	6	62	61	62—	.....
54	.....	.....	May 7	16	.....do.....	.....	105,000	70,000	56,000	C 14	May 11	10	May 15	13	62	61	62—	.....
55	.....	.....	May 7	16	.....do.....	.....	118,000	None.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
56	.....	.....	May 7	16	.....do.....	.....	124,000	None.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
57	.....	.....	May 7	16	.....do.....	.....	111,000	70,000	60,000	C 19	May 11	10	May 15	5	62	61	62—	.....
58	.....	.....	May 7	16	.....do.....	.....	118,000	80,000	70,000	C 20	May 11	10	May 15	7	62	61	62—	.....
59	.....	.....	May 7	16	.....do.....	.....	125,000	84,000	68,000	C 21	May 11	10	May 15	5	62	61	62—	.....
60	.....	.....	May 7	20	.....do.....	.....	110,000	80,000	77,000	F 6	May 11	14	May 15	13	63	61	62	.....
61	.....	.....	May 7	20	.....do.....	.....	125,000	110,000	75,000	F 5	.....	.....	May 15	15	63	61	62	.....
62	.....	.....	May 7	20	.....do.....	.....	95,000	85,000	78,000	F 4	May 11	8	May 15	7	62	61	62—	.....
63	.....	.....	May 7	20	.....do.....	.....	112,000	100,000	80,000	F 3	May 10	10	May 15	6	62	61	62—	.....
64	.....	.....	May 7	20	.....do.....	.....	100,000	95,000	87,000	F 2	May 10	10	May 15	5	62	61	62—	.....
65	.....	.....	May 7	20	.....do.....	.....	100,000	85,000	75,000	F 1	May 11	8	May 14	15	62	61	62—	.....
66	.....	.....	May 7	20	.....do.....	.....	105,000	90,000	77,000	F 32	May 11	8	May 14	5	62	61	62—	.....
67	.....	.....	May 7	20	.....do.....	.....	105,000	75,000	75,000	F 31	May 11	8	May 14	8	62	61	62—	.....
68	.....	.....	May 7	20	.....do.....	.....	100,000	90,000	80,000	F 30	May 10	11	May 15	13	63	61	62	.....
69	.....	.....	May 7	20	.....do.....	.....	110,000	95,000	70,000	F 29	May 10	15	May 14	15	63	61	62	.....
70	.....	.....	May 7	20	.....do.....	.....	125,000	110,000	90,000	F 28	May 10	10	May 14	6	62	61	62—	.....
71	.....	.....	May 7	20	.....do.....	.....	105,000	75,000	70,000	F 27	May 11	7	May 15	5	62	61	62—	.....
72	.....	.....	May 7	20	.....do.....	.....	90,000	50,000	49,000	F 26	.....	.....	May 14	15	62	61	62—	.....
73	May 6	20	May 7	20	Fort Washington seine.....	63°	77,000	60,000	55,000	F 24	May 12	17	May 15	15	63	61	62	8 19
74	May 6	20	May 7	20	.....do.....	63°	55,000	45,000	45,000	F 23	May 11	8	May 15	6	62	61	62—	8 10
75	May 6	18 30	May 7	20	.....do.....	63°	125,000	95,000	60,000	F 22	May 11	8	May 14	10	62	61	62—	7 15½
76	May 5	18 30	May 7	20	.....do.....	62°	75,000	75,000	57,000	F 21	May 12	7	May 14	11	62	61	62—	8 16½
77	May 6	18 30	May 7	20	.....do.....	63°	90,000	60,000	60,000	F 20	May 12	15	May 15	13	63	61	62	8 18½
78	.....	.....	May 8	16	Fort Washington Station.....	.....	85,000	75,000	75,000	B 16	May 12	7	May 15	13	63	61	62	.....
79	.....	.....	May 9	16	.....do.....	.....	112,000	98,000	92,000	B 31	May 12	11	May 17	6	66	62	62.6	.....
80	.....	.....	May 9	16	.....do.....	.....	125,000	112,000	100,000	B 30	May 12	11	May 16	7	64	62	62.5	.....
81	.....	.....	May 10	15 30	Fort Washington seine.....	.....	100,000	70,000	65,000	B 1	May 13	10	May 18	5	66	62	63.1	.....
82	.....	.....	May 10	15 30	.....do.....	.....	115,000	85,000	80,000	B 2	May 13	9	May 18	6	66	62	63.1	.....
83	.....	.....	May 10	15 30	.....do.....	.....	120,000	120,000	100,000	B 3	May 13	6	May 18	4 30	66	62	63.1	.....
84	.....	.....	May 10	15 30	.....do.....	.....	115,000	100,000	95,000	B 4	May 13	6	May 18	6	66	62	63.1	.....
85	.....	.....	May 10	15 30	.....do.....	.....	125,000	110,000	95,000	B 5	May 13	10	May 17	7	66	62	63	.....
86	.....	.....	May 10	15 30	Fort Washington Station.....	.....	100,000	75,000	73,000	B 6	May 13	10	May 17	14	66	62	63	.....

*See crate card.

TABLE V.—*Daily register of eggs received and fish hatched at Central Station, U. S. Fish Commission, season of* 1885—Continued.

No. of record card.	Eggs taken.		Eggs received.		Whence obtained.	Temperature of water used in impregnating the eggs.	Total number received.	Number received alive	Number of fish produced.	Disposal of eggs while hatching.	Period of hatching.				Temperature during incubation.			Days and hours in incubating.
	Date.	Hour of day.	Date.	Hour of day.							Began.		Ended.		Max.	Min.	Av.	
											Date.	Hour of day.	Date.	Hour of day.				
		h. m.		*h. m.*								*h. m.*		*h. m.*				*d. h.*
87	.....	.....	May 10	15 30	Fort Washington Station.....	.....	120,000	80,000	80,000	B 7	May 13	10	May 18	5	66	62	63.1	.....
88	.....	.....	May 10	15 30	.....do.....	.....	125,000	80,000	70,000	B 10	May 13	10	May 17	14	66	62	63	.....
89	.....	.....	May 10	15 30	.....do.....	.....	105,000	80,000	65,000	B 11	May 13	10	May 16	7	64	62	62+	.....
90	.....	.....	May 10	15 30	.....do.....	.....	105,000	98,000	95,000	B 12	May 13	6	May 16	7	64	62	62+	.....
91	.....	.....	May 10	15 30	.....do.....	.....	112,000	95,000	80,000	B 13	May 12	15	May 16	20	66	62	63	.....
92	.....	.....	May 10	15 30	.....do.....	.....	119,000	100,000	65,000	B 14	May 13	10	May 17	9	66	62	63	.....
93	.....	.....	May 10	15 30	.....do.....	.....	125,000	85,000	78,000	B 15	.....	.....	May 16	8	64	62	62+	.....
94	.....	.....	May 10	15 30	.....do.....	.....	120,000	120,000	105,000	B 29	May 13	10	May 17	9	66	62	63	.....
95	.....	.....	May 10	15 30	.....do.....	.....	115,000	110,000	85,000	B 28	May 13	6	May 15	13	63	62	62+	.....
96	.....	.....	May 10	15 30	.....do.....	.....	98,000	90,000	80,000	B 27	May 13	6	May 16	16	64	62	63	.....
97	.....	.....	May 10	15 30	.....do.....	.....	91,000	75,000	70,000	B 26	May 13	6	May 17	17	66	62	63.1	.....
98	May 10	.....	May 11	16	Fort Washington seine.....	.....	120,000	110,000	105,000	B 17*	.....	.....	.....	.....	.....	.....	.....	.....
99	May 10	.....	May 11	16	.....do.....	.....	97,000	77,000	68,000	B 18*	.....	.....	.....	.....	.....	.....	.....	.....
100	May 10	.....	May 11	16	.....do.....	.....	112,000	90,000	75,000	B 19	May 15	6	May 18	9	66	62	63.1	.....
101	.....	.....	May 11	16	Fort Washington Station.....	.....	112,000	90,000	80,000	B 20	May 15	13	May 18	8	66	62	63.1	.....
102	.....	.....	May 11	16	.....do.....	.....	110,000	78,000	77,000	B 21*	.....	.....	.....	.....	.....	.....	.....	.....
103	.....	.....	May 11	16	.....do.....	.....	110,000	82,000	72,000	B 22	May 15	13	May 18	13	66	62	63.3	.....
104	.....	.....	May 11	16	.....do.....	.....	130,000	100,000	70,000	C 17	May 15	8	May 18	6	66	62	63.3	.....
105	.....	.....	May 11	16	.....do.....	.....	120,000	90,000	75,000	C 18	May 15	8	May 18	7	66	62	63.3	.....
106	.....	.....	May 11	16	.....do.....	.....	125,000	100,000	80,000	C 19	May 15	8	May 18	8	66	62	63.3	.....
107	May 11	18 30	May 12	16	Fort Washington seine.....	62°	105,000	98,000	85,000	B 30	May 16	7	May 18	20	67	62	63.6	7 1½
108	May 11	18 30	May 12	16	.....do.....	62°	105,000	92,000	85,000	B 31	May 15	7	May 18	19	67	62	63.6	7 0½
109	May 11	18 30	May 12	16	.....do.....	62°	112,000	98,000	80,000	B 16	May 16	7	May 18	18	67	62	63.6	6 23½
110	May 11	18 30	May 12	16	.....do.....	62°	70,000	60,000	50,000	C 20	May 16	7	May 19	8	68	62	63.7+	7 13½
111	May 11	21 30	May 12	16	.....do.....	62°	130,000	103,000	80,000	C 16	May 16	7	May 19	9	68	62	63.7	7 11½
112	.....	.....	May 12	16	Fort Washington Station.....	.....	113,000	70,000	55,000	C 15	May 16	7	May 18	20	67	62	63.6	.....
113	.....	.....	May 12	16	.....do.....	.....	112,000	78,000	60,000	C 14	May 16	7	May 18	8	66	62	63.6	.....
114	.....	.....	May 12	16	.....do.....	.....	118,000	30,000	22,000	C 13	May 16	7	May 18	20	67	62	63.6	.....
115	.....	.....	May 12	16	.....do.....	.....	115,000	70,000	68,000	C 12	May 16	7	May 18	20	67	62	63.6	.....
116	.....	.....	May 12	16	.....do.....	.....	120,000	85,000	45,000	D 17	May 16	7	May 18	20	67	62	63.6	.....
117	.....	.....	May 12	16	.....do.....	.....	115,000	85,000	60,000	D 18	May 16	7	May 18	19	67	62	63.6	.....
118	.....	.....	May 12	16	.....do.....	.....	122,000	95,000	60,000	D 19	May 16	7	May 18	19	67	62	63.6	.....
119	.....	.....	May 12	16	.....do.....	.....	100,000	80,000	80,000	D 16	May 16	7	May 19	8	68	62	63.6+	.....
120	.....	.....	May 12	16	.....do.....	.....	60,000	42,000	35,000	D 15	May 16	7	May 19	8	68	62	63.6	.....
121	.....	.....	May 13	16	Fort Washington seine.....	62°	112,000	95,000	80,000	B 1	May 17	13	May 20	9	68	62	65	.....
122	.....	.....	May 13	16	.....do.....	62°	95,000	70,000	50,000	B 2	May 17	13	May 20	14	68	62	65	.....

123			May 13	16	Fort Washington Station		115,000	92,000	60,000	B	3	May 17	13	May 20	14	68	62	65			
124			May 13	16	do		100,000	85,000	65,000	B	4	May 17	11	May 20	9	68	62	65			
125			May 13	16	do		98,000	80,000	65,000	B	5	May 17	11	May 20	10	68	62	65			
126			May 13	16	do		95,000	78,000	60,000	B	6	May 17	11	May 20	12	68	62	65			
127			May 13	16	do		77,000	50,000	40,000	B	7	May 17	11	May 19	21	68	62	65			
128	May 13	20	May 14	16	Fort Washington seine	61.5°	98,000	80,000	70,000	B	29	May 18	14	May 20	15	68	62	65		6	19
129	May 13	20	May 14	16	do	61.5°	63,000	58,000	55,000	B	28	May 18	10	May 19	21	68	62	65		6	1
130			May 14	16	Fort Washington Station		77,000	60,000	40,000	B	27	May 18	14	May 20	9	68	62	65			
131			May 14	16	do		91,000	42,000	30,000	B	26	May 18	14	May 20	9	68	62	65			
132			May 14	16	do		98,000	72,000	55,000	B	18	May 18	13	May 20	15	68	62	65			
133			May 14	16	do		119,000	90,000	50,000	B	21	May 18	14	May 20	9	68	62	65			
134			May 14	16	do		77,000	50,000	30,000	B	18	May 18	13	May 20	9	68	62	65			
135			May 14	16	do		56,000	40,000	20,000	B	17	May 18	13	May 20	9	68	62	65			
135*a*	May 14	20 30	May 15	16	Fort Washington seine	62°	65,000	None.													
136			May 15	16	Fort Washington Station		125,000	100,000	85,000	B	19	May 19	9	May 21	9	68	62	66.5			
137			May 15	16	do		120,000	80,000	80,000	B	20	May 19	9	May 21	8	68	62	66.5			
138			May 15	16	do		105,000	55,000	55,000	B	21	May 19	8	May 20	16	68	62	66.5			
139	May 15	14	May 16	16	Fort Washington seine	63°	40,000	35,000	25,000	E	2	May 19	13	May 21	17	68	65	67		6	3
140			May 16	16	Fort Washington Station		65,000	55,000	52,000	E	5	May 19	14	May 22	14	70	65	67+			
141			May 16	16	do		110,000	85,000	80,000	E	32	May 19	13	May 22	15	70	65	67+			
142			May 16	16	do		90,000	68,000	60,000	E	28	May 19	14	May 22	11	70	65	67+			
143			May 16	16	do		110,000	80,000	75,000	E	27	May 19	13	May 22	11	70	65	67+			
144			May 16	16	do		120,000	90,000	75,000	E	26	May 19	13	May 21	16	68	65	67+			
145			May 18	16	Fort Washington seine		100,000	85,000	78,000	E	17	May 19	17	May 22	18	70	66	68			
146			May 18	16	do		105,000	90,000	82,000	E	18	May 19	18	May 23	17	70	66	68			
147			May 18	16	do		95,000	78,000	78,000	E	19	May 19	18	May 23	12	70	66	68			
148			May 18	16	Fort Washington Station		110,000	75,000	65,000	E	20	May 20	14	May 22	6	70	66	68			
149			May 18	16	do		112,000	55,000	50,000	E	21	May 20	14	May 23	4	70	66	68			
150			May 18	16	do		112,000	45,000	45,000	E	16	May 20	14	May 23	4	70	66	68			
151			May 18	16	do		100,000	80,000	72,000	E	15	May 19	17	May 23	4	70	66	68			
152			May 18	16	do		105,000	90,000	85,000	E	14	May 19	20	May 23	11	70	66	68			
153			May 19	16	Fort Washington seine		100,000	83,000	80,000	E	10	May 21	12	May 24	15	70	68	69			
154			May 19	16	do		28,000	28,000	25,000	E	9	May 21	12	May 24	7	70	68	69			
155			May 19	16	Fort Washington Station		112,000	90,000	85,000	E	13	May 21	12	May 24	6	70	68	69			
156			May 19	16	do		112,000	60,000	60,000	E	12	May 21	12	May 24	6	70	68	69			
157			May 19	16	do		100,000	60,000	57,000	E	11	May 21	12	May 24	8	70	68	69			
158	May 19	18	May 21	16	Fort Washington seine	70°	100,000	90,000	90,000	E	17	May 22	8	May 25	15	71	68	69.5		5	21
159	May 19	18	May 21	16	do	70°	50,000	48,000	48,000	E	18	May 22	8	May 25	8	71	68	69.5		5	14
160			May 21	16	Fort Washington Station		115,000	75,000	75,000	E	19	May 22	8	May 25	11	71	68	69.5			
161			May 21	16	do		105,000	60,000	60,000	E	20	May 22	8	May 25	8	71	68	69.5			
162			May 21	16	do		120,000	75,000	75,000	E	21	May 22	8	May 24	10	71	68	69.5			
163	May 20	18 30	May 22	16	Fort Washington seine	70°	78,000	77,000	77,000	E	17	May 23	8	May 26	5	71	70	70.5		5	$\frac{1}{2}$
164	May 20	18 30	May 22	16	do	70°	95,000	92,000	92,000	E	18	May 23	8	May 26	5	71	70	70.5		4	$23\frac{1}{2}$
165			May 22	16	Fort Washington Station		98,000	95,000	95,000	E	19	May 23	8	May 26	8	71	70	70.5			
166			May 22	16	do		105,000	102,000	102,000	E	20	May 23	8	May 26	8	71	70	70.5			
167			May 23	16	Fort Washington seine		45,000	45,000	44,000	E	23	May 25	17	May 27	16 30	71	70	70.5			
168	May 21	18 30	May 23	16	do	70°	35,000	35,000	30,000	E	22	May 24	16	May 27	6	71	70	70.5		5	$11\frac{1}{2}$
169	May 21	17	May 23	16	do	70°	77,000	77,000	77,000	E	21	May 24	16	May 27	7	71	70	70.5		5	14
170	May 22	18 30	May 23	16	do	69°	78,000	75,000	72,000	E	20	May 24	16	May 27	15	71	70	70.5		4	$20\frac{1}{2}$
171	May 21	20	May 23	16	do	70°	75,000	70,000	60,000	E	19	May 24	16	May 27	7	71	70	70.5		5	11

*Shipped (as eggs) to Fred Mather, N. Y., 7 p. m. May 13, 1885.

TABLE V.—*Daily register of eggs received and fish hatched at Central Station, U. S. Fish Commission, season of* 1885—Continued.

No. of record card.	Eggs taken.		Eggs received.		Whence obtained.	Temperature of water used in impregnating the eggs.	Total number received.	Number received alive.	Number of fish produced.	Disposal of eggs while hatching.	Period of hatching.				Temperature during incubation.			Days and hours in incubating.
	Date.	Hour of day.	Date.	Hour of day.							Began.		Ended.		Max.	Min.	Av.	
											Date.	Hour of day.	Date.	Hour of day.				
		h. m.		*h. m.*								*h. m.*		*h. m.*				*d. h.*
172	May 21	18 50	May 23	16	Fort Washington seine	70°	72,000	72,000	69,000	E 18	May 24	16	May 27	6	71	70	70.5	5 11½
173	May 21	17	May 23	16	....do	70°	35,000	35,000	33,000	E 17	May 24	16	May 27	7	71	70	70.5	5 14
174	May 22	17	May 23	16	....do	70°	50,000	48,000	45,000	E 16	May 25	17	May 28	6	71	70	70.5	5 13
175	May 22	19 30	May 23	16	....do	70°	60,000	57,000	56,000	E 15	May 25	17	May 28	5	71	70	70.5	5 9½
176	May 22	18 30	May 23	16	....do	69°	35,000	35,000	35,000	E 14	May 25	17	May 28	5	71	70	70.5	4 22
177	May 22	19 30	May 23	16	....do	70°	85,000	77,000	75,000	E 13	May 25	12	May 28	5	71	70	70.5	5 9½
178	.....	.....	May 23	16	Fort Washington Station	.....	100,000	97,000	96,000	E 12	May 24	16	May 27	15	71	70	70.5	.....
179	.....	.....	May 23	16	....do	.....	45,000	45,000	45,000	E 11	May 24	16	May 27	14	71	70	70.5	.....
180	.....	.....	May 23	16	....do	.....	105,000	75,000	66,000	E 10	May 25	10	May 27	15	71	70	70.5	.....
181	.....	.....	May 23	16	....do	.....	60,000	55,000	55,000	E 9	May 24	16	May 27	9	71	70	70.5	.....
182	May 23	21 30	May 25	16	Fort Washington seine	70°	85,000	75,000	75,000	E 17	May 26	14	May 28	20	71	70	70.5	4 22½
183	May 23	20	May 25	16	....do	70°	90,000	84,000	84,000	E 18	May 26	14	May 28	20	71	70	70.5	5
184	May 23	18 30	May 25	16	....do	70°	35,000	28,000	28,000	E 19	May 26	14	May 29	6	71	69	70	5 11½
185	.....	.....	May 25	16	Fort Washington Station	.....	112,000	100,000	100,000	E 20	May 26	14	May 28	19	71	70	70.5	.....
186	.....	.....	May 25	16	....do	.....	78,000	75,000	75,000	E 21	May 26	14	May 28	21	71	70	70.5	.....
187	May 24	21	May 26	16	Fort Washington seine	70°	70,000	70,000	70,000	E 16	May 27	16	May 30	21	70	69	70—	6
188	May 24	21	May 26	16	....do	70°	70,000	70,000	70,000	E 15	May 27	17	May 30	10	70	69	70—	5 13
189	.....	.....	May 26	16	Fort Washington Station	.....	72,000	72,000	72,000	E 14	May 27	20	May 30	8	70	69	70—	.....
190	.....	.....	May 26	16	....do	.....	85,000	85,000	85,000	E 13	May 27	20	May 30	10	70	69	70—	.....
191	.....	.....	May 26	16	....do	.....	98,800	86,000	86,000	E 12	May 27	21	May 30	5	70	69	70—	.....
192	May 25	20 45	May 27	16	Fort Washington seine	67°	84,000	77,000	77,000	E 17	May 28	14 30	May 31	10	70	69	69.5	5 13½
193	May 25	20 45	May 27	16	....do	67°	90,000	84,000	84,000	E 18	May 28	14 30	May 31	9	70	69	69.5	5 12½
194	May 25	22	May 27	16	....do	67°	70,000	62,000	62,000	E 19	May 28	14 30	May 31	6	70	69	69.5	5 8
195	May 25	23 30	May 27	16	....do	67°	30,000	22,000	22,000	E 20	May 28	14 30	May 30	20	70	69	69.5	4 20½
196	.....	.....	May 27	16	Fort Washington Station	.....	100,000	90,000	90,000	E 21	May 28	14 30	May 31	6	70	69	69.5	.....
197	.....	.....	May 27	16	....do	.....	112,000	100,000	100,000	E 22	May 28	13	May 30	21	70	69	69.5	.....
198	.....	.....	May 27	16	....do	.....	80,000	77,000	77,000	E 23	May 28	14 30	May 31	7	70	69	69.5	.....
199	.....	.....	May 27	16	....do	.....	80,000	76,000	76,000	E 24	May 28	14 30	May 30	21	70	69	69.5	.....
200	May 26	20	May 28	16	Fort Washington seine	69°	112,000	95,000	90,000	E 16	May 30	9	June 1	10	70	69	69.5	5 14
201	May 27	20 40	May 28	16	....do	71°	85,000	75,000	75,000	E 15	May 30	21	June 2	12	70	69	69.5	5 15½
202	May 26	20 30	May 28	16	....do	69°	42,000	40,000	40,000	E 14	May 30	21	June 1	11	70	69	69.5	5 14½
203	May 26	20 30	May 28	16	....do	69°	63,000	60,000	60,000	E 13	May 30	21	June 1	21	70	69	69.5	6 0½
204	May 26	.....	May 28	16	Fort Washington (Moxley's Point) Station.	.....	77,000	77,000	77,000	E 12	May 30	21	June 1	17	70	69	69.5	.....
205	.....	.....	May 28	16	Fort Washington Station	.....	95,000	82,000	77,000	E 11	May 30	9	June 1	6	70	69	69.5	.....
206	.....	.....	May 28	16	....do	.....	110,000	95,000	85,000	E 10	May 30	9	June 1	13	70	69	69.5	.....

207	.....	.....	May 28	16	.....do	.....	77,000	70,000	70,000	E 9	May 30	9	June 2	17	70	69	69.5	.....
208	.....	.....	May 28	16	.....do	.....	110,000	75,000	70,000	E 7	May 30	9	June 1	13	70	69	69.5	.....
209	.....	.....	May 29	16	Fort Washington seine	.....	49,000	None.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
210	May 28	22	May 29	16	.....do	70°	105,000	85,000	85,000	E 18	May 31	23	June 3	20	71	69	70	5 22
211	May 28	21 15	May 29	16	.....do	70°	98,000	75,000	75,000	E 19	May 31	14	June 3	7	71	69	70	5 9¾
212	.....	.....	May 29	16	Fort Washington Station.....	.....	110,000	70,000	70,000	E 20	May 31	14	June 3	7	71	69	70	.....
213	.....	.....	May 29	16	.....do	.....	130,000	90,000	90,000	E 21	May 31	14	June 3	18	71	69	70	.....
214	May 29	21 40	May 30	16	Fort Washington seine	71°	91,000	68,000	68,000	G 22	June 2	11	June 5	4	72	69	70.5	6 6½
215	May 29	19 40	May 30	16	.....do	71°	72,000	50,000	45,000	G 23	June 2	12	June 4	21	72	69	70.5	6 1½
216	May 29	23	May 30	16	.....do	70°	85,000	75,000	.....	G 25†	.....	.....	.....	.....	.....	.....	.....	.....
217	May 29	23	May 30	16	.....do	70°	72,000	42,000	42,000	G 26	June 2	13	June 4	14	72	69	70.5	5 15
218	.....	.....	May 30	16	Fort Washington Station.....	.....	85,000	70,000	60,000	G 11	June 2	11	June 4	11	72	69	70.5	.....
219	.....	.....	May 30	16	.....do	.....	72,000	54,000	50,000	G 10	June 2	12	June 4	11	72	69	70.5	.....
220	.....	.....	May 30	16	.....do	.....	75,000	52,000	50,000	G 7	June 2	12	June 4	7	71	69	70	.....
221	.....	.....	May 31	15	.....do	.....	95,000	50,000	50,000	G 16	June 4	6	June 5	13	72	69	70.5	.....
222	.....	.....	May 31	15	.....do	.....	50,000	30,000	30,000	G 15	June 4	6	June 5	6	72	69	70.5	.....
223	May 31	36	May 31	15	Fort Washington seine	72°	65,000	None.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
224	.....	.....	June 3	16	Fort Washington Station.....	.....	35,000	34,000	34,000	G 14	June 6	6	June 7	6	73	71	72	.....
225	.....	.....	June 6	16	.....do	.....	42,000	40,000	40,000	G 14	June 8	8	June 10	5	73	71	72	.....

*Eggs of one female shad.

†To J. F. Ellis, for hatching on car No. 3.

TABLE VI.—*Statement of young shad planted in waters of the United States, season of* 1885.

Date.		Stream stocked.	Place of deposit.	Number of fish shipped.	Number died on the way.	Number planted.	Product of.	Messenger in charge of shipment.
May	4	Monocacy River	Frederick Junction, Md	300,000	(*)	300,000	Central Station	F. L. Donnelly.
	4	Chester River	Chestertown, Md	250,000	(*)	250,000	Battery Station	Do.
	6	Susquehanna River	Harrisburg, Pa	300,000	(*)	300,000	do	Do.
	9	Shenandoah River	Luray, Va	199,000	2,000	197,000	Central Station	W. A. Dunnington.
	10	Palmer River	Eight miles from Providence, R. I	1,850,000	25,000	825,000	do	N. Simmons.
	14	Congaree River	Columbia, S. C	1,050,000	525,000	525,000	do	G. H. H. Moore.
	15	Shenandoah River	Waynesborough, Va	1,000,000	(*)	1,000,000	do	Do.
	15	Conecuh River	Troy, Ala	200,000	(*)	200,000	do	F. L. Donnelly.
	15	Murder Creek	Evergreen, Ala	100,000	(*)	100,000	do	M. N. Tune.
	15	Sepulga River	do	100,000	(*)	100,000	do	Do.
	15	Mattaponv River	Milford Station, Va	344,000	(*)	344,000	do	C. A. Stewart.
	16	Carp ponds	Washington, D. C	100,000	(*)	100,000	do	J. Mace.
	16	Occoquan River	Wood Bridge Station, Va	347,000	(*)	347,000	do	C. A. Stewart.
	16	Alabama River	Montgomery, Ala	774,000	(*)	774,000	Battery and Central Stations	N. Simmons.
	17	Broad Run	Near Bristoe Station, Va	375,000	(*)	375,000	Central Station	C. A. Stewart.
	18	Accotink Creek	Long Branch Station, Va	175,000	(*)	175,000	do	Do.
	20	Acquia Creek	Richland Station, Va	200,000	(*)	200,000	do	Do.
	20	Potomac Creek	Near Brooks Station, Va	220,000	(*)	220,000	do	Do.
	21	Ochlockonee River	Intersection Savannah, Florida and Western Railroad, Georgia.	300,000	18,000	282,000	do	N. Simmons.
	21	Aucilla River	do	300,000	18,000	282,000	do	Do.
	21	Withlacoochee River	do	300,000	18,000	282,000	do	Do.
	21	Allapaha River	do	350,000	21,000	329,000	do	Do.
	21	Rivanna River	Charlottesville, Va	220,000	(*)	220,000	do	C. A. Stewart.
	21	Rappahannock River	Rappahannock, Va	350,000	(*)	350,000	do	J. E. Brown.
	22	Rapidan River	Rapidan Station, Va	189,000	(*)	189,000	do	C. A. Stewart.
	22	Hudson River	Mechanicsville, N. Y	1,250,000	(*)	1,250,000	Battery Station	J. F. Ellis.
	23	Appomattox River	Mattoax Station, Va	185,000	18,000	167,000	Central Station	C. A. Stewart.
	23	Chickahominy River	Near Hunslet, Va	187,000	5,000	182,000	do	J. E. Brown.
	24	Colorado River	The Needles, Ariz	998,000	150,000	848,000	do	G. H. H. Moore.
	24	Rappahannock River	Fredericksburgh, Va	370,000	(*)	370,000	do	J. E. Brown.
	25	Dan River	Danville, Va	1,500,000	(*)	1,500,000	Battery Station	J. F. Ellis.
	27	Green River	Near Landrum, S. C	1,000,000	50,000	950,000	Central Station	N. Simmons.
	27	North East River	North East, Md	250,000	(*)	250,000	Battery Station	F. L. Donnelly.
	28	Rivanna River	Charlottesville, Va	187,000	(*)	187,000	Central Station	C. A. Stewart.
	28	Gunpowder River	Gunpowder, Md	250,000	(*)	250,000	Battery Station	F. L. Donnelly.
	28	North Anna River	Chesapeake and Ohio Junction, Va	175,000	(*)	175,000	Central Station	C. A. Stewart.
	28	Little River	Near Taylorsville, Va	175,000	(*)	175,000	do	J. E. Brown.
	30	Patapsco River	Relay House, Md	200,000	(*)	200,000	Battery Station	F. L. Donnelly.
June	1	Elk River	Elkton, Md	250,000	(*)	250,000	do	Do.
	2	Fox River	Aurora, Ill	500,000	40,000	460,000	Central Station	N. Simmons.
	3	Illinois River	Peoria, Ill	700,000	56,000	644,000	do	Do.

5	Bush River	Bush Station, Md	250,000	(*)	250,000	Battery Station	F. L. Donnelly.
7	Susquehanna River	Sunbury, Pa	500,000	(*)	500,000	do	Do.
8	Blue River	Manhattan, Kans	345,000	24,000	321,000	Central Station	N. Simmons.
8	Republican River	Junction City, Kans	247,000	17,000	230,000	do	Do.
8	Smoky River	do	345,000	24,000	321,000	do	Do.
10	Snake River	Ainsworth, Wash	10,000	(*)	10,000	do	G. H. H. Moore.
11	Willamette River	East Portland, Oreg	900,000	850,000	50,000	do	Do.
13	Carp ponds	Washington, D. C	74,000	(†)	74,000	do	J. Mace.
May 10 to June 13	Piscataway River	Fort Washington Station	1,000,000		1,000,000		
	Total		20,732,000		18,871,000		

* Too small to estimate. † None.

The results of the work of shad production conducted on the Potomac River and at Central Station during the season of 1885 under my immediate direction are as follows:

Number retained at Fort Washington Station	1,557,000
Number forwarded to Central Station	21,019,000
Total number of shad eggs collected on the Potomac River, season of 1885	22,576,000
The number of eggs received at Central Station in good condition was	16,536,000
Number of eggs shipped to other points	325,000
Number of eggs hatched at Central Station	16,211,000
Number of shad fry planted in the Potomac River at Fort Washington Station	1,000,000
Number hatched and distributed from Central Station	14,531,000
Total product for distribution from Potomac River stations	15,531,000

The average loss from impregnation to the period of hatching was 31 per cent.
The average loss during incubation at Central Station was 10 per cent.

The cost of production was, in round numbers, at the rate of $330 for each million shad fry furnished for distribution, or more than thirty young shad for each cent of expenditures made. The above table VI includes the entire distribution made under my direction by car and messenger service. It does not include the local plants made in the Delaware by the commission steamer Fish Hawk, nor those made in the Susquehanna near Battery Station.