XX.—REPORT OF OPERATIONS IN CALIFORNIA IN 1873.

By Livingston Stone.

A—CLEAR LAKE.

1.—FIELD-WORK IN THE WINTER OF 1872–'73.

On the 1st of January, 1873, at which date my last report closes, I was at San Francisco, making observations in regard to the fish and fishing of the Sacramento, and intending, in a few days, to go to Oregon to look for a suitable location on the Columbia River for obtaining a supply of eggs of the salmon of that river.

A succession of storms on the Pacific coast deferred my departure from San Francisco for this purpose, and, while waiting for fair weather and an outward-bound steamer, advices were received by telegraph, stating that a large number of white-fish eggs were on their way to California from the great lakes.

At the same time, Mr. S. R. Throckmorton, the chairman of the California fish-commission, requested me to assist Mr. John G. Woodbury, then in the employ of the State commission, in selecting a favorable site for hatching the white-fish eggs on their arrival, and for depositing the young fish when hatched.

In compliance with the requirements of this new turn of affairs, I abandoned my plan of going to the Columbia, and, on the 10th of January, took the cars for Clear Lake, Lake County, California, one hundred and twenty miles north of San Francisco, having in view the objects just mentioned.

2.—CHARACTER OF CLEAR LAKE.

After two or three days spent in examination of various waters, it was decided, on the 15th of January, to locate the hatching-works for the white-fish eggs at Kelsey Mills.

These mills are situated on Kelsey Creek, a tributary of Clear Lake, and are three miles above Kelseyville, Lake County, and six miles from the outlet of Kelsey Creek into Clear Lake.

The water-supply was taken by a pipe from the flume of the mill, and was ample. The hatching-works were in every way satisfactory.

Owing to the difficulty of obtaining moss in the Eastern States in midwinter, the first lot of white-fish eggs forwarded from the East were packed in sponges.

This kind of packing, though suitable for short trips, was not adequate to the requirements of the long journey across the continent, and the eggs were all dead when they arrived at Clear Lake. A second lot, sent on afterward, to take the place of those which were lost, arrived in good condition, and from them 25,000 white-fish were hatched under the charge of Mr. J. G. Woodbury. About the time of the absorption of the yolk-sac, the young fish were placed in various portions of Clear Lake. This was the first introduction of the white-fish (*Coregonus albus*) into the waters of the Pacific slope.

While stopping at Clear Lake, I gathered the following items in regard to its waters and the fishes that inhabit them.

It is a singular fact, illustrating the inaptness with which names are often given to natural objects, that the water of Clear Lake is never clear. It is so cloudy, to use a mild word, that you cannot see three feet below the surface. The color of the water is a yellowish brown, varying indefinitely with the varying light. The water has an earthy taste, like swamp-water, and is suggestive of moss and water-plants. In fact, the bottom of the lake, except in deep places, is covered with a deep, dense moss, which sometimes rises to the surface, and often to such an extent in summer as to seriously obstruct the passage of boats through the water.

There are large soda-springs boiling up at various points in the bed of the lake, which discharge into it vast quantities of soda-water daily. A reddish-brown, frothy substance is produced in such abundance by the natural evaporation of the soda-water that the lake in places seems to be full of it.

In winter, the water is cool and not disagreeable, in spite of its earthy taste; but, in summer, it grows warm, the swampy flavor becomes intensified, the frothy substance from the soda-water increases, the plants and moss from the bottom float in great quantities in the water, and it becomes unfit to drink.

These conditions would seem to be unfavorable to fish-life in the lake; but, by another of those numerous contradictions for which California is noted, this lake seems to be particularly adapted to fish, and the water teems with them. In the spring, when they run up Kelsey Creek, Cold Creek, and other tributaries, to spawn, they swarm in these streams by millions, forming an almost solid mass, so that it is even difficult to cross the fords with a horse on account of them.

3.—LIST OF FISHES INHABITING THE LAKE.

The local names of the fish are as follows:

1. Perch.
2. Shapaulle.
3. Hitch.
4. Suckers.
5. Chy.
6. Roach.
7. Spotted sun-fish.
8. Mud-fish, (mud-suckers.)
9. Black-fish.
10. Trout.
11. Bull-heads.
12. Viviparous perch.

Perch, (Smithsonian Collection, No. 146.*)—The perch is very abundant, indeed. It resembles in color and shape the white perch of the Potomac, but is rather deeper and shorter. Those that I saw in February were about six inches long by three inches in depth. Their flesh is excellent, and they are highly prized as food both by white men and Indians. The perch spawn in May around the margin of the lake. Millions of young perch are seen in June.

Shapaulle, (Smithsonian collection, No. 152.)—This fish is a cyprinoid, and is the same as the Sacramento pike, or the California white-fish, of which several specimens have been forwarded to the Smithsonian Institution in my collections on the Sacramento and McCloud Rivers. It averages in weight about five or six pounds, though some have been caught as heavy as thirteen pounds. Their flesh is white, soft, and bony, and they are only a medium table-fish. I was told that they spawn in the sand and gravel in the creeks in May; but, from the fact that they are caught in great quantities during this month with the hook and line, I am inclined to think they spawn earlier, perhaps as soon as the beginning of March.

Hitch.—This is a small, light-colored, and slender fish, about a foot in length, and very full of bones. The whites do not consider them fit to eat. The Indians eat them, bones and all, and appear to like them. They run up the streams in the spring to spawn in countless numbers. It is not unusual to see one or two acres of ground covered with hitch, which the Indians have dried for food.

Suckers, (Smithsonian collection, No. 152.)—These resemble the common suckers of other localities. They are poor food, except the large red-finned suckers, which are esteemed tolerably good eating. They spawn on the sand-beaches of the lake and also in the tributary streams. They dig holes for their nests as large round as a bushel-basket and from six to twelve inches in depth. They run up the creeks in March, and probably spawn about that time.

Chy, (Indian name;) *silver sides*, common name; (Smithsonian collection, No. 148.)—This fish is quite small, and is said to be all bones. They run up the creeks to spawn in May and June in vast numbers. The Indians eat them, but they are not valued by the whites.

Roach, spotted sunfish.—These fish are edible, and are seen in vast quantities around the sand-beaches in May, when they probably spawn. They are not of much account.

Mud-fish, or *mud-sucker.*—This fish is a short, thick fish, of a bluish color. Its flesh is soft, and is of no value. It is supposed to spawn in May around the beaches and among the tules.

Black-fish.—I could not obtain a specimen of this fish to examine, but I heard different persons say that it was a very excellent fish for the table. Some ranked it next to the trout, while others placed it below

*The numbers attached to the names of the fishes refer to my catalogue of the specimens collected for the Smithsonian Institution.

the shapaulle. It grows to a considerable size, the full-grown fish weighing three or four pounds. It is not abundant as a rule, although large quantities of the black-fish collect in the tules in May, when many are killed with clubs. This is undoubtedly their spawning-season.

Salmon-trout, (Smithsonian collection, No. 151.)—This is the local name of a fine, large trout which inhabits the lake, and runs up the tributaries to spawn in the latter part of the winter. It is highly prized for the table. In summer, when the water is warm, the trout collect around the cold springs of the lake, and seem to live there exclusively; the water of the rest of the lake probably being too warm for them. The Indians fish them very regularly and steadily. These trout used to be very abundant in the lake, but the whites have pursued them so unrelentingly on their spawning-grounds that they are rapidly diminishing. It is difficult to find one now where hundreds used to come to spawn. Those that I saw in February, 1873, were about eighteen inches long, and averaged nearly two pounds in weight.

The common California trout is also abundant in the brooks and streams in the vicinity of Clear Lake, but cannot properly be called one of the fishes of the lake.

Bull-head.—I did not learn much about this fish, except that it likes the mud and is an inferior fish. It is not the bull-head, (*Pimelodus*,) or horn-pout, of the Eastern States.

Small perch, (see Nos. 244–250, Smithsonian collection;) (*viviparous perch.*)—This is a beautiful little fish, quite small, but very good eating. It is the same as the viviparous perch of the Sacramento, specimens of which are included in my Smithsonian collection of 1873. As its name implies, it brings forth its young alive. It is quite abundant in Clear Lake.

4.—THE CONDITION OF THE FISH IN CLEAR LAKE AT DIFFERENT SEASONS.

January.—In January, the lake rises somewhat, the tributary streams are full and high, and the trout of the lake run up the streams to spawn. A few suckers are also found in the creeks when they are roiled by the rains. It is said that black-fish are caught with the hook at this time, but I did not hear of any being taken during my stay in January. The Indians fish with a sweep-seine during this month, and catch various kinds of fish. They also catch the lake-trout with hook and line, and the perch with nets.

February.—In February, the shapaulle run up the streams, and are caught in considerable quantities. The lake-trout return to the lake. Black-fish are caught this month. The tributary streams are very high.

March.—Suckers and shapaulle abound in the creeks. The shapaulle bite somewhat in the lake. Black-fish are more abundant and more easily caught.

April.—Hitch, chy, shapaulle, and suckers abound in the creeks.

This is the best month for catching shapaulle. Perch, shapaulle, hitch, and chy are caught in the lake with hook and line this month. Black-fish are abundant.

May.—The first of May is about the best time for catching perch. In respect to the other fish, this month is very much like the last.

June.—The larger part of the fish which have gone up the creeks in such vast numbers have returned to the lake by this time. They have also left the sand-beaches and tules where they have been spawning, and have returned to deep water. Most kinds of the Clear Lake fish can be caught in the lake during this month with hook and line; more perch being caught, however, than any other species. The Indians go this month to the cold feeding-springs of the lake to catch trout with the nets.

July.—This month does not differ much from the last in respect to the fishing; but the water during this month becomes warm, and the fish get soft, and are not good.

August.—The lake is not fished much this month, the water being warm and the fish soft and inferior. The Indians, however, continue to fish for trout around the cold springs which feed the lake. There is one spring in particular fished by the Indians, two miles east of Morgan Young's, which is forty feet in diameter, and which boils up so that one cannot row a boat across it. This spring would make a small river if confined. It is thought that it furnishes the chief water-supply of the lake in the summer. It is, of course, cold all the year round.

A great number of dead black-fish are seen about the lake this month, and some dead perch and roach around the shores and among the tules, which, in many parts of the lake, line the edges densely to a depth of twenty or thirty feet.

September.—Fish and fishing are about the same as in August. The weather is a little warmer. No one fishes during this month except the Indians, who still keep after the trout. The water this month is in its worst condition. It is full of the frothy product of the soda-springs. A green scum covers a large part of the surface, and it is not only uncleanly to look at, but unfit to drink; and yet, strangely enough, this lake, which one would think uninhabitable by fish, fairly teems and swarms with them.

October.—In October the water begins to cool a little, but as yet there have been no rains, and there is no other improvement in the water except the cooling of it. There is no more fishing done this month than in September.

November.—The water is colder this month. The wind and rain clear off the stagnant scum which collects on the surface in the summer. The fish are better, but there is no fishing done.

December.—The lake is clear again on the surface, and begins to rise with the rains. The water continues to grow cooler, and the fish improve; but there is no fishing of any consequence done before the new year.

B—SACRAMENTO RIVER.

After leaving Clear Lake, I went to the Sacramento River to procure a collection of the fish caught at this season, (February.)

At Rio Vista and other points, I gathered the following fragmentary notes, which I present here as supplementary to my report on the fish of the Sacramento River for 1872.

1.—CHARACTER OF FISHING ON THE SACRAMENTO.

The fishing on the Sacramento River is done in three ways: 1. By drift-nets; 2. By fyke-nets; 3. By sweep-seines.

Drift-nets.—The drift-nets are used exclusively for catching salmon. They have an 8¼-inch mesh, are usually 40 meshes deep, and from 150 to 200 fathoms long. As nearly as I could learn, there were not far from a hundred salmon-nets in operation on the Sacramento River in 1872. At the meeting of the salmon-fishermen of the Sacramento that year, there were ninety-five boats represented.

These nets are worked by simply drifting them with the tide. The salmon, which, of course, are heading against the tide, are gilled in the meshes. The turn of the tide is the most favorable time for this sort of fishing.

The nets are frequently drifted a mile before being hauled in. The salmon-fishing is conducted entirely by white men; no Chinamen being allowed to participate in it. There is no law regulating the matter; but public opinion is so strong in relation to it, and there is such a prejudice against the Chinese, that any attempt, on their part, to engage in salmon-fishing would meet with a summary and probably fatal retaliation.

The number of fresh salmon shipped from Rio Vista to San Francisco in the year 1872 is as follows:

January	792	July	1,145
February	1,581	August	1,496
March	1,945	September	2,335
April	3,354	October	583
May	4,408	November	441
June	1,201	December	390

On one day in February, when I came down the Sacramento, there were put on board the steamer, at Courtland, 7 fresh salmon; at Rio Vista, 32 fresh salmon; at Sherman Island, 32 fresh salmon; at Collinsville, 123 fresh salmon.

The number of fresh fish (salmon and sturgeon) brought down the Sacramento River to San Francisco in 1872, by the steamers for the Central Pacific Railroad Company, is as follows:

January	5,514	August	15,677
February	5,799	September	14,706
March	11,394	October	3,082
April	15,563	November	2,367
May	27,394	December	3,716
June	5,561		
July	6,043	Total	105,796

The proportion of sturgeon and salmon in the various months are estimated as follows:

January: 10 per cent. salmon; 90 per cent. sturgeon.
February: 10 per cent. salmon; 90 per cent. sturgeon.
March: 50 per cent. salmon; 50 per cent. sturgeon.
April: mostly salmon.
May: all salmon.
June: all salmon.
July: all salmon.
August: all salmon.
September: all salmon.
October: 50 per cent. salmon; 50 per cent. sturgeon.
November: 50 per cent. salmon; 50 per cent. sturgeon.
December: 10 per cent. salmon; 90 per cent. sturgeon.

Besides the salmon above mentioned, a large number are taken by sailing-vessels and by the opposition-line of steamers and other conveyances to San Francisco and the larger towns.

The points from which salmon are shipped on the river-steamers are Sacramento City, Courtland, Emmatown, Rio Vista, Collinsville, Antioch, Benicia, Martinez.

In the spring of 1872; about 25,000 salted salmon came from the Sacramento River to San Francisco, and in the fall about 9,000.

The Rio Vista salmon-fishermen recommend the prohibition of fishing from June 1 to October 1 or from June 15 to October 15.

Fyke-net fishing.—The fyke-nets have a mesh of 2½ inches. There were, in the winter of 1872–'73, eighty-five fyke-nets on the Sacramento at Rio Vista. They are stationary of course, and are examined every twenty-four hours.

All the kinds of fish in the river are caught in these nets. Mr. John D. Ingersoll, a prominent fyke-fisherman of Rio Vista, informed me that the daily catch for twenty nets is now about seventy-five pounds of fish. They include: chubs,* (Nos. 210–216, Smithsonian collection;) perch, (Nos. 217–231, Smithsonian collection;) hardheads, (Nos. 231–236, Smithsonian collection;) Sacramento pike, (Nos. 237–243, Smithsonian collection;) viviparous perch, (Nos. 244–250, Smithsonian collection;) split-tails, (Nos. 251–262, Smithsonian collection;) suckers, (Nos. 263–264, Smithsonian collection;) herrings, (Nos. 265–270, Smithsonian collection;) sturgeons, (Nos. 271–273, Smithsonian collection;) crabs, (No. 275, Smithsonian col-

* Numbers referable to catalogue forwarded with specimens.

lection.) Of these varieties, the perch, pike, and sturgeon are the best food-fishes.

There has been a vast decrease in the returns of the fyke-nets during the last twenty years.

In 1872 and 1873, they used to catch 700 or 800 pounds a day in one fyke-net. An average of 250 pounds a day for one net, at Sacramento City, was usually expected in those times. The present catch of 75 pounds a day in 20 nets certainly presents an alarming contrast.

The fyke-net fishing is conducted wholly by white men, I believe; the Chinese fishermen being ruled out by the force of public sentiment. The fyke-nets are usually visited early in the morning of each day, and the catch is sent down to San Francisco by the noon-boat. The fyke-net fishing begins in November, and is continued till May. The best fishing is when a rise in the water drives the fish inshore where the fyke-nets are placed.

During the summer-months, the water is warm, the fish are poor, and the fishing is discontinued.

On the 27th of February, 1873, I went the rounds of Mr. Ingersoll's set of fyke-nets with him. We visited twenty nets; but, as some of them had not been examined for over twenty-four hours, the yield was supposed to be equivalent to one day's fishing for thirty nets. The nets had four hoops each, and 14-foot wings. We took about 120 pounds of fish in all. Hardheads were the most numerous, and the Sacramento pike next. Mr. Ingersoll said that perch used to rank second in abundance, the average for thirty nets being 200 or 300 pounds a day, but on this day the perch were quite insignificant in numbers. We found in the nets seven small viviparous perch and two small sturgeons. I learned also that minks, beavers, and otters are sometimes caught in the nets. In 1872, Mr. Ingersoll caught eight minks, two beavers, and one otter in his fyke-nets.

Sweep-seine fishing.—The sweep-seine fishing is given over to the Chinese, who are not allowed by public sentiment to engage in either of the other two kinds of fishing just described. What they are not permitted to do by the prohibited methods, they make ample amends for by their own methods. They are, I should say, the most persistent and industrious fishermen on the Sacramento. They fish all the year round; they use fine-mesh nets, with which they sweep every part of the river, especially the partially stagnant fresh-water lagoons, or "*slews*," as they are called in California, where the fish collect in myriads to spawn. With these nets, they catch vast quantities of fish of all sizes; and so destructive has their fishing been on the Sacramento that all the fish except salmon are disappearing from that river with unexampled rapidity. It is owing to this kind of fishing that the returns of the fyke-nets have diminished so alarmingly the last few years. The Chinese have been at it for seven or eight years; and, if they keep on three or four years more at this rate, the small fish of the Sacramento will be

practically exterminated. I have no means of ascertaining with any exactness how many Chinese fishermen there were on the river, but there are a large number, and Mr. Ingersoll said that they were increasing every year. Most of their fish they send to the San Francisco market as soon as caught; but they also dry great quantities of them on bars and floors prepared for the purpose. These are partly eaten by themselves, and the balance are sent packed in barrels to the Chinese market in San Francisco. While at Rio Vista, in February, 1873, I visited a Chinese fishing-station on the Sacramento River. It was located about eighty rods above the Rio Vista steamboat-landing, and consisted of a nest of Chinese fishing-boats, numbering seven small boats and three large ones. There were also on the shore, just across the road, two old tumble-down buildings, with drying bars and floors near by, in the open air, where some of the fishermen lived, and attended to the drying of the fish. The small boats were common flat-bottomed dories, square at the stern, sharp at the bow, about fifteen feet long, and strongly built. The large boats were also strongly built, but narrow and pointed at both ends, and constructed after the Chinese fashion. Two of these large boats had one mast, and the other one had two masts, considerably raking, with Chinese sails, which were not like any sails used in this country. Nearly amidships, but a little nearer one end than the other, was a tent in which the Chinamen lived. There was also considerable space in the hold of this really Chinese junk, which added a good deal to their house-room. The whole air and look of these crafts was decidedly foreign, and I might say oriental. If I understand their method rightly, the small boats are to visit the "slews" and various fishing-points with, when they go out to draw the seine, and the large boats are really only movable dwelling and store houses, where they live and receive the fish that are brought in by the small boats, and which, of course, they move from place to place on the river as the exigencies of the changing fishing-seasons may require.

C—CALIFORNIA AQUARIUM-CAR.

After leaving the Sacramento River, I went to San Francisco, and immediately began making preparations for going East to procure a car-load of live fish, under the auspices of the California commissioners; but as the United States contributed toward defraying the expenses of this expedition, I will introduce the following account of it here. I left San Francisco on the 17th of March, 1873, and arrived in Boston on the 28th of March, having made a short stop at Sacramento to arrange for the transportation of the car, and also at Salt Lake City to provide for the reception and hatching of a consignment of shad and salmon which Professor Baird proposed to send to Great Salt Lake, Utah.

I quote the following account of the aquarium-car trip from my report to the California commission of that expedition:

"My plan of operations for the whole undertaking was, first, to

collect the fish at some favorable point at the East, where they could be kept alive until everything was ready for the journey; secondly, to fit up a car with the apparatus most suitable for transporting living fish; and, thirdly, to take this car when loaded to California in the least possible time, and without any transfer of its contents. This plan was successfully carried into practice up to the time of the accident just beyond Omaha.

"The first installment of living fish intended for the California car arrived at Charlestown, N. H., the point of rendezvous, on the 7th of May. It consisted of eighty-two black bass, (*Grystes fasciatus;*) glass-eyed perch, (*Lucioperca;*) and bull-heads, (*Pimelodus;*) and about 300,000 eggs of the *Perca flavescens* and the *Lucioperca*.

"These fish were collected at Lake Champlain, and at the Missisquoi River in Vermont, and were taken a journey of thirty hours by rail, before reaching Charlestown. They, nevertheless, bore their trip admirably, and arrived at their destination in first-rate order.

"The next two weeks were spent in fitting up the car, which had arrived at Charlestown, N. H., and making other preparations for the difficult undertaking in prospect. Arrangements had been previously made, at the suggestion of Hon. Spencer F. Baird, United States Commissioner of Fisheries, with Mr. Monroe Green, at Castleton, on the Hudson, for a supply of young shad and fresh-water eels; and also, with Capt. Vinal Edwards, of Wood's Hole, Mass., for young lobsters and other salt-water fish. The eastern trout (*Salmo fontinalis*) were to be taken from the Cold Spring trout-ponds at Charlestown; the large lobsters were to come from Johnson & Young's establishment at Boston; and Mr. Myron Green was dispatched to the Raritan River for cat-fish.

"The equipment of the car having been completed, and everything being ready, the 3d day of June, 1873, was set for our departure. At midnight of June 2d, Mr. W. S. Perrin arrived from Boston with a special car, having on board the lobsters, oysters, small lobsters, salt-water eels, tautogs, and reserves of ocean-water. We began at daylight the next morning filling the tanks in the car and loading in the fish, and by 1 o'clock in the afternoon everything was ready, and at a quarter past 2 on Tuesday, June 3, the California aquarium-car started on its journey.

"The car was furnished by the Central Pacific Railroad Company, and was one of their fruit-cars, intended for quick trips across the continent. It was 27 feet long and 8 feet wide, and was provided with a Westinghouse air-brake and Miller platform, which enabled us to take it along with passenger-trains.

"At one end of the car was a stationary tank, built of 2-inch plank, lined with zinc, and occupying the whole width of the car and 8 feet of its length. This tank was 2 feet and 8 inches deep, and held, when full, about five tons of water. At the other end of the car was a large ice-

box, the reserves of sea-water, six large cases of lobsters, and a barrel of oysters. In the center of the car, and occupying nearly all the room in it, were the other portable tanks for carrying the fish. Our beds were on the top of the large stationary tank, which, of course, was covered. The large tank was also arranged so that we could take on water on a large scale from the water-works at the railroad-stations *en route*. This proved to be a very great convenience, and was, in fact, indispensable.

"When we left Charlestown, N. H., the car contained upward of 60 black bass, from Lake Champlain, (*Grystes fasciatus:*) 11 glass-eyed perch, from Lake Champlain, (*Lucioperca, Americana;*) 110 yellow perch, from Missisquoi River, (*Perca flavescens;*) 80 young yellow perch, from Missisquoi River, (*Perca flavescens;*) 12 bull-heads, (horn-pouts,) from Missisquoi River, (*Pimelodus atrarius;*) 110 cat-fish, from Raritan River, (*Pimelodus;*) 20 tautogs, from near Martha's Vineyard, (*Tautoga Americana;*) 1,500 salt-water eels, from Martha's Vineyard, (*Anguilla bostoniensis;*) 1,000 young trout, from Charlestown, N. H., (*Salmo fontinalis;*) 162 lobsters, from Massachusetts Bay and Wood's Hole; 1 barrel of oysters, from Massachusetts Bay; supplies of minnows for feed-fish.

"The black bass, bull-heads, cat-fish, and part of the lobsters were *full-grown and heavy with spawn.*

"Besides the fish above enumerated, I took on at Albany 40,000 fresh-water eels from the Hudson, and arranged for 20,000 shad and shad-eggs (*Alosa præstabilis*) from the Hudson, to overtake us at Chicago.

"The receptacles for holding the fish consisted of 1 large stationary tank, 8 feet square and 2 feet 8 inches deep; 1 round wooden 70-gallon tank; 1 round 50-gallon tank; 3 round 30-gallon tanks; 3 conical-shaped 30-gallon tanks; 6 conical 10-gallon tin cans; 1 conical 15-gallon tin can; 3 round 9-gallon tin cans; 2 35-gallon casks; 6 large cases, containing the lobsters; the total capacity of the whole, excluding the lobster-cases, being about 16,000 pounds of water.

"Besides the vessels for holding the fish, the car contained the following articles: 1 large 120-gallon cask, filled with ocean-water; 1 60-gallon cask, filled with ocean-water; 1 large ice-box; ½ barrel of live moss; ½ barrel of water-plants; curd and meal for feed; 1 bushel of salt for killing parasites; the aerating-apparatus referred to; 1 alcohol-stove; 1 set carpenter's tools; 2 lanterns; 2 hammocks; 2 spring-beds; 2 mattresses and pillow; 2 sets bedclothes; 1 broom; 1 lot green sod; 2 thermometers; pipes, spouts, and siphons, for taking in and letting off water; 1 long-handled dip-net; 2 short-handled dip-nets; movable steps to door of car; sundry barrels, pails, dippers, &c.; maps, with stations marked where we knew the water to be good or bad; our trunks, valises, and private baggage.

"When the car left Charlestown, there were four of us in it: Mr. W. T. Perrin, of Grantville, Mass.; Mr. Myron Green, of Highgate, Vt.; Mr. Edward Osgood, of Charlestown, N. H.; and myself. We arrived at Albany at 11.30 p. m. the same evening, all the fish doing well, and the

water in the tanks standing at 45° F. Here we took on the 40,000 eels mentioned above and half a ton of ice. We also left Mr. Myron Green here to go to the New York Shad-Hatching Works at Castleton, on the Hudson, and get a supply of young shad.

"On my urgent application to the New York Central Railroad authorities, that road took us with their passenger-train, which was due to leave Albany at 2.40 a. m. on the same night. We reached Suspension Bridge about noon, and left for Detroit with a passenger-train on the Great Western Railroad. We took on ice and water at Hamilton, Canada, and reached the boat at Detroit ferry about 11 p. m. the same day, Wednesday, June 4; all the fish being in good order, except the lobsters, which were dying in considerable numbers. The track on the ferry-boat being just filled by the train, without the aquarium-car, they left us east of the river all night, and, it being very warm, I spent the rest of the night till daylight looking up ice, of which I at last obtained about a ton and a half.

"Leaving Detroit that morning—Thursday, June 5—we proceeded directly to Niles, Mich., with a passenger-train, via the Michigan Central Railroad. We had now come all the way with passenger-trains, and had we known this beforehand we need not have lost any time in bringing on the shad; as it was, however, we expected to make slow time on freight-trains from Albany to Chicago, and I hence arranged to have the shad brought on by express from Albany two days after we left that point. These two days we had now on our hands, and it was very aggravating to be obliged to lose so much time when time was so precious. There was no help for it, however; and as I thought it would be better to wait part of the time on the road than to spend the whole of the two days in Chicago, I had the car dropped at Niles, Mich., and we remained there till 6.10 the next morning—Friday, June 6—when we went on to Chicago, after taking on ice and water, and catching some minnows to feed the large fish with. We entered Chicago about 10 o'clock on Friday morning, all the fish doing well except the lobsters and eels.

"The temperatures at which I aimed to keep the different varieties of fish were as follows:

	Degrees Fahrenheit.
"Cat-fish	50
"Fresh-water eels	45 to 50
"Tautogs	45
"Salt-water eels	45
"Black bass	42
"Yellow perch	42
"Bull-heads	42
"Glass-eyed perch	42
"Trout	38
"Lobsters	34 to 36
"Oysters	34 to 36

"From the experience which I have now had, however, I would advise a change with some of the fish, which would make the temperature as follows:

	Degrees Fahrenheit.
"Cat-fish	50
"Fresh-water eels	50
"Bull-heads	48
"Glass-eyed perch	48
"Yellow perch	45 to 48
"Black bass	42 to 45
"Salt-water eels	42 to 45
"Tautogs	40
"Trout	36 to 38
"Lobsters	34 to 36
"Oysters	34 to 36

"Mr. Myron Green rejoined us with the shad the next morning, Saturday, June 7th, and at 10.15 a. m. the same day, after having taken on three tons of ice and three tons of Lake Michigan water, we left Chicago for Omaha, via the Chicago and Northwestern Railroad.

"We took on water again at Cedar Rapids, Iowa, and arrived at Omaha at 11 o'clock on the morning of Sunday, June 8th. Through the courtesy of Mr. C. B. Havens, the train-dispatcher of the Union Pacific Railroad, who detailed an engine to take our car to the ice-house at the Union Pacific shops, we were enabled to take on a ton and a half of ice, and about 1 o'clock we started westward again. We were now on our sixth day out, and everything was promising well. All the dead eels had been removed, and we had 20,000 or 30,000 left. The mortality of the lobsters was on the decrease, and we still had over forty alive and in good condition. All the other fish were in splendid order. We had ice and water enough on board to take us, if necessary, to the Sierra Nevada—certainly with what supplies we could get in the Wahsatch Mountains, where the water is good. The circumstance of the fish having lived so well up to this time gave us a good deal of confidence, and we were encouraged to hope that they would continue to do well to the end of their journey.

"After leaving Omaha, we stowed away as well as we could the immense amount of ice we had on the car; and, having regulated the temperature of all the tanks, and aerated the water all round, we made our tea and were sitting down to dinner, when suddenly there came a terrible crash, and tanks, ice, and everything in the car seemed to strike us in every direction. We were, every one of us, at once wedged in by the heavy weights upon us, so that we could not move or stir. A moment after the car began to fill rapidly with water, the heavy weights upon us began to loosen, and, in some unaccountable way, we were washed out into the river. Swimming around our car, we climbed up on one end of it, which was still out of water, and looked around to see where we were.

We found our car detached from the train, and nearly all under water, both couplings having parted. The tender was out of sight, and the upper end of our car resting on it. The engine was three-fourths under water, and one man in the engine-cab crushed to death. Two men were floating down the swift current in a drowning condition, and the balance of the train still stood on the track, with the forward car within a very few inches of the water's edge. The Westinghouse air-brake had saved the train. If we had been without it, the destruction would have been fearful.

"One look was sufficient to show that the contents of the aquarium-car were a total loss. No care or labor had been spared in bringing the fish to this point, and now, almost on the verge of success, everything was lost.

"I immediately telegraphed the state of affairs to Mr. S. R. Throckmorton, chairman of the California fish-commissioners, and to Hon. Spencer F. Baird, the head of the United States Fish-Commission at Washington. I received instructions, by telegraph, from Washington the next morning, to return east immediately, with my assistants, and take on a shipment of young shad to California under the auspices of the United States Fish-Commission."

D—OVERLAND JOURNEY WITH LIVE SHAD.

1.—PREPARATION FOR THE TRIP.

As soon as was practicable after the accident to the first California aquarium-car, I reported to Professor Baird at Washington, reaching that city on the morning of June 15th.

Having received here more explicit instructions in regard to the trip with shad, I made immediate preparations for undertaking this journey, and arrived at Castleton, on the Hudson, with my men, on the 25th day of June. The New York State shad-hatching works, under the immediate charge of Mr. Monroe Green, are located here, and it was at this point that I was to procure my consignment of shad for California.

2.—THE START.

At 6 o'clock in the afternoon of the same day, Wednesday, June 25, I left the shad-hatching camp, with 40,000 young shad. They were packed in eight 10-gallon cans, each can containing 5,000 fish. They had been just taken from the shad-hatching boxes in the river by Mr. Green, and appeared very healthy and lively; but they looked so frail and delicate that it seemed almost a hopeless task to undertake to carry them alive 3,000 miles, and deposit them in a river at the other extremity of the continent, and I certainly despaired of getting them there safely.

There were four of us in all at the start: Mr. H. W. Welsher; Mr. W. T. Perrin; Mr. Myron Green; and myself. Mr. Welsher accom-

panied us as far as Omaha, and the success of the expedition is largely owing to his skill and experience. The remaining three went through to California with the shad.

3.—THE APPARATUS.

Our outfit was very simple, consisting merely of the eight cans containing the fish, one similar can filled with water for a reserve, two or three pails and dippers, a thermometer, and the apparatus for changing the water. This apparatus and its use demand a few words of explanation.

The requirements demanded for keeping young shad alive in transit are radically different from those involved in carrying any other fish, I believe, that have yet been experimented with. They require changes of water, of course, like any other fish; but they always scatter indiscriminately through all portions of the water containing them, instead of dropping to the bottom of their can, and remaining quietly there, as is the custom with very young trout and salmon. In consequence of this, the water cannot be dipped out and thrown away to make room for fresh supplies without dipping out and throwing the fish away with it.

It becomes necessary, therefore, to separate the fish from the water before renewing it. To accomplish this, the apparatus in question is intended. It consists of a cylinder 2 inches in diameter, made of very fine copper-wire netting, and about as long as the can is deep. The bottom is closed with the same netting. The top is open. In connection with this is used a piece of ½-inch rubber tubing 6 feet long. To change the water, the wire cylinder is thrust into the can to any desirable depth; the water immediately enters the cylinder through the wire net-work, which also keeps the fish out. One end of the rubber hose is now dropped into the cylinder, the other end being placed in the pail or can intended for the waste water. The water being started in the hose by applying suction at the lower end in the pail, it acts at once as a siphon, and begins to draw the water out of the cylinder. As the fish cannot get into the cylinder, the water is drawn off without drawing off the fish. When a sufficient quantity has been removed, the cylinder and siphon are taken out, and the spare room in the can replaced by putting in fresh reserves of water very carefully with a dipper. Thus the changing of the water is safely accomplished. This very simple, ingenious, and effective method is the invention of Seth Green.

4.—THE CARE OF THE FISH.

The points about carrying living young shad safely are such as to make it very delicate and critical work. They are substantially as follows:

1. To make constant changes of water.
2. To keep the temperature of the water within specified limits.

3. To avoid sudden changes of temperature in the cans containing the fish.

4. To avoid any agitation of the water in the cans.

5. To furnish constant supplies of water containing minute natural food.

6. To guard vigilantly against the use of water in the least degree unwholesome.

Any failure to supply the above conditions will be immediately followed by fatal results.

Changes of water.—To make constant changes of water, experience has shown to be one of the important secrets about keeping the young fish in good condition. A change is usually made once in two hours. Any temporary neglect of this precaution soon shows its effect in the weakening of the fish, and prolonged neglect is fatal.

A spare can containing a reserve of fresh water is usually carried along with the other cans, and is filled as may be required at railroad-stations. The changes in the cans are made as just described under the head of apparatus for changing the water. In our case, the water was changed every two hours, night and day, for the first half of the trip, and almost every hour for the last half. As we had eight cans of fish, and were seven days and nights on the way, we made almost a thousand changes of water. The labor, of course, was almost incessant. It was like walking a thousand miles in a thousand hours.

Temperature of the water.—It has been ascertained that a lower degree of temperature than 62° Fahrenheit or a higher degree than 75° Fahrenheit is unfavorable to young shad. It becomes necessary therefore to keep the water in the cans between these two points, viz, 62° and 75°. This is done by cooling the water used for changing with ice when too warm, or heating it with artificial heat when too cold.

It is not usually a very difficult matter to obtain water of the right degree for changing with, because most trips with shad are made in warm weather, and in a warm climate, and the main difficulty is to get the water cool enough, which can easily be done with ice. On our overland journey, however, we passed through a very cold climate in crossing the high ridges of the continent. Indeed, at one point on the Rocky Mountains, it snowed in the day-time, although almost the 1st of July; and at these high altitudes the nights were always very cold. To keep the temperature of the water up to a safe point under these conditions, in a cold car, with no fire in it, and with reserves of water which themselves were cold, was no easy matter, as will appear in the account of the journey. Indeed, at one time there seemed to be no possible chance of saving the fish, though, through the untiring labor and perseverance of Mr. Perrin and Mr. Green, it was accomplished.

Sudden changes.—Sudden changes of temperature are very injurious, and often fatal, to shad. So important is the precaution thought to be of guarding against this danger that an alteration of more than two degrees

in the cans when changing the water is avoided if possible. This end is accomplished by preparing the reserve water in a pail or can beforehand, and having it within two or three degrees of the temperature of the shad-water when the change is made. This can usually be done, but it adds very much to the labor and care. If we could simply have put a piece of ice in the shad-cans, or have poured in some warm water when it became necessary to depress or raise the temperature, the work of keeping it right would have been comparatively simple; but to be obliged to grade it by this slow process of preparing the water beforehand, and then to affect the temperature of the cans only two degrees at each change, was a complicated work, and required constant care and vigilance, as is evident from the consideration that if the temperature of the shad-cans took to rising or falling rapidly, it would get the advantage of us, so that we could not change the temperature fast enough, at the rate of two degrees at a time, to keep up with it, and to restrain it within the required limits.

Still another complication comes in passing through cold climates, which is that the character of hot water that is obtained cannot be tested, and it therefore cannot be safely used on the fish, even when reduced to the right temperature, and can only be employed as a warm bath to place the vessels containing the reserve water in. This is not all. The only way, at times, on the overland journey that we could get hot water was to heat bars of iron in the engine-furnace, and thrust them, when heated, into a vessel of water, the train, of course, being all the time in motion.

Under these circumstances, then, five steps became necessary in order to regulate the temperature of the shad-cans: (*a*) to heat the irons in the engine-furnace; (*b*) to heat water with these irons; (*c*) to warm the reserve water used for a change by placing a vessel of it in the water heated by the irons; (*d*) to make the change with the prepared reserve; (*e*) to continue altering the temperature in this way two degrees at a time until the desired point was reached.

To work all night at this, in a moving railway-car, in a cold climate, with the temperature of the water falling faster than you can possibly raise it two degrees at a time by the most active exertions, while all the time the lives of the fish and the success of the whole expedition are hanging in the balance, is no child's play. It was like the ancient punishment of being fastened to a pump up to one's chin in water which rose as fast as the most vigorous pumping could keep it down.

Agitation of the water.—Contrary to the requirements of young trout and salmon, agitation of the water, which is to the utmost degree beneficial to them, is equally injurious to shad. To avoid this injurious agitation, shad are carried in tall and (comparatively) slender cans, instead of in broad and shallow vessels. These cans, which have rather a narrow neck, are filled up to the narrowest point. By these precautions, the motion of the trains is almost entirely prevented from agitating the water. In putting in the fresh reserves, care is taken to place the water in gently,

and never to pour it in hard, with the same object of avoiding a violent disturbance of the water. As our cans were properly made, having been prepared under the direction of Mr. James W. Milner, the very efficient assistant of Professor Baird, we had no trouble from the motion of the train agitating the water.

Supply of minute forms of life as food to the fish.—To furnish the fish with constant supplies of water containing minute natural food, is obviously necessary to do after the fish are two or three days old, and the yolk-sac absorbed; for then they are ready to feed. Nearly all creatures, as is well known, require, with great frequency when first born, supplies of nourishment to replace the waste produced by the vital processes; but with fish this is particularly true, and especially so with young shad.

To supply this nourishment is usually not difficult, all but very cold water containing more or less of it. The main precaution to be observed is to take on sufficient reserves of (relatively) warm water when opportunity offers. The warmer the water, other things being equal, the greater is the amount of nutriment in it. We had no particular trouble on our journey on this score.

Unwholesome water.—To avoid the use of water in the least degree unwholesome is a precaution the necessity for which is apparent. Unwholesome water will kill any fish even when not confined, and especially so highly-organized a fish as a young shad. And if this is important with fish in their free state, it is obvious how much more so it must be with fish confined by thousands in small cans, where all the conditions, to begin with, are unfavorable to life, and where only a slight addition to the increase of the evils of their situation is sufficient to turn the scale the wrong way and destroy them.

To guard against unwholesome water in traveling with live shad, various precautions are employed. Passengers and railroad-employés on the train are consulted as to the character of the water ahead. This usually helps somewhat in a great many cases; though great caution must be exercised in accepting the information so obtained. On arriving at any given water-station, further inquiries are made; and if all accounts agree that the water is lime or alkaline water, or otherwise unsuitable, it is given up; but if nothing is learned against it, it is then tasted, and, if this first tasting is favorable, a supply is taken on board. It is then more carefully and deliberately tasted, and, if traces of lime or alkali are discovered, it is thrown away; if not, a few fish are placed in a tumbler full of it, and their movements watched. If it is very unwholesome, they will show it at once by their actions. If they do not seem uneasy in it, the tumbler may be set aside for an hour or two, and if, at the end of that time, the fish appear to be doing well, it is considered safe to use the water. I may add here that it is surprising how sensitive and accurate one's taste will become after a few days' practice in detecting traces of lime or alkali in the water, The improvement in this respect during the journey in the case of our party astonished us. Our palates seemed to become as quick and positive in their actions as the most sen-

sitive chemical tests. I believe at the end of the journey we could have detected almost the slightest traces of alkaline mixture in the water, by the taste.

It was always a matter of great anxiety with us, at every change of water, lest we should get unwholesome water into the cans, and so destroy in a moment the fruits of all our pains and care. It was particularly so at first before we had acquired confidence in our judgment of the qualities of different waters, and the thought that *one mistake in all the thousand changes of water to come would be fatal to the enterprise was appalling.* It seemed as if it would be a miracle if we should safely run the gauntlet of this thousand changes in passing through a country the water of which for two thousand miles held lime or alkali, and for a thousand miles was frequently so bad that cattle could not drink it.

We went through it all, however, safely; and, though we exercised all the caution we could bring to bear on the subject, I think we owed it as much to good luck as to our own care that we escaped the danger of using bad water.

I forwarded to you at Washington a list of the places *en route* where we found good water, so that hereafter, with this for a guide, there need not be much danger of going wrong.

5.—JOURNAL OF THE TRIP.

As before mentioned, we left the shad-hatching works at Castleton, on the Hudson, for the Castleton railroad-station at 6 o'clock on the afternoon of Wednesday, June 25, with forty thousand young shad packed in eight cans of water, each holding ten gallons.

On arriving at the Castleton station, we changed the water once, and left Castleton for Albany at 9.15 p. m., the water in the cans standing at 70°. At Albany, we made two changes, and took the westward-bound train for Sacramento at 11.30 p. m. We took on water at Utica, Syracuse, Rochester, Buffalo, Dunkirk, Erie, Painesville, Cleveland, Illyria, (well-water, doubtful,) Edgerton, Elkhart, South Bend, (lime-water, bad,) and Chicago, keeping the temperature of the cans very near to 70°, and arriving at Chicago on Friday morning, July 27, with the fish in good order. It was exceedingly hot at Chicago, the mercury standing at 100° in the shade, and it was only with the utmost difficulty; and by constant changes of water, that we succeeded in keeping the water down to a safe point. As it was, the heat made the temperature of the cans rise to 74°.

On leaving Chicago, the air grew cooler, and by night we had brought the temperature down to 68°; but approaching Omaha the next morning, it went up again to 70°; and while waiting at Omaha, which we reached on Saturday noon, July 26, it rose to 73°, though we tried hard to keep it down. Between Chicago and Omaha, we took on water at La Salle, Bellows station, Bureau, Tiskilwa, Rock Island, Davenport,

Kellogg, Casey, and Avoca. Mr. Welsher left us at Omaha, and returned to Rochester.

We left Omaha on the Union Pacific road at 3 o'clock on Saturday, with the fish in excellent order. Through the courtesy of Mr. C. B. Havens, the Union Pacific train-dispatcher, I was permitted to stop the train at the Elkhorn River, where the aquarium-car accident happened, to take on a reserve of river-water at that point; the little experience I had had in it leading me to think that it would be good for the shad.

The country west of Omaha for fifteen hundred miles is, as is well known, very poorly supplied with good water. It therefore seemed necessary to have a larger reserve of water on board than the 10 gallons which served our purpose east of this point. I accordingly took on at Omaha a 30-gallon tank, which had been rescued from the aquarium-car wreck, which, with our pails and spare can, gave our reserves a capacity of 50 gallons.

On arriving at the Elkhorn River, the train stopped, and we took on a full reserve of 50 gallons of the river-water. The river was somewhat roily, and the temperature was 84° to 85°, but the water tasted good and soft; and, by a singular coincidence, it proved to be the best for the shad that we found on the road.

The river that had swallowed up so unsparingly the car-load of California fish, thus contributed more than any other toward assisting the shad across safely to that State.

After taking on the Elkhorn water, we placed a few shad in two tumblers of it, and observed their movements. They seemed highly pleased and entirely at home in it. Being satisfied from their movements that the water was good, we immediately reduced its temperature with ice, and began making changes with it. The afternoon being very warm, however, we could not get the temperature below 72° till night. It grew cooler after dark, and by 1 o'clock, Sunday morning, we had the temperature of the cans down to 69° and 70°, the air in the car being at 69°. We took on ice Saturday night at Grand Island, Nebraska, one hundred and fifty-four miles beyond Omaha, and water at daylight on Sunday morning, at Big Springs, Nebraska, three hundred and sixty-one miles from Omaha. The water at Big Springs was clear and very good, with a temperature of 58°. The shad placed in a tumbler of it seemed to like it. At 10 o'clock on Sunday, June 29, the temperature of the cans was at 67° to 69°. We were now gradually climbing up the eastern slope of the continent. The air was cool and pleasant, and we had no difficulty in keeping the water at about 68° all day. At 6 o'clock p. m., on Sunday afternoon, we reached Laramie, Wyoming Territory, and took on 50 gallons of Laramie River water; temperature 62° and good water. We were now at an altitude of over 7,000 feet, and as soon as the sun set the air grew very cold. In spite of our best efforts, the water in the cans dropped to 65°. This I considered too rapid a decrease from the 72° of Saturday afternoon, so we built a fire in the stove of the express-

car in which the cans of fish were carried, and heated our reserves, but only succeeded, with difficulty, in raising the temperature of the cans a degree or two, to 66° and 67°.

Monday morning, June 30, opened with a warm, bright sun, and the promise of a warm day, and we let the fire in the stove go down; but before noon it became very cold again, with a squall of snow at Bryan, Wyoming Territory. There was also snow on the side of the track. We built up another fire in the stove, and kept the water in the cans at 66°.

We arrived at Evanstown, Utah, about 2 o'clock p. m., on Monday, and took on a reserve of river-water. It was clear and comparatively good, with a temperature of 57°. As we descended Weber Cañon, toward Great Salt Lake, the weather grew warmer, and we descended to Ogden without mishap, reaching this point at half past five, Monday afternoon, with the fish all in first-rate order. Here I left 5,000 of the shad, as fresh and lively as when they were taken from the Hudson, in the care of Mr. Rockwood, of Salt Lake City, who deposited them in the Jordan River, a few miles above its outlet into Great Salt Lake. We also took on here 50 gallons of water from the Weber River, and started westward again on the Central Pacific Railroad, 15 minutes earlier than we arrived, according to the Central Pacific Railroad time, but really about two hours later.

Everything now looked exceedingly favorable and encouraging. We had passed through more than a thousand miles of the dangerous country without loss; the shad appeared as lively and healthy as when we started; we had 50 gallons of good water on board, and only four hundred and sixty miles to run to the beginning of good water again, at Humboldt, and only three hundred and fourteen miles more from there to Sacramento. We thought we had reason to feel encouraged. Our spirits rose accordingly. The terrible strain of the past five days of anxiety began to slacken. We did not know what was coming that very night, or we should not have felt so well over it, for the next night was the most alarming and critical of the whole journey.

The temperature of the cans was standing at 65°, or within 3° of the limit of danger; our reserves of water stood at 60°, or 2° below the limit. The night came on extremely cold; there was no stove or place for a fire in the car; and the temperature of the cans was falling every moment. In the day-time, hot water could have been obtained by telegraphing ahead; but at night this was quite impracticable. The situation was exceedingly alarming.

Through Mr. Perrin's foresight, however, at Ogden we made a favorable beginning of the night. While I was busy arranging for the transfer of the shad for Salt Lake, and attending to indispensable matters which absorbed all my time at the Ogden depot, Mr. Perrin, on discovering that there was no stove in the Central Pacific express-car, with admirable foresight went into the kitchen of the depot-restaurant,

and procured permission to heat some water on the stove, by which we obtained eight gallons of hot water and got a good start.

I also took the first opportunity to go forward into the postal car and obtain permission to heat water on the mail-car stove during the night, The danger was now apparently averted, and, it being my night for sleep, I, having been up the greater part of the night previous, retired, leaving Mr. Green to remain on duty till midnight, and Mr. Perrin from midnight till daylight, when I was to go on again.

Mr. Perrin and Mr. Green deserve the entire credit of taking the shad through the critical night that followed, and for an account of it I will quote from Mr. Perrin's journal:

"As we left Ogden on Monday evening, it became evident that we should need hot water during the night; for the water which we took on at Ogden was, I think, about 60°, and the temperature of the air promised to be no higher, while it was necessary to keep the temperature of the cans above 62°. Accordingly, Mr. Stone made arrangements to heat water, if necessary, in the postal car, where there was a stove, but after he went back to the sleeping-car, the man in charge of the mail-car came to us and said that they were very busy and did not see how they could have a fire in the car. So Mr. Green went into the engine-cab and persuaded the engineer to heat some iron couplings in the furnace of the engine, and then to put them when red hot into our pails filled with water. This water was, of course, dirty and unfit for use in many other respects; so Mr. Green took the larger tin pail, and filled it with warm water, and set into it a smaller one with good water in it, but too cold In this way, he heated a sufficient quantity for immediate use. When he woke me up at 12 o'clock, the air in the car was cold, and growing colder, and it was apparent that work must be done to keep the temperature up to the right point. At the first stopping-place, I went forward to the engine, but found that at that place they changed engines and also engineers.

"The new engineer hardly understood the case, and was at first unwilling to do what I desired. The conductor, too, seemed averse to any delay, and was not very pliable; but after a statement of our necessities they both consented, and I was to go forward for hot water at the next stop. This I did, and obtained hot water heated in the way I have described. The engineer remarked, that he could heat no more till he reached Toano, about 4 o'clock a. m., when he could give me all I wanted. But at 2.30 a. m. the temperature of the car was about 52°, and the water in the cans about 63°, and, of course, going down. I was getting a little nervous, for before 4 o'clock the water would surely get too cold unless something was done. The train stopped, and I ran forward, and after the engineer heard my case, he told me that they were going to stop for water in about 20 minutes, and then he would let me have another supply of warm water. About 3 a. m. the train stopped, and I went forward, and the engineer took out the hot irons and heated the

water, and I was enabled to keep the water up to the right temperature until we reached Toano, where I got another supply. At Wells, I think it was, another engineer drew off boiling-hot water from the engine. This took some time, for the water ran very slowly, as it was mostly steam that came out. I could not have gotten enough hot water in this way had not the train made a stop of 15 or 20 minutes for breakfast.

"In this way I got through the night without letting the temperature fall below 62°; of course, it kept me almost constantly at work."

On Monday, at daylight, I joined the car again, and was quite appalled to hear of the dangers that had been passed the night before.

The water in the cans now stood at 63°; we were on a descending grade; the sun was quite warm; and by 10 o'clock, at Carlin, Nev., we had the water up to 66°. The sun and air grew warmer, and by noon the temperature in the cans rose to 70°. We had now descended 1,600 feet, and it was so warm that we began to use ice again to cool the water. I did not allow myself, however, to be deceived by appearances, but telegraphed ahead to Humboldt for hot water. I also telegraphed to Mr. Throckmorton, of the California fish-commission, for a supply of ice and river-water at Sacramento, on the arrival of the train.

We reached Humboldt at half past 6 the same day, Tuesday, July 1, and took on 8 gallons of hot water and 30 gallons of cold water. The water, which was from a spring, was very good indeed, and had a temperature of 65°. In three hours more, to our great consolation, we began climbing the Sierra Nevada, with all the bad water left behind us and only good water before us. We were also now only fourteen hours from Sacramento City. We had both hot water and ice on board, and the fish were in splendid condition. We therefore had great hopes of bringing them through safely.

The rest of the journey was comparatively free from anxiety or danger, or any marked events. About sunrise on the morning of Wednesday, July 2, our last day, we crossed the summit of the Sierra Nevada, and began descending the Pacific slope into California; the water in the cans now standing at 65° to 66°. At 9 o'clock we took on 20 gallons of good water, with a temperature of 60°, at Alta, Cal., and arrived at Sacramento City at half past 1 Wednesday afternoon, with the shad as fresh and lively as when they left the Hudson River a week before. It seemed like a miracle!

At Sacramento, we met Mr. Throckmorton, and took on the ice and water which he had provided at the depot.

At 20 minutes past 2 we took the California and Oregon cars up the Sacramento River, in company with Mr. John G. Woodbury, the California State fish-warden, and, after several changes of water and no mishaps, arrived at Tehama, Tehama County, California, about 9 o'clock in the evening. In a few minutes we were at the river-side, and just at 10 minutes past 9 on the evening of Wednesday, July 2, 1873, in the presence of Mr. Woodbury, Mr. Green, Mr. Perrin, and several others, cit-

izens of Tehama, the 35,000 shad from the Hudson River, New York, were deposited safely and in good order in the Sacramento River, at Tehama, Cal.; and we turned away from the river toward our hotel, feeling as if a load of incalculable weight had been lifted from us. I ought to add here that, at Ogden and various other places on the road, we removed the sediment and dead fish from the water by placing the can-end of the rubber siphon close to the bottom of the cans, and starting the stream through the siphon without using the protecting cylinder. The live shad not resting on the bottom at all, this simple method will clean up every particle of impurity that has settled in the water without drawing off the live fish. This device serves a double purpose; for it not only removes all the dirt, but it draws off all the dead fish, where they can be seen and counted. In this way we arrived at a very near estimate of the loss *en route*, which we placed at about 400 fish, or only 1 per cent. of the whole.

In regard to Mr. Perrin and Mr. Green, and their work on the car, I must say that two better men for the undertaking could not have been found. Faithful, untiring, and nerved by the most resolute determination to succeed, they did all, and more than could be asked of them, and the extraordinary success of the expedition is, without doubt, greatly due to their efforts.

6.—EXPERIMENTS TO ASCERTAIN THE CHARACTER OF THE WATER.

The temperature of the water used in the experiments given below was approximated to that of the water in the cans at the time the experiments were tried.

Elkhorn River (*Nebraska*) *water*.—Soft, but roily. Saturday, June 28, put one shad in tumbler, containing three tablespoonfuls, at 4 p. m. He appeared to like it; was alive and doing well at midnight; showed signs of distress toward morning; at sunrise was just alive; at 7 a. m., on Sunday, was dead.

Big Spring (*Nebraska*) *water*.—Clear but a little hard. Put one shad in tumbler containing three tablespoonfuls of water; at 8 o'clock a. m., Sunday morning; showed signs of distress at noon; was alive at 2 p. m.; died soon after.

Laramie River (*Wyoming Territory*) *water*.—Not quite clear. Put several shad in a tumbler full, at 7 p. m., on Sunday; appeared to like it at first, but afterward to suffer some; at midnight were in considerable distress; at 1 a. m., Monday morning, they began to die; at 4 a. m., nearly all dead; at sunrise, all dead.

River-water, Evanstown, Utah.—Somewhat roily. Put two shad in a tumbler full, at 3 p. m., Monday, June 30; did well in it.

Humboldt Spring (*Humboldt, Nev.,*) *water*.—Put several shad in tumbler at 5 p. m., on Tuesday, July 1; seemed to like it; appeared well most of the night; in a good deal of distress at daylight; died in the forenoon.

7.—STATIONS AFFORDING SUPPLIES OF WATER.

West of Humboldt all the water is good, and it is not necessary to test it.

We took on water east of Omaha at Albany, Utica, Syracuse, Rochester, Buffalo, Dunkirk, Erie, Painesville, Cleveland, Illyria, (well-water, doubtful,) Edgerton, Elkhart, South Bend, (bad lime-water,) Chicago, (Rock Island Railroad depot,) La Salle, Bellows station, Bureau, (rain-water,) Tiskilwa, (spring-water,) Rock Island, (good,) Davenport, (from Mississippi River,) Kellogg, Casey, and Avoca.

West of Omaha, we took on water at Elkhorn River, 50 gallons, 84° F., roily;* Big Springs, 10 gallons, 58° F., clear; Laramie River, 50 gallons, 62° F., clear; Evanstown, (spring-water,) 10 gallons, 57° F., clear; Ogden, (Weber River,) 50 gallons, 60° F., roily; Humboldt station, (spring-water,) 50 gallons, 65° F., clear; Alta, 20 gallons, 60° F., clear; Sacramento, 20 gallons, warm, muddy.

8.—TEMPERATURE OF WATER IN THE CANS.

The temperature of the water in the cans was as follows: Hudson River water, 70°; Albany to Chicago, 70° to 74°; Chicago to Omaha, 74° to 68°; Omaha to Laramie, 73°, 67°; Laramie to Ogden, 67°, 65°, 67°, 66°; Ogden to Humboldt, 66°, 62°, 70°; Humboldt to Sacramento, 70°, 66°, 67°; Sacramento to Tehama, 67°, 70°; Sacramento River water at Tehama, 74°.

9.—CONCLUSION.

I will close this account of the overland journey with the shad by saying that, considering all the liabilities to accident and delays which are incident to railway-travel, especially when encumbered as we were with a dozen cans and pails, weighing in the aggregate half a ton, I think we were surprisingly fortunate in getting along as well as we did. We made numerous changes of cars and transfers of our freight from one train to another, often in the greatest confusion and hurry, with trunks flying about our heads and feet, and railroad-employés pushing and thrusting us and our cans out of their way. We were often ordered away by baggage-masters and express-agents, though we could not, with safety, leave our charge for a moment; and at times, especially at the junctions of the great lines of railways, where we were hardly left a place to stand, and where at the same time in all the confusion and crowding we felt obliged to take on water and even to change the water in the cans, it seemed as if some disaster must certainly come—either that the fish would be injured, or that the cans would be upset, or left behind, or that some of us would be left, or enter the wrong train, or something of the sort happen.

* I do not consider roily water at all objectionable, but the reverse. I think it much better to take on large reserves at a few places than small reserves at many places, because *every change of water involves a risk.*

Yet, though it seems almost incredible, not an accident, or delay, or drawback of any kind happened. We did not lose a fish from any contingencies of any sort, nor meet with a moment's delay, but entered Sacramento City with all our fish alive, just on the moment that we were due to reach it by the 11.30 p. m. train which we took from Albany on Wednesday the week before.

E—THE McCLOUD RIVER STATION.

The next evening, after depositing the shad at Tehama, I took the train for Redding, and the stage thence for the McCloud River, arriving at the river at daylight of the following day, July 5, 1874. My object in making this journey was to see in what condition our camp of last year on the McCloud might be, and to make some examinations of the river itself, with special reference to using the river-water this year for maturing the salmon-eggs for shipment. I confess I was somewhat surprised, considering the unsettled condition of the country and the presence of Indians, to find the house and belongings exactly as we had left them. Nothing had been molested, and nothing apparently touched, except some spare lumber which an agent of the California and Oregon Stage Company had borrowed in an emergency, and which was immediately settled for. An examination of the river seemed to indicate that water for the hatching-house could be obtained by carrying it in a ditch from a point about fifty rods above the site selected for the hatching-works.

These hasty examinations having been concluded, I went to Shasta City to engage the services of two fishermen who had assisted us the year before, and thence I proceeded to San Francisco. Having secured supplies and men for the season's campaign, I left this San Francisco city again for the McCloud River on the 5th of August, arriving at camp the next morning at daylight.

The year before, the idea of using the McCloud River water not having suggested itself, I had been obliged to locate the camp and hatching-works at a considerable distance from the river, in order to obtain brook-water for maturing the eggs. The inconvenience of this arrangement, which placed the fishing-grounds and the hatching-works a mile apart, is apparent. In fact, the constant necessity for crossing and carrying materials from one point to the other, frequently in a temperature of 110° in the shade, became so intolerable before the season was over, with its consequent labor, risk, and loss of time, that I had resolved if possible, the next season, to bring the camp, hatching-works, fishing-grounds, and stage-communication together at one place. This I was fortunately enabled to do by using the river-water for hatching at a point where the California and Oregon stage-road touches the west bank of the McCloud. The first plan for conveying the water from a higher part of the river to the hatching-works was not successful on account of there not being sufficient fall for a satisfactory hatching-apparatus, and for other reasons. This plan was therefore abandoned,

and the attempt was made to raise water from the river by a wheel placed in the current. This method, which worked to our entire satisfaction, will be more particularly described hereafter.

Previous to my arrival, I had dispatched my foreman, Mr. Woodbury, together with Mr. Green and Mr. Anderson, to the McCloud, with instructions to move the camp and hatching-works to the river-bank, and to make preparations for using the river-water for hatching.

When I arrived, on the 6th day of August, I found things in a very satisfactory condition. The house had been moved in good order, and was now placed just at the water's edge a few rods from the junction of the stage-road with the river. The large hatching-tent had been erected, a considerable number of salmon had been caught and corraled, and everything promised well. I was soon after waited upon by a deputation of the McCloud tribe of Indians, who, at the time of their visit, expressed themselves friendly and well-disposed.

Our camp now consisted of John G. Woodbury, foreman; Myron Green, head-fisherman; Oliver Anderson, man of all work; George Allen, carpenter; Benjamin Eaton, steward; A. Leschinsky, fisherman; J. Leschinsky, fisherman; Livingston Stone, in charge; Indians, Lame Ben, Uncle John, One-eyed Jim, and others.

The eggs in the parent salmon at this time showed an advanced state of development, indicating that the spawning-season was not far distant. As there was a great deal yet to be done to get ready for the two million salmon-eggs which I hoped to take, no time was lost in pushing the preparatory work to completion; and we were so well prospered in our labors that by the evening of the 19th of August we had the water running through the hatching-troughs, and were ready for the first installment of eggs.

1.—CATCHING THE PARENT SALMON.

I will now leave the chronological order of events, and will speak of some of the branches of our work, beginning with the capture of the parent fishes and confining the parent salmon. I was very undecided whether to capture the salmon this year with a seine, or to construct a large trap in the river which would take advantage of their instinct to ascend the stream. As the result proved, I think it would have been easier and cheaper to build the trap, but I decided to use the seine, and continued to use it, and nothing else, through the season. My reasons for doing this were—

1. I had tried the seine-fishing, and knew it could be depended upon.

2. I had not tried a trap on any extensive scale, such as would be necessary in this instance, and was not certain that it could be relied upon.

3. The building of the trap would be an expensive undertaking, and the means at my command were such as rendered economy a primary consideration.

4. I had all the implements for seine-fishing on hand, and no expense for an outfit would be incurred in using the seine.

Had we been able to keep alive all the fish we caught till we had taken their eggs, the seining-method would have been the best and cheapest; but, as will be seen farther on, the parent salmon in our inclosures died so fast and in such numbers that I had to keep up the seine-fishing far beyond the expected time, which made it very expensive and probably less economical in the end than the trap-project would have been.

Our seine was a short one, of about 20 fathoms, and of a mesh small enough to catch half-pound grilse and trout. At the beginning of the fishing in July and first part of August, we caught a good many trout, but, in the latter part of the fishing in September, very rarely one. We drew the seine at first in still places, where the river had formed a large, broad, and deep basin, but we found subsequently that we caught more fish by carrying the seine up the river-channel a few rods, and sweeping the channel as well as the basin. In fact, our experience seemed to show that there were more salmon in the narrower channel above the deep holes than in the holes themselves. Later in the season, while the fish were spawning, we had the best success in the rapids below the holes, or, I should say, as near the rapids as we could go with the boats and seine; the rapids themselves being too swift water either to haul a seine or to row a boat in.

At times, the salmon caught would be mostly males; at other times, mostly females; and at other times, nearly all grilse, which seemed to indicate that there were separate runs of males and females and grilse, respectively. We usually began fishing at dark, and fished till midnight or daylight, according to circumstances. Mr. Myron Green had charge of the fishing most of the time, and performed his part very creditably and faithfully.

Table showing the character of the fishing at different intervals.

Date.	Number of fish caught.	Remarks.
Aug. 13	18	9 females.
14	80	60 females.
15	31	Chiefly females.
16	62	Chiefly females.
Sept. 3	120	Nearly all males and grilse.
4	32	Equal number of males and females.
5	60	Equal number of males and females.
6	10	
8	120	20 females; the rest males and grilse.
9	20 females	Many males and grilse besides.
10	20 females	Many males and grilse besides.
19	15 females	7 had spawned. 8 had eggs.
22	9 females	6 had eggs. 3 had spawned. Last day of fishing.

We caught about 1,000 salmon altogether during the summer's fishing.

The weight of the salmon caught (including grilse) varied from less than a half a pound to 29 pounds. The smallest and the largest were males. The largest male was caught on the 14th of September, and weighed 29 pounds. He measured 41 inches in length, and was 22 inches round just in front of the dorsal fin. (See No. 313 of my collection for the Smithsonian Institution.) We caught the smallest salmon, a grilse, of course, and a male, on the 16th of September. He was thin and worn, but full of very ripe milt. He weighed less than half a pound. (See No. 314*c*.) The largest female which was weighed was caught on the 28th of July. She weighed 22 pounds, (see No. 192*c*;) girth just in front of dorsal fin, 22½ inches. I think, however, that later in the season larger females were caught, which were not weighed. The smallest female was caught on the 17th of September, and weighed 6 pounds after being spawned; girth, 12½ inches. She yielded nearly 3,000 eggs. (See No. 315*c*.)

The first ripe male was caught on the 17th of August. The milt was ripe and good. He seemed to be in a healthy condition, but was dark and slimy. Weight, 26 pounds; girth, 23 inches. (See No. 280.)

The first female caught ripe in the net was taken on the night of the 29th of August. Two ripe ones were taken that night, but the weight was not observed. The two together yielded 13,000 eggs.

We found ripe females in the corrals three days before this. It might be inferred at first sight from this fact that confinement hastened the ripening of the spawn; but this does not necessarily follow, because the fish were, when caught, on their way to a higher point on the river, where the spawning-season naturally comes on earlier than it does lower down, so that the fish previously caught and now confined in the corrals were really earlier-spawning fish than those caught on the spot with ripe spawn in them.

The comparative weight of the spawn in the female fish, contrasted with the fish itself, may be inferred from the following specimen caught August 14:

Female salmon; spawn nearly ripe; weight, 19 pounds; length, 33½ inches; girth, 20½ inches; weight of spawn, 2¼ pounds. (See No. 206.)

On the 18th of August we caught with a hook a trout that had a very peculiar appearance, on account of the unmistakable marks of old age which it presented. It was very thin and lank. Its fins and tail were a good deal worn. Its eyes were sunken, and its whole appearence corresponded to that of an old dog or horse. It was the most aged-looking fish I ever saw.* (See No. 282.)

2.—CONFINING THE SALMON.

The corral.—The confinement of the parent salmon in suitable inclo-

* For a description of the appearance of the salmon of the McCloud River, and the changes which they undergo at the approach and during the progress of the spawning-season, see my report of operations on the McCloud River printed in the United States Fisheries Report for 1872.

sures, though it seems so simple a matter, was a very trying and difficult problem to solve, and gave us no end of trouble. To show the character of this difficulty, I will give my experience in the order in which it came.

We began building our inclosures by staking down a small circular fence of stakes in a shallow place in the river near the shore. The stakes were driven down one by one very firmly, and then firmly bound together and held in their place by withes. The main objection at first to this was that it was on too small a scale. We then built other inclosures on the same plan, but larger and deeper. This gave the fish more scope for jumping, and, although the top of the stakes was several feet above the surface of the water in the inclosure, the salmon easily jumped over them and escaped into the river. We then put a covering, or roof, over the corral on a level with the top of the fence. The salmon now, although they could not escape by jumping out, were no less persistent in their attempts to do so, and literally wore and lashed themselves to death in their frantic and ceaseless efforts to escape. I then built a large covered wooden box, 16 feet long and about 4 feet deep, and 5 feet broad, with wide seams between the boards to let the water through, and anchored it in the current. As the box when soaked sank nearly its depth in the water, the salmon had no chance to jump and lash themselves as in the staked inclosure, and we flattered ourselves we had found the solution of this troublesome problem of providing a suitable place of confinement; but what was our surprise and disappointment when, on examining the salmon in the box a few days after, we found them all dead. The close confinement of the box had really prevented them from injuring themselves as before by jumping, but at the same time had acted so unfavorably in other ways as to cause their death.

The prospect now looked very discouraging. We could catch salmon enough for our purpose, but we could not keep them alive. They were, in fact, dying as fast as we caught them. It now occurred to us that an open pond, supplied by a good stream of river-water, would obviate the difficulties presented, as then the fish, having nothing but dry land to jump on to, would give up jumping and remain quiet. I accordingly put on a force of Indians at once, and in a few days had a pond of considerable size ready, and supplied by a stream of water taken from the flume which conveyed the river-water from the wheel to the hatching-house. A large number of salmon were then put in here, and we felt decidedly encouraged. But now a new difficulty presented itself: the fish would not ripen in the pond. Whether it was that the roiling of the pond by their movements when frightened prevented the eggs and milt from maturing, or whether the friction produced by their incessant jumping is one of the necessary conditions of their ripening, I do not know, but it is certain that neither eggs nor milt matured in the pond, and I think we did not take a single ripe egg or any first-rate

milt from one of the fish there confined. My next move was to build a close board floor over the staked inclosures in the river, almost touching the surface of the water. This prevented the fish from wearing themselves out by jumping, and did not seem to interfere with their ripening, but it did not keep them wholly from dying. At last I became convinced, and am still of the opinion, that the Sacramento spawning-salmon cannot be kept alive in any inclosure on a small scale. There seemed now to be but one alternative left, and that was to let those die that were confined, and to keep on fishing and catch what were needed as we went along. This we did; and fortunately there were so many fish running in the river that we were able, even after this, to obtain enough to furnish the requisite supply of eggs.

Our experience this year has shown one thing, and that is that if a seine is used exclusively in future for taking the parent salmon, the true way will be to begin fishing only just before the spawning-season commences, for all the spawn that we took from fish caught and confined at that time amounted to very few indeed, while, on the other hand, there was no difficulty in catching enough salmon after the season commenced to yield our quota of two million eggs.

The best way, however, for catching the salmon on the McCloud is, I think, to extend, if practicable, some impassable barrier across the river obliquely, say at an angle of 45° with the course of the current, and to have the upper end lead into a large inclosure, or pound, where the fish can be conveniently taken out for spawning.

This method, though involving a good deal of labor at first, will compel all the fish ascending the river to enter the pound, and will, of course, obviate the constant labor and expense of drawing the seine, which is no inconsiderable item when kept up for a long time.

The current and volume of the McCloud River are so formidable that it may be impossible to construct such a barrier; but if operations are continued on that river another year, I propose to make the attempt to dispense entirely with drawing the seine. The pound will, of course, be arranged so that the fish not required for our purposes can be allowed to pass up the river to spawn. This, in fact, would be necessary for another reason; for, if the salmon were entirely cut off from ascending the river, the Indians above us would be sure to make trouble.

Moving the parent salmon.—The moving of the living parent salmon across the river, being quite an important feature of our work, deserves a few words here.

The river at the place of crossing was about sixty yards wide, with swift water part of the way, and rapids just below. On account of the rapid current, no very heavy load could be towed across in safety. Our first plan for conveying the fish across was to bring them in a large box placed on the stern of the boat. This answered very well for a small quantity, but was on too small a scale for the carrying of large numbers. Our next plan was to tow them over in the seine, but this was not only la-

borious work, but it gave the fish a chance to injure themselves. The next plan, and the one we finally adopted, was as follows:

We took the large box containing about 2,000 gallons of water, which was first used to keep the parent salmon in, and afterward abandoned, and placed it close to the corral where the salmon were confined; we then lifted the salmon out from the inclosure with a net and deposited them in the box. The box was so large that it would always hold all we had to carry across, and a great many more. The salmon being all in, the cover was fastened down, and the box was ready for transporting. The 2,000 gallons of water in the box weighed about ten tons, so that towing it through the current with the boat was not to be thought of, and we had not a strong line long enough to reach across the river. We accordingly attached one end of what rope we had to the box, and made the other end fast to a rock as high up above the box on the same side of the river as it would reach. Then the box being ready, the boatman unfastened the upper end of the rope, and started across the river at the same time that others pushed the box out into the current. By quick rowing he could cross with the boat-end of the rope before the box had become unmanageable in the current. The boat-end of the rope was then made fast on this side of the river, and the box, with some help from the boat, gradually swung across to where it was wanted. This little maneuver, though so simple as to seem hardly worth mentioning, really had to be conducted quite dexterously to be successful in our rapid and dangerous river, and on that account assumed more importance than it may seem to possess.

3.—THE INDIAN SENTIMENT IN REGARD TO CATCHING THE SALMON.

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 their river, with the exception of one settler, a Mr. Crooks, whom they murdered a few weeks after I arrived. 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 the white man. 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 taking possession of the land which they claimed as their own, and settling down on it. They assembled in force, with their bows and arrows, on the opposite bank of the river, and spent the whole day in resentful demonstrations, or, as Mr. Woodbury expressed it, in trying to drive us off. Had they thought they could succeed in driving us off with impunity to themselves, they undoubtedly would have done so, and 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 too vivid 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. Individuals frequently said to me afterward, however, that I was stealing their salmon and occupying their land; but it was more as a protest against existing facts than as an endeavor to make any change in the situation. Once, when I was walking alone in the woods on the other side of the river, an Indian with a very forbidding aspect met me, and said in the Indian dialect that he wanted to talk with me. I expressed my gratification at having an interview with him, and we sat down on the rocks, and the talk began. He was very much excited and very wrathful. He told me that this was his land, and that his fathers had always lived there, and that I had no right to be there. He said the salmon were his, too; that they belonged to his tribe, and that I was stealing his salmon. He ended by saying that the white men had lands and fish in other places, that the Indians did not go there and steal their lands and salmon, and that white men ought not to come here and take what belonged to the Indians. There is room enough in the world for the white men, he said, without taking this river from the Indians to live on.

I confess that his arguments seemed sound. The whole panorama of the Indian's wrongs and sufferings, as the history of this country portrays it, with the encroachments and injustice of the white man, and the gradual but certain disappearance of the red man before the advance of civilization, seemed to come up before my mind, and I felt that though I was the representative of a powerful and enlightened nation, I could not answer this poor, ignorant, indignant savage before me. I did not try to answer him, but I told him I was his friend; that I did not mean to take his land or his salmon; that I should go away in a few months; that I only wanted the spawn of the salmon; and that the Indians might have all the salmon as soon as I had taken the eggs. He was not satisfied or appeased, however, and left me in the same disappointed and indignant spirit with which he met me. This spirit continued to prevail among the tribe until we began to take spawn and to give them the salmon. Then, when they saw that they received only kind treatment from us always, and food and medicine occasionally, and that we gave them all the salmon to eat, securing only the spawn for ourselves, they seemed to see things in a new light. The public sentiment, I think, became entirely changed, and was pretty correctly expressed in what an Indian said to me, about that time: "I understand," said he, "you give Indian salmon; you only want spawn; that all right!"

I had one man in my employ who had fished on the McCloud the previous season for salmon on his own account; and, having taken some pains to clear away a fishing-ground for drawing the seine on the river-bank, he claimed the fishing as his private property. I allowed his claim at first, and paid him a considerable sum for the use of his ground, as he called it; but, after making inquiries, and taking legal advice

upon the point, I made up my mind that if any one had rights on the river, it was the United States Government, to whom it belonged and whom I represented. The demands of the man having become exorbitant, and it being illegal for him to sell his salmon if he caught any, I told him that, after a certain time, I should fish there on my own responsibility without paying any toll. He was exasperated beyond measure at hearing this, and when he found that I was in earnest, and meant what I said, he became dangerous, and attempted violence, which would certainly have been followed by fatal results, if it had not been for the vigilance and presence of mind of Mr. Myron Green, who had charge of him for nearly three hours, part of which time he acted like a raving maniac. I fished there, however, as I had announced, and the man acquiesced at last, though under protest. A more thorough investigation of the facts showed conclusively that I was entirely correct in assuming the right to fish on the grounds in question; no one under the circumstances having *exclusive* rights to fish there.

This circumstance led me to think that it might be desirable for the United States to reserve to themselves the right to fish in a certain portion of the McCloud, so that, under no circumstances, could its representatives be prevented from obtaining spawning-fish for breeding-purposes.

4.—SPAWNING THE FISH.

The first spawn was taken on the 26th of August, neither the males nor females being very ripe. At first, we thought it required three men to spawn the fish: one at the head, one at the tail, and one to take the eggs. Afterward, we found that two could manage it; and Mr. Green finally brought the work down to its greatest simplicity by putting the salmon's head between his knees, holding the tail with one hand, and taking the spawn with the other. As we did not undertake to save the salmon alive, this one-man method proved perfectly satisfactory, except with very large fish, and, of course, saved employing so much extra labor.

At first, also, all the eggs that we took came from the salmon confined in the corral; but, as the season advanced, we took more and more in the net, till at last most of the eggs were taken from the fish as soon as they were caught in the seine. The parent salmon were then thrown on shore for the Indians, and, of course, not confined at all.

Below will be found a daily list of the eggs taken during the season.

Daily list of salmon-eggs taken at the United States salmon-breeding establishment. McCloud River, California, during the season of 1873.

Date.	Number of eggs taken daily.	Total number in troughs.
August 26	23,000	23,000
August 29	58,000	81,000
Date unrecorded	38,000	119,000
	45,000	164,000
	95,000	259,000
	60,000	319,000
	48,000	367,000
	80,000	447,000
	110,000	557,000
	93,000	650,000
September 6	30,000	680,000
September 7	120,000	800,000
September 8	140,000	940,000
September 9	55,000	995,000
September 10	195,000	1,190,000
September 11	70,000	1,260,000
September 12	100,000	1,360,000
September 13	100,000	1,460,000
September 14	40,000	1,500,000
September 15	100,000	1,600,000
September 16	110,000	1,710,000
September 17	60,000	1,770,000
September 19	70,000	1,840,000
September 21	130,000	1,970,000
September 22	30,000	2,000,000

5.—THE HATCHING-APPARATUS.

The water-supply.—In the season of 1872, I used water for hatching from a spring-brook which emptied into the McCloud a short distance above the site of our present camp, and which had its sources about a mile to the west of the river. This brook gave us no end of trouble on account o its unsuitableness to its purpose. Its average flow in the morning was a little over 1,000 gallons an hour, but at night, after a very hot day, it would shrink to 250 gallons. It would also heat up some days to a very dangerous temperature; then, again, the hogs, which run in the woods in a semi-wild state, would wallow in it and make it so roily that all attempts to filter it clean were fruitless; and, last but not least, there was present in the water all the time a vegetable growth, resembling our eastern *Conferva*, yet somewhat dissimilar to it, that no device of ours could cleanse the water of. It seemed to be ubiquitous, and gave a great deal of trouble.

These combined disadvantages of the water-supply of 1872 decided me to abandon it this season, and to look elsewhere for water. But here a new difficulty arose. There was no other spring or brook of any magnitude within several miles. To go that distance to locate would either

destroy our stage-communication or take us away from the river. There was but one alternative left, and that was to take the water-supply from the McCloud. To accomplish this, a ditch was commenced from a point about fifty rods above the new hatching-house site, and was continued for about two hundred feet, when it was abandoned; the obstacles in the way of its successful prosecution making it practically useless.

We were now left without any water-supply whatever. There were salmon in abundance at our very feet, but no water to hatch the eggs with.

The wheel-pump.—In this emergency, the idea of raising the water from the river itself by a wheel was suggested, and immediately put into practice. From this time till it was finished, the wheel was the central object of interest at the camp. So much depended upon it and its successful working, and the project was so novel and unprecedented, that the progress of the work on it was watched with the greatest solicitude; and, at last, when it was completed, and actually revolved and lifted its 6,000 gallons of water an hour higher than our heads, and poured it down the flume into the hatching-troughs, our relief and enthusiasm were unbounded. I celebrated the occasion by raising at sunset a large American flag over the camp.

I consider this device for raising water for hatching-purposes one of considerable importance, as by this method a water-supply can be obtained on any similar salmon or trout stream when all other resources fail, and in regions where no other water-supply is available. On account, therefore, of its possible value to future operations, I will be more explicit in describing the wheel than might otherwise be thought appropriate. The wheel was placed in the rapids, just below the hatching-house, on our side of the river; the shore-pier resting on the river-bank. The other pier was built at the required distance out in the water, and was constructed by fastening heavy timbers together in the shape of a triangle, and filling the inclosed space with large rocks; the timbers forming the triangle being 12 feet long on the hypotenuse, and those on the sides being 8 feet long. The shaft was 11 feet long and 9 inches in diameter. The journals were 9 inches long and 7 inches in diameter. The journals were of pine and the boxes were of oak. The wheel was 12 feet in diameter, 8 feet wide, and had 16 paddles, each 15 inches wide. The buckets, containing between 4 and 5 gallons each, were arranged around the circumference of the wheel, on the shore-side of it, and were, of course, so constructed as to fill at every revolution, and discharge their contents just at the right moment.

A margin of several inches was allowed for raising and lowering the wheel in the water, so as to regulate its power at pleasure. The velocity of the current in which it was placed was such that, with my utmost exertions, I could just hold our fishing-boat against it with a good pair of oars.

At last, after many trials and discomfitures, and renewed efforts in

constructing the wheel, it was finally pronounced complete, and our whole camp assembled to see it lowered into the water. To say that we were breathless with excitement was no exaggeration. Our suspense cannot be overdrawn. The situation, as it presented itself to our minds, was simply this: if the wheel worked well, our efforts to obtain salmon-eggs would be a success; if the wheel did not work, our whole expedition would be a failure. No wonder we watched the lowering of the wheel with absorbing interest. Our disappointment and dismay can hardly be exaggerated, then, when we perceived the wheel, having reached its resting-place, give a convulsive start, revolve perhaps a third of the way around its axis, utter a groan, and stop entirely. There was not power enough to lift the buckets of water. We then went to work to throw out a wing-dam on the river-side of the wheel, about 30 feet in length and at an angle of nearly 45° with the river-current. This was built by making fast one end of a large log to the outer pier and the other end to a point on the shore above by means of a cable, and filling in underneath the log with rocks and brush. To obtain the log was at first quite a problem, for the dam required one that our whole force could not move. We overcame this difficulty by going half a mile or so up the river and felling a large tree into the current. This as it lay in the river, we sawed into the requisite length, and then, with a good deal of labor and no little excitement and danger, towed down through the intervening rapids to the wheel. This dam increased the force of the water against the paddles very materially To gain still more power, we cleared out the channel below the wheel by exploding giant-powder in the obstructing rocks.

Everything being again ready, the wheel was once more lowered A more vigorous start, a somewhat longer revolution, another groan, and another entire stoppage was the result. Not a drop of water was raised up to the flume.

We were, however, very near the fulfillment of our hopes. We now had a bucket at every paddle, making sixteen in all. The wheel was required, therefore, to raise 16 buckets: 16 times 4½ gallons, or 72 gallons (720 pounds) at every revolution. There was evidently not power enough for that amount of work. So, to obviate this difficulty, we knocked off every other bucket, leaving eight only. The next time the wheel was lowered it creaked and groaned as the buckets filled, but revolved entirely around, and continued to do so without interruption, with a motion that seemed to our gratified eyes really majestic. Our watches showed that it made three revolutions a minute, raising 108 gallons in that time, or 6,480 gallons an hour. The problem of obtaining hatching-water was solved, and our minds were relieved of a great suspense and anxiety. The working of the wheel was from this time to the end a perfect success. The river was fed by the steadily-melting snows of Mount Shasta, so that it never fell, and, as no rains occur at that season in California, it never rose. The wheel revolved regularly,

without interruption or change, until the eggs were matured and sent to their destinations.

The work that this simple contrivance accomplished really seems surprising. It raised 1,080 pounds 10 feet, or 10,800 foot-pounds every minute. This was 648,000 foot-pounds an hour, or 15,552,000 every day.

Our water-supply was now guaranteed, and the rest of the hatching-preparations were comparatively simple.

The flume.—They consisted of a flume from the wheel to the filtering-apparatus, the filtering-apparatus, and the hatching-troughs. The flume was a simple structure of wood, about fifty yards long, supported by trestle-work.

The filtering-boxes.—The filtering-boxes were made unusually large. This was rendered necessary by the spawning of the salmon in the river. In building and covering up their nests, they filled the water with particles of earth and vegetable growth, which, at that season, it required a great deal of filtering to keep out. I used three filtering-boxes, one large one, which first received the water, and two smaller ones, which received the water from the larger one. The larger box contained one screen of two thicknesses of mosquito-bar, and four screens of flannel, each measuring 3½ by 3 feet, yielding, in all, 63 square feet of filtering-surface. The smaller boxes contained one screen of three thicknesses of mosquito-bar, and seven flannel screens, having each about 2 square feet of filtering-surface.

The water of the McCloud River.—The water of the McCloud at the spawning-season is peculiar. It is not roily in the common sense of the word, or in the least approaching to being muddy; but the impurities in it, which have been stirred up from the bottom of the river by the working of the parent fish while spawning, can be distinctly seen, mechanically held in the water, which, with the exception of the presence of these foreign particles, seems very clear and pure. It has at this season more the appearance of water in which fine sand has been stirred up than what is generally considered turbid or roily water.

The distributing-spout.—The filtering-tanks conveyed the water into the distributing-spout, and the distributing-spout discharged it into the hatching-troughs.

The hatching-troughs.—The hatching-troughs were placed parallel with each other, and at right angles with the distributing-spout, as is the usual custom in hatching-houses. There were ten rows of troughs placed in pairs, with a passage-way between each pair, and in each row were three troughs, each sixteen feet long, placed end to end, one below the other, so as to give a fall from the first to the second, and from the second to the third, of a few inches. The troughs were on an average about breast-high, and were furnished with covers made by stretching white cotton cloth on a light frame of wood. Most of the eggs rested on the charcoal bottom of the troughs; but I used trays to a considerable extent formed of iron-wire netting, coated with asphaltum, and

found them satisfactory for maturing eggs in for shipment, though I do not think fish hatched in the asphaltum troughs are as healthy as those hatched in charcoal troughs.

Seth Green's shad-box.—I also used, by way of experiment and with Seth Green's permission, half a dozen of his shad-hatching boxes, anchoring them in the river-current. They worked so well that I have no doubt that, in a river of a warm-winter temperature like that of the Sacramento, salmon-eggs could be hatched in them with perfectly satisfactory results, which adds another merit to this very simple but wonderfully effective invention. The only difficulty which we experienced with the boxes was the inconvenience of getting at them to pick out the dead eggs. On account of this inconvenience, I would prefer the stationary hatching-troughs if I had my choice, but should feel perfectly confident of hatching successfully any number of salmon-eggs with nothing but the shad-boxes.

The tent.—The whole hatching apparatus (excluding, of course, the flume and wheel) was covered in as before mentioned by a large and substantial tent 60 feet by 30 feet. The hatching-house, or, more properly speaking, hatching-tent, contained our work-bench and tools, and was the place where all the mechanical work was done.

6.—HATCHING THE EGGS.

Considering that the eggs were matured under so many entirely new conditions, and where eastern experience in hatching salmon-eggs furnished in many points no precedent for a guide, I think the hatching succeeded remarkably well.

There were losses, however, the causes of which may be classed chiefly under six heads:

1. Loss by suffocation.
2. Loss from direct rays of the sun.
3. Loss from diffused light of the sun.
4. Loss from inherent causes.
5. Loss from excessive agitation.
6. Loss from want of impregnation.

Death of eggs by suffocation.—The loss that resulted from this cause was very trifling. At the lower end of one of the lower troughs containing some of the most advanced eggs, one of the division-cleats separating the compartments had been made so high as to impede the circulation of the water just above it, in consequence of which some of the eggs in the water had an insufficient supply of air, and were suffocated. I may add here that I have noticed that a vast amount more of circulation in the hatching-water is demanded by trout and salmon eggs at a late period of their development than at the earlier stages. When these eggs are first taken, they can be literally piled together in heaps, in water having a very slight movement, without danger; but after the embryo has shown itself distinctly in the egg, great caution must be

exercised in regard to crowding them or placing one tier above another, and an abundant circulation must be provided to prevent suffocation. In the case in question, the eggs were two tiers deep; the circulation about the eggs of the lower tier was insufficient, and loss ensued. The mischief, however, was almost immediately discovered, and the causes removed, so that the loss did not exceed 900 eggs.

Loss from direct rays of the sun.—The lower end of the hatching-troughs extended almost to the eastern end of the tent, so that the morning sun, unless the canvas covering of that end of the tent was carefully kept down, shone directly into the open end of the hatching-troughs. As the tent was made a thoroughfare by the Indians, and by our own household also, there was constant passing through it, and the folds of the canvas were sometimes left carelessly raised at night, so as to expose the eggs of the lowest compartments of the troughs to the direct rays of the early morning sun. The consequence, of course, was the loss of all the eggs so exposed. This accident happened with what might have justly been called an unpardonable frequency had we not all of us had our hands too full otherwise to look after this source of mischief. The mortality from this cause during the whole season, including both before and after we discovered the cause, amounted to perhaps 30,000 eggs.

Loss from the diffused light of the sun.—This was the main cause of mortality among the eggs this season; and it was all the more destructive because I was not aware before then that sunlight distributed and diffused through a barrier of canvas was fatal to the life of the eggs. This proved to be the fact, however. The fact was even worse than this; for the light, after passing through the canvas covering of the tent, and also through the cloth covering of the troughs, destroyed the eggs. This was so unexpected, and, I think, so unprecedented, that we were a long time discovering the cause of the trouble. Some simple experiments, however, revealed the fact that the diffused light of the tent was killing the eggs. The obvious remedy, of course, was covers. To provide board covers was out of the question; for it would take a week, certainly, and perhaps two weeks, to get the lumber; so I sent to the nearest town for some cotton cloth, and made covers from it by stretching the cloth on tight wooden frames. These were placed on the troughs. The sunlight had now the tent-canvas and the cloth covers to pass through, and I felt safe. But they were insufficient, and the cause being of so extended a nature, and being accompanied by consequences of a correspondingly extensive character, a great many eggs were lost. Even in the few troughs to which we could afford board covers, the diffused light through the cracks, reflected from the inner surface of the sides of the troughs, destroyed a considerable number of eggs.

It should not be inferred from this that the total number of eggs obtained in the end was reduced any by these losses. The effect of the

losses was not to diminish the total number of eggs, but simply to make us more work; for the fact was that salmon-eggs were so abundant that any loss could be replaced at once, and was actually so replaced as fast as the loss occurred. By referring to the daily table of eggs taken, it will be seen how easily this was done. For instance, from the 10th day of September to the 13th, inclusive, we took 465,000, which was more than enough to cover all losses to the impregnated eggs from all causes combined.

Loss from inherent causes.—I include under this head losses that occurred with eggs that were already injured when they left the fish, and which could not live under any circumstances, as, for instance, eggs taken from dead fish, (chiefly by way of experiment,) and eggs already dead when in the fish. This loss—if to be deprived of anything which never had any value in the beginning may be considered a loss—may be set at 30,000.

Loss from excessive agitation.—This loss occurred, of course, in the earlier stages of the embryo; agitation, though very fatal at first, being harmless in the later stages of the eggs' development. The agitation was caused (*a*) by the action of the supply-stream on eggs placed too near the point where the stream falls into the hatching-troughs; (*b*) by carelessness of our Indian assistants in feathering the eggs when picking them over; (*c*) by the action of the river-current on the eggs which were placed in Seth Green's shad-hatching boxes.

The first two causes need no comment. In regard to the third, I will say that in experimenting with the shad-hatching boxes, we placed some of them at first in too active a current, which gave the eggs so much agitation that they became addled, and died. After a little experience, we learned what force of current they needed, and subsequently had capital success with them.

Mr. Woodbury informed me that after my departure he succeeded in finding just what degree of movement in the water was required for the salmon-eggs, so that his later experiments were attended with as good success as we met with in the hatching-troughs.

The losses from all causes of agitation combined I estimated at 100,000.

Loss from want of impregnation.—The mortality from other causes was not distinguishable from that resulting from want of impregnation, so that it is impossible to ascertain what the loss from this cause was this season. I should say, however, that the unimpregnated eggs numbered less than 100,000, or 5 per cent. of the whole. This would place the percentage of impregnated eggs at 95 per cent. I may add here that on account of the abundance of salmon-eggs on the one hand, and the scarcity of time on the other, it was often more of an object to save time than to get a very high rate of impregnation. For instance, supposing that, in taking 100,000 eggs, an hour should be consumed in taking pains to save 2 per cent. in the impregnation, the gain would be 2,000 eggs. The same amount of time spent in catching additional salmon and

spawning them rapidly would have yielded, say 6 female salmon, or 30,000 eggs, of which 28,000 would be impregnated. This, it will be seen, is fourteen times the number gained in the same time by careful impregnation, which shows that the time spent in getting eggs is better rewarded than that consumed in laboring to obtain high percentages of impregnation.

To resume now the chronological order of events, I will repeat that by the 19th of August we turned the water through the hatching-house, and had the pleasure of seeing what I had long looked forward to, a successful hatching-apparatus in perfect working-order in the salmon-breeding regions of the Pacific slope. There seemed to be something in the very sound of the rippling and plashing water to exhilarate our spirits as it leaped through the troughs for the first time. I celebrated the day by collecting our whole force of whites and Indians at sunset and raising a large American flag over the camp.

We continued to catch more salmon and to build more corrals for them, and to extend the preparations for hatching the eggs. The female salmon now began to show every sign of being nearly ready to spawn, and we were daily expecting to find some ripe eggs. We remained, however, in this not unpleasant state of excitement and anticipation until the 26th of August, when we took the first ripe salmon-eggs of the season, numbering 23,000.

Now came a new and unexpected drawback. The salmon, confined in the corrals, had been literally wearing themselves out in their frantic endeavors to ascend the river. Every moment, day and night, impelled by their irrepressible instinct, they kept jumping and lashing themselves against the sides of the inclosures, and now, comparatively exhausted by their efforts and bruises, they were beginning to die from the effect of them. Fortunately, there were enough more in the river to get eggs from, for had we depended on our stock on hand when the first eggs were taken we should have obtained a very meager supply. As it was, I kept on fishing and replacing the dead salmon with live ones, so that we had no lack of eggs, and obtained in the end the full two millions, at which number I had set my limit.

Nothing further occurred to interrupt our steady progress. We continued to take eggs every twenty-four hours, both night and day, and the number in the troughs increased rapidly.

On the 10th of September, at noon, we had a million eggs laid down; on the 14th of September, at daylight, we had a million and a half; and on the 22d, at daylight, the quota of two millions was complete. On the 12th of September, the first eye-spots were visible in the eggs taken on the 26th of August, making sixteen days for the interval between the extrusion of the eggs and the appearance of the eye-spots, (the formation of the choroid pigment.) The water in the river had a temperature of 53° at sunrise when the first eggs were taken; but it always rose in the hatching-troughs during the day, sometimes to 58°, and sometimes as high as

64°, so that the exact average temperature of the water for the whole time cannot be stated.

On the 20th of September, I sent 300,000 eggs to the Atlantic coast; and on the 30th of September, I went east myself with 600,000 more, leaving the camp in charge of Mr. Woodbury.

On the 6th of October, Mr. Myron Green left camp with a third lot of a quarter of a million; and about a week later, Mr. Woodbury forwarded by express the balance of the eggs, amounting to another quarter of a million, or more.

7.—PACKING AND SHIPPING THE EGGS.

The taking of the eggs and the maturing of them for shipment was a marked success. Indeed, I have never seen a finer lot of salmon-eggs than we had in the hatching-troughs under the mammoth tent at the McCloud. Nothing could be wished for more happy and prosperous than our progress up to the point of shipping the eggs; but here came a formidable and threatening difficulty.

Between our camp and the waters which were awaiting the eggs, there lay a long stretch of three thousand miles of land, which must be crossed by the young embryos before they could be made available for the service for which they were intended. It was enough to make the most confident enthusiast falter.

We all looked forward to this dangerous journey of the eggs with dread. When we packed them in the moss, and screwed down the covers, it seemed like burying them alive; and when we saw the crates containing them loaded into the wagons, and sent off to the railroad-station, and thought of the almost interminable journey before them, and the ten thousand chances of injury that these frail creatures would be exposed to on the way, it seemed nothing less than infatuation to expect that they would survive them all and ever see the light again alive.

They must go, however, and we packed them as well as we could, and sent them off. The boxes in which they were packed were all two feet square and a foot deep. The eggs were packed as usual, with first a layer of moss at the bottom of the box, and then a layer of eggs, then another layer of moss, and so on to the top. Midway in the interior of each box, there was a thin wooden partition, to break the force of the superincumbent mass of moss and eggs. We packed about 75,000 in a box. When the box was filled, the cover was screwed down, and it was packed with another one of the same size in a crate, which was three inches and a half larger on all sides than the combined bulk of the two boxes inclosed; this intervening space being filled with hay to protect the eggs from sudden changes of temperature. On the top of the crates was a rack for ice. The nearest and only suitable moss that we could hear of was seventy miles away, at the sources of the Sacramento River. I accordingly dispatched Mr. Woodbury to Mount Shasta to procure a

supply. He returned in a few days with thirty-five bushels of moss, all of which we used in packing.

The manner of the packing has been a matter of considerable criticism. On this point, I will only say that I had but one precedent to be guided by, viz, the shipment of salmon-eggs from the same place the last year. It was reported concerning this consignment that the eggs which did not hatch on the way arrived in excellent order. In a critical and difficult undertaking like this in question, there seemed to be no choice between adopting a method which had succeeded and others which had never been tried, so I adhered to the plan of the last year's shipment, and packed these eggs in precisely the same way.

8.—THE METHOD OF PACKING DISCUSSED.

To give the *pros* and *cons* of this method of packing would lead to a long discussion, which would, perhaps, be out of place here; so I will simply say that the packing was no hap-hazard affair, but the result of careful thought, and the exercise of as much foresight in regard to the journey as we could bring to bear upon the subject; and even now, after plenty of leisure for reflection, I do not know of any other practicable method of packing salmon-eggs which are to be sent this overland journey, without an attendant, which secures as many favorable combinations, or which is not open to quite as many objections, as the one adopted. Indeed, I think the results were a decided vindication of the merits of the packing. The first lot, forwarded in September, was undoubtedly destroyed by the heat; the second lot arrived in as good order as could be expected; the third lot was reported to arrive in excellent condition; and the fourth and last lot came the best of all. Of those sent to Great Salt Lake, distant a thousand miles, only 3 per cent. were lost. What more could be asked of the packing? A method that will carry salmon-eggs a thousand miles with a loss of only 3 per cent. cannot be a very bad one. Seth Green reports a loss on the 200,000 eggs consigned to him of only 11 per cent. both in transportation and in hatching. This certainly does not seem to reflect any discredit on the packing of the eggs; and when we remember that they came from a climate where the mercury stood at 110° in the shade, and that they were conveyed twenty-two miles in a wagon, to begin with, over a very rough mountain-road, and after that three thousand miles by rail, I think it is rather creditable to the packing than otherwise. I am open to conviction, however; and if there is any better way of packing the salmon-eggs for their overland journey, I should like to know it, and should be thankful for any light on the subject.

9.—COST OF THE EGGS.

The cost of getting the ova and preparing them for transportation was about $4,000. There were very nearly 1,500,000 impregnated eggs in good condition for shipment. This makes the cost of the eggs at the

hatching-works $2.66 a thousand. I think in future, with the experience that has been acquired and with the work that has already been accomplished, that it is highly probable that the eggs can be got out at a still less expense; and I should not be surprised, in the event of the undertaking being repeated on the McCloud River another year, if 5,000,000 eggs could be secured at a cost of $5,000, gold, or at the rate of $1 a thousand.

10.—JOURNAL OF OVERLAND TRIP WITH SALMON-EGGS.

Below will be found an account of an overland trip with one lot of California-salmon eggs:

At 4 o'clock on Tuesday afternoon, September 30, 1873, all the eggs for one shipment, to the number of 600,000, having been packed in three large crates, we began moving them to the wagon which was to carry them to the railroad-station at Redding, Cal. The crates containing the eggs averaged in weight about 300 pounds apiece, and it was a difficult job, in the burning sun, to get them up the long, steep hill to the stage-road where the wagon was waiting. With the help of half a dozen Indians, it was accomplished at last, however, and at about 5 o'clock I started for Redding, distant twenty-two miles. So rough and difficult is the road that we did not reach our destination till 1 o'clock in the morning. I had previously arranged to have 200 pounds of ice provided at Redding, which I distributed on the crates.

The eggs were consigned as follows: To Seth Green, Rochester, N. Y., 3 boxes, 200,000; R. G. Pike, Middletown, Conn., 2 boxes, 150,000; F. W. Webber, Cold Spring trout-ponds, Charlestown, N. H., 1 box, 50,000; E. A. Brackett, Winchester, Mass., 1 box, 50,000; C. G. Atkins, Bucksport, Me., 1 box, 50,000.

The train left Redding at 3 o'clock a. m., on Wednesday, October 1, for Sacramento City, which I reached safely at 1 p. m., the crates apparently in good order. I left Sacramento on the Central Pacific Railroad on the train going east at 2 p. m. the same day; the eggs being in Wells & Fargo's express-car. The morning was warm; the night had been quite cool. The next morning, Thursday, October 2, I telegraphed for ice at Carlin, which was furnished when the train reached that point, and which I broke up and put on the crates.

On Friday morning, October 3, at 7 a. m., we reached Ogden, and the crates were transferred to the express-car of the Union Pacific Railroad train, which connects here with the Central Pacific Railroad. During the afternoon of Friday I opened one of the crates, and examined the top layer of eggs. They were in perfect order, and looked precisely as well as when they were first packed. I put on more ice and left them till morning. On Saturday morning, October 4, I got up early, and went to the express-car to examine the crates. The night had been cool, but the express-messenger had kept a hot coal-fire in the car and it was very hot. I procured a lot of ice at Cheyenne, Wyo., which I used at once,

and telegraphed ahead to Laramie for more. The day was comfortably warm. No mishaps occurred except the heating-up of the car the night before.

On Sunday, October 5, at 1 p. m., we reached Omaha, crossed the Missouri River, and left Council Bluffs at 3 p. m., on the Chicago, Burlington and Quincy Railroad. That night was quite cool.

On Monday, October 6, at 3 p. m., we reached Chicago. The last night was cold and favorable for the eggs. Left Chicago on the Michigan Central at 5.15 p. m., with the eggs apparently in good order. Up to this time I had kept constantly replenishing the crates with ice.

On Tuesday morning, October 7, at 4 o'clock, we entered Canada on the Great Western Railroad, and the Union Pacific express-car, which still accompanied the train, was sealed up by the custom-house officers, so that I could not enter it till we left Suspension Bridge that afternoon at 2 o'clock. The crates had been well provided with ice, however, the night was frosty, and the day was cool, so I did not feel uneasy about the eggs. The car which contained them had a large amount of gold and silver coin and bullion in it, and the messengers had instructions to keep every one out of the car. Their instructions are so imperative in this particular that they will not even listen to any explanations. I had fortunately provided myself with a letter from Mr. Tracy, of Sacramento, one of the head managers of Wells & Fargo's express, and by means of it managed to get aboard the express-car and attend to the crates. Without the letter, there would have been no chance whatever of getting at the eggs. Even with such a letter a man insisting on entering the car runs a risk of being injured by the messenger's revolver. We arrived at Rochester about 5 p. m., Tuesday, October 7. Here I left the three boxes (a crate and a half) for Seth Green.

Tuesday night, at 2 a. m., the train reached Albany with the crates in good order. I went to bed supposing that the express-car would go on with the train to Boston, but in point of fact it is the custom to leave it at Albany.

On Wednesday morning, October 8, at about 8 o'clock, the train arrived at Boston. To my great surprise and dismay I could not find the salmon-eggs for Mr. Atkins and Mr. Brackett, and now learned for the first time that they had been left with the car at Albany. I was the more chagrined at this because I had been so very careful to keep with them. I might almost say I had hardly let them go out of my sight, and now at the end of this long and exceedingly anxious journey, just as I thought my care had been rewarded with success and was at an end, there came this disappointment and new anxiety. I could not get track of these eggs again or learn for some time what delayed them; and it was three days before Mr. Brackett got his and four days before Mr. Atkins received his. It was very provoking, when time was so precious, to reflect that the eggs were one-half as long going from Albany to Winchester, two hundred miles, as from our camp to Albany, three thousand two hundred miles. As the weather was very warm during these intervening days,

it is surprising that the eggs were not entirely lost. Mr. Brackett, however, saved one-half of his, and Mr. Atkins one-tenth of his consignment. The eggs for Mr. Pike and for the Cold Spring trout-ponds were put off at Springfield, Mass. The latter arrived in good condition, but there was a large loss in the former lot. I learned subsequently from Seth Geen that his lot of 200,000 arrived in excellent order, and that only 11 per cent. of the eggs were lost, both in transportation and in hatching.

11.—DISTRIBUTION OF SALMON-EGGS.

The following table shows how the eggs were shipped and distributed.

First lot was shipped September 20, 1873	300,000
Second lot was shipped September 30, 1873	500,000
Third lot was shipped October 7, 1873	330,000
Fourth lot was shipped October 14, 1873	250,000
Fifth lot was shipped October 19, 1873	20,000
	1,400,000

The various shipments were distributed as follows:

First shipment, September 20, 1873:		
To J. H. Slack, Bloomsbury, N. J	150,000	
To James Duffy, Marietta, Pa	150,000	
Total		300,000
Second shipment, September 30, 1873:		
To Seth Green, Rochester, N. Y	200,000	
To R. G. Pike, Middletown, Conn	150,000	
To F. W. Webber, for United States Fishing-Commission, Cold Spring trout-ponds, Charlestown, N. H	50,000	
To E. A. Brackett, Winchester, Mass	50,000	
To Charles J. Atkins, Bucksport, Me	50,000	
Total		500,000
Third shipment, October 7, 1873:		
To A. P. Rockwood, Salt Lake City, Utah	40,000	
To George H. Jerome, Niles, Mich	120,000	
To James Duffy, Marietta, Pa	20,000	
To J. H. Slack, Bloomsbury, N. J	150,000	
Total		330,000
Fourth shipment, October 14, 1873:		
To J. H. Slack, Bloomsbury, N. J		250,000
Fifth shipment:		
To Dr. W. A. Newell, San Francisco, Cal		20,000
Total		1,400,000

F—CATALOGUE OF COLLECTIONS SENT TO THE SMITHSONIAN INSTITUTION IN 1873.

190. First male salmon taken; caught with a hook; weight, 8 pounds; girth, 14 inches; McCloud River, California, July 27, 1873.
191. Male salmon; weight, 5 pounds; girth, 13 inches; McCloud River, July 27, 1873.
192. Salmon caught in seine; weight, 22 pounds; girth, 22 inches; female; July 28, 1873.
193.
194.
195. Six small trout, McCloud River, California, August 6, 1873.
196. Two heads of small male salmon, McCloud River, August 6, 1873.
197. Female salmon; weight, 21 pounds; girth, 21 inches; caught with seine and kept some time in pen; fins and tail partly destroyed by fungus and abrasion; McCloud River, California, August 6, 1873.
198. Trout, McCloud River, August 8, 1873.
199.
200. Trout, McCloud River, August 8, 1873.
201. Jar of trout, McCloud River, August 7, 1873.
202. Four small trout, McCloud River, August 7, 1873.
203. Skin and head of female salmon; weight, 10 pounds; full of spawn, not separated, but nearly ripe; meat, dark salmon-color; skin now quite dark, slimy, and scales nearly absorbed; August 8, 1873.
204. Female salmon; weight, 12 pounds; girth, 17 inches; August 13, 1873; McCloud River.
205. Male salmon; weight, 4 pounds; girth, 11 inches; McCloud River, California, August 13, 1873.
206. Female salmon; very slimy and dark; weight, 19 pounds; girth, 20½ inches; length, 33½; spawn weighed 2¼ pounds and was nearly ripe; August 14, McCloud River, California, 1873.
207. Pyloric appendages and roe of 206.
208. Male salmon; weight, 6 pounds; girth, 13 inches; August 3, 1873, McCloud River, California.
209. Male salmon; weight, 5 pounds; girth, 12½ inches; McCloud River, California, July 29, 1873.
210. Female salmon; weight, 21 pounds; girth, 21 inches; McCloud River, California, August 6, 1873.
211. Male salmon; weight, 24 pounds; girth, 21 inches; McCloud River, California, July 30, 1873.
212. Female salmon; weight, 20 pounds; girth, 18 inches; McCloud River, California, July 25, 1873.
213.

277. Female salmon; weight, 19 pounds; girth, 19½ inches; full of eggs nearly ripe; McCloud River, California, August 15, 1873; very slimy, but not in bad condition.
278. Female salmon; weight, 8 pounds; girth, 14 inches; McCloud River, California, August 15, 1873; full of eggs nearly ripe.
279. Grilse; McCloud River, California, August 15, 1873.
280. Large male salmon; milt ripe and good; weight, 26 pounds; girth, 23 inches; McCloud River, California, August 17, 1873; in good condition, but dark and slimy; first ripe male taken.
281. Pyloric appendages of 280, (in jar.)
282. Trout, (see drawing;) probably an aged individual; fins and tail worn considerably; thin and slab-sided; weight, 4 pounds; girth, 11 inches; caught with a hook; McCloud River, California, August 18, 1873.
283. Lizard, (local name "salamander";) McCloud River, California, August 18, 1873.
284. Stomach of No. 282.
285. Male salmon, (see drawing;) weight, 28 pounds; girth, 23 inches; scales all absorbed; one of the largest caught this season; McCloud River, California, August 20, 1873.
286.
287.
288. Trout, Utah Lake.
289. Snub-nosed trout, San Andres Lake; spawning-season.
290. Fish from Utah Lake.
291. Fish from Utah Lake.
292. Trout from Utah Lake.
293. Trout from Utah Lake.
294. Fish from Utah Lake.
295. Trout from Utah Lake.
296. Trout from Utah Lake.
297. Trout from McCloud River, July, 1873.
298. Salmon-skin, McCloud River, August, 1873.
299. Trout, McCloud River, August, 1873.
300. Trout, McCloud River, August, 1873.
301. Split-tail, (herring,) same as Sacramento split-tail, McCloud River, August 23, 1873.
302. Grilse, McCloud, August 26, 1873.
303. Grilse, McCloud, August 26, 1873.
304. Male salmon; weight, 28 pounds; girth, 22 inches; McCloud River, September 1, 1873.
305. Male salmon; weight, 20 pounds; girth, 21 inches; McCloud River, September 2, 1873.
306. Jar of young trout and salmon, McCloud River, September 2, 1873.
307. Trout, McCloud River, California, September 3, 1873.
308. Trout, September 3, 1873, McCloud River.

309. Trout, McCloud River, California, September 3, 1873.
310. Head of male salmon, McCloud River, California.
311. Very small grilse, McCloud River, September 9, 1873.
312. Female-salmon skin after spawning, September 9, 1873.
313. Very large male salmon; weight, 29 pounds; girth, 22 inches; length, 3 feet 5 inches; McCloud River, California, September 14, 1873.
314. The smallest grilse caught this season, thin and worn, but full of milt and very ripe, McCloud River, California.
315. Smallest female caught this season; weight, after spawning, 6 pounds; girth, 12½ inches; contained about 2,500 eggs; McCloud River, California, September 17, 1873.
316. Salmon-trout, McCloud River, September 19, 1873.
317. Trout, McCloud River, California, September 19, 1873.
318. Trout, McCloud River, California, September 19, 1873.
319. Trout, McCloud River, California, September 21, 1873.
320. Trout-skin, McCloud River, California, September 22, 1873
321. Trout-skin, McCloud River, California, September 22, 1873.
322. Skin of female salmon; weight, 13 pounds; girth, 17 inches; McCloud River, California, September 26, 1873.
323. Skin of female salmon; weight, 13 pounds; girth, 17 inches; McCloud River, California, September 20, 1873.
324. Coarse tule matting, Clear Lake Indians, Lake County, California, February, 1873.
325. Fine tule matting, Clear Lake Indians, Lake County, California, February, 1873.
326. Material from which Indian baskets are made, Clear Lake, Lake County, California, February 10, 1873.
327. Trout, McCloud River, California, September, 1873.
328. Trout, McCloud River, California, September, 1873.
329. Trout, McCloud River, California, August, 1873.
330. Trout, McCloud River, California, August, 1873.
331. Trout, McCloud River, California, August, 1873.
332. Trout, McCloud River, California, August, 1873.
333. Trout-spawn, McCloud River, California, September, 1873.
334. Jar containing 56 small trout (or salmon) and three packages of pyloric appendages, McCloud River, California, August and September, 1873.
335. Jar containing small trout (or salmon) McCloud River, California, August and September, 1873.
336. Lizards, (local name "salamander,") McCloud River, California, August, 1873.
337. Unknown quadruped, McCloud River, California, August, 1873.
338. Bottle of exceptionally large salmon-eggs, McCloud River, California, September, 1873.
339. Jar containing three California lizards, also large salmon-eggs, McCloud River, California, September, 1873.

340. Sacramento salmon, artificially hatched at Cold Spring trout-ponds, Charlestown, N. H., December, 1873.
341. Hat (or basket) of McCloud Indians, McCloud River, California, September, 1873. (See 326.)
342. Spear-points, made of ankle-bone of deer, used by McCloud Indians for spearing salmon, October, 1873, McCloud River, Shasta County, California.
343. Indian girdle, badge of honor, McCloud Indians, McCloud River, California, September, 1873.
344. Indian rope, made from plant which grows on Little Sacramento River, McCloud Indians, California, September, 1873.
345. Hat, (or basket,) McCloud Indians, McCloud River, California, September, 1873. (See 326.)
346. Manzanita-berries, and flour made from berries by McCloud Indians, McCloud River, California, September, 1873.
347. Soaproot, used by McCloud River Indians for soap, and to make brushes, McCloud Rivér, California, 1873.
348. Omitted.
349. Insect supposed to make noise at night, McCloud River, California, September 10, 1873. (Contributed by B. B. Redding.)
350. Moth from Summit station, Central Pacific Railroad, Sierra Nevada, California, December 22, 1873. (Contributed by B. B. Redding.)
351. Plume of the McCloud Indians, McCloud River, California, September, 1873.
352. Plume of McCloud Indians, McCloud River, California, September, 1873.
353. Plume worn by Indian Dick, who murdered Mr. Crooks, a white settler on the McCloud River, California, September 24, 1873.
354. Water-ouzel's nest, headwaters of Little Sacramento River, Siskiyou County, California, September, 1873.

G—A LIST OF M'CLOUD INDIAN WORDS SUPPLEMENTARY TO A LIST CONTAINED IN THE REPORT OF 1872.

BY LIVINGSTON STONE.

All-ale, Up, world of good spirits.
Ar-kal, Gone, used up.
Ar-nouka, I don't care to.
Attle-nas, Tattooing.
Bar-widder, Come and eat.
Barla, Irony, a joke (or) a falsehood.
-beeda, To be in want of.
Bew-wy, To be the matter with.
-bim, (an intensifier,) Very.
Boolock too mah, Not big enough.
Chaw-awl, Cooked, done.
Chee-oomay, To bury.
Che-hammis, Ax.
Chil-chilch, Bird,
Chilluk, Provoked.
Chinny, To take.
Chin-ou-le barda, I'll take it by and by.
Chippewinnem, Midnight.
Chocky, Near by.
Choo-hay, To gamble.
Chorck, Wooden.
Chuna, Dance.
Clarbooruck, Quartz.
Col, Lips.
Colcha, Pleasant weather.
Cou-yarda, It hurts me.
Dar-khal, Burned.
Darnal, Get out!
-de, (a pronoun referring to the speaker.)
Dee-ee, Yes, (very emphatic.)
Dōkhy, Chin.
Doompcha, To bathe.
Ello-de-hestarmin, Nothing is the matter with me.
Elponna, Come in.
E-wear, I don't know how.
Furbiss, New.
Hareimar, To carry away.
Harliss-penarda, I don't want to go.
Harpa, Father.
Harrardar, Good-by.
Hebarky, I guess so.
Hestarm, What's the matter?
He-wy-hy, More.
Hissarm, How much.
Hissart, How many.
Hornda, A long time; (also,) always.
Hoo-roo-chook, Needle.
Kaiser, Quick.
Kar, Cloudy.
Kar-har, A great wind.
Khark, Insane, crazy.
Kī-ra-ma, Finished.
Kellar, Straight.
Ken, Down.
Kent-parna, To rise up.
Kette-wintoon, Twenty; (*i. e.*, one Indian, all his fingers and toes.)
Khal-lokh, Plume.
Khee-yay, Uncle.
Khlark, Rattlesnake.
Klarmet, To give.
Klaw-ma, To kill.
Kleetich-liss-penarda, I don't want to work.
Koorcha, Pig.
Khlesh, Soul, spirit.
Kwee-yer, Sick.
Lén-darda, Long time ago.

Leepida, (used only with *mame; mame leepida*, I am thirsty.)
Lor-e-ke, Over that way.
Ma-art, Ear.
Man, Any one, (like the German.)
Markh-us, Leg.
Mī-ee, Foot.
-minner, Cannot.
Mooty, To understand.
Neechī, Nephew.
Nick-el, Skin.
Niss, Me, (objective case of *nett.*)
Now-owse, Cloth.
Nun-narma, True.
Oh-my, Enough.
Oo-koo, Yonder.
Oosa, Almost.
Oose-lénda, Day before yesterday.
Oose-poppil, Last year.
Oo-yool, Grapes.
Pahn-ee-tus, Handkerchief.
Park, Body.
Pee-echa, To make.
Pī-ee, Manzanita.
Poilarn, Little while ago.
Pom missima, Winter.
Pom-kenta, Down, world of bad spirits.
Pooly, There.
Poo-re-war, Dark.
Poo-tar, Grandmother.
Poppil, Year.
Po-Po-oppil, This year.
Poppum-Po-poppil, Next year.
Sawny-winnem, Noon.
See-ee, Teeth.
See-okoos, To brush.
See-wy, Writing, letters, &c.
Shonn, Stone.
Shono, Nose.
Shoohoo, Dog.
Shookoo, Horse.
Soo-harna, Will you please?
Sukey, To stand.
Tabar, Gambling-stick.
Tar-kee, Hat.
Tay-ruch, Tanned buckskin.
Tee-chellis, Squirrel.
Tilteeta, To go visiting.
-tole, In, (or) on, (or) among; *e. g.*, *meetole*, in a tree.
Toon-makh, Bosom.
Toon-oo, Back.
Too-too, Mother.
Tu-lich, To swim.
Wawtcha, To cry.
Way-ee-worry, Come again.
Weh! Come here!
Werry-werry, Hurry up!
Wilner, To get up, (from bed.)
Win! Look!
Winne-harra, To go in search of.
Winnem, Middle.
Winne-squeea, I want to see.
Wittelly, Quickly.
Wohar, Cow.
Woor-ous, Fish-spawn.
Ya-mutta, Trail.
Yar-loo, Quit!
Yaw-lar, Snow.
Yay-lo-cou-da, Move away!
Yet-u-nas, Name.
Yilkh-mar, Heavy.
Yolie, Now.
Yolie-poppum, Pretty soon.
Yorkos, Gold.

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