

ACCOUNT OF OPERATIONS AT THE McCLOUD RIVER FISH-BREEDING STATIONS OF THE UNITED STATES FISH COMMISSION, FROM 1872 TO 1882, INCLUSIVE.**By LIVINGSTON STONE.**

[Written by request of Professor Baird, for the London Exhibition, 1883.]

The United States salmon-breeding establishment on the McCloud River, California, which afterwards became the largest of its kind in the world, arose from small beginnings. A rough board cabin 12 feet by 14 feet, and a small set of hatching-troughs, resting on the ground, without a roof over them, constituted the McCloud River salmon-breeding station of the United States in 1872, the first year of its history. Three white men, including the writer, with the help of one or two Indians, did all the work. Our one room answered the purpose of office, kitchen, dining-room, and bed-room for all of us. Thirty thousand salmon eggs, matured for shipment, which afterwards dwindled down to 9,000 living ones at the end of their overland journey, constituted the results of the season's work. We even actually suffered, at times, for want of means. More than once my remittances from Washington being unexpectedly delayed, we were obliged to sell part of our clothing and some of the cooking utensils to obtain money for our immediate necessities. Our force was so small that we were repeatedly in danger of being robbed and murdered, and it often became necessary for the same man to work all day and two-thirds of the night to complete the day's work. From these small beginnings and straitened circumstances sprung the McCloud River salmon-breeding station, which a few years afterwards employed forty or fifty men, and distributed in one season nearly 14,000,000 salmon eggs, which went not only to various parts of the United States, but to several foreign countries, of which New Zealand was the most remote.

The results of the season's work, however, small as they were, were enough. They were sufficient to establish the important facts that salmon eggs could be procured in California, could be matured for shipment, and, what was more gratifying than all, could be sent alive across the North American Continent.

To settle the points just mentioned was a matter of no small consequence. Every one of them was regarded as extremely doubtful before the expedition set out, while at the same time every one of them was absolutely indispensable to success. The whole project, indeed, of getting salmon eggs on a large scale on the Pacific coast, and transporting them alive to the Atlantic coast, had been looked upon with great distrust. It was considered very doubtful whether the California salmon eggs could be procured in large quantities. It was considered doubtful whether, under the changed conditions of the Pacific slope, salmon eggs

could be brought to the shipping (packing) age in a healthy state; and finally it was generally thought to be decidedly impracticable to transport them alive a distance of over three thousand miles from one ocean to the other, in which latter view the writer to some extent shared.

It will be seen, therefore, that to settle these doubtful points was no small achievement, and the fact that they were settled makes the results of this first season, insignificant as they were in magnitude, of the utmost importance in point of fact.

At all events, the United States Commission felt authorized by the results to continue the work another year, and each successive year more and more clearly vindicated the wisdom of this decision. Perhaps, as ten years have elapsed since that time, I may be pardoned for recalling some of the reminiscences of that first year at the fishery, so full of novelty, of anxiety, and of interest to those who were engaged in the work.

I arrived in California on the 8th of August, 1872, with instructions from Professor Baird, United States Commissioner of Fisheries, to find a suitable place for procuring the eggs of the Pacific coast salmon on a large scale, and if practicable to obtain and forward some to the Eastern States that year. As the salmon with which I was familiar—the *Salmo salar* of the Atlantic coast—does not deposit its spawn until October, I did not feel at all uneasy on account of not having time enough. I nevertheless spared no pains to gather information as to where the Pacific coast salmon spawned, and as to what would be the best location for procuring their eggs on a large scale.

I expected to be informed at once where the spawning grounds of Sacramento salmon were.

Reared in New England, where almost every square foot of ground has been explored, I supposed that almost any one who had given attention to the matter could tell where the salmon spawned. To my very great astonishment, not a man could be found in California who could give the desired information.

The fishermen at Sacramento, and between Sacramento and San Francisco, knew all about catching salmon, but none of them knew where the salmon spawned. The State fish commissioners, although they had collected valuable information of other kinds, had not yet learned the location of the spawning grounds of the Sacramento salmon. As I was about giving up in despair, Hon. B. B. Redding, secretary of the California fish commission, introduced me to Mr. W. W. Montague, the chief engineer of the Central Pacific Railroad, who gave me the first clew I had yet received to the much-desired information in regard to the spawning of the California salmon. Mr. Montague said that he had seen Indians spearing salmon on the McCloud River, and was quite sure that he had seen the ripe spawn coming from the fish that had been speared. Here was a clew to work from. I lost no time in taking conveyance to the McCloud River. I arrived on the river on the 29th of

August, and with my own eyes saw proofs of the correctness of Mr. Montague's statements. Indeed, the Indians were there actually spearing salmon, with the ripe spawn coming from them. Here, at last, was found one at least of the spawning grounds of the salmon of the Sacramento River. There was no doubt about that, but it was associated with another fact that filled me with dismay, and that was that the salmon were at this very time engaged in depositing their spawn, and I had no net, no hatching-house, no hatching apparatus, and indeed nothing whatever, to enable me to avail myself of the facilities presented right here of securing the salmon eggs, that in thousands upon thousands were now being deposited by the parent fish. Every one knows that it is as impossible to procure salmon eggs after the salmon-spawning season is over, as it is to pick a dish of blackberries after the blackberry season is over. In either case no amount of money or zeal is of any avail. Our dismay can perhaps be imagined, then, when it is known that we discovered that the spawning season was nearly at its height, that it must necessarily soon be over, while we had not the means to mature a single egg. It should be remembered also that we were in an unsettled wilderness, 50 miles from a railway and telegraph station, and about the same distance from a saw-mill. The situation called for the most energetic measures, and no pains were spared nor a moment lost in bringing lumber to the spot that I had selected for the hatching works, and in getting some system of fishing under way for procuring a regular supply of salmon eggs. Our party worked so industriously, and were so favored by circumstances, that on the 16th of September we had on a brook near by, a set of hatching-troughs established, in good running order, and had also built a small cabin of rough boards, where we could sleep at night and keep our tools and other valuables. I was also prepared to draw a seine regularly in the river for parent salmon.

It was none too soon, for now the spawning season was very near its end, and by far the larger proportion of salmon in the river had spawned. By dint of persevering labor, which sometimes involved working night and day, we obtained the eggs of about twenty salmon and placed them in good condition in the hatching-troughs.

Our trials were, however, by no means at an end. In California there are many bands of hogs running in a half-wild state in the woods and hills. One hot day a number of these hogs refreshed themselves by bathing and wallowing in the little brook that supplied the hatching-troughs with water; in a few minutes the water was as roily as the Missouri River and in half an hour the eggs in the troughs were covered with mud. This was both discouraging and alarming, but we finally cleaned the mud off the eggs, drove away the hogs, and restored everything to its normal condition. From this time until the season was over we had to "watch out" for the hogs and drive them off, and notwithstanding our vigilance we were several times compelled to clean the hatching-troughs of the mud which the hogs had stirred up when they

found us off our guard. This was not all. To our great alarm we found that on very hot and dry days the brook which fed the troughs would shrink by nightfall to one-half or one-fourth of its size in the morning, owing to evaporation and leakage. However, we did not take enough eggs this season to cause even this much-reduced water supply to become insufficient, and we consequently did not suffer much from this cause; but the climax of our troubles was reached when, one hot afternoon, on trying the thermometer in the brook, we found that it stood at 84° F., and on looking at the salmon eggs we found every one white and dead. This was indeed a dark day for the young salmon-hatching station. Still there was one hope left. We could perhaps obtain a few more eggs before the last straggler among the breeding salmon had deposited its spawn, and the cooler weather of the fall being now near at hand there was some chance of the water not getting hot enough to kill the eggs. On this frail hope and chance we went to work again, although heavily handicapped in spirit and energy by this last almost fatal discouragement. This time we succeeded, by hook and by crook, by resorting to every possible means of securing spawning fish, in obtaining thirty thousand more eggs. These were safely laid down, and succeeded in running the gauntlet of all the dangers that threatened them, and in sixteen days showed the welcome eye-spots. The sight restored our failing courage. Half the battle was over. It was now proved that salmon eggs could be procured and developed to the proper stage for shipment.

But a still greater difficulty loomed up before us; this was to transport the eggs alive from these foot-hills of the Sierras to the waters of the Atlantic coast where they were wanted. I confess I had but a very feeble hope that this could be done. However, it was attempted. I sent 50 miles to Mount Shasta for moss for packing, packed the eggs as well as I could, and, wishing them a God-speed for their long journey, sent them on the stage to the nearest railway station, from which the cars took them more than 3,400 miles to their destination in New Jersey. I did not expect to ever hear of them alive again, but in a week or two came the joyful news that about a third of them had arrived on the Atlantic coast in good condition. The other half of the battle was now won; it was settled beyond a doubt that the eggs of the Pacific coast salmon could not only be obtained and matured for shipment, but could be sent alive across the North American Continent.

This is a summary account of the first beginnings of the United States salmon-breeding establishment of California; but though it was small and weak at first, it grew every succeeding year in strength and efficiency, and soon in capacity and actual results eclipsed all other similar establishments in the world.

At the close of this report will be found a diary of the more important events of its history, illustrating its growth and development from year to year.

I will now leave the chronological order of events, and take up in succession the various subjects connected with the carrying on of this station which seem to present themselves most prominently, and will speak first of its advantages of location.

ADVANTAGES OF LOCATION.

There are several tributaries of the Sacramento in California that the salmon formerly ascended for the purpose of depositing their spawn. With three exceptions, all of these rivers, as, for instance, the Feather River, the Yuba, the American Fork, have long ago been completely ruined as spawning grounds, in consequence of the immense deposit of mud in them, caused by the hydraulic mining operations on these rivers. Not a salmon ever enters these streams now. Except possibly at a time of very high water, these streams are so thick with mud that it would kill any fish attempting to ascend them. The three exceptions mentioned are the Pit River, the Little Sacramento, and the McCloud, which is really a tributary of the Pit River. Now of these three rivers, the Pit above its confluence with the McCloud becomes too warm for salmon in the summer, and the Little Sacramento is rapidly losing its salmon owing to mining operations which have been carried on there during the last few years. It will consequently be seen that the McCloud remains the only stream tributary to the Sacramento that furnishes good spawning grounds for the Sacramento salmon. Up this river the great body of the Sacramento River salmon go to spawn, and on this river, 2 miles from its mouth, is built the salmon-breeding station of the United States Fish Commission.

Advantageous as this situation is for its abundance of salmon, it would be of little use as a distributing point for the eggs if it had no convenient lines of communication with the rest of the world; but fortunately the California and Oregon stage route—the only direct through road but one in the country, connecting Oregon and California—follows the north bank of the McCloud for a short distance, and it is just where the stage road coming south touches the river that the salmon-breeding station is built. It was a most happy combination of circumstances that this through line happened to strike the point where, of all others, the California salmon could be most abundantly obtained. The consequence is that we have had, during our whole ten years there, a daily mail north and south and all the incidental advantages, which are very great, of living on the great thoroughfare between the two States.

Besides these advantages just mentioned, this station has another, which, though of a negative character, is nevertheless indispensable to its existence. It is that the geological formations of the river do not indicate the presence of gold-bearing ground on its banks. This has saved the river from the miners and still protects it, and it is the only thing that does protect it; for had gold been found in any abundance on the river, the McCloud would have gone the way of its fellows, the Yuba, the

Feather, and the American, and nothing could have saved these magnificent spawning grounds from entire destruction.

The river itself also possesses some great advantages. Being supplied chiefly by springs, the largest of which is formed by the melting snow of Mount Shasta, it is not subject to fluctuations, but remains at the same height all through the egg-taking season, seldom rising or falling even an inch during the whole time. As the parent salmon are taken in the river, and we build a dam across the river to stop the salmon in front of the fishery, and as we take the river water into the hatching house to hatch the eggs with, it will be seen at once what a desirable thing it is to be situated on a river that never rises or falls during the working season. The size of the river is also an advantage, it being large enough to attract vast numbers of salmon up its channel, and at the same time not being so large as to be unmanageable when the bridge is being built and the parent salmon are being caught. The temperature also of the river seems to be just right for bringing forward healthy embryos, and hatching hardy fish, which, however, is only what one would expect from a stream which furnishes the natural and favorite spawning grounds of the salmon of a great river.

I will conclude the enumeration of the advantages of location possessed by the McCloud River station, by the mention of one more, viz, the presence of the native Indians. This at first sight seems perhaps a doubtful advantage; but what could we have done without the Indians? They helped us in our extremity during the first season when we could get no other help. They helped us the next year and every succeeding year in building the dam across the river when the water was too cold and deep and swift for white men to work in it. They have been invaluable, when the spawning season came, for handling the parent salmon, both when the seine is drawn in and during the operation of taking the eggs; and we have never found any one who could take the place of the Indian women in picking over the salmon eggs in the hatching troughs, which is done every day to separate the dead ones from the live ones. The Indians have also been of the utmost service in times of emergency, and on occasions of alarming accidents, as, for example, on the memorable 18th of September, 1881, when the large current wheel, which furnished the whole supply of water for the hatching house, went to pieces, and the Indians saved our seven million salmon eggs by bringing water from the river in buckets from eleven o'clock one morning until four o'clock the next morning without taking any rest. Indeed, I think I may safely say that the white men at the station would have had a very hard time to do their work without the assistance of the Indians, if indeed they could have done it at all, and to make a success of it as they have for ten consecutive years.

THE NATURAL HISTORY OF THE CALIFORNIA SALMON.

Passing now to the salmon themselves, a few words about their characteristics and history may not be out of place.

The California salmon was formerly known as "*Salmo quinnat.*" It is now called "*Oncorhynchus choueka.*" It is, when prime, a handsome silvery fish, resembling very much in shape and general appearance the salmon of the Atlantic coast of both America and Europe (*Salmo salar*), except that it has dark spots on its back and sides that do not belong to *Salmo salar*. The Sacramento salmon, which is the same fish which is found in the Columbia and other rivers on the Pacific coast in great quantities, averages in weight in the Sacramento River from fifteen to twenty pounds, and is found in that river every month of the year, being in best condition during the three winter months, and in the greatest abundance, probably, in March, April, and August. When the salmon enter the Sacramento from the ocean they are, as just mentioned, handsome, silvery fish, but they fall off in looks and quality every week after they leave tide-water and enter upon their journey up the river to their spawning grounds. When we take them full of ripe eggs, in September, at the hatching station, they are mostly of a dark-olive color, the females being distended with spawn, and the males often very thin and deep, sometimes almost black, and frequently having a broad red band on their sides extending their whole length from head to tail. After spawning, and sometimes before, both sexes become emaciated, weak, and covered with white spots. At this stage the salt water of the ocean is the only thing that will revive them; and those that do not reach it in season, and this includes about all that go up the McCloud River, die of sickness and exhaustion.

METHOD OF CAPTURING PARENT SALMON.

Our methods of capturing the parent salmon and confining them, for the purpose of securing their eggs, have been various.

The first year, besides hauling the seine for them, we obtained what we could from the fish-baskets of the Indians. This latter method furnished only a meager and precarious supply, and was entirely abandoned after the first season.

The second year I had to adopt some means of keeping the salmon in confinement after they were caught, because, in order to secure a large number of eggs, I began fishing several weeks before the beginning of the spawning season. I hoped, by catching the salmon early in the season and confining them, to have a large number on hand when the spawning season came. This plan, however, only led to a succession of disappointments; for wherever we put the salmon they would die in a week or two. We put them in large plank boxes anchored in the river, with great apertures in them to insure a good circulation of water. We built capacious pens in the river by driving stakes into the bed of the stream; we built ponds on shore, supplied with a constant stream of river water, and we tried every expedient we could think of to keep them alive in confinement, but all to no avail. The imprisoned fish would spend their whole time in efforts to escape, and in not many days

would be found dead in their pens, in most cases, probably, in consequence of their bruises. Day after day and week after week they died. The more we caught the more we lost; until at last about as many died daily as we succeeded in catching, and though we took that year about two million eggs, we should probably have taken nearly, if not fully, as many if we had not drawn the seine at all until the spawning season began.

THE BRIDGE AND DAM ACROSS THE RIVER.

The evident impossibility of ever successfully confining the parent salmon in ponds or pens made the necessity imperative of devising some sort of means for collecting the spawning fish together in large numbers. The object of this station was to take salmon eggs on a large scale, and if only two million could be secured at a season the enterprise would be virtually a failure. Besides this, the immense amount of labor and expense that was incurred in 1873 in getting the two million eggs of that year seemed exceedingly disproportionate to the number of eggs obtained. At this critical juncture a new idea suggested itself, which was to put a dam across the river at the fishery, which would prevent the salmon from ascending the river any higher. Their irrepressible instinct to push up the stream would, it was thought, prevent them from going down the river, and the dam keeping them from going up any further, it was believed that the salmon would collect in great quantities in front of the fishery. This idea was carried into practice in the season of 1874, and it fulfilled our highest expectations. The impassable dam was built, the river closed to the ascent of the breeding salmon in July, and before the spawning season commenced, to our great delight, they were collected in vast quantities below the dam. The great problem of securing salmon eggs on a large scale was solved. We experienced the great relief which comes when the prospect of assured success takes the place of the prospect of failure. During the spawning season of that year we took 5,750,000 eggs. The crisis was so important and the effect of our project so novel and interesting, that perhaps I may be excused for quoting something relating to the subject from my report of operations for the year 1874:

"With the time and men at my command, the construction of the bridge and dam was an undertaking of no small magnitude. The point selected for the purpose was just below the hatching-tents, where the river begins to break over a series of rapids. It was necessary to do the work here or at some similar place in order to avoid the deep holes and irregularities of the river-bed which prevailed everywhere in the channel. This necessity, however, involved the disadvantage of having very swift water to work in—so swift indeed that a boat could not be held for a moment along the whole line of the bridge without being made fast to the shore. This disadvantage was the more serious because the snow-water which forms the river is so cold that the men working in it, as they were obliged to, a great deal of the time up to

their waists and often up to their necks, could not endure it long without severe suffering. Fortunately, I had with me a force of resolute men who were daunted at nothing, and through their courage and resolution these and all other obstacles were overcome. The space to be bridged over was one hundred and five feet, or, with the corral extension, one hundred and fifty feet. The line was made across the river at nearly right angles with the current. The water was from four to eight feet deep, and running with tremendous force. The river-bed was of loose, detached rocks, varying from a pound to half a ton in weight. We began the work by felling logs in the woods, cutting them into twelve-foot lengths and hewing off the ends square. Three of these lengths were then laid together horizontally and in the form of a triangle, and the ends firmly pinned together with wooden pins. Another similar triangle was then made and placed over the first, then another and another, and so on till the structure reached the required height to support the bridge at a suitable distance above the surface of the water. When this was finished the men waded out with it, with great labor, to its place in the river and fastened it there with cables till it was banked up with rocks, and the hollow space inside was also filled with rocks. When this was done, we had a solid stone pier, resting on the bottom of the river, which the current was unable to move. Another similar pier was then built and placed, and then another and another at suitable intervals, till the other side of the river was reached. The tops of the piers were then connected with logs hewn square and pinned to the piers with strong wooden pins. This completed the bridge. When it is remembered that we had neither horses nor derricks, but relied entirely on our physical strength to do all the work, it will be seen that it was no trifling undertaking. Nothing was yet accomplished, however, in arresting the passage of the salmon, as the space below the bridge was, of course, except at the piers, entirely open to them. It, therefore, now remained to dam the rapid and powerful current so that the salmon could not pass. After some deliberation it was decided to make this dam of poles about two inches in diameter, placed nearly vertically in the river, with the upper ends resting on the side of the bridge, and the lower ends against the bottom of the river. To facilitate the work of placing the poles, we concluded to make a regular fence of them, laying poles side by side about one inch and a half apart, and inserting both ends of each pole into a strong cross-piece of hewn timber running at right-angles with the poles. This having been decided on, the next thing was to get the poles. We required a thousand. The nearest that could be found in any quantity were in a forest four miles off, over a rough mountain trail. I immediately fitted out an expedition with axes, blankets, and provisions for four days. The thermometer was ranging at that time between 100° and 110° in the shade. In the sun it was hot enough to cook eggs. This made the work of lumbering rather severe; but at the end of the four days the expedition returned,

having procured several hundred poles. These the choppers packed on their shoulders to the nearest point on the stage-road, whence they were brought to camp by the mule-teams returning from Oregon. I continued sending to this spot for poles until they reported the stock exhausted. We then scoured the woods in the immediate neighborhood of the camp and gathered in all the scattering ones that could be found until these were gone. There were still many more needed, which were obtained from various quarters and packed into camp on the shoulders of the men employed.

"The poles having been secured, the fence which was to form the dam was constructed on shore in sections, which when completed were taken to the bridge and dropped into the water at an angle of perhaps thirty degrees with the perpendicular of the bridge. The upper side of each section being now firmly spiked to the timbers of the bridge, the current striking it at the angle mentioned forced the bottom of the fence very tightly against the river-bed. All the sections being thus placed, rocks were then piled up around the bottom of the fence and thrust into any crevices which the salmon might get through; and this work having been extended entirely across the river, the bridge and dam were rendered complete.

"About four o'clock in the afternoon, a few days after, the passage of the salmon was obstructed, and before the corrals were made, it was announced that the salmon were making their first assault upon the dam. The whole camp collected on the bridge to witness the attack. It was a sight never to be forgotten. For several rods below the bridge the salmon formed one black, writhing mass of life. Piled together, one above another, they charged in solid columns against the bridge and dam, which trembled and shook continually under their blows. Not daunted by their repeated failures, they led attack after attack upon the fence, one column succeeding as another fell back. Encouraged by their number, and urged on by their irrepressible instinct, they entirely disregarded the observers on the bridge, and struggled at their very best to pass the unwonted obstruction. Finding the fence impassable, many fell back a little and tried to jump the bridge. This several succeeded in doing, sometimes violently striking the men on the bridge in their leaps, and sometimes actually jumping between their feet. For an hour and a half this fierce assault continued, when, exhausted by their efforts and discouraged by many failures, they fell back to the deep hole just below the rapids, arrested, for the first time since the McCloud formed its channel, in their progress up the river. The Indians, who were watching their movements, were wild with excitement over this scene, which, even after a residence of centuries on the river, was new to them."

We had no difficulty after this in obtaining all the salmon that were wanted. The subsequent season, having made the dam or fence a little closer and higher, so that no salmon whatever could get by, we took 8,000,000 eggs, and in 1878 we took 14,000,000, and could have taken

probably 20,000,000 if necessary. We always after this adopted the same plan of putting a barricade across the river, and by that means collecting the parent salmon opposite the fishery, and the plan was always followed by the same magnificent results.

TAKING AND MATURING THE EGGS.

I will now pass from the capture of the fish to the taking of the eggs. About the middle of August we are in the habit of hauling the seine every two or three days to examine the condition of the breeding salmon. During the third week in August we generally find one or two ripe females, and usually more than that number of males, but it is almost always a week after this that the ripe fish appear in sufficient numbers to warrant our beginning on the work of collecting eggs. There is an extreme variation of about ten days in the time of the beginning of spawning season proper, in different years, but by the first week in September we are always fairly under way. Several days before this time arrives we build, just above where the net is drawn, and extending over the water's edge, a commodious brush house, which is simply a framework of sufficient size, covered and inclosed with green boughs. In this house the work of taking the salmon eggs is done. The covering with green boughs is accomplished by Indians and is always an admirable piece of work, and the whole structure answers its purpose to perfection. A few feet out in the river from the water's edge are sunk three large covered wooden corrals or pens, for holding the parent salmon when taken from the net preparatory to spawning. A plank floor is built out from the shore to the corrals, the whole being covered by the green boughs. When the seine is drawn ashore, six or eight men immediately proceed to examine the fish to see if they are ripe. The unripe ones are thrown back into the river. The ripe fish are put in the corrals, one sex in one compartment, the other in another one. We continue to haul the seine till it is thought that enough ripe fish have been secured, and then the fishermen if at night haul off and retire; if in the daytime, they proceed to take the eggs. After I got this part of the work systematized we took a million eggs a day with great ease, and could have taken many more if necessary. So well is the work arranged now and so thoroughly does every man understand and perform his part, that the spawning gang will sometimes fill sixty pans, that is spawn sixty females, in sixty minutes. Any fish-breeder reading this will appreciate the rapidity and efficiency with which the work must be done to accomplish this result, especially when it is added that every particular about the taking and impregnating is minutely and carefully attended to, so that scarcely an egg in the whole sixty pans is lost from injury or from undue lack of impregnation. When the eggs have stood a sufficient length of time, they are taken to the hatching house in buckets, and after being measured are put in the hatching troughs.

As I have already mentioned, our first and primitive hatching works in

1872, put up in the hurry of the moment, consisted only of a set of hatching-troughs under the open sky, without a roof, and with only a board over each trough to protect the contents from the rays of the sun. The next year (1873), in order to afford shelter to the hatching troughs, which had now been removed to the bank of the McCloud River and much extended, I put up two large tents over the troughs. Under these tents the eggs were matured for several years till 1876, when I built a large and substantial hatching house in which the work of bringing forward the eggs was performed, until it was carried away by the great floods of February, 1881. In the following summer (1881) a new, large, and very convenient hatching house was erected on higher ground, and still remains the central structure of the McCloud River salmon-breeding station. To this hatching house we now bring the impregnated salmon eggs, and pour them into the deep wire trays now in use there. These trays or baskets easily hold thirty thousand eggs apiece.

The hatching apparatus used is that which is commonly called the Williamson trough, the principle of which is to force the water up through the eggs instead of flowing the water over the eggs as was formerly done. By adopting this principle the eggs can be put in the trays or baskets several layers deep. Our baskets are six inches deep and we fill them nearly three-quarters full of eggs. The eggs appear to suffer no injury from being piled upon one another to such an extent, owing probably to their being buoyed up by the water which is being forced upwards through them. They do not suffer at all from suffocation, for the same reason.

We can put over 30,000 in a tray, and consequently are enabled to mature several million in a comparatively small space. In illustration of this I will say that in the hatching house at the McCloud station there have been at one time as many salmon eggs in process of hatching as would have covered, with the old method of shallow trays, two acres of ground.

All fish culturists know that as soon as fish eggs are laid in the hatching troughs the daily examination of them and the removal of dead eggs must begin. With the small force of experienced hands at our command during the earlier history of the station, I found some difficulty in getting the eggs picked over in a satisfactory manner, the work being of such a delicate character that hardly any one could be found careful enough and of sufficiently delicate touch to go through the daily picking over of the eggs without killing them; beginners sometimes causing more dead eggs to appear each day than they had removed on the previous day. In this emergency the Indian girls and women came to the rescue and furnished precisely the kind of work that was wanted. From that time we had no more trouble about getting the dead eggs picked out. The delicate fingers and patient natures of the Indian women accomplished the work to perfection. These Indian women come regularly to the fishery every year when the proper season arrives and pick

over the eggs daily until the season for hatching arrives or the eggs are sent off for distribution. Some of them, I think, have picked over the eggs every year of the ten years that the station has been in existence on the river, and the station could hardly get through the picking season without them.

The eggs develop rapidly, and very soon after the hatching troughs begin to fill up, it becomes necessary to prepare for packing them. The packing of a few thousand salmon eggs is not a very laborious task, but the packing of a million for a journey across the North American continent is a considerable undertaking. In 1878 8,000,000 eggs were packed and forwarded from this station, entirely filling two large freight cars. No little preparation is required for packing eggs on so large a scale. Strange to say, no suitable moss for packing is to be found within 50 or 60 miles of the fishery, and the only moss that I know of, even as near as that, is found at the base of Mount Shasta, and nowhere else. Accordingly, we have to get our packing moss gathered at this great distance, and brought to the station on mule teams. As soon as it arrives it is washed and twice picked over very carefully, after which it forms an excellent packing material. A suitable outside packing around the box of moss and eggs, to protect them from changes of temperature, has always been an important desideratum with us. Sawdust is practically unattainable, the cost of getting it to the station being too great. The first year (1872) we used hay. The second year (1873) we also used hay, and with the comparatively few eggs distributed those years, the expense was not very burdensome, but when we came to pack 4,000,000 eggs the next year (1874) it became essential to look around for some material for the outside packing less expensive than hay, for which we then paid \$60 a ton. The Indians again came to the rescue in this emergency. Armed with knives of every description that they could find, they went out into the hills, and cut down several tons of the ferns which grow abundantly about the fishery, and brought them into camp. These ferns made an excellent packing material, and the cost was nothing like the cost of hay. We have used the ferns every year since, to pack and crate the boxes of eggs in.

In 1874, the first year that salmon eggs were packed on a large scale, another emergency connected with the packing developed itself. It arose from the fact that so many eggs must be forwarded at once. A car-load must be got ready and packed at *one* time. No plan that I had hitherto adopted would accomplish the packing of so many eggs in so short a time. So this year a division of labor was effected, and a system adopted substantially as follows: At the upper end of the hatching-house four packing-boxes are placed side by side, and at each box stands a man who packs the eggs in the box, and opposite him another man who helps spread the moss. At each end of the line of packers are seated four Indian girls with nippers to pick out the dead eggs. Just below the packers are two large tubs, kept full by a constantly-running

stream of water, at each of which is stationed a man with a gauged dipper to measure the eggs in. Besides these, there are two other men in the hatching-house, whose business it is to bring the eggs to the measurer at the tubs, and two or three others on the other side of the packers to keep them supplied with moss and mosquito bar for packing. There is also one other man, who sits on one of the rafters overhead, looking down on the whole, and who keeps count of the number of layers of eggs that are put in each box. When everything is ready to proceed with the packing, the two men in the hatching-house bring the eggs to the measurers and pour them into the tubs. Here the stream of water running through the tubs cleanses them, and they are dipped out with long-handled tin measures into pans of water, which are placed on a bench in front of the Indian pickers who pick out the dead ones. When the pans have been thoroughly freed from dead eggs, they are placed on another bench, within reach of the packers, who take them up and strew their contents very skillfully and neatly over the bottom of the packing box, a layer of moss and one thickness of mosquito bar having previously been carefully placed in the box for the eggs to rest on. The packers immediately cover up this first layer of eggs with another piece of mosquito bar and a layer of moss, and, having placed a piece of mosquito bar over the moss, they proceed as before with another pan of eggs, and so on till the requisite number of layers of eggs have been packed, when the box is removed and another empty one substituted in its place, and the packing goes on.

By the method just described we were enabled to pack the eggs very rapidly, *three quarters of a million of eggs having frequently been packed in an hour*, and after this we had no trouble in getting a car-load of eggs ready in a very short time.

THE WATER SUPPLY.

The supply of water which was furnished by the little brook on which we operated the first year was of course wholly inadequate for the maturing of salmon eggs on a large scale, besides being unsuitable for the purpose in consequence of its occasional high temperature and liability to disturbances. I therefore gave up all thoughts of using it another year, and resolved that the next season I would use the river water for the hatching-house, raising it to the necessary height by some device not yet determined upon. Accordingly the next summer I moved the cabin and hatching-trough and all our belongings from the brook where we spent the first season to the north bank of the McCloud River, close to the water's edge. The device which I finally concluded upon for raising water from the river was a current wheel. The first wheel we built was only 12 feet in circumference and raised the water only about 7 feet, but by erecting the hatching-troughs on a low bar not many inches above the level of the river's surface, we made this height (or fall) answer our purpose very well. The wheel worked admirably, and I cannot too highly

recommend it for similar uses in a stream that is free from driftwood during the hatching season, and is not subject to too great fluctuations. I have used a current wheel to supply the hatching-house with water at this station for ten successive seasons without a failure.

The water supply furnished by the wheel this second season (1873) was ample and constant, and, being taken directly from the very spawning grounds of the salmon themselves, was eminently adapted to its purpose. Words can hardly describe the immense relief it was to be freed from the annoyances and constant anxiety caused the year before by trying to do our work on the little, warm, muddy brook which furnished the water for the hatching-troughs. Not a drawback of any serious character once occurred in the maturing of the eggs this year, but as soon as they were sent off, it now being the beginning of the rainy season, we had to take down the tents which covered the hatching-troughs and remove tents, troughs, and all to higher ground for the winter, to save them from being carried away by the rising river, which soon came up many feet over the rocky bar where they had stood. In the mean time the wheel which was erected on two stationary piers in the river had to be abandoned to its fate, and was soon carried by the swift torrent out of sight.

The next two years, 1874 and 1875, the water supply was obtained and the hatching of the eggs conducted as in the season of 1873. Both years were a great success as far as the main object of the station was concerned, viz, the obtaining and maturing of salmon eggs, but each season's operations involved the labor and expense of tearing down our hatching apparatus every fall and re-erecting it the next spring, which seemed, and which was, unnecessary.

The considerations that had caused me to submit to it were these: If a permanent hatching-house were built, it would be necessary to place it, of course, high enough above the water to prevent its being carried away by the rise in the river, which occurs every year during the rainy season. I had thought that a current wheel large enough to raise the water to this height might be unmanageable, but the next year (1876) I resolved to try it. Accordingly, having selected a level spot 15 feet above the summer level of the river, I put up a permanent and very substantial building upon it for a hatching-house, and built a wheel 27 feet in diameter, in a current several rods above the house. This raised the water high enough to supply the hatching-house, and so far all went very well, but a sudden rise in the river during the next rainy season carried off the wheel and a new one had to be built the next year. The loss of so many wheels demonstrated pretty effectually that some change ought to be made, so the next year I put the wheel on two large flat-boats, or rather between two flat-boats, with the ends of the shaft resting on standards erected on the boat. This seemed to solve the question of a water supply for the present, and it did practically, although after the salmon-breeding station was carried away by

the flood of 1881, it became necessary to build the new hatching-house on still higher ground than the old one. This in time necessitated the building of a correspondingly larger wheel in order to raise the water to the increased height now demanded. The wheel that was then constructed is now running and furnishes the water for the hatching-house. It is 32 feet in diameter and rests on boats 36 feet long and 8 feet wide. Its lifting capacity is 50,000 foot-pounds a minute.

RESULTS OF OPERATIONS AT SALMON-BREEDING STATION.

In the eleven years since the salmon-breeding station has been in operation, 67,000,000 eggs have been taken, most of which have been distributed in the various States of the Union. Several million, however, have been sent to foreign countries, including Germany, France, Great Britain, Denmark, Russia, Belgium, Holland, Canada, New Zealand, Australia, and the Sandwich Islands.

About 15,000,000 have been hatched at the station, and the young fish placed in the McCloud and other tributaries of the Sacramento River. So great have been the benefits of this restocking of the Sacramento that the statistics of the salmon fisheries on the Sacramento show that the annual salmon catch of the river has increased 5,000,000 pounds during the last few years.

UNITED STATES TROUT PONDS.

In July, 1879, I received instructions from the United States Commissioner of Fisheries to establish a station on the McCloud River, for taking and distributing the eggs of the black spotted McCloud River trout (*Salvelinus irideus*). After a careful and thorough exploration of the McCloud for 17 miles from its mouth, a suitable place was found near the mouth of a creek on the west side of the river, 4 miles above the salmon fishery. This creek is fed by a spring, and furnishes a large supply of cold water in the hottest and driest time in summer. A trout-breeding station was built here in the fall of 1879, from which 388,000 trout eggs were distributed during the next spawning season (January-May, 1880). An immense deal of labor was expended here this year (1880) in catching parent trout for the ponds, and we were so well rewarded for our pains that by Christmas there was gathered here the finest collection of live trout in America, and probably in the world, consisting of 3,000 full-grown fish, averaging in weight 3 pounds apiece, all in good health and in fine condition. In February, 1881, just as the trout were beginning to spawn, there came the great flood of that year and washed such enormous quantities of mud into the ponds that many trout were killed, and Mr. Myron Green, who had charge of the station, was unable to send away more than 261,000 eggs.

During this year (1881) the losses among the parent trout were made up as far as possible by persistent fishing in the river, and at the next spawning season 367,500 more eggs were distributed.

The fishing for parent trout in the river is now being continued, in order to add to the stock already in the ponds, which probably contain at present about three tons weight of healthy and fine-looking fish.

I will conclude this report by giving an annual record of the most important events at the two stations of the United States Fish Commission on the McCloud River, from the beginning of operations (1872) up to the present time (1882).

ANNUAL RECORD OF OPERATIONS AT THE FISH-BREEDING STATIONS
OF THE UNITED STATES FISH COMMISSION ON THE McCLOUD
RIVER.

1872.

The spawning grounds of the Sacramento salmon discovered in the McCloud River. A small station for taking salmon eggs, temporarily established on a stream on the west side of the McCloud.

Operations were begun too late in the season to accomplish any considerable results this year, but 30,000 eggs were sent to the Atlantic coast, and the very important fact was established that salmon eggs could make the overland journey to the Atlantic in safety.

1873.

Salmon-breeding station moved to the bank of the McCloud River. Hostile demonstrations were made by the natives to prevent the work from going on. Referring to this, my report for the year says:

"Our attempt to locate a camp on the river bank was received by the Indians with furious and threatening demonstrations. They had until this time succeeded in keeping white men from the river, with the exception of one settler, a Mr. Crooks, whom they murdered a few weeks after our arrival. Their success thus far in keeping white men off had given them a good deal of assurance, and they evidently entertained the belief that they should continue, like their ancestors before them, to keep the McCloud River from being desecrated by the presence of white men. Their resentment was consequently very violent when they saw us bringing our house and tents and camp-belongings to the edge of the river, and they spent the whole day in resentful demonstrations, or, as Mr. Woodbury expressed it, in trying to drive us off. Had they thought they could have succeeded in driving us off with impunity to themselves, they undoubtedly would have done so, and would have hesitated at nothing to accomplish their object; but the terrible punishments which they have suffered from the hands of the whites for past misdeeds are undoubtedly too fresh in their memories to allow them to attempt any open or punishable violence. So, at night, they went off, and seemed subsequently to accept in general the situation."

Raised the water for the hatching-house from the river by means of a current-wheel 12 feet in diameter. Endeavored unsuccessfully to keep

salmon alive in corrals and pens and artificial ponds. Used a large tent for a hatching-house. Enlarged the dwelling-house. Hatched some eggs in boxes floating horizontally in the river. Took and distributed 2,000,000 eggs.

1874.

Used deep trays exclusively in maturing the salmon eggs. Built a bridge and rack across the river just above the seining ground to obstruct the ascent of the salmon. This experiment proved very successful and resulted in a yield for the season of 5,750,000 eggs.

1875.

Built large dwelling-house this year and made various improvements. Took 8,610,000 eggs. In December of this year President Grant made a United States reservation of the fishery premises by public proclamation.

1876.

Abandoned the use of tents and built a permanent hatching-house, 100 feet long by 26 feet wide. Erected a current-wheel 17 feet in diameter. Salmon eggs abundant. Took 1,000,000 eggs for the hatching-house in one day; took 7,500,000 eggs in all.

Salmon eggs were sent this year to New Zealand and to the Sandwich Islands. The eggs shipped East this year were forwarded in a freight car filled with ice, and traveling with passenger trains. The result was very successful, the loss in transportation across the continent being extremely small.

1877.

Used floating flat-boats to support the wheel instead of stationary piers. Result very favorable, the wheel rising and falling with the river, and consequently free from the danger of being carried away by high water. Had a guard of soldiers on the McCloud River this year.

Took 7,000,000 salmon eggs, of which some were sent to England, France, Germany, Holland, Russia, Australia, and New Zealand. Only 2½ per cent. loss in transportation to the Atlantic States. Two million young salmon returned to the tributaries of the Sacramento. The Columbia River salmon-hatching establishment was built this year on the Clackamas River, Oregon, by the writer.

1878.

A post-office was established here this year and named Baird, and the post-office building built. A breakwater was constructed from the river to the high land behind the buildings to protect them from high water. A second hatching-house was built at a spring near the river.

Salmon very abundant this year. In July the salmon, about sunset, were jumping in the river in great numbers. One hundred and forty-

five were counted jumping in the space of a minute. There was an Indian war in Idaho this year. Dangerous threats of burning the fishery were made by neighboring Indians. All our men were furnished by the War Department with rifles and ammunition. 14,000,000 salmon eggs were taken and two car-loads sent East.

1879.

The McCloud River trout-pond station was established this year. 7,000,000 salmon eggs were taken, of which 2,000,000 were hatched for the Sacramento, and the remainder sent to the Eastern States, Europe, and Australia. The Indian war being over, the Indians were friendly again.

1880.

This was an uneventful year at the salmon fishery. Seven and a half million salmon eggs were taken. At the trout-breeding station 338,000 trout eggs were taken and a great number of large parent trout were caught in the river and added to the stock in the pond. Salmon were very abundant indeed in the McCloud River this year.

1881.

The flood of February 3 carried away almost the whole of the salmon-breeding station. During the night of February 2 the rain, which had been falling in torrents for several days, seemed to increase in volume, and the river rose at the rate of a foot an hour. Long before midnight the water had risen above the danger mark, and at half past two on the morning of February 3 the large dwelling house toppled over with a great crash and was instantly swept down the river by the irresistible current, followed soon after by the other buildings. Nothing of any consequence was left. My report for the year says:

"The men's house, where the workmen had eaten and slept for nine successive seasons, and which contained the original cabin, 12 by 14 feet, where the pioneers of the United States Fish Commission lived during the first season of 1872; the hatching house which, with the tents that preceded it, had turned out 70,000,000 salmon eggs, the distribution of which reached from New Zealand to St. Petersburg; the large dwelling house, to which improvements and conveniences had been added each year for five years, these were all gone, every vestige of them, and nothing was to be seen in the direction where they stood except the wreck of the faithful wheel which through summers' suns and winters' rains had poured a hundred million gallons of water over the salmon eggs in the hatchery, and which now lay dismantled and ruined upon the flat-boats which had supported it and which were kept from escaping by two wire cables made fast to the river bank.

"The river continued to rise the next forenoon, until it reached a maximum height of 26 feet and 8 inches above its summer level. This, of course, is not a very extraordinary rise for a slow-moving river, but

when it is remembered that the McCloud is at low water a succession of cascades and rapids, having an average fall of 40 feet to the mile, it will be seen at once what a vast volume of water must have been poured into this rapid river within a very short time, and with what velocity it must have come to have raised it 26 feet when its natural fall was sweeping it out of the cañon so swiftly. Those who saw this mighty volume of water at its highest point, rushing through its mountain cañon with such speed, say that it was appalling, while the roar of the torrent was so deafening that persons standing side by side on the bank could not hear each other talk.

"It must be over two centuries since the McCloud River rose, if ever, as high as it did last winter. There is very good evidence of this on the very spot where the fishery was located, for just behind the mess-house, and exactly under where the fishery flag floats with a good south breeze, is an Indian graveyard, where the venerable chiefs of the McClouds have been taken for burial for at least two hundred years, and there is no knowing how much longer. One-third of this grave yard was swept away last winter, and the ground below was strewn with dead men's bones. Now the fact that the Indians have been in the habit of burying their dead in this spot for two centuries proves that the river has never risen to the height of last winter's rise within that time, for nothing could induce Indians to bury their fathers where they thought there was the least danger of the sacred bones being disturbed by floods.

"When the waters subsided, it became apparent what a clean sweep the river had made. Here and there the stumps of a few posts, broken off and worn down nearly to the ground by the drift wood rubbing over them, formed the only vestiges whatever to indicate that anything had ever existed there but the clean, rocky bar that the falling waters had left."

An appropriation was made by Congress for rebuilding the station, and the work of restoration began in May and was completed in September, the newly erected buildings being much better than those that were destroyed. Seven and a half million salmon eggs were taken this year.

At the trout ponds many parent fish were killed by the mud which was carried by the very heavy rains into the ponds. Only 261,000 trout eggs were distributed this year. During the year many very large trout were caught in the river and put alive in the ponds.

1882.

The appropriations came so late this year that very little was done at the salmon-breeding station. Four million salmon eggs were taken, and all hatched for the Sacramento River.

At the trout ponds 337,500 eggs were taken, most of which were shipped east.