FISH CULTURE IN ALASKA.

By WARD T. BOWER,
Inspector, Alaska Salmon Fisheries.

THE HATCHERIES AND THEIR OUTPUT.

Of the seven salmon hatcheries operated in Alaska during the season 1910–11, two are owned by the Government and five by private companies. The present combined normal capacity of the Federal stations is 144,000,000 red salmon eggs, while of the private hatcheries it is 189,000,000, or a total capacity of 333,000,000 for all Alaska hatcheries. There has been no change in the number of stations operated since the completion of the Government hatchery at Afognak in 1908. The following table enumerates the hatcheries operated in 1911 and gives their present normal capacity:

SALMON HATCHERIES OPERATED IN ALASKA IN 1911.

Name.	Location.	Owner and operator.	Present normal capacity (red salmon eggs).
Yes Lake	Yes Lake	United States Bureau of Fisheries	72,000,000
Afognak	Afognak Island	do	72,000,000
Fortmann	Naha Stream	Alaska Packers Association	110,000,000
Karluk	Karluk River	do	48,000,000
Klawak	Klawak Lake	North Pacific Trading & Packing Co. and North Alaska Salmon Co.	8,000,000
Hetta	Hetta Lake	Northwestern Fisheries Co	11,000,000
Quadra	Quadra Lake	do	12,000,000
			333,000,000

As stated in subsequent pages, the basis for reckoning numbers of fish eggs is not the same at Government and private hatcheries. Accepting the figures as furnished, however, the output of the hatcheries during the fiscal year ended June 30, 1911, was in round numbers 190,000,000 eggs and fry, or a decrease of approximately 65,000,000 from the fiscal year 1910. However, the coming season will show much improvement, as the total take of 269,666,800 eggs during the fall of 1911 is 55,000,000 more than the take of 1910. In fact, the take of 1911 is only a few thousand less than the take of 1909, the largest recorded.

OUTPUT OF THE SALMON HATCHERIES OF ALASKA IN 1911, WITH QUANTITIES OF EGGS TAKEN IN 1911-12.

Hatcheries.	Year ended June 30, 1911.[a]				Eggs taken 1911-12.		
	Red or sockeye.		Humpback or pink.		Red or sockeye.	Humpback or pink	Coho or silver.
	Eggs taken.	Fry liberated.	Eggs taken.	Fry liberated.			
Yes Lake	72,000,000	[b] 68,239,900	114,000	(c)	[d] 72,000,000	.....	.....
Afognak	30,725,000	26,755,000	405,000	364,150	30,520,000	6,472,000	224,700
Fortmann	34,920,000	30,245,000	.....	.....	107,520,000	.....	.....
Karluk	49,626,000	37,722,000	.....	.....	41,026,800	.....	.....
Klawak	6,786,500	6,200,000	.....	.....	5,600,000	.....	.....
Hetta	9,141,000	8,552,500	.....	.....	2,000,000	.....	.....
Quadra	11,200,000	10,350,000	.....	.....	11,000,000	.....	.....
Total	214,398,500	188,064,400	519,000	364,150	269,666,800	6,472,000	224,700

[a] Any fry held over after June 30 are included to make the record complete by seasons.
[b] 1,500,000 sockeye eggs shipped to Columbia River waters.
[c] 100,000 humpback eggs shipped to Puget Sound waters.
[d] 2,000,000 sockeye eggs shipped to Columbia River waters.

HATCHERY REBATES.

Under existing legislation owners of private salmon hatcheries are relieved from all license fees and taxation at the rate of 10 cases of canned salmon for every thousand red or king salmon fry liberated.

The following table shows the name of the owner, location of each private salmon hatchery operated during the year ending June 30, 1911, the number of salmon (red) liberated, and the amount of rebate certificates due each hatchery; these rebate certificates being available to pay license fees on products prepared for market:

REBATES CREDITED TO PRIVATE SALMON HATCHERIES DURING FISCAL YEAR ENDED JUNE 30, 1911.[a]

Owners.	Location.	Red salmon fry liberated.	Rebate due.
Alaska Packers Association	Naha Stream	40,245,000	$16,098
Do	Karluk Stream	41,270,000	16,508
Northwestern Fisheries Co	Quadra Lake	10,350,000	4,140
Do	Hetta Lake	8,552,500	3,421
North Pacific Trading & Packing Co. and North Alaska Salmon Co.	Klawak Lake	6,200,000	2,480
Total	.....	106,617,500	42,647

[a] In the case of the hatcheries where the seasonal distribution of fry is not completed before July 1, the remaining fry are shown in the subsequent fiscal year's report.

HATCHERY EQUIPMENT AND METHODS.

Under this head it is intended to refer briefly to the more important features of the work at each station, both Government and private establishments. All of the five private hatcheries were inspected during the year by agents of the Bureau of Fisheries, and with the augmented force of the Alaska Fisheries Service, a contin-

uance of this plan of careful inspection is contemplated. As elsewhere stated, however, the whole question of private hatcheries in Alaska seems most satisfactorily met by their discontinuance as such, to be taken over and operated by the Government through the Bureau of Fisheries.

GOVERNMENT STATIONS.

YES LAKE.

Egg taking at Yes Lake is confined almost solely to the month of September. During the fall of 1910 and again in 1911 the hatchery was filled to its capacity of 72,000,000 red salmon eggs. It is noteworthy that the collection has been larger during the past two seasons than during the four prior seasons the station has been operated. This improved condition is considered as an indication of the benefits of artificial propagation. A few humpback salmon eggs have also been taken.

At Yes Lake the egg-hatching period continues from December until about the middle of April. Planting of the earlier fry is begun in February. All fry are deposited in the stream and lake near the hatchery. Last season the loss of eggs was about 5 per cent. Much of this was attributed to the extra handlings given the adult fish prior to spawning, handlings which could not be avoided owing to the unusually low water.

With a view to the infusion of new blood into Columbia River waters, two shipments of red salmon eggs were made from the Yes Lake station to Oregon. The first shipment of 1,500,000 was in the fall of 1910, and the second shipment, numbering 2,000,000, was made during the fall of 1911.

The feeding of red salmon fry on canned herring roe was undertaken in an experimental way but without success. The fish became very thin and emaciated and the loss was quite heavy. As soon, however, as they were fed Dolly Varden trout ground up raw, the young salmon did well, and by the first of September they were about 2 inches long. Before another season it is purposed to construct quite a number of additional troughs wherein to feed and rear a large number of salmon until they reach a length of from 1½ to 2 inches before being planted.

The rack across the stream near the station is upwards of 200 feet long. It is erected on a permanent apron embedded in the stream. All pieces are numbered and are so arranged when taken out in the fall that they will be in regular order for use when the rack is put in again the succeeding season. This plan greatly facilitates the operation, and it might well be adopted at other stations where it is not already in vogue.

During the year there has been considerable outlay at the station in the way of permanent improvements, including the erection of an additional building for housing the employees, also the construction of a retaining wall along the bank of the stream adjoining the hatchery grounds. The application of white paint to the interior of the hatchery, including the outsides of the troughs and the trough standards, makes the hatching room much lighter and more convenient to work in.

An order of the President dated February 1, 1906, set apart and reserved as a site for the Yes Lake salmon hatchery certain described land and water areas, including Yes Lake and its catchment basin, its outlet, and portions of the shore lands thereof, a total of approximately 55 square miles. In pursuance of this order, regulations were established prohibiting fishing operations in the reserved waters at all times other than when the run of salmon into the lake appeared to be in excess of the number required to fill the hatchery to its capacity. During the run of salmon each season a deputy is stationed on the bay to see that the regulations are observed.

Following are condensed meteorological data secured at the Yes Lake station during the fiscal year 1911:

METEOROLOGICAL OBSERVATIONS AT YES BAY.

Months.	Air.		Water.		Rainfall.
	Maximum.	Minimum.	Maximum.	Minimum.	
1910.					*Inches.*
July	74	51	53	41	5.48
August	70	41	58	43	5.66
September	66	40	55	47	9.39
October	51	32	47	37	20.43
November	41	13	39	32	11.69
December	39	14	35	32	15.84
1911.					
January	37	− 6	34	32	4.81
February	39	−10	32	32	2.21
March	45	17	34	32	6.70
April	53	22	37	32	10.15
May	56	37	40	33	5.93
June	65	44	44	35	5.99
Total					104.28

AFOGNAK.

From the 30,725,000 red salmon eggs collected principally during the month of August, 1910, a total of 26,755,000 fry were hatched, a loss of about 12 per cent. The planting of these fry in waters tributary to Afognak Lake continued into June, 1911. From 405,000 humpback eggs taken in August, 1910, plants of 364,150 fry occurred. The average number of eggs per female red salmon for the season as

determined by careful measurement was 2,411. The capacity of the station is approximately 72,000,000 red salmon eggs.

During the summer and fall of 1911 the collection aggregated 30,520,000 red salmon, 6,472,000 humpback, and 224,700 coho eggs. Several million of the red-fish eggs came from the field developed first in 1910 at Malina Lake, which debouches on the side of Afognak Island opposite the Litnik or Afognak catchment basin where the hatchery is located. It is necessary to transport the eggs overland several miles to the hatchery. The Malina fish are said to average larger in size than those running into Afognak Lake.

The cohos do not ripen until so late in the season that egg-taking on an extensive scale is out of the question, owing to the interference of ice. A noteworthy increase occurred this season in the take of humpback eggs. It is proposed hereafter to devote more attention to the propagation of this species of salmon. A station at an appropriate point, particularly in southeastern Alaska, would be a desirable acquisition. The establishment of a substation for red salmon eggs at Eagle Harbor on the south shore of Kodiak Island is under consideration.

A runway was blasted out in the falls of Afognak River, thus making it easier for the fish to ascend. A rack was also built across the river for the purpose of counting the number of salmon entering the lake. It is hoped to establish valuable facts concerning the life history of the salmon by these observations, which are contemplated for a series of years.

An interesting experiment was conducted at the Afognak station last season to determine the degree of ripeness producing the best quality of eggs. The loss on the lot taken from females which were dead ripe—eggs flowing very freely—was less than 1 per cent, while with another lot, where the females were ordinarily ripe upon testing in the usual manner, the loss was about 5 per cent. This shows the need of caution in having fish fully ripe before stripping if the highest degree of efficiency is to be expected.

The Afognak station was built in 1907, and as fry have been planted for only three seasons, it will hardly be time before another year to note any returns as a result of fish-cultural operations at this point. It has been generally conceded that the average life cycle of the salmon is four years, but the idea is gaining ground that it may be five years in the colder northern waters, where development would naturally be slower.

Afognak Island, including Sea Lion Rocks and Sea Otter Island, was set aside as a public reservation for fish-cultural purposes by presidential proclamation of December 24, 1892. Early in 1909 the Bureau gave the natives locally resident permission to take limited numbers of salmon, under the supervision of the station superintend-

ent, for their own use. This appeared to be an equitable recognition of the natives' privileges.

The following regulations governing the reserved waters were established and promulgated March 21, 1912, by the Secretary of Commerce and Labor:

1. No person or persons other than the natives of Afognak Island now resident thereon will be permitted to fish in the reserved waters.

2. Licenses for fishing will be granted to the said natives upon application to the Secretary of Commerce and Labor or such representative of the Department of Commerce and Labor as may from time to time be designated by the Secretary.

3. The kinds and amounts of apparatus to be used, the places where and the manner in which it may be operated, and the time when it may be employed, will be determined by the Secretary of Commerce and Labor and will be subject to changes or modifications from time to time at his discretion.

PRIVATE ESTABLISHMENTS.

FORTMANN HATCHERY.

The largest establishment in the world for hatching salmon is the Fortmann hatchery of the Alaska Packers Association, located some 8 miles from Loring. The capacity of the station is normally reckoned at 110,000,000. The older wing of the hatchery is 24 by 240 feet while the new wing is 32 by 280 feet. There are various smaller buildings for housing the employees and for other needful purposes. All buildings are lighted by electricity, and the hatchery is heated by steam. A well-equipped sawmill is a valuable part of the station's equipment, and a tramway several miles long establishes communication with navigable salt water. A telephone line is maintained to Loring, 8 miles, and thence 22 miles to Ketchikan.

The station is unusually well supplied with water, having four distinct sources, any one of which is sufficient ordinarily, barring accident, to meet all requirements. A pipe line to a series of springs about 3½ miles from the station is the most recent addition to the water-supply system, involving an outlay which has been quite heavy, because the contour of the country made necessary a number of extensive trestles in some places and deep cuts in others. Another supply is received by means of a flume one-half mile long from the creek near the hatchery. A third source is a series of small springs just back of the hatchery, and fourth, a large pump operated by steam draws water from a well near the creek.

A peculiar feature of the arrangement of the hatchery troughs is that they are placed end to end in series 13 and 15 troughs long in the old and new wings of the hatchery, respectively. In other words, the water passing in at the head flows through 13 troughs in the one instance and 15 in the other. Ordinarily, water is not conducted through more than 3 or at the most 4 troughs. The water at the

Fortmann hatchery is clear and as there is a fall of 8 inches between each two troughs for aeration, the eggs are undoubtedly as good at the foot of each long series as at the head, and much less water is required by this arrangement. There are 104 troughs in the old wing and 150 in the new, which at 7 baskets to the trough gives a total of 1,778 baskets. Each basket holds upward of 60,000 eggs, thus making the capacity easily 110,000,000 red-salmon eggs.

The eggs are taken by means of hand pressure, but this pressure is greatly modified, as one of the operator's fingers is inserted in the vent and tears it open for an inch or so. While practically all pressure is thus removed from the eggs, taking by the method of incision would insure further improvement both in quality and quantity. Unless an incision is made it is next to impossible to secure all the eggs, as a number that are fully developed will remain in the folds of the organs unless shaken out, which can be accomplished only by actually taking hold of the parts.

The number of eggs is determined by actual measurement in buckets of carefully determined capacity. Salt has not been used to assist in removing dead eggs. Were it used the crew for picking eggs could be reduced materially. Two nursery ponds each about one-half acre in extent receive the young salmon as they come from the hatchery. Additional nursery ponds have been laid out, also a plankton pond on which construction has been commenced. In the latter it is proposed to develop a growth of plankton to serve as food for the young salmon.

From August 27 to November 6, 1910, a collection of 34,920,000 red-salmon eggs was made. In 1911 fry were liberated therefrom to the extent of 30,245,000 or with a loss of 13.4 per cent, of which 10.64 per cent was on the eggs. All fry were liberated from the nursery ponds into the Naha Stream system.

During the period from August 26 to October 22, 1911, the splendid take of 107,520,000 eggs was made. This is the largest collection of salmon eggs ever taken at a single station. The nearest approach was the collection of 105,450,000 made in 1906, also at the Fortmann hatchery. The remarkably heavy runs in 1906 and again in 1911 afford further grounds for the belief in the 5-year rather than the commonly accepted 4-year cycle of the salmon's return. Additional evidence may be found in the recurrence of the two lightest takes of 22,203,000 in 1903 and 24,465,000 in 1908. The number of males handled this season was 40,425 and the number of females 44,266, giving an average of 2,429 eggs per female. This average is reported as rather low, quite a number of the females being partially spent before being stripped. The average for 1908 was 2,544, for 1909 it was 2,642, and in 1910 it reached 2,746. These averages seem rather low upon comparison with actual counts made this season of the eggs

from a number of specimens. The largest produced 5,362 while the smallest gave 3,203, the average being over 4,000. In view of the small number of specimens examined, these figures are not particularly significant as applied to an entire season's operations. In the light of past records it is improbable that the average of the fish actually stripped throughout an entire season will ever run much over 3,000.

That 1911 has been a very successful season is well set forth in a report from the Alaska Packers Association as follows:

> From the results of our season's operations at our Fortmann hatchery it is evident that the Naha Basin is responding to our hatchery's work, as the run of sockeye (red) salmon was larger than ever known in this vicinity. The full capacity of the hatchery was easily filled, and so numerous were the spawning salmon after the hatchery was filled that all the entering streams and lake spawning beds had all the sockeyes that could be massed over them. These spawning salmon even crowded into the flume used for conveying power and entered the ditch carrying the overflow from the nursery ponds. As an example of abundance, one small stream (Fence Creek) where we usually place a fence to hold the spawning salmon and where we generally take about 3,000,000 eggs, this year yielded over 43,000,000 eggs, and after the fence was removed such a large number of salmon entered that every foot of available spawning ground was covered with spawning fish.

The station is in operation throughout the year, the force varying from about 5 to 20 men. It has been roughly estimated that for several months of the season the crew will average one man to 4,000,000 eggs.

KARLUK.

From July 1 to September 15, 1910, the take of red-salmon eggs at Karluk was 49,626,000. During 1910 and 1911 fry were liberated therefrom in Karluk River to the number of 37,722,000, or with the rather heavy loss of 24 per cent. Of this 17.65 per cent represents the loss of eggs, due largely to a shortage of water caused by a break in the supply ditch at a critical stage in the development of the eggs.

From July 1 to October 11, 1911, the collection of eggs was 41,026,800. The number of females stripped was 14,516, and 14,770 males were used. The average number of eggs per female was 2,826.

In the older section of the hatchery erected in 1896 there are 61 hatching troughs containing 292 baskets, which at the rate of 80,000 per basket, makes a capacity of 23,600,000 eggs. In the newer section built in 1903 there are 52 troughs holding 249 baskets, which at the rate of 103,000 makes room for 24,640,000 eggs, or a total capacity of 48,000,000 red-salmon eggs. The troughs in the older section are 1 inch shallower than those in the newer; hence the baskets are elevated about three-fourths of an inch from the bottom by putting blocks at the corners. The dimensions of the baskets are 24 by 14 by 7 inches, the mesh of the wire being three-fourths by one-seventh of an inch.

The hatchery building is well lighted by electricity, power for the generator being derived from a Pelton water wheel. Steam heat is provided. Quarters for the employees are located at one end of and overhead the hatching room. The force varies from 6 or 8 to 15 or 20 men, depending upon the season of the year.

The water supply is conveyed by an open ditch about 1 mile from a series of springs to a most elaborate filtration plant. A small creek near the hatchery also furnishes some water during certain portions of the year.

Brood fish are taken by natives with seines operated in the river below the hatchery. No rack or barrier is erected, thus permitting a good escape up to the natural spawning grounds of Karluk Lake. The stock fish are transferred to two inclosures or corrals; also to a few small ponds to remain until ripening. The corrals are of woven wire, 1½-inch mesh, supported on tripods of 3-inch iron pipe. The corrals are built in semicircular form and measure from 700 to 900 feet around from shore to shore with a maximum depth of about 6 feet. This year the secondary corral was built on the opposite shore instead of just below the main corral as heretofore; it was thought to secure a better bottom and clearer water. Of some 25,000 fish being held in the new corral an estimated number of 20,000 escaped July 13 and passed on upstream to the natural spawning beds. The corrals are normally in fresh water, though they are influenced by high tides.

In addition to the corrals there are 12 ponds in which brood salmon are held while ripening. These ponds are one above another on the side of a slope, and the fish are moved up the hill by means of a gravity system of counterbalanced cars. The ponds range in size from 220 to 1,140 square feet, and all the way from 700 to 1,800 adult fish are put in a pond according to its size. A good supply of water is furnished. Quite a number of fish spawn both in the corrals and ponds. It is estimated that as high as 15 per cent are thus lost from all of the fish handled.

Eggs are taken by incision, but the process is peculiar in that the cut is made forward from the vent to the ventral fins. Quite a number of eggs have thus been left in the fish, but by adopting the better method of a longer incision, extending from the pectoral fins to the vent all eggs will be saved. The placing hereafter of the egg buckets upon a stand or platform independent of that where spawning operations are conducted will do away with the chance for loss as a result of concussion during the tender adhesive period of an hour or so after the eggs are taken. Measurement of the quantity of eggs is made by means of a dipper holding about 4,000 eggs, count being made at frequent intervals to check the average number of eggs con-

tained in the dipper. The baskets, which are deeper than at the other stations, receive from 20 to 25 dippers of eggs each. Instead of being removed by salt the dead eggs are picked out by hand, about 15 men being engaged for this purpose at one period during the past season. The spawning crew is usually made up of 8 men. It is often difficult to get enough good help; the natives are not dependable.

Adjoining the hatchery is a nursery pond about three-fourths of an acre in area and 4 feet deep, supplied by waste water from the hatchery and surplus fresh water from the filtration plant. Practically as soon as the fry hatch they are transferred in buckets to this pond. Also after hatching is over as many fry as possible are held in the troughs until they swim up freely. At the rate of 125,000 to a trough about 7,000,000 fry can be thus held. Last winter over 15,000,000 fry were put in the nursery pond at one time. Ordinarily not more than 5,000,000 get in at a time, for owing to the protracted season the older fry pass out of the pond into the lagoon before the later ones hatch. The fry are spread about the nursery pond as much as possible. They are sometimes fed on canned salmon and a mush made of corn meal. The loss in the pond appears to be very light.

The overflow screens to the pond are usually removed in February, and the young salmon as they swim up work out into the lagoon, which usually remains frozen over from November until May. After the ice breaks up the fry are caught in a live car as they pass out of the pond. This live car is an old skiff with wire mesh-covered ports in the sides and is towed to grounds near the hatchery, where there is a good growth of eelgrass. The ports are then opened and the fry swim out at their leisure. Trout and sculpins no doubt devour quite a number of the young salmon. Last season large numbers of trout were seined near the pond outlet.

There is a tremendous mortality of fish held in the corrals and ponds, due no doubt to crowding so many fish together in a limited space, and the loss is particularly heavy during the latter half of July when the water warms up. The season of 1910, the last for which complete statistics are available, is typical of conditions at Karluk. From June 7 to August 10, 1910, a total of 85,623 adult salmon were impounded. Of these fish a total of 42,174, or nearly 50 per cent, died and were of no use whatsoever. The season's take was 49,626,000 eggs from the remaining salmon, and it is safe to assume, therefore, that a like number, or nearly 50,000,000, were absolutely wasted as a result of the death of fish in the inclosures. It is unfortunate that these fish did not have a chance to reach the natural spawning grounds. Of 200 females selected at random September 12 at Karluk Lake it was found that 197 had spawned clean, 1 contained about

1,000 eggs, while the other 2 each had about 150 eggs which had died with the fish. The need of reform at Karluk is strikingly apparent, and the justification of fish-cultural methods under present conditions is most questionable. The remedy lies in moving the hatchery to the lake, where there will be no need of impounding the salmon. Another argument advanced as a reason for moving the hatchery is that the fry therefrom can be released on the natural spawning grounds of the lake instead of within 2 miles of salt water, as at present. Since it is believed that normally the greater part of the young red salmon remain in fresh water a year before going to sea, it may be assumed that results under the present system of planting at the Karluk hatchery are also of very questionable value. This conclusion is certainly most logical. But irrespective of any loss in this direction there is sufficient actual proof in the enormous loss of eggs due to the death of impounded brood fish to make the removal of the hatchery to the lake an absolute necessity if it is to be operated with satisfactory efficiency.

An exploration was made of Karluk Lake the latter part of July primarily for the purpose of locating a hatchery site. A tributary stream near the lower end of the lake appears to be suitable for this purpose. The lake is about 8 miles long and averages 1 mile in width, but the quite precipitous mountains which almost surround it leave remarkably few tributary streams accessible to the salmon for spawning purposes. The result is that many salmon spawn in the lake along the gravelly beaches. On August 1 the lake contained a large number. Two small lakes drain into Karluk Lake, the outlet of which is Karluk River, a stream shown by compass survey some years ago to be approximately 15 miles long. The present hatchery is about 1¾ miles up from the mouth of the river, to which point it is navigable for a light-draft boat or small launch. Above the hatchery, however, it becomes so swift and shallow in places that only with great difficulty can a light boat be hauled upstream by means of lines from the shore, but there are also stretches where a light skiff can be rowed up without much trouble. To reach the lake it is much easier to go over the old native trail or portage of about 3 miles from the head of Larsen Bay to the river and thence 6 miles up to the lake. A small boat can be rowed most of the way from this point to the lake and can be hauled along shore without much trouble through the mile or so of swift water just below the lake.

The proposed plan of transporting the fry from the Karluk hatchery to the lake for planting is considered impracticable. The removal of the hatchery to the lake would be much more satisfactory. From the foot of the lake to navigable water at the head of Larsen Bay, a distance of some 7 miles in a direct line, the country is open and is

traversed by only one ridge not over 200 feet high. The construction of a tramway would establish an easy line of communication between the lake and salt water.

KLAWAK.

This station is located near the west coast of Prince of Wales Island on Klawak Lake, about 6 miles from the village of Klawak. It is operated jointly by the North Pacific Coast Trading & Packing Co. and the North Alaska Salmon Co.

During the period from August 6 to October 17, 1910, a take of 6,786,500 red salmon eggs was made, from which 6,200,000 fry were planted, beginning in November and continuing into April, 1911. This shows a loss of 586,500 or between 8 and 9 per cent. During the fall of 1911 the total collection of redfish eggs at this point numbered 5,600,000. These figures are based upon a reckoning at the rate of 3,500 per female, but hereafter the quantity of eggs will be actually measured.

The new hatching building erected in 1908 is a substantial single-story structure 24 by 85 feet in size, 12 feet at one end of which is cut off for living quarters. The building is neatly ceiled up both inside and outside with matched lumber and is well lighted. It is heated by means of large stoves; overhead is a loft for storage purposes. The head of the water-supply system is at a dam 2,000 feet from the hatchery. The water is conducted in an almost straight line by means of 1,400 feet of covered flume and 600 feet of wooden pipe. A fall of 16 feet in this distance insures an excellent flow. The water is unusually clear and carries very little sediment.

In the hatchery there are 20 troughs set crosswise of the building, and at 6 baskets to the trough the present maximum capacity is about 8,000,000 red-salmon eggs. There is room, if necessary, to set up several additional troughs and increase the capacity to about 10,000,000. Heretofore eggs have been taken by the method of hand expression, but henceforth the improved method of incision will be employed. The fry are put in buckets and taken to various suitable planting grounds, care being exercised to avoid the mouths of creeks where trout congregate.

The crew consists ordinarily of three persons who are engaged most of the year. Although small, the Klawak station classes with the best in Alaska.

HETTA.

This hatchery is located near the southern end of Prince of Wales Island. From the 9,141,000 redfish eggs taken during the period from August 16 to December 18, 1910, plants of 8,552,500 fry were made, beginning on December 27, 1910, and extending into July, 1911. The loss during the period of incubation was less than 6½ per cent.

The season is unusually long at Hetta, eggs being taken here later than at any other station in Alaska. During the summer and fall of 1911, as the season was dry and only a few fish passed into the lake, the take was small, and numbered but 2,000,000 eggs. Indications point strongly to the conclusion that overfishing of waters contiguous to the mouth of Hetta stream had more to do with the failure to fill the hatchery than low water. Naturally the latter condition caused the fish to loiter longer outside the mouth of the stream than they would had the water been higher.

The hatchery is a gable-roof single-story building of rough lumber 50 feet long and 38 feet wide. At each end is a small shed-like addition containing the heating devices, namely, steel oil drums converted into stoves. Two other buildings for the use of the employees are near by. The hatchery is equipped with 24 troughs of two widths and lengths containing a total of 192 baskets with a capacity of about 11,000,000 red-salmon eggs. The water supply is conducted through a 4-inch wooden pipe about 200 feet long from a small spring-fed creek.

For several years past somewhat old-fashioned methods of operation have prevailed, but beginning with this year a change was inaugurated whereby improvements, including taking by incision, will be adopted. Also the inaccurate and undesirable plan of basing the count of eggs upon the supposed average of 3,500 for each female stripped will be discontinued in favor of actual measurement by dipper.

In planting the fry have been allowed for the most part to pass into a small pond adjacent to the hatchery and thence into the lake. Hereafter more of the fry will be planted about other parts of the lake at suitable points. It is reported that a gill net set off the mouth of the small stream near the hatchery where most of the fry were released caught over 3,000 trout in one season.

Several years ago the plan was tried of feeding fry on "do-overs" from a cannery in the region, but with indifferent success.

The force consists ordinarily of two men, one of whom is engaged practically throughout the year, while one or two others are required for several months.

QUADRA.

At the Quadra Lake hatchery egg-taking commenced August 10 and continued until September 16, 1910, during which time 11,200,000 red-salmon eggs were placed in the baskets. Through the hatching season ending February 16, 1911, there was a loss of 850,000 eggs, or 7½ per cent. Hatching usually begins about 100 days after the eggs are taken.

During the winter 10,350,000 fry were planted in near-by waters, but the release of part of the fry in the two small rearing ponds adjoining the hatchery is of doubtful value, as many are destroyed by trout lying in wait off the mouth of the outlet for the young salmon as they work out into the lake.

For the season of 1911–12, egg-taking began August 24 and by October 2 the hatchery was about filled with a collection of 11,000,000 red-salmon eggs. The largest single day's take recorded in the history of the station occurred September 6, 1911, when 1,122,000 eggs were secured. These computations, however, were based on the assumption that each female produced an average of 3,000 eggs, a method which will henceforth be supplanted by the more modern plan of actual measurement by a receptacle the capacity of which will be determined by actual count. Hereafter, also, the eggs will be taken by the method of incision rather than the obsolete plan of expression by hand. Upon examining a number of females that had been stripped as clean as possible by hand each fish was found upon opening to contain from 100 to 400 good eggs, which might have been removed by means of the abdominal cut in the first place. The taking of the eggs hereafter by the so-called "dry" method—into a pan merely moistened instead of into a pan half filled with water—will also be an improvement.

The hatchery is a single-story structure 81 by 18 feet in size; 12 feet of the building is partitioned off for living quarters. The equipment consists of 30 troughs of two lengths arranged in lengthwise series of 5 troughs each and containing 162 baskets with a maximum capacity of about 12,000,000 red-salmon eggs. The interior arrangement of the hatchery and its equipment are of approved type.

The station is in actual operation some seven months each season, or from about July 15 to February 15. Two men are employed constantly during this period, while a third is engaged during a portion of the season.

ETOLIN ISLAND.

Although Capt. John C. Callbreath's hatchery, on waters tributary to McHenry Inlet, Etolin Island, has been closed since 1906, his plan has been followed of lifting over the dam each season the red salmon endeavoring to ascend to the spawning grounds. During the period from July 22 to September 20, 1911, a total of 2,627 adult salmon were lifted over, this number being made up of 1,487 males and 1,140 females. Over 75,000 red salmon have been thus handled since the beginning of the operation in 1892. A few cohos have also been passed over the barrier, but the less desirable dog and humpback salmon have been carefully excluded. Likewise trout have been kept out so far as possible.

Capt. Callbreath, being a firm believer in the theory that salmon return to the same stream where they are hatched, thought that by artificial propagation and protective measures a heavy run could be built up in a stream attracting normally but a comparatively small number of salmon. He felt that he would have the exclusive preferential right as against other claimants to all salmon produced by his efforts over and above the normal run returning to the stream or for a distance of 2 miles off its mouth. After operating 14 years, failing eyesight compelled Capt. Callbreath to close the hatchery. The fact that no heavy run was established is by no means a reflection on the success of artificial propagation, but indicates instead the fallacy of the parent stream theory, although it is more than probable that the fish return to the same general region where they are hatched.

Mr. Fred Patching, now superintendent of the Fortmann hatchery, states that his observation, based on nine years' experience at the Callbreath hatchery, leads to the conclusion that for every thousand fish which entered from salt water about one million eggs were taken. As many as possible were spawned, but quite a number seemed to disappear.

IMPROVED METHODS OF FISH CULTURE.

Within the last few years there have been noteworthy advances in fish-cultural methods applicable to the propagation of the Pacific salmons. Among the more prominent features is the taking of eggs by the method of incision, also the use of a salt solution in the removal of dead eggs. The value of these and other new methods has been thoroughly demonstrated, and it is only by adopting them that Pacific salmon culture can be brought to the new standard of efficiency. It is the purpose here to direct attention to these requirements and at the same time bring to notice certain precautionary measures and other reforms more or less necessary.

TAKING EGGS BY INCISION.

The long-followed process of taking Pacific salmon eggs by hand expression has been superseded in the last few years by the method of incision, a method discovered and developed by the late Cloudsley Rutter in connection with his study of the life history of the salmon of the Sacramento River. This consists simply of making a cut in the abdominal walls from the throat or near the pectoral fins to the vent, the fish just previously having been killed by a blow on the back of the head. When making the cut the knife is either shielded by a guard or is so held between the thumb and forefinger as to allow not more than half an inch of the blade to project, thus precluding the possibility of injuring any of the eggs. Immediately following the incision the eggs flow in a mass into the spawning pan beneath. The

operator's fingers are inserted into the abdominal cavity gently to assist in removing any eggs that may be enfolded in the organs or that may merely adhere to the walls of the cavity. Fertilization is accomplished in the usual manner.

Care must be exercised not to tear loose from the ovaries any eggs that do not come freely when the organs are moved from side to side by the fingers. Eggs thus torn loose are immature, and if taken it becomes necessary to eliminate them subsequently in the hatchery. It is preferable also to have the fish either in a vertical position or with the head considerably higher than the tail, that gravity may assist the flow of eggs.

It was at first thought necessary—and the practice still obtains at some stations—to bleed the fish either by cutting off the head or tail before making the incision. Experimentation, however, has conclusively demonstrated that no advantage results from this procedure, as the few drops of blood that may occasionally fall into a pan of eggs result in no harm. The extra labor involved in bleeding may therefore be dispensed with entirely.

When taken by the method of incision the eggs are of greatly improved quality; there is no straining or rupture of good eggs as is inevitably the result when heavy hand pressure is exerted; no unripe eggs are torn from the ovaries; and at the same time there is no waste of good eggs left enfolded in the organs, as is certain to be the case in stripping by hand. The improvement in quality is from 5 to 10 per cent and the saving in labor, too, is of noteworthy consideration.

The taking of Pacific salmon eggs by incision marks so distinct an advance in fish culture that it is no longer permissible to continue the obsolete method of stripping by hand.

PREVENTION OF LOSS BY CONCUSSION.

Coincident with the absorptive period in salmon eggs is an adhesive stage varying with the temperature from one to two hours, when the eggs are exceedingly sensitive. This is the so-called period of water hardening. Under no circumstances should the eggs be handled during this stage, nor should they be subjected to the slightest concussion. Repeated tests have demonstrated conclusively that even allowing the buckets containing the eggs to stand on the same platform where spawning operations are being carried on results in considerable loss.

To guard against this, the buckets should either stand on the bottom of the stream or else on a platform in every way independent of and having absolutely no connection with the main platform. To some this may seem like a small and irrelevant consideration, but strict observance is certain to reduce the loss by at least 2 or

3 per cent. During the process of water hardening the buckets should be partly submerged to properly regulate the temperature.

Due caution must be observed not to move the eggs until water hardening is complete. After a little experience the operator can readily tell, upon carefully inserting the hand and finding the eggs free and hard and no longer soft and velvety, even toward the bottom of the bucket, that they may be moved to the hatchery without fear of loss.

EGG COUNTS.

Various methods of measuring quantities of eggs are in vogue, prominent among which is the use of a dipper of a known average egg-capacity determined previously by actual count. Another method is to ascertain by count the average number that will be required to measure up to a mark around the inside of the buckets in which the eggs harden before being placed in the hatching troughs. If the standard for a bucket containing, say, 60,000 eggs is accurately determined and verified from time to time it is even more accurate than the dipper method. The ordinary domestic dipper will not hold much more than 4,000 red-salmon eggs, and as it would be used some 15 times more than a bucket as a unit of measurement the chance for individual variation and error is undoubtedly increased.

It is well established that most fish eggs increase in size not only during the early absorptive period of an hour or so while water hardening, but also throughout the period of incubation. At the Yes Bay station it was found that upon water hardening a quart dipper contained 4,416 red-salmon eggs. Five weeks later but 4,160 of these eggs would go into the same dipper, and at ten weeks of age only 4,000, showing an increase of 10 per cent in size.

To avoid error through any change or variation in the size of eggs all standards of computation ought to be determined by actual count, repeated at frequent intervals. Measurements by water displacement, the von Bayer gauge, or by graduated scales are considered less desirable in their practical application than the common dipper or bucket method before mentioned. Too much caution can not be exercised in the matter of egg counts, for it is only through accuracy as to detail that such data become valuable either to science or economics.

Careful computation of the take of eggs minus subsequent losses is the basis for determining the number of fry released, for it is unsatisfactory and impracticable actually to count the fry other than the very small number which may die between the time of hatching and planting. Error is bound to result if the output of fry is determined by a volume measurement of the eggs just before hatching and using the same standard that was employed near the beginning of the period of incubation.

HANDLING EGGS IN HATCHERY.

At some of the Bureau's stations where salmon eggs are handled it was the custom until a few years ago to "bury" the eggs or leave them undisturbed (aside from picking once the day after spawning) for two or three weeks after putting them in the baskets. The result was that they were in some instances literally buried under and in such a mass of mud and sediment that many eggs were killed. Discontinuance of the practice resulted in a very appreciable improvement.

When the water is so turbid as to cause a heavy deposit of sediment it is better to go over the eggs occasionally, even through the critical stages of development, or until the line of the fish is well formed. Of course the eggs must be handled with utmost caution at all times, but owing to their extreme sensitiveness during the two or three days following the closing of the blastopore and until a perceptible curve shows in the tail, they should be left entirely untouched. It soon becomes easy to determine the stage of an egg's development by holding it up to the light between the thumb and forefinger. In the absence of cautious and skilled operatives and unless the water is roily for an extended period, it is undoubtedly better to let the eggs remain undisturbed until the curvature of the tail is visible to the unaided eye. The accumulation of a moderate coating of sediment which readily washes off is not injurious. In a few instances it has become necessary to handle the eggs during the tender stage to arrest the spread of fungus, but where the water supply is reasonably well adapted to fish-cultural purposes such a course is rarely if ever necessary.

REMOVAL OF DEAD EGGS BY THE USE OF SALT SOLUTION.

Among the most noteworthy advances in fish-cultural methods during the last few years has been the use of salt as an aid in the removal of dead eggs. The development of this process has extended over a period of several years, but it is more during the last year or so through the efforts of Mr. L. E. Baldridge, of the Yes Bay station, that it has reached a high degree of efficiency.

Compared with the time-honored process of picking by hand there are marked advantages in using the salt solution, and chief among these is the great saving of labor. It is estimated that if the eggs happen to be of not more than mediocre quality it would take at least 20 pickers to remove as many dead eggs as could 2 men using the salt solution. Moreover, the operation is much more thoroughly performed in the latter process than is possible in picking by hand.

Another advantage of using the solution is that it is possible thoroughly to clean the eggs. This greatly reduces any loss through

contamination and infection resulting from the decomposition and fungus growths which inevitably follow the long-continued presence of dead eggs that in the hand-picking method frequently escape attention. Even when utmost care is taken to pick out all dead eggs, fungused masses will occasionally appear. This condition is rarely observed when the salt solution has been used, and it undoubtedly means that in the aggregate many eggs are saved. Still another point in favor of the solution, it is generally believed, is that it acts as a tonic or stimulant to the good eggs while at the same time as a deterrent to the growth of fungus. Again, in picking by hand there is apt to be loss by movement of the eggs during delicate stages of development; and the oft-repeated insertion of egg tweezers, which are bound to touch other eggs, undoubtedly at times results in injury.

Recent experience has demonstrated that the solution may be applied effectively to eggs freshly taken as well as those in more advanced stages of development.

The principle of the salt bath is simply that the specific gravity of the good eggs is greater than that of the bad eggs, hence upon being placed in the salt solution the good eggs sink and the bad remain afloat and are easily removed. It is vitally essential to the success of the undertaking that the solution be of the proper strength, and it is for this reason that the beginner is apt to become discouraged. If the solution is too weak all the eggs, both good and bad, will sink, while if it is too strong all will remain afloat. The margin of the proper density is so narrow that in the operation it is necessary every few minutes to strengthen the solution by adding more salt or brine, otherwise the small amount of fresh water which adheres to a basket of eggs as it is lifted from the hatching trough into the solution will affect unfavorably the results when treating succeeding baskets. Experience and careful observation, however, will soon make it possible for the operator accurately to judge when to add a bit of the stock solution. It is a convenience, of course, to have a salinometer at hand when preparing the solution. It is commonly the practice as an aid in preparing the solution to test it occasionally with a few eggs.

Highly successful results in using the solution with red-salmon eggs have been attained at the Yes Bay station, and a detailed description is accordingly given of the methods pursued at that place:

The chief item of equipment consists of a water-tight wooden tank, 4 feet long, 2½ feet wide, and 10 inches deep, for holding the solution in which the eggs are immersed. Before each basket is immersed it is necessary that the surface of the solution be perfectly quiet, for any ripple or current will tend to disturb the buoyant effect of the solution upon the eggs. Therefore it was found of great convenience last winter to use a floating frame made of half-inch material 6 inches

wide fastened together vertically and at right angles, thus forming open squares about 6 inches either way. After each basket of eggs is lifted from the salt bath this frame is placed in the solution to stop all motion of the water, being pushed down until it is almost submerged and held firmly against the side of the tank for a few seconds. Upon being carefully withdrawn the solution is quiet and the next basket of eggs may be immersed without further delay.

Another piece of equipment is a feather fan with which gently to push the floating dead eggs away from over the submerged basket into which the good eggs have settled. Unless the dead eggs are quickly moved they too will sink. A feather fan made by fastening eagle feathers to a thin strip 8 inches long by 1½ inches wide works much more satisfactorily for this purpose than a wing. An ordinary hand scaff net about 12 by 14 inches in size for removing dead eggs from the tank, a dipper, and a bucket complete the outfit. Wood and metal surfaces in all equipment should be well coated with asphaltum or some similar preparation.

At Yes Bay as soon as five or ten million eggs are far enough advanced to stand light concussion the baskets are lifted out of the troughs and the eggs are stirred thoroughly with the hand, which causes practically all of the unfertile or empty eggs to turn white. As soon as the line of the fish shows plainly when held up to the light and there is a distinct curvature to the tail, the eggs are sufficiently well advanced in development to stand stirring. After this process the baskets are returned to the troughs and allowed to remain three days, for when first turned the unfertile eggs are about as heavy as the good eggs and consequently would sink if the salt solution were applied at once.

On the fourth day after stirring, everything being in readiness, five or six baskets are removed from a trough and set on top to drain. After a few moments a basket is grasped at each end and is lowered into the tank containing the solution until the liquid comes through the eggs. A light shake is then given to level up the eggs in the basket. Next, slowly and very gently, the basket is lowered until the brine comes almost to its rim and is held perfectly still for a moment. All the eggs in the basket will rise, but soon the good eggs will begin to sink, and presently, if it is a basket of poor eggs, the surface will be completely covered with bad eggs. Now, without the slightest jar, the basket is lowered far enough below the surface to permit an egg to float over the rim. The bad eggs will immediately start toward the edges of the tank. After a few seconds the basket is gently lowered until it rests upon the bottom. The remaining dead eggs are then brushed away from over the basket by means of quick, short, and light strokes of the feather fan; long, sweeping strokes are to be carefully avoided. One end of the basket is then gently raised until it is above

the surface of the brine and the basket is drawn toward the end of the tank and out from under the floating dead eggs. At the same time the fan is used with the other hand to aid in moving any of these floating eggs to one side. The fan is then dropped and the lower end of the basket is grasped and the whole is quickly raised out of the solution. The basket is set at an angle on the tank for a moment to drain and is then carried to the hatching trough. The attendant lifts out another basket to drain along with the four or five others originally removed and returns to the tank of brine with the basket that has been draining the longest.

While this is being done the other operator skims the dead eggs off the surface of the brine and places the frame described above in the tank for a moment to stop all motion of the solution. After five or six baskets have been treated, any eggs that have settled to the bottom of the tank are removed, as they absorb and weaken the brine. It is necessary, as earlier mentioned, to add a little fresh brine after handling each basket. The eggs should be as clean as possible, as the solution will not be effective when it contains much sediment. A 1-inch hole with plug in one corner of the tank is convenient for drawing off any deposit of this character. Should failure occur in treating a basket of eggs, as, for example, if by sudden jar they are all caused to sink, or if the brine is too weak or too strong, the basket must be put back in the hatching trough, as it will not respond to treatment again the same day.

At Yes Bay last winter a large portion of the 72,000,000 eggs were thoroughly cleaned up at one handling. Two men ran as many as 10,000,000 eggs through the salt bath in a single day. It is customary on the day after treating the eggs to have them gone over, so that if any dead eggs remain they may be picked out by hand. This, however, requires very little time, as but few dead eggs are found. No alarm need be felt if the eggs seem to shrink as a result of the immersion, for they will soon resume their normal size upon being replaced in fresh water.

The use of the salt solution has been extended lately to the handling of lake-trout eggs in Michigan and Minnesota, and there appears to be no reason why it is not equally well adapted to the eggs of other salmonoids. Certainly its many advantages commend further experimentation in this direction.

PLANTING.

Although good judgment and foresight are usually displayed by the fish culturist in the manner of taking and handling fish eggs, there is often a decided tendency to neglect in the planting process. The desire to make a good showing as regards numbers in the hatchery output is commendable, but paramount to this is always the real

object and purpose of fish-cultural operations, viz, to increase the productivity of the waters. No matter how thorough the work in the hatchery proper may be, no adequate or justifiable return can be expected unless every possible precaution is likewise taken to conclude the process properly. There is no justification whatever for artificial or, perhaps, as it may be termed "protected," propagation where the returns to the waters are not made in the most scientific and intelligent manner possible. Otherwise it were better to let nature do the work.

Especially is there lack of consideration as to the proper age at which to plant young fish, and again as to the selection of places for releasing them in order to give the best results.

With the means ordinarily at command the best results are obtained by planting young red salmon when the umbilical sac is about two-thirds absorbed, which is the time when the fry begin to swim up freely. It may sometimes be necessary to plant before the sac is sufficiently absorbed in order to relieve a congested condition in the hatchery, for fry require much more trough space than eggs; but so far as possible the planting of fry before the sac is two-thirds absorbed is to be guarded against. With the temperatures prevailing at the Alaska hatcheries this means that the fry must be held at least four or five weeks after hatching. Fry take food some time before the sac is entirely absorbed, the desire to eat being first apparent to a noticeable degree about the time they begin to swim up freely.

Usually the best planting grounds are rocky places and areas more or less covered with vegetable growths, where the young fish may be scattered to give them all the protection possible from predatory fish and other natural enemies and at the same time afford an adequate supply of natural food.

It is better ordinarily to take the fish out and plant them than to allow them to pass of their own free will into the pond outlet and thence to the stream or lake, for in the latter event the school of trout and sculpins collected at the outlet where the young salmon leave the protection of the pond is certain to cause much loss. If possible, it is well to plant the fish in roily water, thus making it difficult for trout and other enemies to observe and devour them. In the planting of chinook salmon in California it has been the practice upon various occasions to shovel in clay or other earth at a point near where the fry were being planted, thus to create an artificial turbidity.

In Alaska the plan of seining or netting schools of trout from the vicinity of the salmon planting grounds is a worthy practice. The trout are of no value in the region save occasionally when used by natives, and their destruction works as a distinct benefit to the salmon industry. It has been found of advantage at some hatcheries

to construct wire corrals about the mouths of the streams wherein the young salmon have been released, in order to exclude the trout.

In the absence of localities suitable for fry planting it is desirable to rear the fry until they have acquired a degree of activity and strength which will better enable them to cope with their natural enemies or other unfavorable conditions.

The feeding of fry upon herring roe, canned salmon, uncooked fish, and other animal foods has been practiced with varying degrees of success for many years. Both hatching troughs and nursery ponds have been employed for handling the fish. The capacity of the troughs, however, is greatly reduced for young fish as compared with eggs; hence if extensive rearing operations are contemplated it is necessary to have a large number of additional fry troughs, or, better still, a series of rearing or nursery ponds. To produce the best results, nursery ponds should be of limited area, say, 20 feet by 40 feet, thus permitting a control over the fish impossible in large ponds. At one station there is a rearing pond nearly an acre in extent, but its efficiency is much impaired for the reason that the fish do not get the amount of food they require. The food is scattered about the edges, but many of the fish toward the center of the pond obtain little or none of it. In view of the unequal rate of growth considerable loss from cannibalism is bound to result in a pond of this character. Smaller ponds permit of a control over the fish impossible in larger ponds.

In the rearing of young salmon it would theoretically be of advantage to create a growth of minute natural life in the water to afford a supply of food. Taking into consideration, however, the large scale upon which hatching is conducted in Alaska, the idea is of doubtful value, because of the difficulty of producing enough of this food to supply the needs of more than a few salmon. Starvation and cannibalism menace the undertaking. As an aid to or in combination with artificial foods such a plankton growth appears to be very desirable. Further experimentation is necessary, however, before definite conclusions as to the practical value of plankton as food for salmon can be determined. At the Fortmann hatchery of the Alaska Packers Association some preliminary work has been accomplished in this field.

It can not be too strongly urged upon all engaged in fish-cultural operations that it is as highly essential to exercise caution and pursue an intelligent study of conditions in planting the fish as it is to devote care to eggs and fry prior to the time of planting.