REPORT ON THE PROPAGATION AND DISTRIBUTION OF FOOD-FISHES.

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INTRODUCTION.

The work of the Division of Fish-Culture, prosecuted on the same general lines as in past years, is shown by the following abstracts of reports of the superintendents of the various stations. The same stations were operated as in 1896, with the addition of those at Manchester, Iowa, and San Marcos, Tex., which were completed in December. The output of salmon fry was largely augmented by the establishment of auxiliary stations at Battle Creek, Cal., on Salmon River, Oregon, and the Little White Salmon, Washington, which were operated in conjunction with Baird and Clackamas stations. During the year all the stations in New England and on the Great Lakes, as well as those at Wytheville and Quincy, were inspected by the Commissioner and the assistant in charge of the Division of Fish-Culture.

The shad work on the Atlantic Coast was also largely increased, and steps were taken to investigate the rivers along the South Atlantic coast with the view to the establishment of auxiliary stations. On the New England coast, in addition to the operations conducted at Woods Hole and Gloucester, the *Grampus* and *Fish Hawk* were utilized during May and June in collecting lobster eggs off the coast of Maine. The crew of the *Grampus* also rendered material assistance in the cod work, collecting eggs for Gloucester Station from fishing vessels at Kittery.

From the experience gained the past season it is believed that a cod-collecting station can be advantageously established at Plymouth, Mass., and if successful it will obviate the necessity of penning brood fish at Woods Hole, materially reducing the expense of that station.

During the fiscal year 586,144,000 fish and eggs, embracing 30 species and 1 crustacean, were distributed from the following stations:

Green Lake Station, Me.
Craig Brook Station, Me.
St. Johnsbury Station, Vt.
Cape Vincent Station, N. Y.
Gloucester Station, Mass.
Woods Hole Station, Mass.
Steamer *Fish Hawk* (Albemarle Sound, Delaware River, and Casco Bay).
Battery Island Station, Md.
Bryan Point Station, Md.
Central Station, Washington, D. C.
Fish Commission lakes, Washington, D. C.
Wytheville Station, Va.
Put-in Bay Station, Ohio.
Northville Station, Mich.
Alpena Station, Mich.
Duluth Station, Minn.
Manchester Station, Iowa.
Quincy Station, Ill.
Neosho Station, Mo.
San Marcos Station, Tex.
Leadville Station, Colo.
Bozeman Station, Mont.
Baird Station Cal.
Battle Creek Station, Cal.
Fort Gaston Station, Cal.
Clackamas Station, Oreg.

A comparison of this season's work with that of the previous year shows a gratifying increase in the output of fry of most of the important commercial species propagated, such as shad, salmon, lake trout, lake herring, cod, quinnat salmon, Atlantic salmon, flatfish, and lobsters. The distribution from the various stations was made as in past years by station employees in neighboring waters and by means of the four cars owned by the Commission. Owing to the increased output of the various species it became necessary during the spring to hire an additional baggage car from the Pennsylvania Railroad Company to assist in the distribution of shad.

The total mileage traveled by the cars and messengers while engaged in the distribution amounted to 206,615 miles, 84,892 of which were free. The only accident which occurred during the season was at San Francisco, where a freight train collided with car No. 3. The car was repaired free of expense to the Commission by the Southern Pacific Railroad Company.

Car No. 3 was utilized as a temporary hatchery on the St. Johns River, Florida, during February, March, and April. At the opening of the Nashville Exposition in May car No. 4 was detailed for the collection and transfer of marine specimens for the exposition.

Many changes occurred in the personnel of the messenger service during the year, the most important being the promotion of Capts. R. S. Johnson and G. H. Lambson to the superintendency of the stations at Manchester, Iowa, and Baird, Cal., respectively.

GREEN LAKE STATION, MAINE (E. E. RACE, SUPERINTENDENT).

The stock of fish on hand having been distributed during the month of June, the time of the station force during the summer was devoted to the improvement of the water supply, construction of ponds, and general repairs and improvements to the buildings and grounds. The main flume from Rocky Pond to the reservoir, 6,800 feet long, was thoroughly overhauled and arrangements were made to run the water from the flume direct to the hatchery instead of accumulating it in the reservoir as heretofore.

The old ponds between the hatchery and reservoir were condemned and partly refilled, the two back of the hatchery were rebuilt, and five new ones were constructed. The old ponds were 20 feet wide by 38¾ feet long, the new ones 16½ feet by 38¾ feet. A 2-inch pipe was laid from the hatchery to a spring on the side of the mountain, furnishing an increase of 25 gallons of water per minute during the dry season, at a temperature of 43°. During the spring months the amount obtained from this source is much larger.

The usual arrangements were made for collecting eggs from wild fish in Green Lake, Manns Brook, Great Brook, Winkempaugh Brook, Patton Pond, and Boggy Brook. The first landlocked salmon was captured September 17 at Manns Brook and the first brook trout September 29. The run of golden trout at Floods Pond commenced November 1

and continued until November 16. The fish taken were held in traps in Great Brook, Floods Pond, and Patton Pond until their eggs had matured. The brook trout commenced spawning October 17, the salmon on October 19, and the golden trout November 3. The last eggs secured from the salmon were on November 17 and from the golden trout on November 28. The following table shows the number of brook trout, landlocked salmon, and golden trout taken in the various traps and the number of eggs obtained from them:

Body of water.	Landlocked salmon.		Brook trout.		Golden trout.	
	Fish.	Eggs.	Fish.	Eggs.	Fish.	Eggs.
Green Lake	190	217,700	12	16,500	.....	.....
Winkempaugh Brook	49	91,500	211	147,202	.....	.....
Floods Pond	4	10,000	37	8,000	90	82,000
Patton Pond	4	5,200	110	114,000	.....	.....
Total	247	324,400	370	285,702	90	82,000

In accordance with the usual custom, at the close of the season the adult fish were returned to the waters from which they were taken. A number of ripe female salmon collected at Floods Pond yielded 12,000 eggs, but as no males were captured an effort was made to fertilize them with milt forwarded from the Green Lake hatchery in an air-tight jar, which was held for thirty-six hours after its receipt. Fertilization was apparently accomplished and the eggs were forwarded to the hatchery, but after remaining in the troughs for some time they all turned white and were thrown away.

During the fall the following shipments of eggs were made from the station: Of the landlocked salmon, 82,000; quinnat salmon, 30,000; brook trout, 40,000; golden trout, 10,000.

The following consignments were received: From Battle Creek, Cal., 1,000,000 quinnat-salmon eggs; from Fort Gaston, Cal., 50,000 steelhead-trout eggs, and from Craig Brook, Me., 50,000 Atlantic salmon eggs.

The quinnat-salmon eggs arrived in excellent condition on December 17, and commenced hatching February 22. They finished by April 10, the total loss, including the number found dead on arrival, amounting to 75,500. The fry resulting from them were held until the absorption of the sac and then planted in the tributaries of Union River. The steelhead eggs arrived in very bad condition, and had finished hatching by May 18. Only 9,335 young fish remained on hand at the close of the year as a result of this shipment. The Atlantic-salmon eggs commenced hatching on March 20, and after a distribution of 33,000 of the fry during the month of June there still remained 16,220 at the close of the year. These were placed in the reservoir to be reared for brood stock. By April 25 all of the landlocked-salmon, brook-trout, and golden-trout eggs had hatched, the losses during incubation being comparatively small. A sudden rise in temperature during the month of June necessitated a partial distribution of the stock, and at the close

of the year there remained on hand 131,141 landlocked salmon, 16,220 Atlantic salmon, and 9,335 steelhead trout.

Having decided to discontinue the distribution of Von Behr trout, the 769 brood fish on hand in the fall were turned over to the fish commissions of Maine and Vermont. While the flume was being prepared during the summer it was found impracticable to provide ponds for the landlocked salmon that had been reared at the station, and, in view of the fact that they were about 6 years old and had never produced healthy eggs, it was determined to liberate them in Green Lake. There were 2,164 of these fish, varying from 1 to 3 pounds when liberated.

CRAIG BROOK STATION, MAINE (CHARLES G. ATKINS, SUPERINTENDENT).

During the year two large, deep ponds were constructed on the flat alongside Alamoosook Lake for the purpose of continuing the experiment of rearing Atlantic salmon under domestication and for domesticating such species as the steelhead trout, landlocked salmon, and quinnat salmon. These ponds are each about 3,750 feet in area, and the expense of building them was $679. In addition to a number of minor improvements to the buildings and grounds, the old wagon-house was moved and repaired, a stone bridge was built across the brook, two gravel breakwaters were constructed to protect the boat-landing, the fly-house was transformed into a hatchery for the purpose of caring for the quinnat-salmon eggs transferred from the Pacific Coast, and a new stand of troughs was erected for holding the fry. An aqueduct 700 feet long was also constructed in order to convey the water supply from Craig Brook to the above-mentioned stands and hatchery.

At the beginning of the year there were on hand the following fry, hatched the previous spring:

Atlantic salmon	244,405	Swiss lake trout	46,796
Landlocked salmon	11,033	Von Behr trout	487
Quinnat salmon	7,796	Scotch sea trout	1,337
Brook trout	2,668	Steelhead trout	12,511
Rainbow trout	12,778		
American lake trout	38,965	Total	378,776

During July 3,315 steelheads were liberated; the remainder of the stock was carried through to October, when the fish were counted and distributed with comparatively small losses The food given was the same material usually employed—chopped liver and other butchers' offal, the flesh of horses, and maggots reared at the station. A small quantity of herring roe was also used and appeared to be acceptable to the quinnats, though it was not readily taken by the Atlantic salmon. As in former years the food most readily eaten was the maggots, which were given alive. This year for the first time a large number of fry were kept in the ponds, and although the losses were slightly heavier than heretofore, these fry did remarkably well and outgrew the trough fish. In all, 102,265 Atlantic salmon and 8,122 steelhead trout were transferred to the ponds; three months later 91,017 Atlantic salmon and 7,398 steelheads were removed, showing a loss of 11 per cent on the

salmon and 8.9 per cent on the steelheads. The loss in the troughs amounted to 9.1 per cent, 143,374 salmon being taken out at the expiration of seven months. It is probable that the loss on the trough fish during the three months that the others were in the ponds did not exceed 3 per cent, but in point of growth the pond fish were far superior, the pond salmon in the fall averaging 101.1 grains against a mean of 45.8 for the trough fish. These figures were obtained by actually weighing the fish.

A summary of the result of rearing fry to the yearling stage from eggs collected in the fall of 1895 is presented below in tabular form:

Kind.	Number of eggs.	Number hatched.	On hand June 1, 1896.	On hand July 1, 1896.	Total remaining at fall count.	Percentage—		
						Of eggs laid out.	Of fish hatched.	Of fish remaining alive June 1.
Atlantic salmon	275,004	274,158	263,818	244,405	234,983	85.4	85.7	89.1
Quinnat salmon	8,345	8,248	7,961	7,796	7,407	88.7	89.7	95
Landlocked salmon	18,883	18,730	12,464	11,033	10,889	57.7	58.1	87.3
Brook trout	7,120	6,364	2,726	2,668	2,219	31.2	34.8	81.4
Rainbow trout	25,485	25,377	13,303	12,778	11,651	45.7	45.9	87.6
Swiss lake trout	51,892	51,294	49,803	46,796	41,130	79.3	80.2	82.6
Von Behr trout	7,371	6,652	5,978	487	653	8.8	9.8	10.9
Lake trout	43,460	42,906	40,112	38,065	10,411	23.9	24.3	25.9
	437,560	433,735	396,165	364,928	319,343	72.9	73.6	80.6

Atlantic salmon.—During the previous June 677 brood salmon were collected and released in the inclosure at Dead Brook; and, with the view of increasing this stock, a trap was constructed early in August near the Bangor Dam in order to stop any salmon that might ascend the river to spawn in the fall. This dam, located below the natural head of tide water, is subject to partial submergence during periods of high water. It is also provided with a good fishway, but it forms a serious obstacle, nevertheless, to the ascent of fish, and considerable numbers were collected there during the season. They were especially noticed under the wheelhouse of the waterworks at the west end of the dam, where the trap was located. This trap was constructed of steel and wood, as offering the least resistance to the constant heavy current, being formed like a pound in an ordinary weir, with a V-shaped entrance and a wing running obliquely out into the river. It was secured by bolts and numerous guys in the ledge forming the bed of the river, and was provided with halyards by which it could be drawn up for inspection or hauled down for work. The trap proved to be well adapted for the purpose, as the salmon passed in readily and were removed without difficulty or serious injury. The work of construction was quite arduous and consumed more time than was anticipated, as it was not ready for operation until August 12, when the water temperature registered 79°. It had also become very muddy from the operations of a contractor who was putting in a cofferdam preliminary to some improvements to the waterworks. Under these adverse circumstances very few salmon were taken; but the conditions improved later on, and 8 were secured

on August 27, making a total of 33 captured by the trap. These were placed in the cars and towed to Orland, whence they were transferred to the Dead Brook inclosure, 26 of them being delivered alive.

It appears that salmon do not congregate in large numbers at midsummer, and, moreover, it is very difficult to transfer them at that season to the inclosure, which is 30 miles distant, on account of the high temperature of the water. To obtain good results, the trap should be constructed early in the spring and a retaining pool provided in the immediate vicinity.

During the summer 109 dead fish were removed from the pools, which should have left 594 breeders, but as a matter of fact only 539 were found, indicating a loss of 25 per cent. Of these, 174 were males and 365 females, 12 of which yielded no eggs. From the others, the weight of which aggregated 1,050 pounds, 3,192,124 eggs were secured, of which the Maine Commission received 496,000. From the remainder, 490,000 were shipped as follows: To the New York Fish Commission, 100,000; to the Connecticut Fish Commission, 100,000; to U. S. Fish Commission stations, 100,000; to W. S. Hadaway, Plymouth, Mass., 25,000; to the Pennsylvania Fish Commission, 100,000; to the Adirondack League Club, 25,000; to Amos Ellis, Rangeley, Me., 40,000.

From the balance of the eggs 2,008,766 fry were hatched, all of which, with the exception of 390,000, were liberated in the tributaries of the Penobscot above Oldtown and in streams in the vicinity of the station; 150,000 were planted in the St. Croix River at Vanceboro, and 240,000 were retained for rearing. The loss on this stock to the close of the year amounted to 24,442. At the beginning of the year there were on hand 705 Atlantic salmon which had been hatched during the season of 1893-94; of these, 290 were distributed and the balance were placed in one of the new ponds and retained for domestication. In June, 1897, the usual arrangements were made for the collection of adult salmon, but owing to the late run only 595 were obtained. The losses during June were very light, and favorable results are expected in the fall.

From the two lots of domesticated salmon (descendants of parents reared in confinement in fresh water) 4,400 eggs of inferior quality were secured during November; these yielded 2,167 fry, but only 1,600 of them survived to the close of the year. Of the parent fish there now remain 41.

Landlocked salmon.—Late in October 10,889 yearling landlocked salmon were deposited in Toddy Pond. These fish resulted from a consignment of eggs delivered at the station by a number of citizens who were interested in keeping up the supply of fish in that pond. In November, 1896, the same parties furnished another consignment of 2,352, from which 2,129 fry were hatched.

Other species.—The brook, rainbow, lake, and von Behr trout were distributed with the other fishes in the fall, the losses being very slight, except in the case of the lake trout. On July 1 there were 38,965 lake trout on hand, as a result of the eggs shipped from North-

ville the previous winter. They appeared to be very healthy for a time, but later in the summer they were attacked by a parasitic trematode, which appeared in large numbers, especially on their fins and jaws. The mortality resulting aggregated over 26,000, leaving only 10,411 for distribution in November. No other species were attacked by this parasite, though all were kept in the same locality and under the same conditions. A large percentage of fish was hatched from the consignment of Swiss lake-trout eggs received from Switzerland in February, 1896. A few of these were held over and distributed in the spring of 1897, but the bulk of them were disposed of in the fall.

Steelhead trout.—The fish on hand at the beginning of the year were carried through the summer with small loss, and all of them with the exception of 200 were distributed during the fall. These were placed in one of the new ponds for domestication, and 191 of them survived to the close of the year. From a consignment of eggs received in April 94,811 fry were hatched; all but 10,000 of these, which have been retained for rearing, were distributed in local waters during May and June.

Quinnat salmon.—The quinnat salmon on hand at the beginning of the year were the result of a consignment of eggs received from Baird in December, 1895. They were carried through the summer without material loss, and in November 7,062 yearlings were liberated in local waters. During the fall 200 of them were transferred to the aquarium in Washington and held until the following spring, when they were sent to Nashville for exposition purposes. Another lot of 200 was retained at the station until the following June, when they were liberated, with a loss of only 4, in local waters. In December, 1896, a consignment of 1,440,000 eggs was received from Battle Creek, Cal. Some slight mishaps befell them and it became necessary to crowd them considerably on account of lack of space, but notwithstanding these adverse circumstances 1,255,594, or 87 per cent, of them hatched. Of these, 789,000 were deposited in the Penobscot and its branches above Oldtown, 77,449 were liberated in local waters, and 50,000 were transferred to the Maine Commission, making a total distribution of 916,449; 250,000 were reserved at the station to be reared and distributed in the fall, and at the close of the year they were in excellent condition.

The total amount of food used consisted of 42,746 pounds of butcher's offal, beef blood, and horse carcasses, the original cost of which was $592.25, the additional expense of freight and drayage aggregating $105.97. This large increase in cost and amount of food was due to the increased number of fish carried; and it was learned by experiment that quinnat salmon require a larger amount of food than Atlantic salmon and other fishes.

The stock of fry held for distribution in the fall consisted of 240,000 Atlantic salmon, 2,167 domesticated Atlantic salmon, 2,295 landlocked salmon, 250,000 quinnat salmon, 1,894 Scotch sea trout, and 10,000 steelhead trout.

Following is a record of the meteorological observations made at the station during the year:

Date.	Mean temperatures.						Rainfall.	Snow.
	Air.		Water.					
			Hatchery, inside.		Head of feed-trough stand.			
	7 a. m.	2 p. m.	7 a. m.	2 p. m.	7 a. m.	2 p. m.	Inches.	Inches.
1896—July	64.71	70.00	68.98	71.77	63.55	67.35	5.05	.....
August	61.02	74.56	69.28	72.23	64.05	68.40	1.55	.....
September	53.45	64.88	62.78	65.05	59.83	63.13	6.95	.....
October	40.27	51.74	53.08	55.15	52.18	55.00	4.15	.....
November	34.02	40.73	44.73	46.15	45.70	47.37	4.25	½
December	17.77	27.85	34.74	35.45	37.92	39.29	1.55	½
1897—January	13.81	26.02	33.56	34.19	36.65	38.18	1.65	18
February	15.09	30.62	33.66	34.82	35.34	38.02	1.65	9
March	24.55	35.13	34.11	35.77	35.87	38.87	2.30	14½
April	37.13	50.10	37.95	40.98	38.72	43.42	2.35	.....
May	49.14	60.49	50.77	53.06	48.70	52.37	3.90	.....
June	55.54	65.77	58.71	60.92	54.60	57.82	3.00	.....

ST. JOHNSBURY STATION, VERMONT (J. W. TITCOMB, SUPERINTENDENT).

A special appropriation for increase of the spring water supply, construction of reservoir, and general improvement to the grounds having been provided, the work was undertaken early in the summer under the direction of the superintendent. In order to increase the water supply, the springs on the station property were developed by excavating ditches into the hillsides. These were lined with 3-inch land tile, laid on hemlock boards and covered with stones and gravel. Wooden boxes were set at the outlet of each ditch to catch the water, from which it is conveyed through pipes connecting with the main line to the reservoir. Much difficulty was experienced in making the excavations on account of the land containing quicksand and clay, which also made it impossible to obtain water free from sediment. The supply secured by this means was about double the amount obtained under the old system. During the rainy season the capacity of the springs has averaged about 80 gallons per minute.

In order to prevent the clogging of the intake at the dam in Sleepers River, a deflecting wall 30 feet long, 6 feet wide at base, 4 feet wide at top, and 6 feet high, was constructed. A framework of timber inserted in the wall on the east side near the lower end and fastened to the intake on the west side forms a recess for the water to pass through into the intake. This recess is protected by a grating formed of iron rods extending perpendicularly down through the framework. Below the grating, between the jetty and the crib, a piece of 10-inch cast-iron pipe was inserted, to be used for flushing during periods of high water, when the entrance to the crib becomes filled with sediment. The wooden gates connecting the two 8-inch pipe lines were replaced by iron ones.

A reservoir of 172,198 gallons capacity was constructed between Emerson Falls and the hatchery, at an elevation of 83 feet. A much

larger one had at first been proposed, but it became necessary to reduce the size owing to the discovery of quicksand. The reservoir was surrounded by a wall made of local stone and Rosendale cement, the dimensions being 2½ feet thick at base, 2 feet at top, and 5 feet in height. The sides of the reservoir and the wall were covered with Portland cement and plastered with a mixture of 1 part cement to 2½ parts clear sand. The filter to the reservoir is so constructed that it can be cleaned by reversing the current. A roof was constructed over the reservoir, four doors being provided in it to permit access to the reservoir. On January 23 the overflow from the reservoir was broken by an earthquake, which interfered materially with its use until the weather permitted of its being repaired.

Considerable work was done in grading the grounds, building plank walks around the ponds, installing a steam-heating plant, and in repairing the ponds constructed the previous year, frost having injured them to such an extent that it became necessary to rebuild all of the supply and stand pipes. A large amount of work was also done in the interior of the hatchery, completing unfinished rooms, etc.

At the beginning of the year the stock on hand was as follows:

Species.	Calendar year in which hatched.	
	1896.	1895.
Brook trout	8,748	.....
Rainbow trout	700	.....
Atlantic salmon	1,753	.....
Steelhead trout	.....	90
Lake trout	.....	5
Total	11,201	95

During the summer field stations for collecting brook-trout eggs from wild fish were established at Darlings Pond, Caspian Lake, Greensboro, Willoughby Lake, Groton, Fairbanks Pond, and Pico Pond.

Darlings Pond is about 36 miles from St. Johnsbury, 30 by rail and 6 by wagon road. The fish there were captured by means of a V-shaped slat trap or weir and held in retaining pens until ripe. A shanty was erected near the trap for the accommodation of the attendant. The first run of trout occurred on the 23d of August, 1,650 being taken in the brook during a heavy rain storm. Very few were captured from that time until September 6, when 1,000 more entered the trap. The fish continued to run in schools during the rainy weather, and on October 15, when the trap was removed, 7,138 had been captured. During the season it was discovered that large numbers of trout were ascending streams which dry up in summer. At the request of the owners of the pond they were not disturbed, but it is doubtful whether their spawn ever matured. The first eggs were taken on September 24 and the last on October 26, over 900,000 being secured. The loss in hatching was very heavy, only 25 per cent producing fry available for distribution; but these were vigorous, and no definite reason can be

ascribed for the large loss, though it has been attributed to confinement of the trout for a considerable period before they were ripe. Next year a temporary auxiliary hatchery will be constructed at this point.

At Caspian Lake, 32 miles from St. Johnsbury, the trout were collected by means of small-meshed gill nets and dip nets, the only improvement in the apparatus being the jack lights, which were constructed especially for the purpose. Most of the fish were caught between sunset and midnight. The first were captured October 29, and work continued until the lake froze over, on December 2. Long after the 1st of January the trout could be seen at work on their beds under the ice. The total number taken in dip nets amounted to 1,457, their average weight being a little over 1 pound. The season lasted one month, commencing November 10, and 97 per cent of the 500,000 eggs were good. For convenience and comfort while collecting the eggs a boat-house was constructed over the confining pen in the lake, with platform space for the spawn-takers. The eggs were placed in a small private hatchery located near the lake, and as soon as they had reached the eyed stage were transferred to St. Johnsbury. The hatching of the eggs taken at this point continued from January 17 to about the end of April.

Willoughby Lake (situated 26 miles from the station, 16 by rail and 10 by wagon road) was examined with the view to collecting eggs of the lake trout, but owing to pressure of other work the investigation was delayed until November 10, when it appeared that the fish had already deposited their eggs. From the extent of the spawning-grounds and the abundance of fish there seems to be little doubt that a large number might have been taken. Suitable facilities were found for the establishment of an auxiliary field station.

At Fairbanks Pond, 3 miles from St. Johnsbury, 31,500 eggs were collected. The work at Pico Pond proved unprofitable, and operations were discontinued after 12,000 eggs had been secured.

All of the fish were returned to the waters from which they were taken, the total loss on nearly 10,000 amounting to only 36. During the winter 140,000 eggs were shipped to the applicants mentioned below, and from the balance of the season's take 491,000 fry were hatched, a fair proportion of which were returned to the waters from which the eggs were collected:

S. M. Pearson, Stratham, N. H....	10,000	L. J. Johnson, Brattleboro, Vt...	15,000
Vermont Fish Commission	50,000	Clarence Brown, Toledo, Ohio...	15,000
Adirondack League Club, N. Y...	25,000	Connecticut Fish Commission ...	25,000

While there is a marked difference in the sizes of the trout eggs taken from different waters, they do not always vary according to the size of the fish, as was supposed. The sizes of eggs taken at three of the field stations were in the proportion of 34, 41, and 42 to the square inch. Those numbering 34 and 42 to the inch were taken from trout averaging 5 to the pound, while those numbering 41 were secured from fish weighing over a pound each.

Observations as to the effect of low temperature on trout eggs confirmed the experience of the previous season. Eggs eyed and hatched entirely in the spring water (ranging from 45° to 50°) yielded a larger percentage and better fish than those taken under the same conditions and at the same time which were hatched in water varying from 32° to 50° in temperature. The comparisons were made with eggs collected at Caspian Lake. It was also observed that eggs eyed in spring water before being subjected to colder water yielded a larger percentage than green eggs laid down in cold water. The investigations were carried still further by trying different temperatures during the period of incubation on various lots of eyed eggs, but these were not fully completed owing to an accident to the water supply during the critical period.

It was intended to carry all of the eggs after they were eyed in a mixture of the spring and river water, the spring-water supply being insufficient, but on the 4th of March, and periodically from that time to April 15, it became necessary to shut off the spring water entirely. The eggs were thus subjected to the reduced water temperature from 12 hours to 16 days at a time, the temperature during these periods ranging from 32½° to 35°. After reaching 32½° the development of the eggs was apparently suspended for several days, which accounts for the length of time between the commencement and the end of the hatching periods with the various lots. One lot of 35,000 was placed in water registering 32½° as soon as eyed and kept there until they hatched, for the purpose of comparing the results with those obtained in hatching in spring and river water mixed. They commenced hatching March 15 and finished April 24, the total loss to May 30 amounting to 520 eggs and 1,435 fry. An equal number of the same lot of eggs placed in mixed water, but subjected to changes caused by shutting off the spring water periodically, began hatching February 26 and finished April 15, with a loss of 1,223 fry and 487 eggs to May 30. Better results would undoubtedly have been secured had it not been necessary to shut off the spring water.

In addition to the collections made in the vicinity of the station 300,000 quinnat-salmon eggs were received in December from Battle Creek, 5,000 landlocked-salmon eggs from Green Lake in February, and 100,000 steelhead-trout eggs from Fort Gaston in April. The quinnat-salmon eggs arrived in excellent condition and commenced hatching on April 3 in water of an average temperature of 34°, but during the hatching period it went down to 32½° on several occasions. The fry resulting from them numbered 200,000 at the time of their distribution. They were deposited in tributaries of the Connecticut and Merrimack rivers during the month of July. During incubation white spots appeared on some of the embryos, causing the loss of many. Those on which the spots were most noticeable were separated from the others and in a large number of instances they hatched, the spots disappearing with the absorption of the sac. The steelhead-trout eggs arrived during a period of unusually warm weather and were in very bad condition,

only 26,379 healthy fry resulting from them; 10,000 were distributed in New Hampshire waters and the balance were retained for rearing.

During the summer months observations were made in air and water temperatures at Caspian Lake, with the view to testing the qualifications of the lake water for use in operating a trout hatchery on a large scale. During November the surface temperature ranged from 45° to 33°. On the spawning-beds (from 1 to 6 feet in depth) it registered the same, whereas it varied from 45° to 38° when taken from a depth of 40 feet. In December and January, with an air temperature below zero, the water from 20 to 100 feet registered 37° and 38° above zero, indicating that an equable temperature of from 37° to 40° can be maintained throughout the year with water taken at a depth of over 20 feet.

A small sandpiper was killed on June 13 and in its gizzard were found the vertebral columns of several small fish about 1½ inches long.

In November the superintendent was instructed to make an investigation in New Hampshire respecting the advisability of establishing a station for the propagation of trout at some suitable point in that State. This work covered a period of two weeks in December and January.

CAPE VINCENT STATION, NEW YORK (H. D. DEAN, SUPERINTENDENT).

An appropriation of $2,500 having been secured for the completion of the hatchery and grounds, the work of improvement was commenced early in July. The building was completed, the grounds graded, a wire fence constructed around the property, a walk laid from the street to the hatchery, and a gas plant installed.

Permission having been granted by the Canadian Government to collect whitefish eggs in Bay Quinte, under the supervision of the fishery overseers, the grounds between Belleville and Deseronto were examined and arrangements were made with the fishermen to operate four seines in the vicinity of Massassaga Point, the fishermen agreeing to pay all expenses of running the seines for the coarse fish and to allow the Commission to have the whitefish. The fish were penned in crates, under the supervision of one of the employees of the station. Of the 400 collected, only 25 per cent proved to be females, and a number of these were so bruised in handling that the eggs were worthless. As it was seen that very few eggs could be taken at this point, on November 13 four more seines were secured nearer Deseronto. Many fish were caught there, but only a few were females, and these yielded no eggs, though they were held in pounds for some time. Pound nets belonging to the Commission were also operated in Chaumont Bay without results, and at Three Mile Bay six or seven traps were operated and a good many fish captured, but owing to heavy gales the bulk of them died before the eggs could be taken.

As a result of the season's operations only 2,300,000 eggs of very poor quality were obtained from all sources, from which 750,000, fry were hatched and liberated in the St. Lawrence River. The total cost of the work with this species for the season was $476.41.

As there seemed to be little prospect of securing a supply of lake trout eggs in the vicinity of the station, early in November arrangements were made to attend the tug fishermen at Dunkirk, and as a result nearly 1,000,000 eggs were secured, at an expense of $141. In addition to these 145,000 were taken in the vicinity of Charity Shoals, and on November 24 a consignment of 1,000,000 was received from Northville Station, giving a total of 2,085,000. The hatching period extended from April 19 to May 8, and the 1,290,000 fry hatched were distributed in Lake Ontario and its tributaries.

In addition to the operations with lake trout and whitefish the following consignments of eggs from other stations were hatched and distributed. A shipment of 2,095,000 quinnat-salmon eggs arrived from Baird, Cal., on December 15 in excellent condition, and although much crowded in the troughs, 94 per cent of them were hatched and were planted in tributaries of Lake Ontario and in the Hudson and Delaware rivers. One thousand of these fry were retained at the station, and at the close of the year they had attained a length of over 3 inches. From the 50,000 Atlantic salmon eggs received from Craig Brook 48,000 fry were hatched, the period of incubation extending from March 19 to April 8. All of the fry were deposited in the Salmon River on May 17. Two consignments of steelhead eggs, aggregating 50,000, were received from Fort Gaston on April 24. As they were in very bad condition on arrival, only 10,600 fry were obtained from them for distribution. A shipment of 27,700 rainbow-trout eggs from Wytheville yielded 11,600 fry, which were distributed soon after hatching to applicants in the State of New York.

The following table gives the average, maximum, and mean temperatures of air and water at the station for the fiscal year, by months:

1896.	Air.			Water.			1897.	Air.			Water.		
	Min.	Max.	Mean.	Min.	Max.	Mean.		Min.	Max.	Mean	Min.	Max.	Mean
July	62	85	73.5	61	72	66.75	January	−9	57	24	33	36	33.6
August	56	88	74	68	76	72	February	0	44	25.75	33	33	33
September	39	80	62	58	69	64.33	March	6	49	33.66	33	33	33
October	34	68	47	47	59	52	April	23	69	47	33.5	43.5	38
November	25	63	43.66	42	51	45.3	May	44	77	57	42	51.5	47.5
December	−1	48	27.4	33	41	36.8	June	49	85	66.75	50	64	59

GLOUCESTER STATION, MASSACHUSETTS (C. G. CORLISS IN CHARGE).

Upon the appointment of E. F. Locke as superintendent at Woods Hole in October, C. G. Corliss, fish-culturist, was placed in charge of Gloucester Station. Repairs were made to the hatching-boxes, buildings, and machinery, and by November 13 the station was ready for operations.

Cod.—The crew of the *Grampus*, under the direction of Captain Hahn, was stationed at Kittery Point, Me., as heretofore, and commenced making egg collections for the station on November 19. The eggs were transferred to Gloucester, packed in closed jars, and surrounded with

crushed ice or snow to keep the temperature equable. Collections continued daily until March 26, the total take amounting to 113,000,000 eggs, from which 62,305,000 fry were hatched and planted. The meteorological conditions during the season were much more favorable than for several years previous, especially in the months of November and December, when 63,000,000 eggs were secured, from which 45,000,000 fry were hatched. The fish from which the eggs were taken were caught in gill nets and in trawls fished by vessels making their headquarters at Kittery.

It has been customary to fertilize cod eggs by what is known as the wet method, but this year the dry method was employed, and the increased percentage of fry hatched is thought to have been due to that fact. This percentage, though much smaller than is secured with the eggs of other species handled by the Commission, was remarkably good considering the conditions under which they were taken. Owing to heavy storms it is frequently necessary to allow the fish to remain in the nets for several days, and in such instances those captured in the gill nets perish. The fish taken by the trawl nets frequently live for several days, and for this reason the eggs secured from that source are superior to those obtained from the gill nets. Where the fish have been dead only a short time it is customary to save the eggs, and though they appear to be good when received at the station very heavy losses occur after they have been in the apparatus for some time. The principal losses with cod eggs occur during the earlier stages of development, and until the embryo is well formed great care must be taken in handling them; after that stage has been passed they are quite hardy and comparatively few are lost. During the early part of the season the temperature ranged from 47° to 40°, but after the 15th of December it fell gradually, reaching 35° on January 15. It having been found that the water on the spawning-grounds ranges from 37° to 38°, steam was employed from that time on for the purpose of maintaining about the same temperature in the boxes.

The experiment of hatching eggs by means of air circulation in the McDonald automatic jar was again tried, but the results did not indicate that this method could be successfully adopted. The temperature of the water in the jars was kept at 40° by packing them in salt and ice; the water was changed twice a day during the earlier stages and more frequently later on, as it became foul in a very short time. About one-third of the eggs which reached the hatching point were hatched in the jars; the remainder, though kept in circulation for several days, did not hatch until they were transferred to a McDonald tidal box, when the fry appeared within twenty-four hours, being strong and healthy, apparently. Instead of liberating them in Gloucester Harbor, as heretofore, they were taken out in a sailing boat to the natural spawning-grounds in Ipswich Bay and deposited at the point of collection. The loss in transportation was very small.

The following table shows the daily collections of cod eggs lost during incubation, number of fry hatched, and period of incubation:

Cod season at Gloucester Station, 1896–97.

Date received.	Whence.	Eggs received.	Loss during incubation.	Fry hatched.	Period of incubation.
1896.					*Days.*
Nov. 19	Kittery Point, Me	575,000	167,000	408,000	12
20	....do	509,000	136,000	373,000	13
21	....do	752,000	149,000	603,000	12
23	....do	1,693,000	413,000	1,280,000	12
24	....do	1,847,000	414,000	1,433,000	12
25	....do	2,451,000	633,000	1,818,000	12
27	....do	1,251,000	661,000	590,000	11
28	....do	1,784,000	1,172,000	612,000	11
30	....do	2,557,000	579,000	1,978,000	13
Dec. 1	Kittery Point and Rockport	2,649,000	683,000	1,966,000	14
2	Kittery Point, Me	1,749,000	1,219,000	530,000	14
4	....do	3,759,000	1,093,000	2,666,000	14
5	....do	2,119,000	888,000	1,231,000	14
7	....do	3,102,000	1,874,000	1,228,000	14
8	....do	3,708,000	470,000	1,786,000 1,452,000	15 15
10	Kittery Point and Rockport	2,559,000	969,000	1,590,000	15
11	Kittery Point, Me	1,148,000	609,000	539,000	19
12	....do	1,121,000	858,000	263,000	20
13	....do	983,000	610,000	373,000	20
14	....do	3,327,000	1,654,000	1,673,000	21
18	Kittery Point and Gloucester	1,733,000	708,000	1,025,000	24
20	Gloucester, Mass	161,000	37,000	124,000	24
21	Kittery Point, Me	4,371,000	1,732,000	1,138,000 1,501,000	24 24
22	....do	4,022,000	1,177,000	2,845,000	24
24	....do	2,185,000	679,000	1,506,000	24
25	....do	785,000	388,000	397,000	24
27	....do	949,000	436,000	513,000	24
28	....do	963,000	158,000	805,000	23
29	....do	840,000	301,000	539,000	23
30	....do	3,572,000	1,880,000	1,692,000	23
31	....do	726,000	573,000	153,000	22
1897.					
Jan. 2	....do	1,111,000	733,000	378,000	25
6	Kittery Point and Rockport	437,000	247,000	190,000	22
7	Kittery Point and Gloucester	1,153,000	700,000	453,000	21
	....do	1,708,000	646,000	1,062,000	22
12	Kittery Point and Rockport	710,000	303,000	407,000	20
13	Kittery Point, Me	758,000	471,000	287,000	20
14	Rockport, Mass	1,299,000	477,000	822,000	19
16	Kittery Point, Me	624,000	200,000	424,000	20
17	....do	1,137,000	367,000	770,000	19
20	....do	1,919,000	662,000	1,257,000	18
22	Kittery Point and Rockport	2,387,000	655,000	1,069,000 663,000	19 21
23	....do	4,185,000	2,891,000	1,294,000	21
27	Kittery Point, Me	1,691,000	1,518,000	173,000	20
29	....do	1,209,000	484,000	725,000	20
30	....do	1,777,000	1,179,000	598,000	22
Feb. 1	....do	885,000	571,000	314,000	20
2	Kittery Point and Rockport	1,108,000	242,000	866,000	20
5	Kittery Point, Me	2,828,000	1,148,000	1,680,000	22
6	Rockport and Kittery Point	3,644,000	3,139,000	505,000	21
8	....do	4,124,000	1,953,000	1,965,000 206,000	21 20
10	Kittery Point, Me	1,705,000	573,000	1,132,000	20
11	....do	1,695,000	1,312,000	383,000	19
12	....do	1,646,000	1,021,000	625,000	18
13	....do	482,000	74,000	408,000	20
14	....do	997,000	558,000	439,000	19
17	....do	1,167,000	869,000	298,000	16
18	....do	368,000	332,000	36,000	19
20	Rockport, Mass	192,000	179,000	13,000	18
26	....do	398,000	94,000	304,000	20
27	Kittery Point, Me	2,333,000	1,212,000	1,121,000	19
28	....do	942,000	388,000	554,000	18
Mar. 5	Kittery Point and Rockport	3,985,000	1,114,000	2,871,000	19
6	Kittery Point, Me	643,000	127,000	516,000	18
8	Kittery Point and Rockport	1,440,000	739,000	701,000	19
9	Rockport, Mass	503,000	337,000	166,000	18
	Total	113,140,000	50,835,000	62,305,000	

Lobster work.—Arrangements were made for collecting berried lobsters from fishermen in the vicinity of Gloucester, Boston Bay, and Kittery Point, and with the view to further extending the work the schooner *Grampus* was detailed to make collections along the Maine coast from Portland to Rockland. Permission having been obtained from the commissioners of Maine, New Hampshire, and Massachusetts for holding egg lobsters in live-boxes for the use of the Commission, Captain Hahn visited the various fishing centers in March and made the necessary arrangements with the fishermen, who agreed to deliver large females for 15 cents each and small ones for 10 cents. A small steamer was chartered to make the collections in Boston and Gloucester harbors. The season extended from April 17 to July 19, the total collection amounting to 54,532,000, from which 47,869,000 fry were hatched and planted. These results, though not as good as had been expected from the extent of the territory covered, indicated that the work can be greatly extended under favorable conditions. The weather during the early part of the season was very bad, and as a large part of the territory covered was new, the fishermen did not take much interest in the work until the season was well advanced. The greater part of the lobsters from Boston Bay came from the dealers, and by employing two or three local agents instead of one next year it is probable that better results can be secured.

The collections by localities were as follows: Boston Bay, 23,687,000; Gloucester Harbor, 5,950,000; Kittery Point, 6,966,000; the schooner *Grampus*, in Maine, 17,370,000; Marblehead, 559,000. The egg lobsters collected on the Maine coast were transferred without difficulty in the well of the *Grampus* to Gloucester, where the eggs were stripped and placed in jars, the lobsters being liberated by the vessel's crew at points along the Maine coast on the return trip. Those collected in Boston Bay were transferred by steamer, and little difficulty was experienced in transporting them during the early part of the season. On the first five or six trips they were carried in hogsheads packed in seaweed, no water being used, but as the weather grew warmer it became necessary to use water and to change it frequently en route. Ice was used, but without any apparent effect. This failure late in the season was probably due as much to the condition of the lobsters when received as to the temperature, since many of them had been shipped to Boston, from distant points, packed in ice. A vessel with a well should be used for transporting them.

The eggs were developed as heretofore, in the McDonald jar. As the temperature of the water remained below 50° until June 1, the fry did not commence hatching until after that date, but from that time on they came out very rapidly, necessitating large plants each day. The bulk of them were distributed in Massachusetts waters between Marblehead and Rockport. By means of the *Grampus* 11,665,000 were shipped to Maine and planted in the localities from which the lobsters were col-

lected, little difficulty being experienced in the transfer. During the latter part of the season several shipments were sent by rail to Portland in charge of a messenger. The first two lots were planted without loss, as the weather was cool, but the third, shipped on a very warm day, suffered heavy losses, as it was impracticable to use ice on account of its freshening the water.

Mackerel.—Early in June steps were taken to secure eggs from the trap-net fishermen in the vicinity of the station, but no mackerel were caught until June 9, when the drag nets secured a small number 15 or 20 miles offshore. Spawn-takers were detailed to attend the drag nets, and the launch visited the traps in the vicinity of Magnolia and Manchester daily. The first eggs were collected June 16, and the last on July 12, the total collections amounting to 1,108,000, from which 652,000 fry were produced. From some of the eggs collected over 90 per cent were hatched. They were handled in the McDonald tidal box in the manner adopted for the cod eggs, except that the motion given was not so violent. This was regulated by setting the siphon high enough to allow the water to rise and fall not over an inch. By doing this the full strength of the current did not reach the surface where the greater part of the eggs were, and a gentle motion was secured, just sufficient to keep them in circulation. The eggs hatched in from 3 to 5 days and were cleaned only once. They should not be changed from one box to another during the first day or two.

The following table gives a summary of the work at the station:

Species.	Eggs collected.	Fry planted.
Cod	113,000,000	62,305,000
Lobster	54,532,000	47,869,000
Mackerel	1,108,000	652,000
Total	168,640,000	110,826,000

The hatchery and pumps were taxed to their utmost capacity many times during the season, and at its close arrangements were made to enlarge the plant so as to be able to meet all emergencies another year.

WOODS HOLE STATION, MASSACHUSETTS (E. F. LOCKE, SUPERINTENDENT).

The following statement shows the kinds of fish propagated, number of eggs collected, and fry hatched and distributed during the year:

Species.	Eggs collected.	Fry planted.
Cod	65,167,000	35,053,000
Lobster	74,152,000	64,419,000
Flatfish	84,591,000	64,095,000
Tautog	1,646,000	624,000
Sea bass	241,000	193,000
Mackerel	153,000	.....
Total	225,950,000	165,284,000

The work at the station was directed by Alexander Jones until October 10, when he was relieved by E. F. Locke, who was appointed superin-

tendent of the station. With the view to increasing the output, additional live-cars for holding adult cod were constructed and arrangements were made with the commercial fishermen to supply the fish. The *Grampus* was also detailed during the latter part of September to make collections. The first consignment of cod was delivered at the station on October 3, and by the 4th of November 9,379 fish, averaging 4 pounds and more in weight, had been delivered; 2,910 were furnished by the *Grampus* and the balance were purchased. They were apparently in first-class condition when received, and no serious losses occurred until the middle of November, when the death rate became very heavy, as many as 200 dying in 24 hours. This loss was due to injuries received in capture and transportation from fishing-grounds and to the breaking out of sores, which formed just under the skin and spread over the entire body. Of the smaller fish, 2,800 were transferred to a small pool near the residence, many of them being affected as described above, but after remaining in the pool a short time the sores healed and they apparently recovered.

The collection of eggs commenced November 9 and continued until January 25, during which time 50,914,000 were secured from 884 spawners. The results attained were very discouraging, as the number of brood fish secured was much larger than in past years. During the winter 2,350 of the smaller ones were released, as they gave no evidence of spawning. The experience of this season seems to show that no fish weighing less than 6 pounds should be retained for spawning purposes. On January 25 all of the stock on hand, amounting to 1,500, were killed by anchor frost. From the following table it appears that not only a much smaller percentage of the fish purchased this year were spawners, but the yield of eggs per fish was also much smaller than in past years:

Year.	Brood fish.	Eggs taken.	Ripe fish.	Eggs per fish.
1889-90	349	8,500,000	91	93,000
1890-91	3,000	67,600,000	587	115,000
1891-92	1,620	48,600,000	444	102,000
1894-95	3,320	85,500,000	1,107	71,000
1895-96	3,836	70,800,000	415	170,000
1896-97	9,379	50,914,000	884	57,000
Total	21,504	331,914,000	3,528	608,000

In addition to the eggs collected at the station, 5,606,000 were received from Kittery Point, Me., and 8,647,000 from the fishermen near Duxbury, Mass. It having been decided in January to attempt the collection of eggs at the latter point, the mate of the *Grampus*, Mr. J. C. Conley, was placed in immediate charge of the work with a small force, and, although the collection was undertaken at the time of year when the weather is most unfavorable, the results attained were gratifying, and it seems probable that about 75,000,000 eggs can be obtained from this source next season. The total output of fry from the eggs handled at the station amounted to 35,953,000, the hatching being done, as usual, in the McDonald tidal box. The temperature of the

water having fallen to 35° in January, it was raised and maintained at from 38° to 40° by introducing steam directly into the supply pipes.

The fry distributed during the month of November were deposited in the harbor, but all those hatching after December 1 were liberated on the spawning-grounds off No Man's Land and Gayhead, part of the plants being made by the steamer *Fish Hawk* and part by a small sloop chartered for the purpose.

The following table shows in detail the daily receipts of eggs, number of fry hatched, and period of incubation:

Date.	Number of eggs received.	Number of fry hatched.	Date of hatching.	Date of planting.	Date.	Number of eggs received.	Number of fry hatched.	Date of hatching.	Date of planting.
1896.			1896.	1896.	1896.			1897.	1897.
Nov. 9	337,000	235,000	Nov. 19	Nov. 20	Dec. 17	2,298,000	1,096,000	Jan. 14	Jan. 16
10	545,000	261,000	20	21	18	758,000	431,000	14	16
12	972,000	560,000	21	22	19	1,516,000	788,000	18	22
14	426,000	302,000	24	24	21	1,420,000	979,000	19	22
16	1,162,000	640,000	25	25	22	213,000	124,000	19	22
17	663,000	397,000	26	28	26	2,370,000	1,472,000	22	29
18	1,085,000	700,000	27	28	28	1,017,000	580,000	24	29
19	758,000	400,000	29	29	30	379,000	263,000	25	29
20	1,279,000	728,000	29	30	1897.				
21	1,943,000	1,138,000	30	30	Jan. 1	1,720,000	1,844,000	27	25
23	1,966,000	1,080,000	Dec. 2	Dec. 3	4	948,000	654,000	29	Feb. 9
24	1,160,000	594,000	3	4	6	758,000	521,000	Feb. 2	5
25	2,487,000	1,430,000	4	6	8	237,000	102,000	2	5
27	2,842,000	1,760,000	8	9	10	1,801,000	1,320,000	8	8
28	2,038,000	1,400,000	8	12	11	5,070,000	1,844,000	8	8
30	2,131,000	1,319,000	12	14	12	427,000	230,000	11	13
Dec. 1	1,092,000	864,000	13	14	14	2,914,000	1,539,000	11	13
4	2,180,000	1,232,000	15	18	16	450,000	174,000	11	13
5	1,188,000	655,000	16	18	18	758,000	179,000	11	13
6	758,000	490,000	17	18	21	237,000	127,000	16	17
7	474,000	91,000	21	24	22	758,000	226,000	16	17
8	2,465,000	1,712,000	21	24	23	47,000	11,000	16	17
9	592,000	296,000	23	24	24	616,000	379,000	16	17
10	663,000	362,000	25	31	31	948,000	314,000	26	27
11	1,233,000	687,000	27	31	Feb. 1	1,326,000	305,000	26	27
			1897.	1897.	2	1,137,000	546,000	26	27
12	544,000	379,000	Jan. 6	Jan. 9					
14	2,061,000	1,019,000	7	9		65,167,000	35,953,000		

Flatfish.—Early in February fyke nets were set in Woods Hole Harbor and Waquoit Bay, and the first ripe fish were captured on the 15th. From that time collections were continued daily until the 15th of April, 305 ripe females being secured from the seven nets operated. The take of eggs aggregated 84,591,000, or an average of about 277,000 per fish; the yield per fish varied with the size, one female, 3½ pounds in weight, producing 1,462,000. The fish captured in Waquoit Bay were much larger than those from Woods Hole Harbor. The hatching was done, as usual, in the modified McDonald box, the period of incubation varying from 7 to 22 days, according to the temperature of the water. By the close of the season 64,095,000 fry had been hatched and distributed on suitable grounds in Buzzards and Waquoit bays.

Lobsters.—While engaged in collecting lobsters for shipment to the Pacific Coast during October and November 887,000 eggs were collected and placed in hatching-jars. They did well throughout the winter, but the losses became very heavy about the 1st of April, and as a result only 385,000 fry were hatched from them. The regular spring collections commenced on April 7. The field of operations was enlarged by the employment of an agent at Plymouth, Mass., who purchased egg

lobsters from the fishermen operating between Green Harbor and Ship Pond, including Duxbury, Kingston Bay, and Plymouth Harbor. This territory proved to be very disappointing, as the entire number of eggs received during the months of April, May, and June amounted to only 5,335,000. Collections were made at the usual points in the vicinity of Woods Hole, and steps were also taken to secure the egg lobsters captured in the vicinity of Block Island and along the Connecticut coast, a small smack being chartered for the purpose of bringing them to the station and transporting the fry back to the spawning-grounds. The lobsters brought in by the smack were much larger than those obtained from the other points, hence the yield of eggs per lobster was greater. All of the adults handled were returned to the waters after the eggs had been stripped. The eggs were handled in the universal hatching-jar, and the losses were comparatively light, the total take of 74,152,000 yielding 64,419,000 fry. The planting of the fry was commenced on May 19, and during the season several shipments were sent by rail to Plymouth and Provincetown, being carried in the ordinary transportation can without serious losses. The last deposit was made on July 13. Experiments were tried during the latter part of the season in holding and feeding young lobsters in hatching-boxes containing sand, gravel, stones, and vegetable life. Collections of crustaceans and copepods were made daily, and microscopical examinations showed that these, together with some vegetable life, formed their principal food. In only a few instances was cannibalism observed.

Mackerel.—During May and June efforts were made to collect mackerel eggs from fish caught in pound nets in the vicinity of the station, but no ripe ones were captured, though the nets were visited daily from June 16 to the end of the month. Spawn-takers sent to Edgartown to make collections from the hand-line fishermen reported that all of the female mackerel were either spent or unripe, and the only eggs received were several small shipments, aggregating 153,000, sent by the spawn-taker stationed at Barnstable, Mass. These were collected between June 19 and 26, and were forwarded to the station in Mason jars, packed in an ordinary transportation can partly filled with ice water. They were apparently in good condition when received, but died on the second day, and it is thought that the change in temperature affected them, as the water inshore where they were packed was 6° higher than that at the point of collection.

Sea bass.—Efforts were made to secure eggs of the sea bass in connection with the collection of mackeral eggs, but only two ripe fish were found. The 241,000 eggs obtained from these produced 193,000 fry, which were planted in Vineyard Sound. As large numbers of these fish are usually taken off Cotuit and Hyannis by hand-line fishermen a spawn-taker was sent to those points, but he found that the fishery had been abandoned before the commencement of the spawning season.

Tautog.—At the approach of the spawning season of this fish arrangements were made for continuing the work begun last season, and on

the 29th of June fishermen were employed to capture brood fish. Many large ones were secured, but only 24 of them were ripe. These yielded 1,646,000 eggs, from which 735,000 fry were hatched and planted in Vineyard Sound. The last eggs were taken on July 9, and the average period of incubation was from two to three days.

STEAMER FISH HAWK (LIEUT. FRANKLIN SWIFT, COMMANDING).

With the view of determining the spawning-grounds and season of the shad on the St. Johns River and other southern streams, the steamer *Fish Hawk* proceeded to Florida in January to undertake the collection and hatching of shad eggs. Palatka was reached on January 16, and an investigation of the fishing-grounds between that point and the headwaters of the St. Johns was at once commenced. It was found that the majority of the shad taken in the upper part of the river were caught in haul seines; from Volusia Bar to Lake Monroe, a distance of 50 miles, 30 of them were operated, while above the lake there were only 3. The seines were of 3½-inch mesh, 300 yards long, and 40 meshes deep. No ripe shad were caught at Sanford and an examination of those taken indicated that they would not spawn for some time.

As the water at the mouth of the Ocklawaha River was found to be well adapted for hatching purposes, a suitable anchorage was found and the vessel was removed there on January 26. The water in this section of the river was found to be slightly brackish, and it continued so until February 17. This was attributed by the inhabitants to the presence of salt springs in the lakes and river, but it seems more probable that it was caused by the banking up of the sea water at the mouth of the river by easterly gales. Tide gauges were used and regular observations of density and temperature were kept during the time the vessel was stationed at this point. As operations were being conducted on a large scale at Volusia Bar, arrangements were made with the fishermen for collecting eggs, and through the courtesy of Capt. W. A. Shaw, commanding the steamer *City of Jacksonville*, free transportation was furnished the employees of the Commission engaged in the work. Volusia Bar is situated at the entrance of the St. Johns into Lake George, and is so narrow that a seine can be stretched across it, thus effectually stopping all fish. The seines are operated from sunrise to sunset, and as soon as one is laid out and ready to be hauled in another is run out behind it, so that the shad passing up the river have little chance to escape. The catch was large throughout the season, and at times amounted to over 1,000 per day.

Spawn-takers were stationed at this point and at Welaka on Feb ruary 23 for the purpose of making regular examinations of the fish captured. The ship's nets were also set regularly, but the majority of the fish taken were gizzard shad. On the 3d of March 8,000 eggs were secured at Volusia Bar. They were hatched without loss, the mean temperature of the water during incubation being 73°. The fry were strong and healthy, and exhibited no signs of weakness, as might have been expected from the high temperature of the water. They were

liberated in the middle of Little Lake George. At the time these eggs were taken it was thought that the spawning season had at last arrived, but no more were secured, though operations were continued daily. In order that the entire field might be covered, car No. 3 was stationed at Sanford, Fla., in February, and a part of the crew of the *Fish Hawk* was detailed to assist Capt. T. C. Pearce in making collections in Lake Monroe and in the river above and below it.

From February 20 to the end of March the spawn-takers from the car attended daily the seines operated at Manuel Landing, between Lakes George and Monroe. The appearance of the shad in general remained the same to the close of the season, though several ripe ones were found early in March, from which 57,000 eggs were secured. The first two lots taken were placed in the hatching apparatus as usual, but inside of twenty-four hours they were all dead. This loss was attributed to the use of water from the city works, which contains tannin. The third lot of eggs was hatched without difficulty in water taken from Lake Monroe, and the 10,000 fry resulting from them were liberated in that lake.

At Volusia Bar observations continued until the close of the month, but though large numbers of shad were being taken in the various seines and gill nets fished on that river, no ripe ones were found

About the close of March spawn-takers were sent to Lake Harney, 35 miles up the river, but they reported that there was no fishing for shad at that point. Again, in April, one of the men returned and made several hauls with a seine, capturing 1. He was informed that small numbers of spent shad had been caught there for the past three weeks. A third trip to that lake, on April 15, resulted in the capture of 5 spent fish. On April 5, after the close of the fishing season, a seine was hired and four hauls were made at Manuel Landing, resulting in the capture of 18 roe shad, none of which was ripe.

Trips were also made to Lakes Poinsett, Winder, and Washington, but from the information gathered it seems that very few shad go beyond Lake Harney.

Though much valuable information was obtained, the results as a whole were unsatisfactory, as the main object had been to locate the spawning-grounds and to determine definitely at what season eggs are deposited. The dealers stated repeatedly that spawning fish had been captured in January and February. It may be that the headwaters of the river and the lakes are the principal spawning-grounds, but as there is no commercial fishing in those waters this was not decided.

On March 25 the *Fish Hawk* sailed for Albemarle Sound, arriving at Mackey's Ferry on April 1. As soon as possible afterward the owners of the seines, pounds, and gill nets were interviewed and arrangements made for collecting eggs. Spawn-takers were sent out on April 2 and the first eggs were brought in on the 5th. From that time to April 27 eggs were taken every day except Sunday, when fishing is prohibited by law. On April 7 the eggs collected the previous day commenced

dying, and as their general condition before being placed in the jars was good, the loss was attributed to the water. An examination by the chemist failed to show any deleterious substances, but to avoid further losses the vessel was removed to Avoca, on Salmon Creek, where it remained to the close of the season. This location proved excellent, as it was within reach of the seines owned by Dr. Capehart and Mr. Hampton. The ship's launches and five spawning boats were in constant use, and by April 27 the collection from all sources amounted to 27,901,000; 22,540,000 of these were secured from the seines at Avoca and 3,965,000 from Mr. Hampton's seines on the Roanoke River; the balance were obtained from pound nets. As the result of the season's work 16,911,000 fry were hatched and planted in the Albemarle and its tributaries, under the direction of Dr. Kendall, who had been detailed to observe their habits after liberation. The temperature of the water during the season varied from 59° to 63°.

On April 27 the vessel proceeded to Delaware Bay, the 5,473,000 impregnated eggs still on hand having been turned over to Dr. Kendall, to be hatched in floating boxes anchored in the Salmon River. Owing to the very poor circulation of the water here the loss on these eggs was very heavy; the 750,000 fry resulting from them were liberated in the Chowan River. The vessel arrived in the Delaware on May 1, and remained at Howell Cove until May 28, when it removed to an anchorage off Gloucester. For the first time in the history of the shad work on this river the efforts to collect eggs from the fisheries above the city of Philadelphia met with success. Collections commenced at once and continued without interruption until June 11, during which time 66,708,000 eggs were obtained and 42,130,000 fry hatched. Over a third of the eggs were collected in Howell Cove; the balance were obtained from gill-net fishermen and from seines above Philadelphia.

The following table shows the daily collection, number of ripe fish used, fry hatched, and average temperature of air and water:

Date.	Female fish used.	No. of eggs obtained.	No. of fry hatched.	Average temperature each day.		Date.	Female fish used.	No. of eggs obtained.	No. of fry hatched.	Average temperature each day.	
				Air.	Water.					Air.	Water.
				° F.	° F.					° F.	° F.
May 1	2	94,000	.....	64	59.5	May 23	Sunday	.....	3,376,000	63	65.5
2	Sunday	.....	.....	64	59	24	74	2,982,000	2,179,000	62.5	66
3	24	1,214,000	.....	55	60.5	25	58	2,325,000	.....	60	67
4	90	3,453,000	.....	58	60	26	45	2,302,000	.....	60	65
5	61	2,927,000	.....	63	61	27	63	3,110,000	.....	62	65.5
6	68	2,984,000	.....	68	61	28	30	1,901,000	1,000,000	65	65
7	51	2,206,000	.....	63	60	29	3	142,000	1,155,000	61	66
8	4	199,000	50,000	60	60	30	Sunday	.....	1,690,000	64	66
9	Sunday	.....	500,000	62	62.5	31	54	2,767,000	2,000,000	66	66.5
10	34	1,211,000	956,000	68	63.5	June 1	30	1,125,000	2,494,000	63.5	66
11	82	3,369,000	1,994,000	66.5	64.5	2	23	1,025,000	1,726,000	61	66
12	40	1,550,000	2,800,000	71	65	3	46	2,054,000	.....	72.5	66
13	48	2,761,000	2,337,000	66.5	66	4	19	954,000	1,500,000	72	68
14	46	1,942,000	273,000	67.5	66.5	5	.....	.....	1,409,000	69	69
15	14	715,000	1,500,000	64	65	6	Sunday	.....	649,000	68	69
16	Sunday	.....	1,851,000	62	64	7	10	513,000	1,191,000	60.5	68
17	121	5,930,000	1,996,000	64.5	64.5	8	.....	.....	574,000	59	67
18	87	4,297,000	1,076,000	65	64.5	9	6	255,000	.....	61	66
19	87	3,422,000	1,122,000	69	65	10	11	378,000	.....	67.5	66.5
20	93	3,611,000	670,000	68.5	65	11	16	547,000	380,000	70	67
21	45	2,169,000	1,000,000	63	65						
22	7	294,000	3,597,000	64	65		1,511	66,708,000	43,045,000		

Several times during the season the capacity of the vessel was taxed to its utmost, and on two occasions it was found necessary to transfer eggs to other stations. In addition to the jar, various forms of apparatus, such as the Seth Green boxes, tidal boxes, and aquaria, were employed temporarily in hatching.

The shad work was discontinued on June 14 and the vessel proceeded to Woods Hole, arriving there June 16. It was the intention to remain here for a time, to cooperate in the collection of mackerel eggs near Edgartown, but after waiting for several days and failing to secure any eggs she proceeded on June 24 to Casco Bay and anchored in Orr Island Harbor. This location was selected as the base of operations on account of its being the headquarters of the mackerel fishermen; it was also in easy communication with Portland, where large numbers of lobsters are collected. Arrangements were at once made for the spawn-takers to attend the pound nets in the vicinity and to accompany the drag-net fishermen regularly on their trips. The weather at this time was so bad that the drag-netters were often prevented from going out, and on July 13 a southwesterly gale completely wrecked the pounds at two of the fisheries. As a result the total number of mackerel eggs secured amounted to only 999,880, most of which were taken from the pounds on Jaquish Island. The period of collection extended from June 25 to July 8.

In view of the difficulties experienced the past season in hatching eggs of the mackerel, Dr. J. P. Moore was employed to make a special study of the development of the egg, with the view to suggesting some practical improvements in the hatching methods.

The following are the most important of the hatching processes experimented with: Increase of density from the normal 1.0224 to 1.0252 by the addition of salt; floating box in supply tank; McDonald jar with supply covered; inverted cod-jar with tidal flow; jar with bottom feed and cheese-cloth top; jar containing salt water to which new water was added from time to time; and, finally, the tidal-box system. There appeared to be no marked improvement in any of the methods over that of the tidal-box system, which last year hatched over 70 per cent in one instance. As far as could be observed the difficulty appeared to be with the egg and not with the hatching apparatus. Many fish were found to be spent soon after the commencement of operations, and eggs were found in all stages of development throughout the season. At the end of July fish were noticed that had not yet spawned. There is no difficulty in fertilizing the eggs, as all taken appear to be impregnated.

It has been stated in previous reports that the eggs lacked sufficient vitality to produce healthy fry, and it was thought that the good eggs were given up while the fish were endeavoring to escape from the net. Nothing occurred during the season to disprove this, but from further investigations it would seem that the greater number of the mackerel spawn offshore. This view is substantiated by the condition of the fish when taken, and by the fact that only with offshore winds

were eggs found in the surface tow net used. Before coming to any definite conclusions on this point, however, it would be necessary to conduct a series of offshore towings, and to carefully examine the eggs under a microscope in order to note their development, if impregnated, and to compare it with that of eggs artifically treated.

Lobsters.—The *Grampus*, which had been engaged in collecting seed lobsters and transferring them to Gloucester, was instructed to cooperate with the *Fish Hawk* on the arrival of the latter in Casco Bay. During the season 372 lobsters were received, from which 4,877,935 eggs were secured, and 4,616,065 fry hatched and liberated 2 miles offshore, directly in the center of the bay. The direction of the wind and the current were considered in making the plants, so as to provide against the fry being swept toward the shore.

Experiments were also conducted in the holding of lobster fry. They were placed in boxes with a good circulation of water, individually and in lots of fifty, rock, gravel, and rockweed being provided so as to imitate as nearly as possible the conditions of nature. They were fed with towings from the surface of the water in the vicinity of the ledges. It was soon found that they would not live under these conditions, and they were removed to floating boxes in the supply tank and overboard. Notwithstanding these efforts it was impossible to keep them alive longer than 13 days. Death was not caused by starvation, as their stomachs were found to contain such food as copepods, diatoms, vegetable débris, and fragments of algæ. In but few instances could the mortality be attributed to cannibalism, as only one specimen of the many examined was found to contain any portion of a lobster. It was also noticed that those confined separately lived no longer than those in lots of fifty.

Toward the end of the season young lobsters in the second, third, and fourth stages of molting appeared in the jars which contained eggs and fry in the first stages. Most of these when first noticed must have been three or four weeks old. As the increase in size became apparent they were placed in a jar by themselves and fed on lobster eggs. They were brought to Woods Hole on the return of the vessel on July 31, but they all died the night of the arrival, probably because of the change in the temperature of the water, which showed an increase of 10°. They had passed the fourth stage and taken on the characteristics of the adult; the largest were over five-eighths of an inch in length. Of adult lobsters handled during the season, 332 were liberated in open waters and 40 died in transportation.

Battery Station, Maryland (Alex. Jones in charge).

Ice disappeared from the Susquehanna early in March, and, as reports from the lower part of Chesapeake Bay indicated a very early season, the station was gotten ready for operations by April 1, and on April 8 the first lot of eggs were received. The weather turned cool, however, and the temperature of the water remained so low that the full force of employees was not taken on until April 19. From that date collections

continued daily until June 5, the total take for the season amounting to 71,145,000, not including 3,000,000 received from the steamer *Fish Hawk*. From these eggs 50,682,000 fry were hatched and distributed. A shipment of 994,000 eggs was sent to Nashville during the season for exposition purposes.

The following table shows in detail the daily collections of eggs, fry hatched and planted, and average temperature of the air and water:

Date.	Eggs received.	Loss.	Hatching.		Number of fry planted.	Average temperature.	
			Date.	Number hatched.		Air.	Water.
						°F.	°F.
Apr. 8	35,000	35,000					
14	60,000	60,000				58	53.4
15	58,000	58,000				58	54
16	279,000	149,000	Apr. 28	130,000	130,000	58	54
17	180,000	96,000	Apr. 29	84,000	84,000	55	54.5
18	388,000	172,000	Apr. 29	216,000	216,000	55	54.6
19	247,000	131,000	Apr. 29	116,000	116,000	55	54.6
21	321,000	213,000	Apr. 29	108,000	108,000	55	54.6
22	78,000	41,000	Apr. 29	37,000	37,000	55	54.7
23	1,725,000	645,000	May 1	1,080,000	1,080,000	55.3	54.7
24	2,938,000	973,000	May 1	1,965,000	1,965,000	56.7	55.7
25	420,000	218,000	May 2	202,000	202,000	57	55.7
26	1,254,000	1,184,000	May 3	70,000	70,000	57	55.7
27	2,395,000	973,000	May 4	1,422,000	1,422,000	58	56
28	1,212,000	298,000	May 6	914,000	914,000	58.3	56.2
29	4,729,000	1,457,000	May 7	3,272,000	3,272,000	59	56.4
30	6,902,000	2,297,000	May 8	4,605,000	4,605,000	59	56.4
May 2	428,000	185,000	May 9	243,000	243,000	60	57
3	2,018,000	697,000	May 11	1,321,000	1,321,000	60	57
4	1,270,000	401,000	May 14	869,000	869,000	60.4	58.1
5	894,000	103,000	May 15	791,000	791,000	60.7	59
6	448,000	132,000	May 16	316,000	316,000	60.7	59.3
7	550,000	155,000	May 16	395,000	395,000	61	60
9	951,000	126,000	May 17	825,000	825,000	61.3	60
10	1,301,000	341,000	May 18	960,000	960,000	61.3	60
11	1,142,000	343,000	May 18	799,000	799,000	61.5	61
12	929,000	252,000	May 19	677,000	677,000	61.5	61
13	1,609,000	389,000	May 19	1,220,000	1,220,000	61.7	61.1
15	636,000	196,000	May 21	440,000	440,000	65	63
16	203,000	73,000	May 21	130,000	130,000	65.9	64
17	1,189,000	289,000	May 23	900,000	900,000	65.9	64.3
18	2,004,000	650,000	May 23	1,354,000	1,354,000	65.9	64.3
19	2,377,000	636,000	May 25	1,741,000	1,741,000	66	64.7
20	5,888,000	1,149,000	May 26	4,739,000	4,739,000	66	65
20	*1,800,000	684,000	May 26	1,116,000	1,116,000	66	65
21	2,398,000	760,000	May 27	1,638,000	1,638,000	66.3	65
21	*663,000	155,000	May 27	508,000	508,000	66.3	65
22	*198,000	32,000	May 28	166,000	166,000	64	65.2
22	1,764,000	678,000	May 28	1,086,000	1,086,000	64.7	65.1
23	816,000	320,000	May 29	496,000	496,000	65	65
24	45,000	10,000	May 30	35,000	35,000	65.3	65.1
25	346,000	34,000	May 30	312,000	312,000	65.3	65.1
26	340,000	30,000	May 30	310,000	310,000	65.7	65.3
27	1,544,000	362,000	May 31	1,182,000	1,182,000	65.7	65.5
28	3,416,000	816,000	June 1	2,600,000	2,600,000	66	65.7
29	2,580,000	618,000	June 2	1,962,000	1,962,000	66	65.9
30	1,432,000	513,000	June 3	919,000	919,000	66.3	65.9
31	3,667,000	704,000	June 4	2,449,000	2,449,000	66.3	66
June 1	2,260,000	415,000	June 5	1,845,000	1,845,000	67	66.1
2	1,039,000	178,000	June 7	861,000	861,000	67	66
3	1,574,000	623,000	June 8	951,000	951,000	67.3	66.5
4	805,000	325,000	June 9			68	66.7
5	400,000	95,000	June 11	305,000	305,000	68.3	67.2
Total	74,145,000	22,469,000		50,682,000	50,682,000		
May 3	†1,280,000	780,000	May 6	500,000	450,000	57	58

* Steamer *Fish Hawk*.

† Eggs of striped bass.

Storms were very frequent throughout the season, and as they usually occurred at slack water, between sunset and midnight, the daily collections were materially interfered with, though the total take exceeded that of any season since 1888. It is worthy of mention that 11,000,000

eggs were obtained between midnight and daylight, more than 3,000,000 between 8 a. m. and noon, and 6,000,000 between noon and night.

Contrary to past experience, the eggs collected during the day were of excellent quality and produced strong, healthy fry. This year the number of fry hatched amounted to 72 per cent of the total take of eggs. The fishermen in the neighborhood cooperated with the superintendent throughout the season, and furnished 26,000,000 eggs, or nearly three times the number furnished last year, at a rate of $20 per 1,000,000.

Striped bass.—For several years the station force has been on the lookout for striped bass or rockfish eggs, and on May 3 the spawn-taker attending the Carpenter Point seine brought in 1,280,000, which he had collected from a fish weighing 12 pounds. The eggs were nearly transparent and measured one-seventh of a linear inch, or 24,552 to the quart. After attempting to hatch them in the McDonald jar it was found necessary to improvise a special form of apparatus somewhat similar to the McDonald tidal box, owing to the fact that there is very little difference between the specific gravity of the water and that of the eggs. The improvised form consisted of four bell aquaria inverted and placed in a box supplied with water through a ⅜-inch tube and discharged through a 1-inch tube, thus giving a rise and fall of 5½ inches every 8 minutes. By the afternoon of May 6 the hatching was completed, the mean temperature during the period of incubation being 58°. The fry resulting from these eggs (estimated at 450,000) were liberated in the Susquehanna River near Port Deposit. The small percentage hatched was occasioned partly by the muddy condition of the water and partly by imperfect circulation due to the character of material used for covering the jars. For the purpose of closer observation during the period of incubation, two small glass jars were placed in a bell aquarium fitted with tidal motion. The water used was first run through a charcoal filter.

BRYAN POINT STATION, MARYLAND (S. G. WORTH, SUPERINTENDENT).

In August and September important improvements were made under the direction of the superintendent, embodying repairs to the boiler-house, seine-house, and boat-house; the wharf was repaired and protected against damage from ice by driving piles 20 feet away from the corners, on a line with the end, and a well 18½ feet deep was excavated, which affords a copious supply of cold, clear water. The station has heretofore been dependent on a very unsatisfactory spring and upon river water, which caused sickness.

A large amount of worn-out property, including seines, seine boat, and other fishing apparatus, was condemned and sold at auction. A topographical survey of the station was made during the year, and an estimate was submitted by the superintendent for a large hatchery, where the entire product of the station can be cared for, thus obviating the necessity of transferring the eggs to Central Station.

In view of the receipt of large numbers of shad during March, 104,000 being received from the 14th to the 28th, preparations were made

to open the station two weeks in advance of the usual time. Mr. L. G. Harron was detailed to assist the superintendent in field work.

Special attention is called to the fact that although immense numbers of shad were taken in March, the catch during the spawning period (April 15 to June 30) was much smaller than that of any year since 1887, and this accounts for the poor results secured. A few ripe fish were found as early as April 2, but the regular collections did not commence until April 14. The following table shows the daily collections of eggs and the source of supply:

1897.	Haul seines.	Gillers.	Daily total.	1897.	Haul seines.	Gillers.	Daily total.
April 14	472,000	.....	472,000	May 8	78,000	468,000	546,000
15	356,000	177,000	533,000	9	.....	1,353,000	1,353,000
16	481,000	7,000	488,000	10	422,000	2,789,000	3,211,000
17	522,000	120,000	642,000	11	289,000	1,447,000	1,736,000
19	485,000	600,000	1,085,000	12	63,000	1,271,000	1,334,000
20	288,000	336,000	624,000	13	271,000	1,377,000	1,648,000
21	184,000	122,000	306,000	14	.....	1,408,000	1,408,000
22	80,000	671,000	751,000	15	171,000	729,000	900,000
23	203,000	257,000	460,000	16	.....	241,000	241,000
24	461,000	1,010,000	1,471,000	17	.....	605,000	605,000
25	871,000	2,179,000	3,050,000	19	.....	641,000	641,000
26	653,000	1,696,000	2,349,000	20	.....	679,000	679,000
27	60,000	943,000	1,003,000	21	.....	387,000	387,000
28	283,000	604,000	887,000	22	.....	847,000	847,000
29	130,000	208,000	338,000	23	.....	1,483,000	1,483,000
30	116,000	136,000	252,000	25	.....	318,000	318,000
May 1	384,000	1,145,000	1,529,000	27	.....	795,000	795,000
2	511,000	598,000	1,109,000	28	.....	621,000	621,000
5	400,000	611,000	1,011,000	29	.....	401,000	401,000
6	92,000	1,570,000	1,662,000				
7	145,000	386,000	531,000	Total ...	8,471,000	31,236,000	39,707,000

Over 90 per cent of the eggs were from the lower river, whereas only about 15 per cent were obtained from that field the previous year. As the daily collections were very small, half of the temporary employees were discharged on May 15, and most of the remainder on the 29th, sufficient force being retained to dismantle the station and care for the property. On April 20 the daily shipment to Central Station was frozen, though the eggs were closely covered with oil-cloth and placed on the forward deck of the launch, where they were exposed to sunlight. This is the first instance of shad eggs freezing on the trays during the spawning season. A system of temperature observations, embracing 25 miles of spawning territory, was inaugurated on April 20, and it is thought, by continuing the work from season to season, that valuable deductions may be made as to the spawning habits of the shad. During May an effort was made to ascertain the extent to which young shad were frequenting the spawning-grounds at Stony Point. The station was closed on June 7.

Following are the mean temperatures of air and water for March, April, and May:

Month.	Air.	Water.
March	48.25	45.25
April	55.75	54.50
May	66.38	64.73

The following table shows the temperatures of water by weeks, during the shad season, from 1887 to 1897. It will be found of interest in connection with the table on the opposite page:

Year.	Week ending Feb. 7.			Week ending Feb. 14.			Week ending Feb. 21.			Week ending Feb. 28.			Week ending Mar. 7.		
	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
1887	39	39	39	42	40	40.80	43	41	42.17	44	40	43.37	42	40	41
1888	35	35	35	35	35	35	36	35	35.28	39	36	37.07	38	37	37.53
1889	40	36	38.07	39	36	36.32	37	36	36.21	36	36	36	37	36	36.50
1890	46	42	44.07	45	41	42.28	48	42	44.42	48	42	44.35	48	42	44.67
1891	43	40	41.14	46	40	41.66	47	41	44.57	47	42	45.38	42	40	41.42
1892	42	35	38.50	44	37	39.21	44	38	39.35	47	39	42.85	46	41	42.90
1893	36	34	34.85	36	34	34.80	37	34	35.57	38	34	35.42	40	35	36.80
1894	40	38	38.28	40	38	39.53	44	38	39.32	42	37	38.32	46	38	41.75
1895	36	34	34.35	35	34	34.17	35	34	34.82	36	35	35.17	40	36	38
1896	40	39	39.92	40	40	40	40	36	38.32	38	36	36.50	40	38	38.96
1897	36	34	35.03	36	36	36	38	36	36.78	40	38	39.10	42	39	41.03

Year.	Week ending Mar. 14.			Week ending Mar. 21.			Week ending Mar. 28.			Week ending Apr. 4.			Week ending Apr. 11.		
	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
1887	43	41	42.21	43	41	41.71	44	41	42.71	44	42	42.30	52	43	47.17
1888	39	34	37.21	40	34	36.21	40	38	39.07	48	40	44.14	52	48	50.02
1889	40	37	39.07	45	41	43.39	48	45	46.82	50	48	48.92	52	50	50.50
1890	48	41	42.67	48	44	45.85	49	45	47.17	50	47	48.10	53	50	51.46
1891	42	39	40.38	42	39	41.33	46	41	44.04	46	42	44.42	46	44	45.04
1892	46	41	43.60	44	39	41.04	46	40	43.14	52	45	47.28	56	52	53.80
1893	44	37	40.64	44	40	41.53	46	42	44.14	54	45	48.64	54	52	53.21
1894	50	46	48.35	54	50	51.35	56	49	52.42	50	46	48.03	52	48	50.17
1895	43	40	41.82	43	41	42.32	46	42	43.71	48	45	47.14	54	48	59.14
1896	41	38	39.71	41	38	39.50	43	40	41.03	46	44	45.17	47	45	46.07
1897	45	42	43.32	50	44	46.21	51	48	49.89	52	48	50.14	53	52	52.21

Year.	Week ending Apr. 18.			Week ending Apr. 25.			Week ending May 2.			Week ending May 9.			Week ending May 16.		
	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
1887	55	52	54.39	55	54	54.21	57	55	55.71	66	57	62.55	68	66	67.28
1888	52	50	51.22	52	50	50.55	58	51	55	64	58	60.64	66	63	64.53
1889	55	52	52.64	58	52	55.67	58	56	57.71	62	54	57.84	68	61	65.64
1890	58	51	54.60	60	56	57.35	62	58	59.42	64	60	62.07	65	60	62.53
1891	58	46	52.28	64	58	61.33	64	62	63.04	64	60	62	65	60	63.28
1892	52	50	50.85	53	50	51.85	62	52	56.23	68	60	65.09	68	64	65.52
1893	56	52	54.53	55	50	53.36	59	50	53.09	60	56	58.14	66	58	62.47
1894	54	48	50.50	60	54	58.35	66	60	62.39	70	64	68.32	70	68	68.64
1895	54	52	53.32	61	53	56.67	62	57	59.57	70	58	63.39	73	62	67.35
1896	62	50	53.84	66	62	64.50	64	62	63	67	62	64.64	73	67	70
1897	56	52	53.96	59	54	56.03	62	60	60.64	63	60	61.60	66	63	64.39

Year.	Week ending May 23.			Week ending May 30.			Week ending June 6.			June 6 to 10.		
	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
1887	72	68	70.35	73	72	72.67	72	72	72	72	70	71.17
1888	63	61	62.14	65	61	62.75						
1889	70	66	68.64	66	64	65	70	65	67.92	69	65	67.25
1890	68	64	65.92	68	64	66.45	73	66	69.14	74	72	73.61
1891	68	61	64.61	66	62	64.42	70	62	67.42	72	66	68.42
1892	69	65	67.33	66	62	64.57	74	62	68.66	74	70	72.19
1893	69	60	63.57	70	66	69.09	75	68	71.23	76	74	75
1894	70	67	69.10	68	64	65.71	69	62	65.07	77	66	72.71
1895	62	60	61.28	72	62	65.32	82	70	76.28	80	75	77.50
1896	75	72	73.28	72	70	71.78	73	71	72.03	76	73	75.21
1897	67	66	66.14	68	67	67.75	71	68	69	71	70	70.12

The following table shows the receipts of shad from the Potomac River, at Washington, D. C., by weeks during the season, from 1887 to 1897. The data were furnished by Mr. Gwynn Harris, inspector of marine products:

Year.	Non-spawn fish.									
	Week ending Feb. 7.	Week ending Feb. 14.	Week ending Feb. 21.	Week ending Feb. 28.	Week ending Mar. 7.	Week ending Mar. 14.	Week ending Mar. 21.	Week ending Mar. 28.	Week ending Apr. 4.	Week ending Apr. 11.
1887	.....	.....	2	2	64	208	464	3,325	4,841	26,038
1888	.....	.....	.....	.....	2	1	.....	.....	2,963	25,922
1889	.....	.....	.....	.....	.....	1	221	3,020	16,862	42,463
1890	.....	4	15	19	292	391	4,103	15,916	43,520	97,375
1891	.....	.....	2	12	38	53	491	2,447	7,070	15,761
1892	.....	.....	.....	4	2	52	132	1,442	16,493	71,056
1893	.....	.....	.....	.....	.....	38	477	5,914	48,170	58,115
1894	3	2	5	15	.....	.....	.....	.....	23,631	67,325
1895	.....	.....	.....	.....	.....	89	1,897	15,743	70,352	134,800
1896	1	3	1	2	.....	39	101	3,642	23,338	49,456
1897	.....	.....	.....	16	25	1,060	24,986	80,120	84,373	79,257

Year.	Spawn fish.									Total.
	Week ending Apr. 18.	Week ending Apr. 25.	Week ending May 2.	Week ending May 9.	Week ending May 16.	Week ending May 23.	Week ending May 30.	Week ending June 6.	June 6 to June 10.	
1887	50,045	48,634	33,655	49,921	22,951	17,921	5,760	3,881	1,398	269,110
1888	61,611	61,611	53,302	51,363	23,442	14,307	7,700	5,237	893	308,444
1889	88,832	110,254	56,139	72,066	31,979	14,886	8,002	2,308	1,544	448,577
1890	97,676	71,805	45,586	24,328	11,822	3,261	1,369	1,481	337	419,390
1891	87,341	97,600	53,918	21,211	15,194	10,920	3,412	2,061	258	317,789
1892	60,592	38,753	28,173	22,285	8,468	4,655	3,476	3,961	1,358	260,882
1893	55,431	55,392	35,963	18,020	15,220	9,520	3,820	1,514	375	307,978
1894	83,959	79,067	55,370	22,470	20,195	9,044	7,234	12,410	2,777	383,507
1895	126,290	106,501	38,123	56,874	28,642	20,449	13,112	8,826	1,612	623,310
1896	128,050	53,300	32,852	22,973	13,218	7,937	3,307	4,346	592	343,160
1897	60,250	24,079	18,598	10,230	7,273	3,400	1,882	1,151	210	396,899

CENTRAL STATION, WASHINGTON, D. C. (S. G. WORTH, SUPERINTENDENT).

During the summer the superintendent was detailed to make an investigation in the neighborhood of Weldon, N. C., with the view to determining the extent to which the river shrimp, *Palæmonetes exilipes*, enters into the food of the bass and crappie, and to arrange for the extension of its geographical range as a natural food for trout and other edible fishes. They were found in many of the ponds and streams of Halifax and Northampton counties, and shipments were sent to Washington, D. C., Wytheville, Va., and Neosho, Mo. It was learned that they form an important part of the natural food of bass, crappie, and other predaceous fishes, and that they can be successfully shipped in pails of water by express for distances requiring not over seven hours time. Part of the consignment sent to Washington were put in a trout stream near Leesburg, Va. An examination of the pond in Washington during the month of May showed the presence of egg-bearing shrimp.

As in former years, the fish-cultural work included the distribution of the year's production of fish from the Fish Commission ponds, the hatching of shad eggs collected on the Potomac River, and of a few eggs of the quinnat salmon, brook, rainbow, Loch Leven, and lake trouts, which had been transferred from other stations during the winter for the purpose of illustrating fish-cultural methods.

The following table shows the number of eggs received and the fish distributed:

Species.	Eggs received.	Fry distributed.
Brook trout	3,000	2,202
Lake trout	5,000	4,338
Loch Leven trout	3,000	2,209
Rainbow trout	10,000	7,479
Quinnat salmon	10,000	7,516
Shad	40,359,000	25,346,000
Total	40,390,000	25,369,744

The first consignment of shad eggs was received from Bryan Point on April 14, and shipments continued uninterruptedly from that time until the 29th of May, 31,877,000 of the 39,719,000 shipped being received in good condition. A consignment of 640,000 was also received from the Delaware River on May 22.

During the season 25,346,000 fry were hatched and distributed, and 2,070,000 eggs were shipped to Nashville for exposition purposes; the balance were lost during incubation. The eggs were transferred from Bryan Point by means of the Fish Commission launch instead of by passenger boat, as in past years.

At the close of the year the superintendent was detailed for duty in connection with the construction of the station at Erwin, Tenn.

AQUARIUM AT CENTRAL STATION (L. G. HARRON, IN CHARGE).

In October arrangements were made to restock the aquarium with salt-water fishes from Chesapeake Bay, but owing to the prevalence of heavy gales it was impossible to obtain good collections. Fresh-water fishes were collected from time to time in the Potomac River, and consignments of trout and salmon were received from the New England stations.

Comparatively little difficulty was experienced during the year with fungus or disease of any kind.

During March and April 19 yellow perch spawned in the aquarium, but efforts to hatch their eggs were unsuccessful; this was attributed to the presence of alum in the filtered water. Two rainbow trout spawned early in March and another on May 12; none of the eggs hatched, though efforts were made to save them. The goldfish spawned in April and May and the eggs were placed in a separate aquarium in the greenhouse, where they were hatched.

The fresh-water fishes, with the exception of the lake trout, were held without loss until May 6, when a part of the steelhead trout and quinnat salmon were transferred to Nashville. The balance were retained with comparatively light losses until June 18, when they were liberated in a small spring fed pond about 10 miles from Washington. Several adult rainbow trout, weighing from 1½ to 2 pounds, a number of 2-year-olds, and a few steelheads were retained in the aquarium for experimental purposes, and lived until July 4, when they died at a temperature of 82°.

From June 18 to July 4 the water temperature was as follows:

Date.	6 a. m.	Noon.	6 p. m.	Date.	6 a. m.	Noon.	6 p. m.
1897.	°F.	°F.	°F.	1897.	°F.	°F.	°F.
June 18	74	74	74	June 27	77	77	77
19	74	75	75	28	77	77	77
20	75	75	76	29	77	77	77
21	75	75	75	30	77	78	78
22	75	75	75	July 1	78	78	78
23	75	75	75	2	78	80	80
24	75	76	76	3	80	81	81
25	76	76	76	4	81	81	82
26	77	77	77				

The following shows the number and kind of salt and fresh water fishes exhibited during the year:

Species.	No.	Species.	No.	Species.	No.
Fresh water:		Fresh water—Continued.		Salt water—Continued.	
Large-mouth black bass	295	Pickerel	5	Pinfish	3
Small-mouth black bass	32	Channel cat	10	Scup	30
Rock bass	100	Yellow cat	30	Croaker	20
Crappie	120	*Chub sucker*	6	Pigfish	4
White bass	3	Red sucker	4	Striped mullet	9
Yellow bass	1	Leather carp	6	Flounder	8
Rainbow trout	165	Shad	2,700	Mummichog	20
Brook trout	175	Sunfish	120	Tautog	24
Lake trout	193	Mill roach	20	Toadfish	12
Swiss lake trout	150	Common eel	12	Hog-choker	14
Steelheads	300	*Lacefin dace*	25	Moonfish	4
Quinnat salmon	174	Fresh-water shrimp	200	Swellfish	19
Atlantic salmon	20	Bullfrog	12	Striped bass	6
Yellow perch	66	Crawfish	100	Black drum	3
White perch	40	Fresh-water terrapin	4	Sheepshead	3
English tench	12	Snapping turtle	2	Skate	2
Paradise fish	12	Salt water:		Sting-ray	1
Golden tench	300	*Sea trout*	19	Lobster	4
Goldfish	65	Sea bass	40	Hermit crab	12
Golden ide	5	Sea-robin	2	Blue crab	15
Pike	1	Spot or goody	32	Medusa	1

FISH COMMISSION LAKES, WASHINGTON, D. C. (RUDOLPH HESSEL IN CHARGE).

During the fall months the following fish, resulting from the crop of the previous spring, were distributed: Large-mouth black bass, 38,492; small-mouth black bass, 2,688; rock bass, 5,070; shad (estimated number), 1,500,000.

At the close of the previous fiscal year 12,270 young large-mouth black bass had been transferred from the breeding-ponds to the tanks and the small rearing-ponds. This work was continued during the summer, a total of 48,822 large-mouth and 2,976 small-mouth bass being secured.

The losses up to the time of distribution amounted to 11,410, of which 1,080 were the small-mouth species. The heaviest mortality occurred in June, caused by the high temperature and the muddy condition of the water. Their food during the early summer consisted of chopped fish (carp and tench reared at the station), and when the supply was exhausted, fishes purchased from the market were substituted. The bass refused to take the fresh-water species, but the various salt-water fishes, particularly the butter-fish and the sea trout, proved very accept-

able. These were purchased at a rate of 3 cents per pound. In preparing fish as food the scales and gills should be carefully removed.

With the view to enlarging the output of bass, spawning-ponds were constructed along the south banks of the north and south ponds during the winter, and the stock was increased by the transfer of several hundred large-mouth breeders from Quincy and small-mouth breeders from Lake Erie. On the 15th of April 20 adults were placed in each of the partitions of the north pond and the same number of small-mouth bass were placed in the various partitions of the south pond. Spawners were also placed in Pond No. 6 and in a number of the small ponds on the terrace in front of the cottage.

As good results had been attained at Wytheville Station the previous year by the use of artificial nests, all of the ponds were provided with them, in addition to piles of gravel. The nests used were of two forms, one being simply a cement plate 20 inches in diameter, covered with coarse gravel; the other, the Seagle nest, described in the Report for 1896, page 48. The fish commenced spawning on April 18, and it was noticed that they deposited their eggs on the artificial nests quite as readily as on the natural nests of gravel.

The temperature of the water at the opening of the spawning season was 45°. Fungus developed after a few days on the first eggs deposited in partitions 1 and 2 of the north pond and Pond No. 6, but the others did well, and on April 26 young fish were seen in both the north and south ponds.

Owing to the fact that the ponds were not dried during the winter, there was an immense growth of algæ, which not only interfered materially with the removal of the fry, but prevented close observation of their movements. As an examination of the ponds showed them to be abundantly stocked with microscopic food, artificial feeding was not commenced until the bass were about two weeks old.

During the month of May there was every reason to expect a large crop of both species, but late in June a small bug belonging to the family of *Notonectidæ* made its appearance and destroyed large numbers of the young fish.

An insect which belongs to the *Dytiscidæ* family appeared later and caused even greater damage. It attacked the young bass in large numbers, killing and eating in a few minutes a fish 1½ inches long, nothing remaining but the skeleton. Though little is known of the natural history of this insect, it has heretofore been thought that its food consisted solely of dead flesh. The pests fly over into the ponds at night from the river, and the only way to prevent their ravages is to cover the ponds with very fine meshed netting.

At the close of the year, owing to heavy losses caused by the insects referred to, very few of the young fish remained in the small ponds.

Crappie.—As the demand for this species is constantly increasing, a supply of adults was brought to the station from Quincy in the fall, and early in April 23 of them were placed in Pond No. 5 and the remainder

in the acclimatization pond, No. 20, which has an area of 17,500 square feet. In Pond No. 5, where there was very little vegetation, a close watch was kept, with the view of noting the spawning habits of the fish, but in no instance were they observed to nest, though a few fry appeared in June. The vegetation in Pond No. 20 is very dense, and the results attained were apparently much better, as hundreds of fry an inch in length were observed during the latter part of June. The crappie are so delicate that it is impracticable to handle them during warm weather, and no effort was made to remove the young brood, but the old fish were taken out and placed in a smaller pond.

Golden ide.—A part of the stock of golden ide was placed in Pond No. 4 and commenced spawning on April 21. The temperature of the water at that time was 54°, but it fell to 41° on the 24th, causing the loss of all the eggs. A few days later 16 specimens which had been set aside for shipment to Nashville spawned, the temperature at the time being 58°. These eggs were successfully hatched within 10 days, and at the close of the year there were several hundred of the young fish on hand. Their food consists of cornmeal and flour.

All of the spotted catfish and rock bass on hand were shipped to Nashville for exhibition purposes. As usual, large numbers of carp and tench were hatched to be used as food for the bass, and a sufficient number of goldfish were reared for stocking the public parks.

During the winter the old tool-house, the fences, and the partitions around the ponds were removed; a driveway was constructed from Executive avenue to the office, and the grounds were further improved by the planting of ornamental flower beds.

WYTHEVILLE STATION, VIRGINIA (GEORGE A. SEAGLE, SUPERINTENDENT).

The condition of the ponds and buildings was such that it became necessary to expend $800 in improvements during the fall. These consisted of the subdivision of the bass ponds into 9 spawning-ponds by the construction of wooden and earthen partitions, and the painting and repairing of the hatchery and superintendent's residence.

The stock of fish on hand at the beginning of the year is shown in the following table:

Species.	Calendar year in which fish were hatched.				
	1896.	1895.	1894.	1893.	1892 or before.
Rainbow trout	117,300	1,400	560	805	1,830
Black bass	.....	.....	.....	.....	24
Rock bass	.....	.....	.....	.....	140
Total	117,300	1,400	560	805	1,994

At the time of distribution in the fall the trout numbered 81,954; 2,200 of these were retained for breeding purposes and the remainder were planted in public and private waters. Very few black bass were reared at the station, owing to the condition of the ponds, but the out-

put was increased by the transfer of 13,562 from Central Station and 234 from Quincy, Ill. The output of rock bass was 11,485 yearlings and 70 adults reared at the station and 2,550 yearlings transferred from Neosho.

Rainbow trout.—The brood stock at the station in November consisted of 1,623 fish from 4 to 8 years old, 700 three-year olds, 515 two-year olds, and 1,200 yearlings. The spawning season commenced on November 6 and continued until February 5, during which time 770,440 eggs were collected from 984 fish, 620 males being used to fertilize them. Of these eggs 245,000 were assigned to State fish commissions, foreign societies, and private applicants; 52,000 were transferred to other stations of the Commission; and from the balance 365,000 healthy fry were hatched. During March and April 120,000 of these were distributed to applicants in Virginia and Tennessee; the remainder were placed in troughs in the hatchery and in outside ponds to be reared for the fall distribution, the losses to the close of the fiscal year amounting to 63,038.

During the early stages of the existence of the fry their diet consisted entirely of canned herring roe and salted cod roe, but from May 1 to the close of the year a mixture of liver and mush was given to them. After an experience of two years, fish roe, either salted or canned, is considered far superior to the usual liver diet for small fry. Of the two preparations the canned roe is preferable.

There were no unusual casualties until June 23, when the water supply to one of the ponds was obstructed for several hours, resulting in the loss of 327 two-year old fish.

Quinnat salmon.—On December 31, 5,000 quinnat salmon eggs were received. They hatched between January 8 and 12 with slight loss, and on May 28, when the fry were transferred to the ponds, the loss from the time of hatching amounted to less than 200. They grew very rapidly after being released in the ponds, and at the close of the year were about 4 inches long.

Black bass.—To increase the output of the station, 59 adult small-mouth black bass were transferred from Put-in Bay in October. They were kept in one of the spring-fed ponds until April 14 when they were transferred to the spawning-ponds, which had been prepared with artificial nests. Owing to the unusually cool and cloudy weather they did not commence nesting until late in May, and at the end of June only two nests containing eggs had been found.

Rock bass.—Early in April 145 adult rock bass were placed in the spawning-ponds. These were also affected by cool weather, and though they commenced nesting early in May very few eggs were noticed at the close of the year.

Crappie.—Of 104 crappie transferred from Quincy Station in October, there remained but 46 the following spring. These were in excellent condition, apparently, but so far they have shown no indications of spawning.

PUT-IN BAY STATION, OHIO (J. J. STRANAHAN, SUPERINTENDENT).

The following important improvements were made at the station during the year: A frame storehouse 15 by 20 feet, 1½ stories high, was erected on the southwest corner of the station grounds; the old dock was replanked throughout and supplied with new timbers where needed; a rowboat dock, 40 feet by 9 feet, was built at the southeast corner of the building, running parallel to and 20 feet away from the main dock; a 30-foot channel, 260 feet long and 7½ feet deep, was dredged from the dock outward to deep water; retaining walls were built on the north and the west sides of the main building and on the northeast of the grounds on the lake front; the grounds were graded and seeded and walks were built; a 60-light gas plant was installed in the hatchery, and to obviate the possibility of the water supply being cut off, the suction pipe at the end of the dock was placed in deep water in the new channel.

During October the usual arrangements were made for collecting whitefish and herring eggs at various points on Lake Erie, but owing to the exceedingly bad weather during the spawning season the total take was less than half that of the previous year.

The first eggs were obtained on November 4, but a violent storm commenced November 6 and lasted for several days, causing great destruction to the nets, and breaking up and driving the schools of whitefish and herring out into deep water. Scarcely a pound net escaped injury, and it was estimated that over one-third of the gill nets in the western end of the lake were destroyed; 21 pounds belonging to a firm in Toledo were so injured that they were not fished again during the season.

At the close of operations, on November 26, the total collections amounted to 86,139,000 whitefish and 11,725,000 lake-herring eggs, secured from the following fields:

Collecting field.	Whitefish.	Herring.
Port Clinton	45,513,000	5,225,000
Put-in Bay	12,213,000	3,200,000
North Bass Island	12,159,000	1,100,000
Toledo	7,137,000	2,200,000
Kelly Island	4,617,000	.....
Middle Bass Island	2,439,000	.....
Catawba Island	2,061,000	.....
Total	86,139,000	11,725,000

Owing to the unfavorable conditions under which the eggs were collected, their quality was not so good as in former years. The first fry were planted on March 26, and deposits were continued to April 29, during which time 60,309,000 whitefish, and 7,299,000 lake herring were liberated.

For the purpose of experiment, 2,000,000 fry hatched early in April were held in four tanks and were fed on fine middlings prepared by

the roller process. They commenced to take food on April 8, and were apparently healthy and vigorous until April 17, when a considerable number of dead ones were discovered at the bottom of the tanks. The death rate continued to increase from this time until about the 28th, when it had become so large that it was decided to plant half of them. The balance were held for experimental purposes, and various kinds of food were tried, but they all died on the night of May 6.

The temperature of the water during this period was as follows:

Date.	Air.			Water.			Date.	Air.			Water.		
	Max.	Min.	Mean.	Max.	Min.	Mean.		Max.	Min.	Mean.	Max.	Min.	Mean.
Apr. 8	43	41.5	42.25	40.5	40	40.25	Apr. 23	73	64	68.5	46	45	45.5
9	35	34	34.5	40	40	40	24	74	59	66.5	48	47	47.5
10	41	33	37	40	39	39.5	25	61	54.5	57.75	48	48	48
11	38	35	36.5	40	40	40	26	54	54	54	48	47.5	47.75
12	44	38	41	41	40	40.5	27	44.5	40	42.25	47.5	47	47.25
13	59	49	54	41	40.5	40.75	28	59.5	53.5	56.5	48	48	48
14	49	42	45.5	42	41.5	41.75	29	54	51	52.5	48	48	48
15	52	45	48.5	42.5	42	41.75	30	48	48	48	49	47.5	48.25
16	48	44	46	42.5	42	42.25	May 1	41	41	41	48.5	48.5	48.5
17	37.5	37	37.25	43.5	43	43.25	2	42	40	41	48	47.5	47.5
18	58	40	49	43	42	42.5	3	56	47	51.5	48	47.5	47.75
19	36	34	35	43	43	43	4	55	47	51	51.5	51	51.25
20	33	29	31	43	42.5	42.75	5	56	52	54	52	51	51.5
21	50	41	45.5	43.5	43.5	43.5	6	69	57	63	52	51	51.5
22	72	57.5	64.75	44	43.5	43.75							

From a consignment of 1,000,000 lake-trout eggs shipped from Northville Station 794,000 fry were hatched and liberated in the vicinity of the station, on North Bass Island and Peach Point Reef.

Another attempt was made to collect black-bass eggs by setting out artificial nests in the vicinity of the hatchery. Over 100 were prepared and placed in shallow places, but owing to the very high winds and low temperature prevailing during the spawning season only three broods of young fish were hatched.

In the spring the superintendent made an investigation of the sturgeon fisheries at the west end of the bay, with the view to taking up the propagation of that species, but it was found that the conditions would not warrant it.

Following is a record of the maximum, mean, and minimum temperatures of air and water, by months:

Month.	Air.			Water.			Month.	Air.			Water.		
	Max.	Min.	Mean.	Max.	Min.	Mean.		Max.	Min.	Mean.	Max.	Min.	Mean.
1896.							1897.						
July	90	60	76.51	74	64	70.60	January	55	−13	29.56	35.5	32.5	32.84
August	92	65	77.09	80.50	68	73.67	February	44	6	29.47	34.5	32.5	32.63
September	86	54	65.01	70	56.5	66.25	March	56.5	21.5	35.12	38	32.5	33.70
October	67	36	51.48	59	46	51.82	April	74	33	46.51	49	37	42.63
November	66	21	43.05	52.5	38.5	44.30	May	77	40	56.84	62	47.5	55.12
December	51	17	31.85	37	32.5	39.74	June	86	52	68.65	73	56	64.85

NORTHVILLE STATION, MICHIGAN (FRANK N. CLARK, SUPERINTENDENT).

The regular force of the station was employed during the summer in assisting in the various constructions, repairs, and improvements. The stock of fish on hand at the beginning of the year was as follows:

Species.	Calendar year in which fish were hatched.				
	1896.	1895.	1894.	1893.	1892.
Brook trout	17,000	90			
Wild brook trout				675	215
Von Behr trout					230
Loch Leven trout				512	85
Black bass					20
Total	17,000	90		1,187	550

The fish continued to do well until the excavations for the new hatchery were commenced, when it became necessary to cut off a large part of the water supply. This resulted in heavy losses, and by the close of summer there remained on hand only 1,600 yearling fish.

Lake trout.—The collection of eggs on Lake Superior commenced on October 9, and was continued without interruption until November 26, the total take amounting to 12,277,000. Of these, 1,330,000 were obtained in the vicinity of Caribou Island, Lake Superior; 2,174,000 near Alpena, Lake Huron, and the remaining 8,773,000 in Lake Michigan, near Epoufette, Beaver Island, and Charlevoix. The eggs were shipped as usual, on canton-flannel trays incased in wooden boxes, and arrived at the station in excellent condition. During the months of November, December, and January 3,487,000 eyed eggs were transferred to other stations of the Commission, State fish commissions, and private applicants, including one shipment to Germany.

The fry commenced hatching early in January, and the distribution was continued from January 29 to March 21, during which period 50,000 were furnished to private applicants, 1,400,000 were planted in Lake Huron, 1,000,000 in the Straits of Mackinac, 2,350,000 in Lake Michigan, and 480,000 in Pine Lake, Michigan. Over 500,000 were placed in tanks in February and fed, and 400,000 were liberated at Beaver Island, Lake Michigan, on April 28. The balance of the stock was retained for distribution in the fall, and at the close of the year the 141,000 on hand in the rearing ponds and troughs were doing well.

Brook trout.—Very few of the wild brook-trout spawners captured in the Au Sable in 1895 remained this season, as most of them died from lack of water at the time the improvements were being made. Between October 17 and November 25, 81,000 eggs were collected from the stock at the station, and 100,000 eggs were purchased. Excellent results were obtained in hatching, and during March and April 97,500 fry were distributed. Two shipments of eggs were made in December, one consignment of 12,000 being furnished to M. A. Bigelow, Evanston, Ill., and one of 3,000 to Central Station.

Loch Leven trout.—The spawning season commenced October 17 and was continued to November 25, but as the eggs were of very poor quality and the hatchery was crowded, operations were discontinued at that time. From the 129 ripe females handled 130,575 eggs were obtained; from these, 5,000 eggs were transferred to other stations and 15,000 fry were distributed.

Rainbow trout.—The consignment of eggs shipped from Neosho yielded 16,000 fry; 6,500 of these were distributed to applicants in Ohio during the spring, and on June 30 there remained at the station 9,000 healthy fingerlings.

Steelhead trout.—On April 27 a consignment of 41,000 steelhead eggs was received from Fort Gaston Station, and 32,000 of the fry resulting from them were planted in May in streams crossed by the Detroit and Mackinac and the Flint and Père Marquette railroads. The remaining 5,000 were held for rearing.

The following shows the number of fry on hand at the close of the year, the age, and the weight of fish per 1,000:

Species.	Age.	Number.	Weight per 1,000 fish.	Total weight of fish.
			Pounds.	*Pounds.*
Brook trout	4 months	15,000	7	105
Lake trout	4 months	141,000	4	564
Loch Leven trout	3½ months	17,000	3	51
Rainbow trout	2½ months	9,000	2½	22½
Steelhead trout	1½ months	5,000	1½	7½

ALPENA STATION, MICHIGAN, (FRANK N. CLARK, SUPERINTENDENT).

Early in the summer the superintendent and foreman visited the important fishing centers on Lakes Huron, Michigan, and Superior, and made arrangements for the lake-trout and whitefish work. On September 15 the spawn-takers, under the direction of Mr. George Platts, proceeded to Lake Superior and commenced the collection of trout eggs at Spruce Harbor and Michipicoten Island, Ontario, and at the close of the season there they were transferred to various points on Lakes Michigan and Huron. The first whitefish eggs were received at the station on October 27, having been collected at Scarecrow Island, Lake Huron.

The collections continued until December 14, and a total of 35,800,000 were secured from the following points:

Point of collection.	Number secured.	Point of collection.	Number secured.
Warehouse, Lake Michigan	1,300,000	Traverse Bay (tributary), Lake Michigan	600,000
Epoufette, Lake Michigan	650,000	Hammond Bay, Lake Huron	900,000
Naubinway, Lake Michigan	650,000	Rogers City, Mich., Lake Huron	800,000
Manistique, Lake Michigan	10,000,000	Lixeys Fishery (Oscoda), Lake Huron	300,000
Soulchoix Point, Lake Michigan	600,000	Alpena and vicinity	7,000,000
Beaver Island, Lake Michigan	10,000,000		
Manitou Island, Lake Michigan	3,000,000		

The eggs arrived at the station in excellent condition. They commenced hatching on March 28 and 32,000,000 were planted during the months of April and May, as follows:

Waters.	Point of deposit.	Number planted.	Waters.	Point of deposit.	Number planted.
Lake Michigan	North Shore	2,000,000	Lake Huron	Hammond Bay	2,000,000
Do	Frankfort	2,500,000	Do	Scarecrow Island	4,000,000
Do	Manistique	4,000,000	Do	Miller Point	4,000,000
Do	Beaver Island	3,000,000	Do	East Tawas	2,000,000
Do	Straits of Mackinac	2,500,000	Thunder Bay	Whitefish Point	2,000,000
Lake Huron	North Point	4,000,000			

After completing the distribution and placing the station in order, Mr. Downing, the foreman, was detached and ordered to Woods Hole, and Mr. Thayer, fish-culturist, to Northville. The station was placed in charge of a watchman to the close of the year.

QUINCY STATION, ILLINOIS (S. P. BARTLETT, SUPERINTENDENT).

Indications in June seemed favorable for a successful season's work, as the winter had been an open one and the bass and crappie spawned early. Three carloads of fish were distributed between July 6 and 22 to applicants in Minnesota, Dakota, Pennsylvania, Ohio, and Mississippi, but heavy rains occurred on July 25, which stopped all work until September 10, when it was resumed and continued until November.

In addition to the fishes furnished to applicants, collections of breeders were made for the Wytheville and Neosho stations and for the Fish Commission ponds, Washington, D. C. During the year the station furnished for distribution the following adults and yearlings: 32,375 black bass, 3,418 crappie, 1,025 yellow perch, and 1,700 pickerel. In addition to this output, immense numbers of the common fishes, such as yellow perch, catfish, sunfish, and other indigenous species were collected from overflowed lands and returned to the Mississippi and Illinois rivers.

During the winter the boiler-house built the previous year was enlarged, all of the buildings were painted, and the boats and seines were overhauled. Owing to continued high water during the spring no collections of fry were made.

MANCHESTER STATION, IOWA (R. S. JOHNSON, SUPERINTENDENT).

The superintendent assumed charge of the station in January. As the work of construction had not advanced sufficiently during the fall to permit of the collection of trout eggs, consignments of lake and rainbow trout eggs were sent from Northville and Neosho during the winter. All of the fry resulting from them, with the exception of 2,500 of the rainbows, were distributed in the spring. These were reserved to be reared for brood stock. Efforts were made to secure a stock of bass as soon as the ponds were ready, but the first consignment of brood fish received from Quincy developed fungus shortly after their arrival

and died. Fifty adults were then collected from the Maquoketa River and placed in Pond X, but they were captured too late in the season to spawn.

On March 9 unusually high water in the spring branch flooded the lowlands east of the superintendent's residence. The water rose a foot above the floor of the wagon bridge, doing considerable damage to the stone abutments and causing numerous washouts along the pond site. The water supply to the hatchery and ponds was cut off by the washing out of the 14-inch pipe, but the eggs and fry were saved by promptly repairing it. Later in the season considerable work was done with the view to protecting the supply pipe and ponds from damage by future freshets. Owing to changes in the plans and to damage done by the freshet and the cyclone of the previous year, the appropriation for the construction of the station proved inadequate, hence work had to be stopped in the spring, pending an additional appropriation of $4,200, submitted in the deficiency bill.

DULUTH STATION, MINNESOTA (S. P. WIRES, SUPERINTENDENT).

Early in the summer the usual arrangements were made for collecting lake-trout and whitefish eggs from the waters of Lake Superior. The lake-trout season commenced September 15 and closed November 7, resulting in a collection of 5,874,000 eggs from the following points: Ross Port, Ontario, 2,203,000; St. Ignace Island, Ontario, 800,000; Isle Royale, Mich., 1,701,000; Grand Portage, Minn., 410,000; French River, Minn., 40,000; Bayfield, Wis., 690,000; Pueblo River, Ontario, 30,000. They were transferred to the station and 4,768,000 fry were hatched from them and distributed during April, May, and June.

The whitefish collections commenced at Basswood Lake, Minn., on October 17 and the total take of eggs during the season amounted to 4,200,000. The loss during incubation was very heavy, owing partly to unfavorable weather conditions which prevailed during the collecting season and partly to the fact that it was necessary to transport the eggs long distances over rough roads by wagon from the fishing-grounds to the railroad station. As the result of the season's work 1,990,000 fry were deposited at Grace Harbor, Isle Royale, Michigan, on April 29.

In addition to the collections made by the station force 25,000 brook, 21,450 rainbow, and 100,000 steelhead trout eggs were transferred from other stations to be hatched and distributed from Duluth. The brook-trout eggs yielded 15,400 fry, which were furnished to applicants in Minnesota and North Dakota during May and June. The rainbow eggs were in excellent condition when received, but they proved almost a total loss, probably because of the difference in the temperature of the water at Neosho, where they were eyed, and Duluth. The temperature at Duluth during the hatching period was below 34° F., whereas at Neosho it is 57°. The steelhead eggs produced 75,000 fry, which were deposited during July in tributaries of Lake Superior. A number of specimens of that species have been captured in French and Lester

rivers, Minnesota, which indicates that the plants heretofore made in those streams have been successful.

The station force was occupied as usual during the summer months in overhauling the apparatus and painting the buildings. The low, marshy land at the south of the building was also filled in with gravel and stone, and protected from encroachments of the lake by a crib 198 feet long, 6 feet wide, and 3⅔ feet deep.

NEOSHO STATION, MISSOURI (WILLIAM F. PAGE, SUPERINTENDENT).

The work of the station was directed by W. F. Page until April 4, when the foreman, L. E. Baldridge, was placed in charge. A special appropriation of $1,000 having been provided in the deficiency bill for 1896, the money was expended in building an addition to the hatchery 18 feet by 18 feet, similar in style to the main building, and equipped with 6 hatching-troughs. By this change the capacity of the hatchery has been increased over 50 per cent. Bass ponds Nos. 11 and 12 were improved by substituting brick and cement standpipe and kettles in place of old wooden ones, and the wooden outlet flumes were replaced by terra-cotta pipe. The trout pools, formerly constructed of wood, were remodeled and rebuilt with brick walls and concrete flooring.

The regular force was utilized in making various other improvements, including repair and painting of the annex, graveling the walks, miscellaneous repairs to the remainder of the ponds, and the construction of a blind ditch from the cellar of the superintendent's residence to the branch. This ditch was rendered necessary by the frequent flooding of the cellar during the fall and winter after heavy rains.

At the beginning of the fiscal year there were on hand at the station the following fish:

Species.	Calendar year in which fish were hatched.			
	1896.	1895.	1894.	1892 or before.
Rainbow trout	87,448	2,000	487	336
Black bass	20,000	.....	.....	60
Rock bass	.....	.....	.....	82
Strawberry bass	.....	.....	.....	46
Tench	110	.....	.....	23
Total	107,558	2,000	487	547

The fry were held through the summer in troughs and ponds, as heretofore, and distributed during September and October.

Rainbow trout.—The stock of breeders on hand at the opening of the spawning season consisted of 1,700 two-year-old trout derived from eggs shipped from California and 790 fish hatched in 1892 and 1894. The spawning season extended from December 17 to February 11, and resulted in the collection of 578,460 eggs, 509,557 of which were from the old breeders. Only 58 per cent of the eggs from the California fish were fertilized, but this is not surprising, as experience has shown that only about half the eggs taken from very young fish are of value.

The shipments of eggs aggregated 229,125, of which 96,200 were

donated to the Nevada and Wyoming commissions. The balance were transferred to the Duluth, Manchester, Leadville, and Northville stations, and with the exception of one consignment to Duluth they were received in excellent condition. In shipping eggs hay was used for the outside packing around the crates, owing to the scarcity of sphagnum moss in the vicinity of the station. The rest of the season's take were hatched and 27,000 fry were distributed during the month of May; the remainder were retained for distribution in the fall, and at the close of the year they numbered 90,725. A slight epidemic occurred among them in May, but it was checked by the liberal use of salt.

Black bass.—The output of yearling bass in the fall, amounting to 15,660, exceeded that of any previous year by 36 per cent. The fry were reared in troughs and fed on finely grated crawfish collected from the ponds at the station. The brood stock of this species was increased to 134 by the transfer of two consignments from Quincy—one in November and one in March—and on April 6 they were distributed in four of the ponds, which had been provided with gravel for nest-building. On April 20 evidences of nesting were observed, and the first fry appeared May 19. Owing to the unusually cool weather prevailing during the spawning season and to an insufficient amount of natural food in the ponds, the crop of fry at the close of the year is very small.

Rock bass.—The rock bass were also reared in troughs and fed on crawfish through the summer, and the output in the fall amounted to 33,390. Early in the spring artificial nests, similar to those in use at Wytheville, were introduced in the rearing-ponds, but the fish refused to occupy them. On April 20 they commenced nesting in the gravel, within a few feet of the artificial nests, and continued until June.

Crappie and strawberry bass.—As a result of the previous spring's spawning 10,000 young fish were collected from the breeding-ponds early in the fall. They were very small and weak, however, and, though great care was exercised in handling them, the majority died, leaving only 3,129 available for distribution. Experience has shown that the young of this species can not be handled with the same freedom as can the young of the black and rock bass.

On the 30th of August 80 adult crappie were transferred to the station from Quincy, but a number of them died during the winter, and by April only 73 breeders remained. These were placed in the ponds on April 16, and at the close of the year a number of fry were observed, though no nesting or spawning had been noticed among them.

The following table shows the maximum, minimum, and mean temperatures to which the various species were subjected during the year:

Species.	Maximum.	Minimum.	Mean.	Remarks.
	° F.	° F.	° F.	
Rainbow trout	78	46	58.2	
Black bass	94	38	59.2	Ice in December.
Rock bass	82	41	58.2	
Strawberry bass	89	46	61	
Tench	88	57	70	

The following table shows the air temperatures and the amounts of rain and snow, as recorded by months:

Month.	Mean.	Max.	Min.	Precipitation.	Snow.	Month.	Mean.	Max.	Min.	Precipitation.	Snow.
1896.						1897.					
July	78.4	94	53	3.51	.....	January	32.9	69	—4	4.20	2
August	79	102	50	2.20	.....	February	31.3	73	11	3.47	Trace.
September	68.9	93	39	4.44	.....	March	51.5	93	22	5.65	.....
October	57.9	83	29	3.63	.....	April	57.5	81	30	3.58	.....
November	59.3	77	10	3.70	Trace.	May	62.6	85	32	1.73	.....
December	41.5	70	12	.44	Trace.	June	73.8	92	41	5.38	.....

In addition to thousands of pounds of crawfish removed from the ponds, the following enemies of fish were killed: 35 snakes, 18 turtles, 1 egret, 12 kingfishers, 1 grebe, 10 ducks, 2 fishhawks, 7 bitterns, 9 musk-rats, 6 water-rats, and 2 water-hens.

SAN MARCOS STATION, TEXAS (JOHN L. LEARY, SUPERINTENDENT).

Work on the ponds was sufficiently advanced to permit of the reception of brood fish in December. From December 12 to March 23 collections of crappie, black bass, and rock bass were secured from the surrounding streams, 200 rock bass being taken from San Marcos River, and 281 large-mouth black bass from the San Marcos and the Blanco River, 3 miles distant. The crappie were obtained from York Creek and from the Colorado River near Austin. Several hundred of these fish were secured; but as it was necessary to haul them over 18 miles of rough road, thence 36 miles by rail, all but 199 of them perished before reaching the station. The muddy state of the water also augmented the loss.

The black bass were placed in three ponds and commenced spawning on February 10, the time when they were seen nesting in the river. Nesting continued at intervals until June 1. Contrary to their habits in the Eastern States, the large-mouth black bass in Texas deposit their eggs on the clay, first sweeping away the moss and weeds with their tails. To thoroughly test this matter, patches of gravel and artificial nests were placed in the ponds, but in no instance were they accepted, and observations disclosed the fact that all of the bass in the San Marcos River deposit their eggs on clay bottom.

As soon as the fry had attained sufficient size they were transferred from the breeding to the rearing ponds by the use of dip nets and of small seines made of mosquito netting. The food furnished consisted of crawfish, the flesh and roe of the mullet, and beef liver finely chopped. An experiment was made in feeding the salted roe of the cod, but it was not readily taken. As they increased in size the fish were fed on such minnows as could be captured in the vicinity; the young of the mud shad seemed to be the most acceptable. With the view to providing a supply of live food an attempt was made to rear young carp. As only a small number could be secured, however, 42 buffalo-fish were substituted, but the results were not successful. Mud shad proved better adapted for

this purpose, and as they are vegetable feeders they can be placed in the nursery ponds to spawn, thus obviating the necessity of transferring the young. In addition to this they give up their eggs freely and can be hatched artificially if necessary.

The heaviest losses from cannibalism occur during the first four weeks of the life of the young bass. This is probably due to an insufficient amount of natural food, such as minute crustaceans and insects, as it is impossible to provide them in adequate quantities where large numbers of fry are confined in a limited area, though they thrive in abundance under natural conditions. As soon as a length of 2 or 3 inches has been attained this difficulty is partially overcome, as they can be readily fed on the fry of other fishes or on chopped food. To show the extent of loss by cannibalism the following illustration is given: 5,000 bass less than an inch long were placed in a pond 16½ feet by 50 feet and given careful attention.. In 20 days 90 per cent of them had disappeared. This loss must be ascribed solely to cannibalism, as, the water being perfectly clear, the destruction of the fish by such insects as the boat-fly could not have escaped observation.

The growth of the young bass was very rapid, all of them averaging 3 inches and a number 5 inches in length by May 1; 100 of them, retained until the following October, measured over 8 inches. Their rapid growth and the difficulty of securing a sufficient supply of food rendered it necessary to commence distribution in May, and by the end of June 11,700 had been furnished to applicants in Texas.

The rock bass and crappie have shown no signs of spawning up to the close of the year, and it is doubtful whether any results will be realized from them this season. It is probable that they were transferred too late in the year for spawning.

On June 30 the following fish remained on hand:

Species.	Adults.	Yearlings.	Fry.
Black bass	101	180	12,000
Crappie	99	105	.....
Rock bass	200	.....	.....
Carp (scale and mirror)	24	400	.....
Mud shad	8	.....	.....
Total	432	685	12,000

During the excavation of the ponds many human and animal bones were unearthed. These were found in heaps in many instances, and when exposed to the air they crumbled to pieces. Many implements of stone were found, but none of metal. The bulk of this material has been forwarded to the U. S. National Museum, Washington, D. C.

The artesian well maintained a steady flow of over 1,000 gallons per minute throughout the year, at a regular temperature of 72°. The minimum temperature of the water in the ponds during the winter was 61°, in summer 76°. The minimum temperature of the air, in January, was 18°; the maximum, in August, was 101°.

LEADVILLE STATION, COLORADO (E. A. TULIAN, SUPERINTENDENT).

At the beginning of the fiscal year the stock of fish on hand was as follows:

Species.	Calendar year in which fish were hatched.		Eggs.
	1896.	1892.	
Brook trout	137,000	566	.....
Loch Leven trout	11,780	118	.....
Rainbow trout	24,500	.....	44,900
Black-spotted trout	29,000	40	57,900
Yellow-finned trout	.....	.....	15,100

The fish were held in the troughs and rearing-ponds until fall, when the following distribution was made: Brook trout, 94,000; Loch Leven trout, 500; black-spotted trout, 42,200; native or yellow-finned trout, 7,931; rainbow trout, 25,500.

Besides caring for the fish on hand, the employees of the station were engaged during the summer in making a number of improvements, embracing the construction of a flume between the middle and lower lakes, installing troughs in the northern half of the hatchery, which had not previously been in use, and making a number of minor repairs to the various cabins and log buildings.

Brook trout.—Prior to the opening of the spawning season arrangements were made as usual with the owners of Uneva, Wellington, Young, and Decker lakes, Gale and Smith ponds, for the collection of eggs on shares. Lower and Middle Evergreen lakes were also drained and the fish belonging to the Commission removed and placed in ponds near the hatchery. The first eggs were obtained from them on October 7 and the last on December 24, the total take aggregating 418,000. The large loss on these during incubation, amounting to 174,000, or nearly 42 per cent, was attributed to the removal of the fish from the lakes to the ponds too early in the season. The eye-spots appeared within 50 days and the first fry hatched at the end of 93 days. The season at Uneva Lake extended from October 21 to December, and resulted in a collection of 186,600, 6 per cent of which were lost in hatching. The spawning season at Gales Pond covered the same period, and 281,900 eggs were secured. The loss during incubation was 34 per cent, which, though large, was smaller than that of the previous year, when the fish were overfed. In addition to this, a spawning-house had been provided, so that the eggs were not subjected to intense cold, as heretofore.

At Smith Pond the collections aggregated 109,700, and the loss in hatching was 11 per cent. At Ridgeway the fish had to be stripped out of doors during very cold weather, and as a result only 74,000 eggs, of very poor quality, were obtained.

The season at Wellington Lake opened November 5 and continued to the middle of December. The difficulties previously encountered at that point were largely overcome by the erection of suitable shelter and the

exercise of great care in the transportation of the eggs over the rough mountain roads from the lake to the railroad station. Only 13 per cent of the 493,700 taken were lost. At Decker Lake 511,500 eggs were taken, but, owing to the fact that the fish were very closely confined in retaining vats during extremely cold weather, 55 per cent of the eggs and 20 per cent of the fry were lost. At the time the last lot of eggs were taken the thermometer registered 20° below zero in the cabin where operations were being conducted; the eggs froze to the pans and the fish died within a few minutes after being handled. The eggs taken at Young Lake yielded 57,615 fry, or 80 per cent of the number collected.

During the winter 190,000 trout eggs were shipped to the various State fish commissions, private individuals, and stations of the United States Commission. The balance were hatched, and on May 1 there were at the station 1,021,200 fry, 479,000 of which belonged to private parties. Owing to very cold weather throughout the spring, they did not commence taking food until they were about 80 days old.

In order to make room for the eggs of the rainbow, black-spotted, and yellow-finned trout, 287,000 of the fish belonging to the Commission were distributed in May and June to applicants in Colorado. The losses during this period amounted to less than 2½ per cent, and at the close of the year there were 241,465 on hand.

Rainbow trout.—The stock on hand at the beginning of the year was derived from collections made at Twin and Uneva lakes during the previous spring, and in September, when the fish were distributed, the output amounted to 25,500. In February a consignment of 44,000 eggs was received from Neosho. The loss during incubation was only 10 per cent, but the fry were very weak and such large numbers of them died during the sac stage that there were only 2,000 available for distribution in the spring. Collections of eggs were again made at Twin and Uneva lakes in May and June, 54,000 being secured from both sources. The spawning season opened on May 10, and the eggs commenced hatching in 27 days, the eye-spots appearing in 13 days. The losses during incubation amounted to 27 per cent, and at the close of the year there were 25,370 fish and 8,000 eggs on hand.

Yellow-finned trout.—When the general distribution was made in September the output of the species amounted to 7,931. Collections of eggs were made during the following May at Twin Lakes, and as a result there were 8,480 fry on hand at the close of the year. The losses during incubation amounted to 3,920.

Black-spotted trout.—The use of the State trap and hatchery at Twin Lakes having been tendered the Commission by the State authorities, arrangements were made to conduct operations there on a larger scale than heretofore, but as it was necessary to keep a man on watch constantly to prevent the theft of the fish and the destruction of the trap, the results were not commensurate with the expense involved, though they were better than in previous years. A collection of 167,000 eggs was made at Freeman Lake in June, and 5,200 were secured from the

fish at the station. These, with the take at Twin Lakes, made an aggregate of 498,900. A consignment of 5,000 of these eggs was sent to Nashville in June and arrived in excellent condition, only 9 of them being dead when unpacked. They were hatched at the exposition during July with comparatively no loss. The losses on the balance of the stock amounted to 39,300, or nearly 8 per cent, and on June 30 there were 164,780 fry and 289,820 eggs on hand. In view of the poor results attained at Twin Lakes this year it has been decided to depend on Freeman Lake and on such collections as can be made from the stock at the station, for the supply of black-spotted eggs in future.

BOZEMAN STATION, MONTANA (JAMES A. HENSHALL, SUPERINTENDENT).

This station is located on Bridger Creek, in the Gallatin Valley, and is 3½ miles from the city of Bozeman. Its water supply is obtained from two springs, the combined volume of which varies from 1,200 gallons in wet weather to 500 in the dry season; the temperature of the water is 45°, and it is always clear. The superintendent, James A. Henshall, was appointed on the 1st of January and reported for duty on the 11th of that month.

During the winter 25,000 brook trout eggs were received from Leadville and 100,000 steelhead eggs from Fort Gaston. The fry resulting from them were transferred to the rearing-ponds in April and May, and at the close of the fiscal year the brook trout numbered 14,111 and the steelheads 84,858. Besides caring for the eggs and fry, the station force was employed during the winter and spring in completing the roadways, repairing damage done to the ponds by frost, grading around the buildings, and other miscellaneous work.

In the spring arrangements were made to collect eggs from wild black-spotted trout, which were said to spawn during June and July. From information gathered from residents in the locality it was believed that large numbers could be secured at Mystic Lake (about 16 miles from Bozeman, in the mountains), but owing to the impassable condition of the roads the superintendent was delayed until June 12 in making the inspection. This lake is 30 acres in area, has a depth of 100 feet, and is fed by two ideal spawning-streams with gravelly bottoms. Numbers of spawning-beds were found, and it was decided to return at once with the necessary outfit. Owing to heavy rains, however, the return trip was not made until June 17, when it was found that the spawning-beds had been flooded through the raising of a dam by an irrigating company. A few fish were taken in the small holes near the outlet of the lake, and 10,000 eggs were secured.

As trout were reported to occur in great numbers in Soda Butte Lake, in the northwestern section of the Yellowstone Park, an effort was made to collect eggs there in July, but none were obtained, as it was found that the fish there, as in Mystic Lake and other waters in the vicinity, spawn much earlier than has been commonly believed. It is thought that large numbers of eggs can be obtained at both these

points in future, but it will be necessary to construct temporary hatcheries, so that eggs may be eyed before being transferred to the station.

BAIRD STATION, CALIFORNIA (LIVINGSTON STONE, SUPERINTENDENT).

Early in July the rack to prevent the ascent of the salmon was completed and a wagon and foot bridge was built across the river. A new current-wheel, spawning-house, salmon corrals, etc., were constructed by the station force.

The first ripe salmon were captured on August 21, and eggs were taken daily from that time to September 16, the total collection aggregating 5,000,000. These were held until the eye-spots appeared, when they were shipped to the State hatchery at Sisson, Cal. The last of them were disposed of by October 20, and as it had been decided not to make collections from the late run of salmon arrangements were made for the transfer of a large part of the equipment and the force to Battle Creek Station. During December over 2,000,000 salmon eggs were forwarded to Baird from that station, to be hatched and liberated in McCloud River. To prevent the crowding of the troughs, 1,000,000 of the fry were liberated in January; the remainder were divided into four lots and experiments were tried for the purpose of determining what preparation of food would produce the best results. The first lot was fed on liver exclusively, the second on a mixture composed of three parts liver to one of mush, the third on equal parts of mush and liver, and the fourth on three parts mush to one of liver. The fish fed on liver exclusively were found to exhibit a marked superiority in size and strength over those fed on the mixtures, but there was very little difference in the condition of the three lots fed on liver and mush in varying proportions.

Early in June the work of commencing a new rack and bridge for the coming season was undertaken, and the indications point to a very large run of salmon.

The following tables show the daily take of salmon, the daily collection of eggs, and the maximum, minimum, and mean temperatures of air and water, by months:

Date.	No. of eggs taken.	No. of males taken.	No. of females taken.	Ripe females.	Date.	No. of eggs taken.	No. of males taken.	No. of females taken.	Ripe females.
1897.					1897.				
Aug. 22	.....	204	75	36	Sept. 6	277,500	62	68	54
23	184,000	107	109	29	7	221,000	73	72	56
24	81,600	162	98	33	8	211,900	56	63	46
25	320,000	158	102	24	9	212,100	61	62	43
26	129,100	123	66	13	10	198,700	75	74	43
27	50,400	106	70	17	11	162,000	50	76	46
28	144,650	185	107	35	12	171,350	26	33	20
29	227,550	253	176	52	14	169,325	43	54	41
30	154,300	156	72	10	15	125,075	13	18	15
31	185,200	258	138	40	16	144,900	22	31	14
Sept. 1	198,200	166	96	56	17	.....	24	27	24
2	318,950	153	120	70	18	.....	3	5	5
3	351,700	141	135	70	20	133,000	.....	.....	.....
4	445,000	134	131	96					
5	377,400	115	83	66	Total..	5,196,700	2,989	2,170	1,063

Temperatures.

1896.	Air.			Water.			1897.	Air.			Water.		
	Max.	Min.	Mean	Max.	Min.	Mean		Max.	Min.	Mean	Max.	Min.	Mean
July	99	53	66.9	60	55	58	January ..	69	24	44	47	42	44.6
August	96	50	74.6	58	53	56.5	February .	71	26	44.3	49	41	45.4
September .	94	45	68.6	58	48	53.3	March	62	22	44.4	49	41	42.2
October	91	38	60.6	54	45	50.4	April	85	29	58.9	52	45	50.1
November .	62	24	47.6	52	41	46.1	May	96	45	67.8	57	49	53.3
December ..	71	32	46.3	49	43	44	June	94	43	64.1	59	50	56.2

BATTLE CREEK STATION, CALIFORNIA (JOHN P. BABCOCK IN CHARGE).

Recognizing the necessity for increasing the output of quinnat salmon on the Pacific Coast, the Commissioner arranged to erect a hatchery on lands controlled by the California Commission on Battle Creek; also to take charge of and operate the hatchery erected by the State commission the previous year, in accordance with the following agreement:

This agreement, made this 20th day of October, A. D. 1896, by and between J. J. Brice, of Washington, D. C., acting for and in behalf of the United States Commission of Fish and Fisheries, of the first part, and H. F. Emeric, of San Francisco, Cal., acting for and in behalf of the Board of Fish Commissioners of the State of California, of the second part, witnesseth:

That the said party of the second part does hereby agree to take charge of and assume the entire control and management, under the personal supervision of Chief Deputy Babcock, of the spawning station located on the land of F. R. Love, at Battle Creek, State of California; and, in the name of the United States Commission of Fish and Fisheries, operate the hatcheries at said Battle Creek to their fullest capacity.

The said party of the first part does hereby agree to pay all the operating expenses, including the salaries and wages of all men employed, from October 1, 1896, until the close of the season's operations at said Battle Creek.

The said party of the first part also agrees to deliver to the said party of the second part that amount of eyed salmon spawn which the said party of the second part may be able to hatch at the Sisson hatchery.

The hatchery built by the United States Fish Commission has a capacity for about 18,000,000 eggs, and is a one-story frame building, 144 feet long by 40 feet wide, lighted by skylights in the roof and shuttered windows in the sides and ends. It contains two distributing-troughs and 92 hatching-troughs, one-half of which are 16 feet long by 16 inches wide and 6½ inches deep and the other half 16 feet long by 12 inches wide and 6½ inches deep. The troughs are arranged in sections of four, securely bound together, two of them abutting against the distributing boxes, from which they take their supply of water and carry it to the two below. At the head of each hatching-box is a tin aerator, 10 inches by 4½ inches, with perforated bottom. Each trough has a capacity for 200,000 eggs, and the supply of water admitted to each is 24 gallons per minute.

Mr. J. P. Babcock, of the California Commission, was placed in charge of the work, and arrangements were made to operate the station to its fullest capacity. The first eggs were taken October 20 and the collection continued till November 23, when the retaining-racks were carried

away by high water. The entire take amounted to 25,852,880, and there is little doubt that more would have been secured had the rack not been destroyed. The total cost of operating the station for the season, including the construction of the hatchery, was $7,382.56.

The water supply for the station is taken from a creek three-quarters of a mile distant, and as it gathers considerable sediment on its way to the hatchery the eggs were transferred, as soon as the eye-spots appeared, to the California State hatcheries and the hatcheries of the U. S. Fish Commission.

The following shows the disposition made of them:

Where shipped.	Number shipped.
California Fish Commission, Sisson, Cal.	13,645,000
U. S. F. C. car No. 3, for eastern stations	5,150,000
Baird Station	2,000,000
Clackamas Station	3,000,000
Olema Experimental Station, California	750,500
Total	24,545,500

The daily take of eggs and capture of fish is shown by the following table:

Date.	No. of ripe fish taken.	Fish spawned.	No. of eggs taken.	Daily loss of eggs in hatchery.	Temperature of water in hatchery. Lowest.	Highest.
					° F.	° F.
Oct. 18	18	.....	.....	.....	.....	.....
19	10	.....	.....	.....	.....	.....
20	.....	28	155,000	.....	54	57
21	15	15	57,500	.....	52	56
22	.....	.....	.....	3,125	52	56
23	.....	.....	.....	.....	52	55
24	32	32	184,750	.....	52	55
25	.....	.....	.....	3,125	52	54
26	82	42	219,880	1,565	52	53
27	89	101	495,000	3,125	51	55
28	168	163	800,000	6,250	50	55
29	119	119	542,500	14,060	52	56
30	159	159	780,000	13,270	51	55
31	173	173	935,000	17,190	53	56
Nov. 1	216	216	1,095,000	19,280	49	53
2	167	167	900,000	18,500	50	54
3	215	215	1,190,000	15,625	49	52
4	199	199	1,115,000	15,625	48	52
5	156	156	800,000	16,400	49	52
6	227	227	1,187,500	13,280	48	51
7	238	238	1,340,000	15,625	48	52
8	244	244	1,318,750	25,000	51	53
9	253	253	1,385,000	25,000	54	54
10	269	269	1,392,000	15,625	51	52
11	144	144	740,000	31,250	48	53
12	128	128	680,000	37,500	45	50
13	236	236	1,265,000	37,500	46	50
14	156	156	807,500	32,030	48	50
15	206	206	1,047,500	28,910	50	53
16	194	.....	.....	28,910	53	55
17	58	252	1,210,000	31,250	53	54
18	166	166	750,000	28,125	52	54
19	225	225	1,110,000	38,280	50	51
20	80	80	412,500	29,680	50	51
21	137	137	710,000	37,250	51	51
22	151	151	820,000	41,410	51	53
23	71	71	407,500	41,410	49	50
Nov. 24	.....	.....	.....	19,530	49	50
25	.....	.....	.....	45,025	46	48
26	.....	.....	.....	25,500	43	46
27	.....	.....	.....	43,750	43	46
28	.....	.....	.....	37,500	42	44
29	.....	.....	.....	25,780	41	44
30	.....	.....	.....	18,500	43	46
Dec. 1	.....	.....	.....	25,000	46	49
2	.....	.....	.....	37,500	49	51
3	.....	.....	.....	32,030	48	51
4	.....	.....	.....	37,500	49	52
5	.....	.....	.....	18,750	49	51
6	.....	.....	.....	18,750	48	50
7	.....	.....	.....	15,625	46	50
8	.....	.....	.....	21,850	46	49
9	.....	.....	.....	15,625	46	50
10	.....	.....	.....	18,750	49	51
11	.....	.....	.....	15,625	50	51
12	.....	.....	.....	18,750	51	52
13	.....	.....	.....	15,625	50	50
14	.....	.....	.....	15,640	49	49
15	.....	.....	.....	12,500	48	49
16	.....	.....	.....	12,500	47	50
17	.....	.....	.....	18,750	47	49
18	.....	.....	.....	15,625	46	49
19	.....	.....	.....	9,375	46	49
20	.....	.....	.....	9,375	47	49
21	.....	.....	.....	9,375	45	48
22	.....	.....	.....	3,125	45	48
23	.....	.....	.....	3,125	45	48
24	.....	.....	.....	1,560	46	49
25	.....	.....	.....	780	47	49
26	.....	.....	.....	2,260	48	50
27	.....	.....	.....	1,560	49	50
Total.	5,001	4,908	25,852,880	1,308,290	.....	.....

With the view to testing the advantages to be derived from planting fry near the ocean, arrangements were made for hatching 750,000 of the eggs collected at the State experimental station at Olema, Cal. They were shipped on December 31, and the resulting fry were planted during February and March in Dutch Bill, Boccacio, Olema, and Bear Valley creeks. Their movements were carefully noticed by Messrs. A. B. Alexander and N. B. Scofield.

CLACKAMAS STATION, OREGON (W. F. HUBBARD, SUPERINTENDENT).

The superintendent was occupied during a portion of the summer in examining a number of tributaries of the Columbia River, with the view to establishing auxiliary stations, to be operated in connection with the station on the Clackamas. As a result of his investigations, arrangements were made for the collection of eggs on the Salmon River, a tributary of the Sandy, and on the Little White Salmon, emptying into the Columbia above the Cascades, in the State of Washington. The collections on the Snake and Sandy rivers the previous year were so small that it was decided not to operate at those points again.

Early in July the station force commenced the construction of a rack 330 feet long across the Clackamas River. Great difficulty was experienced in this undertaking on account of the extensive rafting of logs and wood from points above, but arrangements were finally made with the lumbermen to provide a boom, and a gate was built in the rack to permit of the passage of the material. The rack was completed on July 18, and the force was utilized during the remainder of the summer in making repairs to the boats and fishing apparatus, building a trap for the capture of spawning fish, and laying a new floor in the hatchery. The collection of eggs from the fish below the rack was commenced on September 11, and operations were continued until October 31, the total take amounting to 1,062,500. On that date a part of the rack was carried away by a rise in the river, and, as it was late in the season and there appeared to be very few fish below the rack, no attempt was made to repair it.

The results of the season's work were very discouraging, as the traps and seines had been worked night and day, and gill nets had also been fished on the riffles below, where a few salmon were observed spawning.

Early in November the volume of the spring brook was so increased by heavy rains that the pumps were discontinued and the supply for the hatchery taken from that source. Considerable damage was done to the station during the month by high water. The bridge across Clear Creek was carried away on the night of November 8, and on the 13th the river rose 13 feet above its normal level, carrying away the plank breakwater built in 1877, covering and greatly damaging the land about the station, and flooding the hatchery so that a boat could be brought into the door.

Shipments of eggs aggregating 2,340,000 were received from the Salmon River station between September 11 and October 6. The fry

resulting from them appeared strong and healthy until they were about two weeks old, when a large number of them were affected by a disease which had never occurred at the station before. Its first indication was the appearance of a small white spot on the yolk-sac, followed by an unnatural position of the fish in swimming, the body being held perpendicular with the head near the surface of the water. As soon as death resulted the yolk-sac would burst. All the fish affected in this way were liberated as soon as possible.

About the middle of December a consignment of 3,000,000 salmon eggs was transferred from Battle Creek, California, being shipped by rail to Oregon City and thence to the station by wagon. The eggs arrived in excellent condition, and by January 25 they had finished hatching. All but 500,000 of the fry were liberated, just before the absorption of the sac, in Clear Creek and on the natural spawning-grounds of the salmon in the Clackamas River, within a range of 2 miles up and down stream. Those retained at the station were fed on finely chopped beef liver and on chopped fish when liver could not be obtained. The rate of growth was rapid. On March 10 the total weight of 1,000 of them was 1¼ pounds, and on May 31, when the last of them were planted, the weight of the same number was 3 pounds. They were liberated in small lots from time to time during the month of May, and the total loss on the 500,000 retained amounted to 11,400.

The only serious loss in addition to the mortality resulting from the disease referred to above occurred on November 26. There were in the hatchery at that time 600,000 fry in excellent condition when the watchman left the building at 5 p. m. On the arrival of the superintendent two hours later all of them were dead. As no one had access to the building and as the water supply was in free operation it was evident that some poisonous substance had been introduced into the water before it entered the hatchery, by some ill-disposed person.

Specimens of the dead fish examined by a chemist in Portland showed the presence of lime and salt. Salt, except in large quantities, is not injurious to fry, but experiments by the superintendent proved that young salmon in flowing water can be killed in a very short time by the introduction of limewater or small pieces of fresh lime.

During the spring the wagon bridge across Clear Creek was rebuilt, and the mess-house and fences, which had been damaged by high water during the previous winter, were repaired.

Salmon River Station.

The site selected for the establishment of the auxiliary station was on a small island in the middle of the Salmon River, about 35 miles from Clackamas Station by wagon road. As the salmon spawn in that river much earlier than in the Clackamas, the rack was put in during the latter part of June and arrangements were made with Mr. J. J. Pankey to furnish ripe salmon at 50 cents each. Immediately after the completion of the rack an open shed was erected, the necessary

troughs were provided, the trap was built below the rack for the capture of the fish, and a flume was laid from a small brook near by, from which the water supply was obtained by gravity. Salmon appeared in large numbers in July, and a few were observed spawning the latter part of the month. The first eggs were obtained on August 11, and the collections were continued until September 12, during which time 2,600,000 were secured from 492 females; 2,340,000 of them were transferred to Clackamas, and the remainder were hatched and liberated in the Salmon River during the month of November. The supply of water failed during the season, and it became necessary to place part of the hatching-troughs in a narrow channel, where they were supplied with water conducted through a short flume from the bottom of the river. Wooden covers were provided for each trough to protect the eggs, and canvas, stretched on poles, shaded them from sunlight. The heavy rains in November caused a freshet in the river, which necessitated the removal of the hatching apparatus to higher ground.

LITTLE WHITE SALMON RIVER STATION, WASHINGTON.

After the examination of a number of localities on the Columbia and its tributaries by Prof. B. W. Evermann, two sites were recommended for establishment of auxiliary stations, one on the Washington shore of the Columbia opposite the Cascades, and the other just below Celilo, on the Oregon side. At the Cascades Mr. George Stevenson, of Vancouver, offered to furnish all the fish required free of charge, with the free use of the land and water controlled by him, and a house for the employees. It was proposed to capture the fish by means of scow wheels and hold them until ripe in a narrow channel between the island on which the wheels are located and the main shore. The superintendent was instructed to make the necessary arrangements, but before undertaking the work an attempt was made to transfer the fish from the wheels to the channel. The results attained were so poor that the site was abandoned. The question of establishing a station at the other site, near Celilo, was also considered, but it was given up as impracticable, in view of the fact that it would be necessary to transfer the fish some distance from the seines to the retaining pond.

As it was believed that the streams in the vicinity of the Cascades afforded the principal spawning-grounds of the quinnat salmon, further investigations were made, and as a result the Little White Salmon was favorably reported on by the superintendent and Mr. Evermann. This stream empties into the Columbia about 14 miles above the Cascades, and the point selected for the establishment of the station is about a half mile from its mouth. Immediately after the site had been chosen, steps were taken to erect a rack across the river and to construct a hatchery and a mess-house for the men. Mr. W. P. Sauerhoff, who had been detailed to assist the superintendent, arrived on the grounds by September 21, and by September 26 work had progressed far enough to commence the collection of eggs. Eggs were taken daily

from that time to October 14, a total of 2,179,000 being secured from the 427 females handled. During the season the salmon appeared in such large numbers below the rack that the Indians often captured two and three at one cast of the spear; many were also observed above the rack, having ascended before it was constructed.

In view of the fact that the work of construction at this point was not undertaken until September 15, when the spawning season had already commenced, the results secured were considered excellent. Had the station been established earlier in the season, there seems little doubt but that seven or eight million eggs might have been collected. The lands on which the station is located are owned by an Indian, Joe Thomas, and steps are now being taken by the Government to lease it. The total cost of operating at this point, including construction of hatchery and outbuildings, amounted to $2,288.27. The hatchery was a rough wooden structure without a floor, lighted by skylights above and unglazed windows in the sides and ends. It was equipped with 50 troughs, and the water supply was obtained from a brook a short distance away. The other buildings consisted of sleeping quarters and a mess-house for the employees. At the close of the collecting season the trough room was found to be insufficient, and additional troughs were erected outside for holding the fry.

Owing to heavy rains on November 15, the water in the brook from which the supply was obtained became so muddy that it was necessary to discontinue using it and to take the supply from the lumber company's flume. During this time the men were obliged to work night and day to keep the screens open and a supply of water flowing through the troughs. Snow commenced falling early in November, and by the 28th the thermometer had fallen to 13° above zero.

Mr. Sauerhoff was detached from the station on January 18 and J. A. Tolbert left in charge. The fry were all liberated between January 7 and February 15 in the Little White Salmon near Chenowith, Wash. At the close of the season the apparatus was stored in the bunk-house, and, as the grounds on which the station is located are liable to floods, the hatchery was weighted down with stone and placed in charge of a watchman, who was permitted to occupy the mess-house.

Siuslaw River Station, Oregon (L. E. Bean in charge).

Upon the recommendation of Dr. S. E. Meek, who was engaged in investigating the salmon streams in western Oregon, the Commissioner authorized the reopening of the hatchery on the Siuslaw River at Mapleton on a small scale. The owner tendered its use to the Commission without rental, and the fishermen agreed to furnish the necessary adult salmon on the fishing-grounds, about 26 miles below Mapleton, free of expense. An effort had been made to operate this station in 1895, but no results were secured, as the fish were all captured several miles below the rack by seines and gill nets. This season it was deter-

mined to transfer a stock of brood fish in live-boxes from the seining-grounds and hold them at the hatchery until they ripened. Several hundred salmon were collected at the seines and floated up to the station in this way, and from them 44 ripe females and 42 ripe males were saved. Between October 26 and November 16, 217,000 eggs were secured from these fish, and during the month of February plants of fry aggregating 180,000 were made on the spawning-grounds in the immediate vicinity of the station. The fry were observed from time to time during the spring by Mr. Bean, and numbers of small schools could be seen in the creeks where the deposits had been made as late as May. They appeared to be from 1 to 1½ inches long—not quite as large as a few which had been retained at the hatchery and fed. Observations were continued throughout the spring, but in June all of the fry disappeared from the upper parts of the creeks, and were apparently moving toward the mouth of the river.

FORT GASTON STATION, CALIFORNIA (CAPT. W. E. DOUGHERTY, SUPERINTENDENT).

This station was operated, as usual, for the collection of eggs of the chinook and silver salmon and the steelhead trout. A rack was constructed in Redwood Creek, and the first eggs were obtained on December 17. As a result of the season's work, 406,000 eggs of the chinook and silver salmon were secured, from which 405,000 fry were hatched and liberated in Redwood Creek during April and May. The spawning season of the steelhead trout commenced on February 7 and continued until April, 805,000 eggs having been secured from 179 brood fish. Of these, shipments aggregating 550,000 were sent to Bozeman, Craig Brook, Cape Vincent, St. Johnsbury, Northville, and Duluth stations, and one consignment of 50,000 was furnished to the New York Fish Commission. From the remainder of the collection 202,000 fry were hatched and liberated in Redwood Creek in June.

Owing to the increased demand for steelhead trout eggs in the East, the Korbel Station, which had been closed the preceding year, was reopened. The results attained at this point were very unsatisfactory, as work was seriously interfered with at the very height of the spawning season by high water, which did considerable damage to dams and racks. From the eggs collected 337,600 salmon and 55,640 steelhead trout fry were hatched and liberated in the Mad River during the month of June.