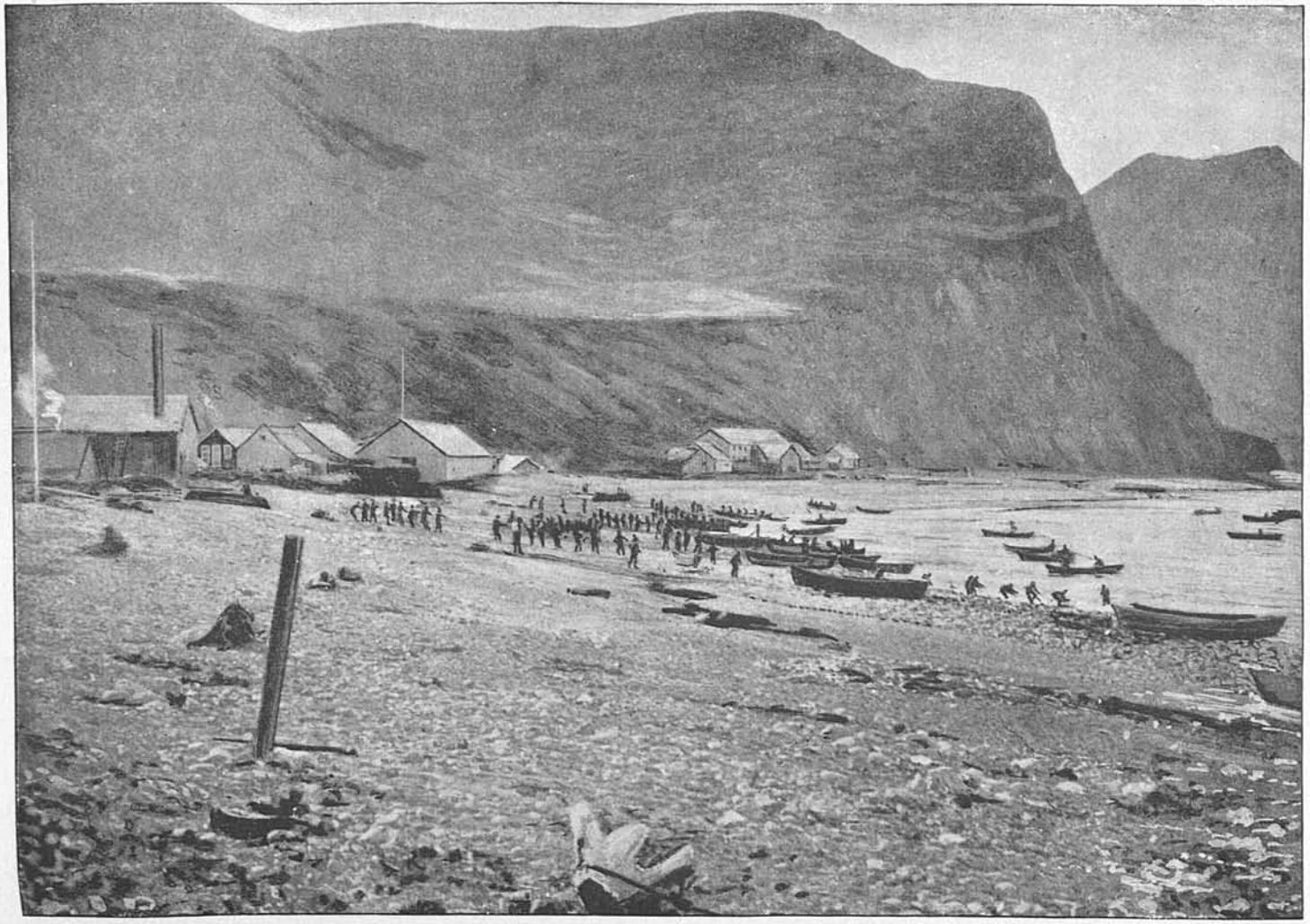


SEINING SALMON AT KARLUK, LOOKING SOUTHWEST. CANNERIES OF KARLUK PACKING COMPANY (LEFT) AND ALASKA IMPROVEMENT COMPANY.

12.—REPORT ON THE SALMON AND SALMON RIVERS OF ALASKA, WITH NOTES ON THE CONDITIONS, METHODS, AND NEEDS OF THE SALMON FISHERIES.

BY TARLETON H. BEAN,
Ichthyologist, U. S. Fish Commission.
(With plates XLV–LXXIX.)

[Reprint of H. R. Mis. Doc. No. 211, Fifty-first Congress.]

LETTER OF TRANSMITTAL.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., June 6, 1890.

SIR: I have the honor to transmit herewith a report of an investigation of the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions of the fisheries and the methods employed in the prosecution of the same, such investigation having been made under the authority of Congress, as conveyed in section 2 of act approved March 2, 1889, and entitled "An act to provide for the protection of the salmon fisheries of Alaska," as follows:

* * * * * * *

SEC. 2. That the Commissioner of Fish and Fisheries is hereby empowered and directed to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production.

* * * * * * *

No appropriation was made to cover the expenses of such investigation, but considering the act mandatory, and realizing the importance of placing before Congress at the earliest date practicable the information necessary to indicate the additional legislation required for the protection and maintenance of the river fisheries of Alaska, I arranged to provide for the expenses of the investigation out of the general appropriation for the propagation of food-fishes, and with the opening of the season placed a party of investigators in the field, with instructions to proceed directly to the island of Kadiak and, after a thorough study of the conditions and methods of the salmon fisheries there, to extend their investigations to Cook's Inlet and its affluents, if the brief season available for field investigation would permit.

Kadiak Island was selected as the initial point because the salmon fisheries there have at present the greatest development and importance and because there the impending destruction of the salmon fisheries is most evident and the flagrant abuses requiring the restraint of law most obvious.

Dr. T. H. Bean, the ichthyologist of the Commission, was placed in charge of the party, his previous knowledge of this region and his training as a naturalist and scientific observer having specially qualified him for this service. Associated with him were Mr. Livingston Stone, the superintendent of our California and Oregon salmon-hatching stations, and Mr. Franklin Booth, of San Francisco. Mr. Stone was charged with the duty of reporting upon suitable sites for hatching stations and Mr. Booth with the study of the topographical features of the region and the physical features of the different river basins. This party continued in the field to as late a period as the season permitted. By reason of the short time available for field work the investigation did not extend beyond the islands of Kadiak and Afognak. Here, however, the fisheries are best organized and most extensively prosecuted, and conclusions based upon the investigation of the salmon fisheries of this region will probably have general application.

As an introduction to the report proper I have presented and discussed in as concise form as practicable the results of the field investigation and submitted certain recommendations as to the additional legislation necessary to "place the salmon fisheries of Alaska under permanent conditions of production."

Very respectfully,

M. McDONALD,
Commissioner.

Hon. THOMAS B. REED,
Speaker of the House of Representatives.

INVESTIGATION OF THE SALMON FISHERIES OF ALASKA.

INTRODUCTORY.

The marvelous abundance of several species of salmon in Alaskan waters has been long known, but in consequence of the remoteness of this region and its inaccessibility, the abundant supply in rivers nearer markets, and a disposition on the part of buyers to underrate Alaskan products, its fishery resources have not been laid under contribution for market supply until within a few years, during which we have seen, as the result of reckless and improvident fishing, the practical destruction of the salmon fisheries of the Sacramento and the reduction of the take on the Columbia to hardly one-third of what it was in the early history of the salmon-canning industry on that river. At present the streams of Alaska furnish the larger proportion of the canned salmon which find their way to the markets.

Whether these fisheries shall continue to furnish the opportunity for profitable enterprise and investment depends upon the policy to be inaugurated and maintained by the Government. Under judicious regulation and restraint these fisheries may be made a continuing source of wealth to the inhabitants of the Territory and an important food resource to the nation; without such regulation and restraint, we shall have repeated in Alaskan rivers the story of the Sacramento and the Columbia; and the destruction in Alaska will be more rapid because of the small size of the rivers and the ease with which salmon can be prevented from ascending them. For a few years there will be wanton waste of that marvelous abundance, which the fishermen—concerned only for immediate profit and utterly improvident of the future—declare to be inexhaustible. This season of prosperity will be followed by a rapid decline in the value and production of these fisheries, and a point will be eventually reached where the salmon-canning industry will be no longer profitable.

SPECIES OF SALMON OF ECONOMIC VALUE.

The species of salmon found in Alaska in quantities sufficient to constitute an economic resource are as follows:

(1) The Red Salmon (*Oncorhynchus nerka*).
(2) The King Salmon (*Oncorhynchus chouicha*).
(3) The Silver Salmon (*Oncorhynchus kisutch*).
(4) The Hump-back Salmon (*Oncorhynchus gorbuscha*).
(5) The Dog Salmon (*Oncorhynchus keta*).
(6) The Steel Head (*Salmo gairdneri*).
(7) The Dolly Varden (*Salvelinus malma*).

The species at present constituting the principal motive and object of canning operations is—

THE RED SALMON.

The southern limit of the range of this species is the Columbia River, in which it is known as the Blue Back Salmon. Its range extends northward to the Yukon River, and it makes its appearance in southern Alaskan waters early in June, the run beginning later as we proceed farther to the north. A succession of schools continue to arrive until August and, after tarrying a short time in the coast waters, begin to ascend to their spawning grounds, which are in the cold snow-fed lakes from which issue the head-waters of the streams that are frequented by this species for the purpose of reproduction. The run is confined chiefly to the smaller streams, such as the Karluk, in which they crowd in numbers absolutely incredible to one who is not an eye witness, and actually force each other out of the water in their eager struggles to reach the sources of the rivers and deposit their spawn.

THE KING SALMON

Is the principal canning species of the Columbia and other rivers of Oregon and California, but at present it has relatively little importance in the Alaskan salmon fisheries. It is distinctively the salmon of the larger rivers, like the Yukon, on which the canning industry has not yet attained much development. It is, however, an abundant species, and, with the growth of the canning industry on the larger rivers, will attain great commercial importance.

THE SILVER SALMON

Is in great request for canning in the Puget Sound region, but is not held in much esteem by the canners of Alaska, because it becomes soft very soon after its capture and can not be kept like the Red Salmon. It spawns in the fall of the year, but does not make its appearance on the coast until shortly before canning operations close for the season, and, consequently, the opportunity for natural reproduction is more favorable than for the Red Salmon and King Salmon. The species is abundant now, and under present conditions of the fisheries will doubtless maintain itself. The flesh, though not highly colored, is probably not inferior in table qualities to the Red Salmon, and in the future, with the extension of canning operations, it will doubtless be utilized more extensively than at present.

THE HUMP-BACK SALMON

Is the smallest, the most abundant, and most widely distributed species of the Alaskan salmon. It arrives on the coast of Kadiak from the 1st to the 10th of July, and continues to run for about five weeks, the height of the spawning season being early in August. It does not ascend far from salt water, and usually enters streams which are too shallow to cover its back fins. This species is not much used at present for canning purposes, but is dried by the natives in large quantities for winter use, and moderately large quantities are salted for the San Francisco and other markets. When fresh run its flesh is not inferior in edible qualities to the Red Salmon, and has a beautiful red color, but rapidly deteriorates after it enters the estuaries of the rivers. This species, from its abundance and wide distribution, will attain great commercial importance when its good qualities are better known.

THE DOG SALMON

occurs very abundantly in the small rivers and creeks of the islands and the main land. It makes its appearance at Kadiak about the middle of June and continues abundant for a month, after which the numbers rapidly diminish. It leaves the coast with the first appearance of ice. The flesh of this species will hardly ever be in request for canning, but it is one of the most important species to the natives, who dry it for winter use.

REPRODUCTION.

The species of salmon above enumerated, though differing in their seasons of reproduction and in their spawning habits and requiring different conditions and environment, are all subject to the constraint of one common law—they must have access to their natural spawning grounds in the rapids of the rivers or in the cold snow-fed lakes from which they issue—and in this natural law is to be found the suggestion of such legislation as may be necessary "to maintain the salmon fisheries under permanent conditions of production."

We must provide that reproduction, natural or artificial, shall be on such a scale as will compensate for natural waste and man's destructive agencies. This may be accomplished in several ways: First, by legislation prescribing and enforcing such regulations in the conduct of the fisheries as will permit the salmon to enter the rivers and ascend to their spawning grounds in sufficient numbers to maintain the supply by natural reproduction; second, by the artificial fertilization and hatching of eggs taken from salmon caught for the supply of the canneries and the distribution of the fry thus obtained to the streams and lakes, which are the natural feeding grounds of the young salmon for some months after hatching.

Existing legislation concerning the protection of the salmon dates from the Fiftieth Congress and provides for the accomplishment of the first of these objects in the act following:

[PUBLIC—No. 158.]

An act to provide for the protection of the salmon fisheries of Alaska.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than two hundred and fifty dollars for each day of the continuance of such obstruction.

SEC. 2. That the Commissioner of Fish and Fisheries is hereby empowered and directed to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production.

SEC. 3. That section nineteen hundred and fifty-six of the Revised Statutes of the United States is hereby declared to include and apply to all the dominion of the United States in the waters of Behring Sea; and it shall be the duty of the President, at a timely season in each year, to issue his proclamation and cause the same to be published for one month in at least one newspaper if any such there be

published at each United States port of entry on the Pacific coast, warning all persons against entering said waters for the purpose of violating the provisions of said section; and he shall also cause one or more vessels of the United States to diligently cruise said waters and arrest all persons, and seize all vessels found to be, or to have been, engaged in any violation of the laws of the United States therein.

Approved, March 2, 1889.

Additional legislation should provide for an increased production of salmon by fish-cultural methods, thus avoiding the enormous waste of eggs and young fish under their natural conditions and repairing, to some extent, the injury caused by over-fishing. The prohibition of obstructions impeding or preventing the ascent of the salmon to their spawning grounds must be strictly enforced, and destructive methods of fishing prevented by Government agents at the fishing localities, or a system of leasing fishery privileges under fixed regulations should be inaugurated.

The great bulk of the salmon taken in Alaska at present are caught by seines, gill-nets, and traps, all of which have been used in a more or less injurious manner. The continual hauling of seines across and near river mouths prevents salmon approaching the spawning condition from entering the streams. Gill-nets have been sometimes set entirely across the channels of rivers, and many traps are reported which act as complete barriers to the ascending fish. The seining operations also entail great unnecessary waste of good material by hauling on the beaches large numbers of trout, salmon, and other food-fishes which are not utilized.

The enormous value of the Alaskan salmon fisheries furnishes a sufficient incentive for prompt action in fostering and preserving the canning industry. In 1889 the number of canneries in operation was thirty-six, representing an investment of nearly $4,000,000, and the products were valued at about $3,000,000. Sixty-six vessels, including thirteen steamers, were engaged in this trade. The industry furnishes remunerative employment for several thousand men.

Alaska is a most promising field for fish-cultural operations. An abundance of gravid salmon can be obtained in the vicinity of good harbors. Ample supplies of suitable water can be conveyed to hatching establishments by gravitation alone. Impassable natural obstructions are almost unknown. Streams which are not subject to great fluctuations of level abound. The climate is favorable. Pollutions are absent. Labor and materials are cheap, and communication with ports in the United States is sufficiently easy. Prompt measures for maintaining the supply of salmon will insure a permanent and improving fishery.

AUTHOR'S LETTER OF TRANSMITTAL.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., January 21, 1890.

Col. MARSHALL MCDONALD,
U. S. Commissioner of Fish and Fisheries,

SIR: In accordance with instructions received from you June 3, 1889, directing me to make an investigation of the salmon rivers of Alaska, with particular reference to the habits, abundance, and distribution of the salmon, the conditions and methods of the fisheries, and the steps necessary to prevent their decline and to render them permanently successful, I left Washington June 10, 1889, in company with Mr. Robert E. Lewis, who was detailed to assist me in the exploration. We arrived in San Francisco June 18.

Finding that Capt. E. P. Herendeen, whose services had been secured as surveyor for the party, could not go with us, Mr. Franklin Booth, of the University of California, was engaged to take his place.

We were delayed in San Francisco, awaiting an opportunity to sail, until July 3, in the mean time purchasing materials necessary for the expedition. Prof. George Davidson, of the U. S. Coast and Geodetic Survey, obtained from the General Office of the Survey permission for us to use various instruments belonging to his office, including a theodolite, a level, a barometer, and other articles mentioned in the surveyor's report.

On July 3 we sailed from San Francisco for Port Townsend, where we arrived July 6. We were joined here by Mr. Livingston Stone, who was detailed by you to inquire especially into the feasibility of fish culture in Alaska.

The Karluk Packing Company's steamer *Karluk*, of San Francisco, was to convey us from here to Kadiak, but we were detained by an accident to her keel and did not sail from Port Townsend until July 19.

We reached St. Paul, Kadiak, July 28, and Karluk August 2.

We found that, owing to the latèness of the season, it was impossible to carry out the programme indicated in your letter of instructions. There was no opportunity of reaching Bristol Bay, and only one vessel departed from Karluk for Cook's Inlet. This was the steamer *Francis Cutting*, which sailed August 7, only five days after our arrival at Karluk, and we learned that she would not return in time for us to accomplish anything at that place during the fishing season.

Finding that Karluk is the most important salmon fishing station in Alaska, yielding fully one-half of the entire catch of the Territory, I concluded that we must begin our studies there, even if it became necessary also to limit them to that locality.

There is practically no communication in Alaska except by water. There are no lines of vessels running regularly from place to place, and whenever it is desirable to cover an extended field of investigation it is essential to provide a vessel to carry the party to the places to be investigated.

On August 15 we left Karluk for a trip to Karluk Lake, to examine the spawning grounds of the red salmon. We could not go up the river because of the low stage of the water, the extreme difficulty of walking along the shores, and the impossibility of taking boats through the rapids, which are several miles in extent. We sailed therefore around into Uyak Bay, and pushed up to the head of one of its arms, from which we made a portage of several miles to Karluk River above the rapids. The journey to the lake was completed August 17, and we remained there until the 21st. On the return to Karluk there was some delay on account of a storm, so that we did not arrive until August 27.

The party sailed September 7 for Alitak Bay, where we remained inquiring into the history of the fishing until the 11th, on which date we departed in the steamer *Haytien Republic* for San Francisco. We reached San Francisco September 21. From here Mr. Stone returned to his station at Clackamas, and Mr. Booth to his duties in the University of California. Mr. Lewis and I arrived in Washington October 13.

We were greatly assisted in our investigations by the Alaska Commercial Company, of San Francisco, and their agents on the island of Kodiak; also by the Karluk Packing Company, whose office at Karluk was our headquarters while at that station. Capt. L. P. Larsen, of the Arctic Packing Company, gave us every possible facility in his vessels and at the canneries of the company. The Kodiak Packing Company assisted us materially in our exploration of Alitak Bay. Messrs. Ford and Stokes, of the Russian American Packing Company, and Mr. Blodgett, of the Royal Packing Company, rendered material aid to Messrs. Booth and Stone during their visit to Afognak.

Mr. Booth has prepared a report upon his work, and also sketches and charts of the regions investigated. In this he was assisted by Mr. Lewis. Mr. Stone's report on the possibilities of fish culture is separately transmitted. Keeping in mind your instructions to devote my time chiefly to the salmon, I did not make large collections of other fishes, and have reserved their discussion for a future occasion. More than fifty photographs were made, to illustrate the physical features of the region and the methods of the fishery.

In conclusion, I wish to suggest the desirability of beginning investigations of this nature earlier in the year and continuing them later. The life history of our Pacific salmon is very imperfectly known, and it is difficult to make practical deductions from the insufficient data in our possession.

Very respectfully,

TARLETON H. BEAN,
Ichthyologist.

COPY OF ORDERS.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., June 3, 1889.

Dr. TARLETON H. BEAN,
Ichthyologist, U. S. Fish Commission:

DEAR SIR: You are hereby charged with the investigation, during the summer of 1889, of the salmon rivers of Alaska, authorized by the following act of Congress, approved March 2, 1889:

> That the Commissioner of Fish and Fisheries is hereby empowered and directed to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production.

Your party will consist, besides yourself, of the following-named persons: Mr. Livingston Stone, Capt. E. P. Herendeen, and Mr. Robert Lewis.

Instructions for the conduct of the work are herewith inclosed. You will arrange to leave San Francisco at the earliest date possible, and will proceed directly to the island of Kadiak, where your explorations will begin.

As you will have only a comparatively short season during which to carry on these investigations, it will be necessary to limit your operations to a few regions, of which Kadiak Island (Plate LXXX), Afognak Island (Plate LXXX), Cook's Inlet, and Bristol Bay are the most important. They should be visited in the order named, unless, after your arrival at Kadiak, you should find that the salmon fishery interests of Bristol Bay have greater need of attention than those of Cook's Inlet, in which case the Bristol Bay region should be taken in hand next after Kadiak and Afognak. This is, however, on the supposition that you will not have the time to visit all of the regions.

You will pay most attention to those rivers in the districts mentioned where the fishery is now being prosecuted with the greatest activity, and also those which, from their location and the abundance of salmon, are likely to attract the canning interests at an early day. Upon your arrival at St. Paul, Kadiak, you will probably obtain the information necessary to enable you to map out the course of your explorations.

It is on the short rivers, and especially those on Kadiak and Afognak islands, as well as those on the adjacent coast of the peninsula, that the greatest fishery abuses are said to exist, and the dangers from injudicious fishing are most imminent. This class of rivers should, therefore, be carefully studied; and you will also seek to locate all the prominent salmon rivers in each district, ascertaining their chief characteristics, even though you may be able to do this, in many cases, in only a superficial way.

Your observations should all be made with a view to their bearing upon the practical question, as to how the salmon interests can best be protected, and to presenting to Congress a clear and succinct report upon the entire subject.

Three subjects are presented by the investigations in question, namely: First, the natural history of the salmon and the physical characteristics of their environment, in connection with which the river fishes generally may be studied. Second, the conditions, methods, and statistics of the salmon fisheries. Third, the artificial propagation of the salmon in Alaskan rivers.

Mr. Stone has been detailed to accompany you on account of his extensive knowledge respecting salmon culture on the Pacific coast. He should be given special charge of that branch of the work, but he will undoubtedly be able to assist you in the other subjects. Otherwise you will apportion the work among your assistants in such manner as seems best.

The duration of your stay in Alaska will be determined by the length of the season suitable for field investigations. A letter has been addressed to the Alaska Commercial Company, requesting them to furnish you and your party with transportation to and from Alaska, and to grant you the customary facilities at their stations. You will call at the office of the company immediately upon your arrival in San Francisco, and ascertain what arrangements can be made with them.

Should the opportunities occur for sending mail home, you will inform me, from time to time, of the progress of your work.

Very respectfully,

M. McDONALD,
Commissioner.

INVESTIGATION OF THE SALMON AND SALMON RIVERS OF ALASKA.

PHYSICAL CHARACTERISTICS OF THE ENVIRONMENT OF THE SALMON.

KARLUK BAY.

(Plates XLV and L-LIX.)

The marine life of the Alaskan salmon is entirely unknown except when the various species approach the mouths of certain rivers to ascend to their spawning grounds. We do not know whether the ocean currents influence the movements of the schools of salmon, and we are not acquainted with the capacity of the salmon for enduring variations of temperature at sea. It appears from the best information we can obtain that the schools of salmon have not been observed at a greater distance than a mile and a half off-shore. The direction of their ocean movements has not been determined, but Mr. Hirsch informs us that in approaching Karluk they come from all directions and continue in compact schools until they are close to land, when the schools break up. It is assumed as an established fact that the great body of the salmon come up from the sea at a certain time of the year and ascend streams for the purpose of reproduction. We know that at the time when the salmon approach the Alaskan shores certain species of small fishes constituting their food are abundant at sea near the land. Among these are the capelin, herring, and lant. Salmon continue to feed upon these species until they are ready to forsake the sea and enter the fresh waters.

We could not learn that variations in temperature had much effect upon the daily catch of salmon. The lowest temperature of the water noted at the surface in Karluk Bay during our visit was 50°, and the highest 60°, the latter observed at noon, August 12. The greatest variation in temperature observed in any one day occurred August 13. At 7 a. m. the surface water was 50° and at noon it had reached 59°. The ordinary variation from 7 in the morning to 6 in the evening was from 2½ to 4½ degrees.

One of the sources of safety for the salmon at Karluk is the presence of beds of the bull kelp, *Macrocystis giganteus*, in which the fish find shelter from the seiners.

Karluk Bay is merely a shallow arm of Shellikoff Strait, limited on the southwest by Cape Karluk, or Karluk Head, and on the northeast by high bluffs at the head of Karluk Spit. The outlook from Karluk Bay is towards the northwest. The beach descends very gradually from a low spit, and is composed of coarse gravel and large granite bowlders. The bottom slopes down gradually until, at a distance of 100 fathoms from the shore, the depth is several fathoms. There is very little good holding-ground for vessels. Some of the firms have fixed moorings at which their vessels ride out

moderately severe storms in safety. A secondary indentation is found between Karluk Head and the mouth of Karluk River. This is a little cove with a fine gravelly beach and is frequently resorted to for seining salmon. The Karluk River empties into the bay at the point of the spit through a narrow and comparatively shallow mouth.

KARLUK SPIT.

(Plates LIV and LXXXI.)

The bay is separated from the Karluk River Valley by a low spit, which is about three-fourths of a mile long, about 100 yards wide at its extremity at ordinary high tides, and scarcely more than 30 yards wide at its head; its average width is about 60 yards. Its ocean beach has already been described. The river beach in its lower half is lined with moderately large bowlders, while the upper half contains finer gravel and deposits of river ooze. The elevation is so slight that in severe storms the sea washes over it into the river, flooding some of the buildings of the canning companies. There is a thin soil along the ridge of the spit which is utilized by some of the workmen for small vegetable gardens. The upper end of the spit not occupied by buildings is covered with a heavy growth of grass and weeds. Mr. Booth describes the formation of this little peninsula in the following words: "The spit is formed of loose granite gravel, washed into its present position by storms and tides from the bases of the high granite cliffs which make the coast-line of this part of Kadiak Island so prominent. These cliffs are constantly crumbling under the combined action of air, water, and frost, and the talus thus formed is constantly being added to the spit, gradually making it wider and longer. As the strongest prevailing gales come from the northeast, the débris is carried southwest to the further end of the spit, which accounts for the present position of the river mouth and the difference in width of the spit.

"There is hardly any doubt that the present lagoon was at one time the estuary of the river, then a far more powerful stream than at present and capable of carrying out to sea the débris carried across its mouth. As the river dwindled in size and volume the spit gradually encroached across its mouth, crowding it southwest along the base of the cliff until its mouth reached the present location.

"The granite cliffs, whose fragments have formed the spit, extend from Karluk Head, a bold headland about one-half mile southwest of the river mouth to the southwestern shore of Uyak Bay, and rise almost perpendicularly to a height of from 1,500 to 2,000 feet. The first rise of the peak, called on the Coast Survey [charts] Cape Karluk, I determined by transit observation to be about 1,600 feet high.

"This peculiar shape of mouth is not confined to the Karluk River alone. The Sturgeon and Little Rivers, distant respectively 4 miles southwest and about 30 miles northeast of Karluk, have similarly shaped mouths, and in each can be seen the outlines of their old estuaries.

"The ordinary tides on the beach at Karluk range from 12 to 18 feet, and in the river from 3 to 5 feet. The tide reaches up the lagoon or old estuary shown on the accompanying charts as far as the lower rapids, where the river and lagoon unite. The river here is about 300 feet wide, the whole width of its bed being filled with bowlders; in summer the water is too shallow for a bidarka to pass. The velocity of the current here is about 1¾ miles per hour."

KARLUK RIVER.

(Plates LX–LXII, LXVIII–LXIX, and LXXXI.)

For reasons elsewhere mentioned we did not follow the entire course of this river; the surveys of Mr. Booth, however, developed the fact that the lower portion of the river bed is much wider than is indicated on the charts furnished us at the outset of our expedition, and the relative widths of the river at its source and Karluk Lake, whose waters it carries off, show a very much greater difference than the maps represent. The direction of the Karluk in the first 5 miles of its length is a little west of north, this portion of the river ending at the portage to the west arm of Uyak Bay. From this portage it pursues a northwesterly direction for a short distance, and the general direction of the remainder of its bed is westerly. According to a manuscript chart prepared in 1867 by Archimandritoff, the mouth of the Karluk is in latitude 57° 34′ 30″ N., and longitude 154° 21′ 20″ W.

Mr. Booth's notes on the river are as follows:

"Karluk River leaves Karluk Lake at its northwest extremity as a shallow stream, about 130 feet wide, with a depth of about 12 inches at the summer stage, and flowing between low banks, from which rise on the western side the range of mountains which borders the lake. It soon leaves these, however, and wanders in a sinuous course, full of sloughs and lagoons, across its wide valley. In its windings it frequently attains a width of 600 feet, with a correspondingly diminished depth. It was a matter of great difficulty to find a place deep enough to float a bidarka. As we traveled farther down the river became narrower and the current more rapid, while places were passed in which the water was 6 feet deep. Near the isolated mountain shown on the chart the river cuts through a bed of ferruginous clay, which it has washed out so as to make an 8-foot channel alternately along the eastern and western banks. This clay bed is worthy of mention as being the only one found by us on the island. After passing the mountain the rate of descent measurably increases. Here we judged by the barometer that the river is about 200 feet above tide water at Uyak Bay.

"The distance in a direct line from the point where Karluk River leaves the lake to its mouth at Karluk we estimated at 16½ miles.

"In the first 5 miles its slope is inappreciable except in the rapids a short distance north of the lake, where in a distance of about 500 yards the river falls about 10 feet. This would leave about 250 feet of descent in about 12 miles direct distance, giving as the slope of the river valley about 20 feet to the mile.

"As we did not travel along the river banks below the point where the barabara, called Nicolai's, is located at the portage to Uyak Bay, we could not determine the length of the river channel, nor hence its average rate of descent. From the generally winding character of the river I should place it at 10 feet to the mile.

"The Karluk appears to travel throughout the whole of its course along the bed of an ancient glacial terminal river, whose successive levels of subsidence can be most plainly seen on the sides of the mountains south of Karluk. Hence its bed and banks are composed of irregularly sized, water-worn slate bowlders, surrounded by the fine gravel of the same material, intermixed with sandstone and jasper.

"After leaving the lake it flows along this level valley, which varies from 1 to 3 miles in width, for a distance of about 6 miles. After this the valley, as far as we could see, is full of low, rolling hills. At its mouth, and for about 5 miles from the spit, its valley is narrow and closely hemmed in by the surrounding mountains. Throughout its course, except in the level and marshy portion, it flows between bluffs from 10 to 40 feet in height. In the lagoon, which was in former times its estuary, these bluffs are as much as 80 feet high and slope steeply to the water's edge.

"There is no timber on the river, and it was only with great difficulty that the natives of our party could find enough dry [shrubs] for cooking purposes at the portage. The low hills of the river valley are covered with tall grass and full of water holes and pitfalls. The level portion of the valley is almost entirely a quaking bog, covered with moss and occasional clumps of low shrubbery."

The shrubs for the most part consist of willows and alder, the willows reaching their greatest size—in fact attaining the size of small trees—along the banks of the small streams tributary to the Karluk. The alder forms dense thickets, which are almost impassable. At higher elevations the alder predominates. The heath family is represented by several species, producing edible berries in great abundance. Cranberries of small size abound in some of the bogs and extend to the tops of the hills at elevations of nearly 2,000 feet. Some species of *Rubus* are very common, and especially *R. chamæmorus*, known on the island of Kadiak as the Maleena. These are edible species and are eagerly sought after by the natives. Fire weed is one of the most characteristic of the common plants of the region, its pink flowers forming masses of color which contrast beautifully with the varied green of the shrubs and the monotonous straw-color of the wild wheat. Crane's bill and golden rod occur in profusion. Monk's hood, blue gentian, and violets are very common. Wild roses are even more abundant than in our own vicinity. Wild celery and wild parsnips are everywhere to be seen. In the river, in certain localities, there is a profuse growth of eel grass. *Sagittaria* and yellow water lilies abound in some parts of the river. The collection of plants, however, will be referred to in detail at another time.

"The surface of the numerous ponds [in the valley of the Karluk] is covered with a peculiar iridescent film characteristic of petroleum. An examination of this region would very probably reveal the existence of petroleum springs and possibly reservoirs. The prospect is certainly fair, for the strata of the whole region is evidently colored with bituminous matter, especially the sandstones. Just such strata are commonly found associated with beds of coal. Since my return I have made some experiments upon the coals of Cook's Inlet, which occur in strata exactly similar."

The Karluk receives no large tributaries, but is augmented by the waters of innumerable small creeks from both sides of its valley. None of the tributaries seen by us and reported by others who have traveled the entire length of the river exceed a width of 6 feet at the mouth. The canneries located on the spit obtain their water supply by damming up small streams behind the native village of Karluk and conveying the water in iron pipes from the reservoirs thus formed to the buildings. As these pipes are carried on the top of the ground, they are taken up in the winter to prevent freezing.

KARLUK LAKE.

(Plates LXIII–LXVII and LXXXII.)

As already stated Karluk River rises in Karluk Lake. This lake is about 8 miles long and has an average width of probably 2 miles. Its general direction is north and south. The maximum depth of the lake is unknown. I tried a sounding, with 27 fathoms of line, about 500 yards from the shore, and found no bottom. The water is blue. Along many portions of the shore the lake is very shoal for a considerable distance from land. In other places there is deep water close to the margin. The shores are composed of bowlders of various sizes, consisting of granite and other rocks. Sand beaches are entirely absent as far as our observations extended. No aquatic plants were observed around the margin of the lake. The shores are covered with a greasy deposit, doubtless composed of decayed animal matter, and in the very shoal water in many places there is a dense growth of dirty looking confervæ. There is a luxuriant growth of grass throughout the basin of Karluk Lake, extending often to the tops of the mountains. Willows exist here as good-sized shrubs, and in some places as small trees. The low grounds in many portions of the basin are covered with cottonwood trees, some of which attain to a height of 60 feet and a trunk diameter of 18 inches.

Conspicuous among the fruit-bearing plants is a species of elderberry, *Sambucus*, bearing brilliant red berries, which form part of the food of the bear. In the cottonwoods are numerous families of the American eagle, and the shores of the lake harbor many species of birds, among which are gulls and terns, plovers, and magpies. Ducks and loons are found on the lake. At about the middle of its length Karluk Lake divides into two arms; one, extending to the eastward, is referred to in this report and on Mr. Booth's charts as the east arm; the other follows the general direction of the lake, and is very much longer than the east arm. Three small islands are situated near the junction of the east and west arms. Karluk Lake receives the waters of numerous small streams, in which salmon and trout are found whenever they are not prevented from entering them by the abruptness of the ascent. Each of the arms of Karluk Lake is connected by a short, rapid, and crooked river with smaller tributary lakes. The lake tributary to the east arm is about four-fifths of a mile in length, and the one connecting with the west arm is about 1½ miles long. In the small tributaries of Karluk Lake the rivers connecting its arms with their tributary lakes and at various places around the shores of the principal lake—particularly at its southern end, between the mouths of rivers—we found nests of the red salmon. Karluk Lake is surrounded on all sides, except the north, by low mountains, some of the elevations of which exceed 2,000 feet.

During our stay, from the 18th to the 21st of August, the lowest temperature of the water of the lake was 48½°; this was at 4.30 a. m. The highest recorded temperature of the water was 55° at 9.30 a. m. August 20. The highest temperature of the air was observed at 10.20 a. m. August 20, when it was 77°, and the lowest temperature during our visit occurred at 4.30 a. m. August 21, when it dropped to 30½°, ice being formed at our camp. Although the air was intensely cold, the surface water of the lake registered 48½°. The small rivers connecting Karluk Lake with its tributary lakes contain no obstructions to the passage of the salmon. These lakes

freeze over in winter, and the natives travel over them to attend to their traps. They claim that they can obtain salmon at any time during the winter through the ice.

The mouth of Karluk River is out of all proportion to the importance of the industry located near it. Its width at low water is less than 100 feet, and its depth is so slight that steam launches drawing only 3½ or 4 feet often find it impossible to enter. It flows parallel to the direction of the beach almost the entire length of the spit before it passes into the sea. When it turns to the eastward it widens out into a shallow lagoon nearly 2 miles long and about a half mile wide. Beyond this lagoon it contracts within its shallow narrow limits and flows over a long series of rapids. The tide rises in the river from 3 to 5 feet, and its influence is felt throughout the lagoon. The fresh water begins practically at the rapids, about 2½ miles from the bay. During the time of our stay the water was so clear that salmon and trout could be seen on the bottom. During freshets, of course, large quantities of soil are brought down, making the water turbid, and numerous plants are rooted up and floated to sea by the current. The temperature of the water at Karluk and other localities, as recorded by Mr. Stone, varied as follows:

1889.	Karluk Bay.		Karluk River.	Air.	State of sky.
	°		°	°	
August 4:					
5 p. m.	52	Tide coming in	53	52.5	Cloudy.
August 5:					
7 a. m.	52	Tide going out	52.5	52	Cloudy.
12 noon	52		55.5	57	
6 p. m.	52	Tide coming in	52	53	
August 6:					
7 a. m.	51	Tide coming in	53	51	Sunshine.*
12 noon	53		59	59	
6 p. m.	53.5		54	59	
August 7:					
7 a. m.	51.5	Nearly low tide	55	55	Sunshine.
12 noon	54.5	Tide ebbing	56.5	60	Do.
6 p. m.	54.5	Tide ebbing	58.5	62	Do.
August 8:					
7 a. m.	51.5	Tide ebbing	55.5	53	Sunshine.*
12 noon	54	High tide	56	60	Do.
6 p. m.	55	Low tide	60	62	Do.
August 9:					
7 a. m.	56.5	Very low tide	55	54	
12 noon	56	High tide	55	58	
6 p. m.	56	Low tide	60	60	
August 10:					
7 a. m.	51.5	Very low tide	57	54	
12 noon	54	High tide	54	54	
6 p. m.	54	Low tide	56	53.5	
August 11:					
7 a. m.	53	Low tide	53	52	
12 noon	54.5	High tide	53.5	62	
6 p. m.	54	Low tide	55.5	60	
August 12:					
7 a. m.	52	Low tide	54.5	54	
12 noon *	60	Half flood	57	60	
6 p. m.	53.5	Low tide	57.5	66	
August 13:					
7 a. m.	50	Low tide	54	52	
12 noon	59	Half flood	57.5	66	
6 p. m.	51	Half ebb	53.5	56	
August 14:					
7 a. m.	51.5	Low tide	53.5	52	
12 noon	53		54	54	
6 p. m.	52.5	Half ebb	56	51.5	
August 15;					
7 a. m.	51	Half ebb	52.5	52	

* These temperatures were taken on the beach. The air has been very warm this forenoon, and partly accounts for the high temperature of bay.

Karluk Lake.	Water.	Air.	Remarks.
August 18:	°	°	
7 a. m	50	.....	
6 p. m	51.5	.....	
August 19:			
7 a. m	50	47	
9 a. m	.....	55	Cloudy.
6 p. m	54.5	53	
August 20:			
5.45 a. m. (sunrise)	.....	36.5	
9.30 a. m	55	65	
10.30 a. m	.....	77	The hottest yet on the island. A beautiful bright, warm, sunshiny day. At 5 a. m. Mr. Lewis found the temperature to be 35.5°.
August 21:			
4.30 a. m	48.5	30.5	A beautiful, faultless morning.
August 22 (Barabara, on Karluk River):			
6 a. m	48.5	50.5	

The foregoing temperatures were taken with thermometer 6801, which was left here by Mr. Stone. The temperatures which follow were taken with thermometer 6802

August 27, 6 p. m., Karluk Bay, 52°; Karluk River, 53.5°; air, 56°; fair. August 28, 7 a. m., Karluk Bay, 50°; Karluk River, 51.5°; air, 53°; cloudy; 12 noon, Karluk Bay, 51°; Karluk River, 51°; air, 54°; cloudy; 6 p. m., Karluk Bay, 50.5; Karluk River, 50.5°; cloudy. August 29, 7 a. m., Karluk Bay, 50.5°; Karluk River, 48°; air, 52°; fair. August 30, Afognak, very stormy and windy; 6 p. m., bay, 49.5°; air, 49.5°. August 31, Afognak, rain-storm; 7 a. m., bay, 54.5°; 12 noon, bay, 49.5°; air, 52°; 6 p. m., bay, 49.5°; 8 p. m., air, 47.°. September 1, Afognak, clear; 7 a. m., bay, 47.5°; air, 47.5°; noon, bay, 56°, air, 60°; 6 p. m., bay, 51.5°, air, 53°. Litnik River, 10 a. m., bay, 47.5°; village, 49.5°; dam, 50°; clear. September 2, Afognak, 7 a. m., bay, 49.5°; air, 47°; clear; noon, bay, 53°; air, 58°; cloudy; 6 p. m., bay, 52°; air, 53°; cloudy. September 3, Uyak Bay, on steamer *Aleut*, 6 p. m., air, 47.5°; rainy; 9 p. m., air, 45°; rainy. September 4, Uyak Bay, on steamer *Aleut*, 7 a. m., air, 46°; fair; noon, air, 51°; fair; 6 p. m., air, 50°; fair. September 5, 7 a. m., Karluk Bay, 47°; Karluk River, 46°; air, 43°.

Annual rain-fall at St. Paul, Kadiak.

	Inches.
1885	65.70
1886	54.25
1887	61.06
1888	64.96
	245.97
Average	61.49

In December and January the rain-fall is usually greatest. In September it is pretty heavy. Snow comes down on the west side of the mountains in summer to within about 500 feet of the sea-level.

During the time of our stay at Karluk there were no obstructions, either natural or artificial, to the ascent of the salmon in the river, unless we may regard the low summer stage of the water in such a light. There were remains of some traps of wire netting which had been placed in the river by certain parties, but these traps did not remain long in the water before they were destroyed by some of the fishermen. In former years there have been impassable barriers to the ascent of the fish, but these were removed before the date of our exploration. It is certain that the seining operations, carried on almost without interruption, except during twenty-four hours in the week, prevent many salmon from going up the stream for the purpose of spawning. The number of salmon actually caught in Karluk Bay, near the river mouth and in the lower portion of the river, is so large as to make a true statement concerning them seem incredible. In 1888 the canneries put up over 200,000 cases,

averaging about 13 red salmon to the case, or more than 2,500,000 fish. In 1889 the number of fish put up was still larger, reaching probably 250,000 cases, containing more than 3,000,000 salmon. As the number of fish arriving at Karluk Bay for a long period of years has been known to be far greater than in any of the other bays of southern Alaska, it is probable that most of these salmon were present at Karluk for the purpose of ascending the river to spawn. Now the number of spawning fish seen in the river, the lakes, and their connecting rivers was comparatively very small, indeed out of all proportion to the number taken on the beach.

We were told by persons who have spent a number of years at Karluk that in former years the great catch of salmon was made in the river, and that at a certain time in the spring myriads of young salmon filled the river on their way down to the sea. In my opinion this river will soon cease to show such a state of productiveness, if indeed it has not already done so, and we must conclude that the most formidable obstruction at present to the ascent of salmon in the Karluk for the purpose of reproduction is overfishing.

The river freezes over in winter with such solidity that the natives travel along its course all the way to Karluk Lake on the ice. As the water is very shoal in many places, it must necessarily freeze to the bottom in such localities. The natives told us, however, that salmon may be taken any time during the winter under the ice in deep holes in the river, as well as in Karluk Lake. Karluk River does not thaw out until late in the spring.

The relations of the rivers to one another could not be determined in the short space of time at our disposal.

The temperature of the air was recorded by Mr. Stone, and a table showing the results of his thermometer readings is given elsewhere.

There is no doubt that the salmon are affected in their movements by the condition of the weather, but observations upon this subject have been so fragmentary that no principles as yet can be deduced from them. For some reason unknown to us the salmon were late in making their appearance at Karluk in 1889. Up to the first of August the outlook for the fishermen was very discouraging, but during the month of August the arrivals of fish were numerous and the schools very large.

Photographs were taken to show the relations of the seining beach to the lower course of the river, and especially the spit with the buildings located upon it, the nature of the banks and adjacent mountain slopes near its mouth, and also a series of Karluk Lake and its tributaries.

ALITAK BAY AND OLGA BAY.

(Plates LXXII–LXXVI and LXXXIV–LXXXV.)

The outlines of this large and irregularly shaped body of water as laid down upon the chart furnished for our guidance differ greatly from those represented upon the running chart of Capt. L. P. Larsen, which Mr. Booth was allowed to copy for the use of the U. S. Fish Commission. About 10 miles to the northward of Cape Alitak the bay contracts abruptly, and continues narrowing to the north for a distance of about 7 miles, when it expands again into a great bay fully 15 miles in length, composed of two enlarged ends connected by a narrower intervening body. This upper portion has been called Olga Bay, and it is the body of water in which we are most interested at

present, because some of its tributaries furnish all of the red salmon now shipped from Alitak Bay. The general direction of Olga Bay is nearly northeast and southwest.

The chief salmon river or creek falling into Olga Bay is "at the outlet of the second chain of lakes into the upper portion of Olga Bay, a point only about 2½ miles from the southwestern shore of the island, Olga Bay itself being separated from the ocean only by a narrow neck of marshy land about three-fourths of a mile across."

"At this river the Arctic Packing Company's cannery is located. The detour required to reach it by steamer is upwards of 30 miles longer than it would be if Olga Bay were connected with the ocean at its western end."—(F. BOOTH.)

The width of this stream at the time of our visit, September 8, was scarcely more than 10 feet near its mouth, and the depth of the water was 8 inches. The river is plotted by Captain Larsen as 1 mile in length. At its head is a chain of two large deep lakes, 4 miles long. At the river mouth the bottom is lined with coarse pebbles similar in size to those composing the adjacent beach. The exit of this stream is often changed by storms. Young salmon, about 2 inches in length, were plentiful here. The fishing is done with sweep seines in the bay near the river mouth and was about closed September 8. Red salmon is the principal species, but a few silver salmon run into it also.

On the shore of Olga Bay opposite the cannery of the Arctic Packing Company there is a small fishing station operated by the Kodiak Packing Company, and known as the White Star Fishing Station. Red salmon and silver salmon are found there.

At the northeastern end of Olga Bay there is a fishing station used by the Kodiak Packing Company and called by them the North Fishing Station. This locality was seen September 9 by Mr. Booth, who describes it in the following words:

"The river at the North Fishing Station spreads out at its mouth into two shallow lagoons, which once formed estuaries for a large river in the present bed. These lagoons are separated from the bay by a long, narrow spit of slate gravel, overgrown with rank grass, through which the river, or rather creek, has an outlet about 30 feet wide and 12 inches deep. This creek takes the drainage from a narrow valley running north amongst a series of very barren, snow-covered mountains. The shores of the lagoons are covered with occasional patches of alder, thicker on the western than on the eastern side. The lagoons themselves are each about 500 yards long and 300 yards wide, and at low water must be almost dry. The company had ceased fishing there at the date of my visit, so we staid but a short time, not sufficient to allow me to attempt any extended reconnaissance."

In the vicinity of the North Fishing Station there is a small belt of timber, consisting chiefly of alder and cottonwood. I was informed that 30 cords of wood suitable for fuel were cut during the fishing season at this locality. Not far away from this station to the westward is a region which is noted for the number of its bears.

The waters of Olga Bay and Alitak Bay at the time of our excursion were teeming with jelly fishes, and in Alitak Bay I observed a number of small whales. The narrows connecting Alitak Bay with Olga Bay receives many small stream on both sides, and several native villages are located at the mouths of these streams. Numerous humpback salmon are found in all of them. At and near the Kodiak Packing Company's cannery, in Snug Harbor, two small creeks fall into the bay, both of which were full of spawning humpback salmon.

The following subjects were photographed in Alitak Bay:

The Kodiak Packing Company's cannery and the fleet in the harbor; Alitak Narrows from Snug Harbor and from the north end; the entrance to Olga Bay and the mountains of Olga Bay; the Salmon River near the Arctic Packing Company's cannery; a salmon creek; a group of natives; and a view looking out of Snug Harbor.

UYAK BAY.

(Plates LXX-LXXI and LXXXIII.)

Although a large and beautiful body of water, affording some fine harbors for the vessels of the salmon fleet, to which they run for shelter from the severe storms that drive them away from the open roadstead of Karluk, Uyak Bay has no streams containing salmon which are at present commercially valuable except humpbacks. A cannery belonging to the Arctic Packing Company is located in a cove forming part of the west arm of this bay. Its supply of fish, however, is obtained from Karluk, 17½ miles distant. Numerous streams of small size empty into the bay from the surrounding mountains. Some of these make their exit into Uyak Bay over an elevation which prevents the salmon from entering their mouths, but there are many streams abounding in humpback salmon, which in the middle of August were spawning or spent. Certain portions of the shores are suitable for seining, other portions are made up of bowlders and sharp stones, many of them incrusted with barnacles, which make it difficult to haul the seine. Alder, cottonwood, and several species of willows are found on these shores, and particularly around the portion called Larsen's Bay or Cove.

Flowering plants and ferns occur also in great profusion.

Around the wharves of the Arctic Packing Company cod, tomcod, herring, and other fishes were very abundant, attracted by the refuse from the salmon splitting-tables.

Across the mountain from the Arctic Packing Company's cannery, a lake is found which is full of fish, probably dolly varden trout, according to the testimony of Mr. Holmes.

One of the most famous of the humpback salmon streams of this bay is the one known as Alexander's Creek, upon which Mr. Booth has made the following notes:

"Directly south of and opposite to the Arctic Packing Company's cannery, in Larsen's Cove, Uyak Bay, is a small creek which at the time of our visit was said to contain more *gorbuscha* than any other known salmon stream in Alaska. This creek is a very short and narrow stream, rising in the high hills on the southern side of the bay and plunging down for about a mile over a very steep slate bed until it reaches the low land on the shores, where it widens out to about 25 feet wide, about a hundred yards from the beach. There was barely enough water to allow the *gorbuscha* to swim, especially at low tide, when, owing to the very gradually sloping beach and great rise and fall of the tides, the creek separates into several channels. At low tide the sea recedes about 300 yards. Its average rise and fall is about 18 feet.

"Several other small creeks empty into Larsen's Bay on its northern side, but owing to the high black slate bluffs, which almost everywhere line the shore, no fish can enter them."

Near the Arctic Packing Company's cannery, at Larsen's Bay, Mr. Booth describes "a large tract which apparently consists wholly of peat to a considerable depth. Above it is a small pond from which the cannery draws a portion of its water supply, the other portion being taken from springs which rise through the peat bog. At one of these springs an excavation 6 feet in depth did not reach the bottom of the peat deposit. Such deposits exist also in many places in the Karluk River Valley, and probably in the Sturgeon River Valley and others of similar topographical features. They may be a valuable source of fuel supply in the future if suitable means for drying the peat could be devised. As yet no attempt has been made to utilize them nor has any of this peat been experimented with so far as my information goes."

Photographs were made of the salmon fleet anchored in Uyak Bay during a southwest gale, of the harbor near the mouth of this bay looking across Shelikoff Strait and also to the northeast, besides Larsen's Bay, including the canning establishment of the Arctic Packing Company.

AFOGNAK BAY.

(Plates LXXIX and LXXXVI.)

After having completed preparations for a trip to Afognak Island, to make collections and photographs and continue our study of the salmon, Mr. Lewis and I were poisoned by a plant which we supposed to be wild celery and had to remain at Karluk. Mr. Booth and Mr. Stone accordingly made the excursion and investigated the physical characteristics of Afognak Bay, lake, and river, and the possibilities of conducting a salmon-hatching establishment in that region. Mr. Booth's account is given below. Mr. Stone's report will be referred to elsewhere:

"The interior of Afognak Island is, from the best accounts, made up of flat marshy valleys separated by mountain chains from 1,500 to 2,000 feet high. These valleys contain many lakes, which connect by means of short rivers and shallow estuaries with deep narrow inlets leading to the open sea. The most important of these is the Afognak River, and in Afognak Bay, the inlet at the mouth of its estuary, are situated the canneries of the Royal and Russian American Packing Companies. This river is but short, its total length measured from the point where it leaves the lake to the upper end of Afognak Bay being not more than 3 miles.

"As the whole of Afognak Lake can be seen from the source of the river, and our time was limited, it was not explored. Its extreme length does not exceed 3 miles, and its greatest width is about three-fourths of a mile. The general configuration is shown on the accompanying chart. It derives its water supply from small streams coming directly down from the surrounding hills and creeks, which drain two wide valleys to the northward. The lake seems to be surrounded by a thick fringe of spruce woods, except at its extreme north end, which is grass-covered, with here and there clumps of alder. Where the river leaves the lake it is about 130 feet wide, but narrows down to 70 feet in width in the course of 100 yards, and after going about one-third of a mile narrows still more, being there not more than 40 feet wide. Thus far it keeps an almost straight course, so much so as to remind one of a canal. From here on it winds about in long curves until it reaches a water-fall about 2 miles below the lake. Here the river crosses either a dike or a bed of very hard sandstone (the rock is much decomposed so that it is hard to tell its original character), falling about 20 feet in a series of cascades about 70 feet long.

"From the 'water-fall' the river flows on for about 100 yards at a much steeper grade than at any point above the falls, until it reaches an old Russian timber *zapor* about 6 feet in height, over and through which it falls, to continue 500 yards further in its steep channel until it reaches tide level and spreads out over its wide and shallow estuary. This estuary ranges from 100 to 400 feet in width, and at low tide is almost bare. Its length is about five-eighths of a mile. Near its mouth the river has again cut through a bed of hard rock, and the channel is narrowed down to about 50 feet and scoured out chiefly by tidal action to a depth of about 4 feet. Another ledge, apparently not so hard as the last-mentioned one, crops out about one-fourth of a mile below the *zapor*. In the upper end of Afognak Bay, around the mouth of the estuary, the bottom is covered with an exceedingly rank growth of the narrow flat-leaved eel grass; so thick is the growth of this grass that it is very difficult to push a boat even in 3 feet of water if the tide is low.

"At the time of our visit, in the latter days of August, the stage of the water in the river was exceedingly low. In the river proper there was no part of the channel where more than 18 inches of water covered the bed, and 12 inches would be fully the average depth, while places were found where the water was not more than 4 inches deep. Yet the river was well filled with *gorbuscha*. The bottom of the river is made up of material greatly similar to that in the bed of the Karluk River, slate, jasper, and quartz gravel predominating, interspersed with bowlders similarly composed of all conceivable sizes and shapes. The cross-section of the bed is uniformly level, but filled with holes the bottoms of which were composed of gravel about egg-size usually, but sometimes contained stones of 3 or 4 pounds weight. The *gorbuscha* were thickest in the neighborhood of these holes, but on examining the holes we found very few eggs under the gravel. Scarcely any finely divided slate was found in the river bed, although the banks were largely made up of this material. Although the river was so shallow at the time of our visit, Mr. Stokes, of the Russian American Packing Company, told us that in March last he was unable on account of the depth of the water to wade it in a pair of high rubber boots. This would make its depth over 3 feet.

"The river flows for almost its whole length through a valley, about 2 miles wide near the lake, gradually narrowing to about one-half mile at the head of Afognak Bay. This valley is filled with low mound-like hills, covered with a thick growth of the spruce peculiar to this portion of Alaska. Between these hills are gullies with small streams, almost completely hidden by the dense growth of sphagnum winding about in them. These woods are usually well supplied with salmon berries, blueberries, and huckleberries, so much so as to be noted for this throughout Alaska. The shores of the river are either flat or gently sloping, being composed of finely-divided slate gravel, which does not admit of very steep banks. Without doubt the present river valley, in common with that of the Karluk and other rivers of this region, was the channel of an ancient glacier, the traces of which are masked under the present abundant growth of bushes and tall grass, leaving nothing but the general configuration of the country to betray their former existence. Near the bay the shores of the estuary assume the form of low bluffs, similar to those at Karluk, but not so high. The mountains immediately surrounding the lake are more rounded in outline than those surrounding Karluk Lake, and at the time we saw them showed no snow-caps, although the mountains separating the two valleys at the northern end of the lake still carried

snow on their summits. As near as we could judge, they were about the same in height as the Karluk Lake range—from 1,500 to 2,000 feet.

"The grade of the river above the falls is very slight—not more than 7 or 8 feet to the mile. From the falls to tide-water the grade is much steeper, there being a difference of elevation, including the fall, of about 40 feet between the river above the falls and high-tide level in the estuary, which is at a distance of about 600 yards below the falls. The difference of elevation of the upper and lower ends of the estuary, calling the lower end of the estuary the head of Afognak Bay, is about 14 feet, that being the average rise and fall of the tide, which generally ebbs to the upper end of the bay, leaving the estuary almost bare. Great numbers of salmon are thus stranded and many die before the next tide rescues them.

"The Afognak River has two tributaries, both of which enter the main stream below the falls, in the position shown on the chart. Owing to the lack of time we did not trace them to their sources. Where they join the river they were from 15 to 20 feet wide and from 12 to 18 inches deep, with a current of about 2 miles per hour. Their shores, surroundings, and rate of descent are similar to those of the main river. At the time of our visit *gorbuscha* were running up them in great numbers.

"In the upper part of Afognak Bay, near the mouth of the estuary, are a number of small, low islands, the largest of which is the highest, its southern end rising in a high slate bluff 70 feet above high water. The slate here, as on the main island of Afognak, dips northwest at an angle of 20 degrees. This island, like the opposite shores on both sides of the bay, is covered with the peculiar species of spruce before mentioned. The strata of the bay shores attract attention by their sharply upturned edges, which cut the boot when walking over them. They consist of highly inclined bituminous shales and sandstones, interstratified with thin beds of yellow sandstone, which are apparently devoid of bituminous matter.

"Across the bay from the canneries in a northerly direction is a small cove running northwesterly about 700 yards. It forms a good anchorage, and is frequently so used. At its extreme end it receives the waters of a small creek, which emerges from the forest with a width of about 20 feet and a depth of 12 inches. Near its mouth it, like the main river and its tributaries, cuts through a bed of hard rock, which gives it a sharp turn. This bed may possibly be a continuation of that cut by the river.

"As regards obstructions, the *zapor* and fall, a sketch of the latter being appended, form the only important ones. The *zapor* is formed like an ordinary timber dam on its inside face. Its foundation consists of rough logs built crib fashion, on the top tier of which rests the spiling, formed of split spruce logs about 10 feet long, set at an inclination of about 30 degrees from perpendicular. This forms the inside wall of the dam, against which is piled gravel to stop up all holes. In its center is an inclined sluice about 3 feet square, opening upwards from the down-stream side, up which the fish run into the trap, a tank made of cribbed logs, about 6 feet square in interior dimensions. Here the fish are speared by the natives. This *zapor* is now going to ruin, many gaps existing in the spiling, which render the trap ineffectual. The fall, however, prevents many fish from ascending the river, as the series of cascades is difficult for them to surmount, owing to the shallow, rocky bed at their termination. If desired it would be an easy matter to construct a fish-ladder here, and obviate the difficulty completely.

"The river and creeks freeze over in winter, but we have no information as to whether the bay itself freezes or not. The silver salmon had just commenced running at the time of our visit. At the upper end of the bay, and along the east bank of the estuary, is an Aleut village of about 40 barabaras, called in the native language Litnik (meaning summer residence.) The natives are attracted here by the facilities for obtaining an abundant supply of salmon and berries for winter use. At the time of our visit nearly all of the barabaras were occupied."

The following temperatures were observed by Mr. Stone at Afognak:

Date.	Time.	Bay.	Air.	Weather.
		°	°	
Aug. 30	6 p. m.	49.5	49.5	Very stormy and windy.
Aug. 31	7 a. m.	54.5	.....	Rain-storm.
Do	12 noon	49.5	52	
Do	6 p. m.	49.5	.....	
Do	8 p. m.	.....	47	
Sept. 1	7 a. m.	47.5	47.5	Clear.
Do	12 noon	56	60	
Do	6 p. m.	51.5	53	
Sept. 2	7 a. m.	49.5	47	Do.
Do	12 noon	53	58	Cloudy.
Do	7 p. m.	52	53	Do.

Mr. Stone's record at Litnik River, September 1, follows:

Date.	Time.	Afognak Bay.	Village.	River dam.	Weather.
Sept 1	10 a. m.	47.5°	49.5°	50°	Clear.

NATURAL HISTORY OF THE SALMON.

In Alaska the salmon family includes numerous species, most of which are represented by vast numbers of individuals. The sea teems with salmon, trout, and smelt, and the rivers and lakes are full of whitefish, grayling, and inconnu.

The largest salmon of the world are credited to this Territory, and there is no doubt that in Cook's Inlet King Salmon weighing over 100 pounds are occasionally taken, but this is far above the average weight of the species. The most abundant salmon in Alaska are the Red Salmon and the Little Humpback, and it is these species which figure in the wonderful tales concerning rivers which contain more fish than water, tales which sound incredible to those who have never visited Alaska, but which, however, in many cases are strictly true.

The salmon have been traced as far north as Hotham Inlet and one species is found well to the eastward of Point Barrow. It is quite probable that this species, the little humpback, extends its migration to the Mackenzie.

There are five species of whitefish in Alaska, one of which reaches a weight of over 30 pounds. This whitefish has formerly been confounded with the common one of the Great Lakes. It is the species known as Kennicott's whitefish, now proved to be identical with Richardson's.

The round whitefish, or the shad waiter of New England and the upper Great Lakes, extends through the Northwest Territory, and other parts of British Columbia, into Alaska, where it ranges far to the northward. Specimens have been obtained in the Putnam or Kuwuk River, a tributary of Hotham Inlet. This is a small fish, seldom exceeding 2 pounds in weight, but it is valuable as food and very abundant. An excellent species found still farther north is the *Coregonus laurettæ*, which has been obtained from the Bristol Bay region to Point Barrow. This is a little larger than the round whitefish, but does not much exceed 3 pounds in weight. It resembles our so-called lake herring. The other two species are less valuable than the three already mentioned, but the natives use them as food in great numbers and feed their dogs upon them also.

A fish resembling the whitefish, but very much larger, more elongate, and with a very strongly projecting lower jaw, which has given origin to the name shovel-jawed whitefish, is one of the best food-fishes of the Territory and grows very large. It is said to reach a weight of 50 pounds and a length of 5 feet. This is the Inconnu of the voyageurs or *Nelma* of the Russians. The *Nelma* is found in the Mackenzie and its tributaries, in the Yukon, and the Kuwuk. Doubtless the species occurs also in the Kuskoquim and the Nushagak.

The grayling, or blanket fish, is very abundant in the Territory, especially northward. Its range southward is not clearly known, but in the northern part of British America and from the Yukon north to the Kuwuk it is very abundant.

The smelt of Alaska are large and very plentiful. They resemble our eastern smelt in appearance. The range of the species is from the Bristol Bay region to Point Barrow, and they are most abundant from the early part of September until November. They abound in sheltered bays and tide creeks.

Still another smelt occurs around the shores of the Gulf of Alaska, which is identical with one of the California species, and a very excellent food-fish.

The capelin is found along all parts of the coast and is one of the most important food species of the cod and salmon.

Eulachon are very common in the Gulf of Alaska, particularly at Katmai on the peninsula of Alaska, where they have been salted and meet with ready sale.

The foregoing representatives of the salmon family have been reviewed simply to call attention to the wealth of the Territory in superior food-fishes. Their commercial importance up to the present time is small, but they will figure eventually and very prominently among the resources of Alaska. There is no doubt that many of the small marine species play a very important part in attracting the larger commercial species of the salmon family to certain localities.

Before proceeding to an account of the salmon and trout it may be well to state that the herring of Alaska is one of the finest species of its genus (*Clupea*), and is universally known as one of the fishes upon which the salmon subsist. The herring visits all parts of the coast of Alaska, running up into the bays in schools, sometimes covering an area of many square miles. It comes into the shallow waters of the bays to deposit its eggs, reaching Cook's Inlet for this purpose early in July, so that its appearance in force coincides with the height of the salmon runs. The capelin is also found early in the summer, and we know that salmon are very eager in their pursuit of this fish. The little sand launce, or lant, is also present in the bays in wriggling masses at the period when salmon abound.

The King Salmon (*Oncorhynchus chouicha*).

(Plate XLVI, fig. 1.)

The largest and finest of the Alaskan salmon is the King, or Chowichee, known also as the Takou, Columbia River, Chinook, and Quinnat. This valuable fish occurs in the large rivers as a rule, but we know that it runs into some of the small streams also, notably the Karluk, and some of the rivers emptying into the eastern part of Cook's Inlet. The Yukon and the Nushagak are the greatest King Salmon rivers. The species is found less abundantly in the Ugashik, Kuskoquim, and Kvichuk.

The King Salmon is the most favorably known of all the species; its average weight is above 20 pounds, and individuals of 100 pounds or more are recorded. At St. Paul, Kadiak, in 1880, Mr. B. G. McIntyre told me he had weighed one which registered 87½ pounds without its viscera; he believed the entire fish would have weighed 100 pounds.

The flesh of the King Salmon is paler in color than that of the Red Salmon, but superior to all others in flavor. The salted bellies are considered a great delicacy. The principal uses of this fish are as fresh fish and for canning purposes. In Alaska

has not yet acquired the importance belonging to it on the Columbia River, chiefly because of the distance from San Francisco to the Alaskan King Salmon rivers, and the difficulties of fishing in those waters.

This species is the first to arrive on the shores in the spring. It makes its appearance in southern Alaska in May, and Nelson found it in Norton Sound, the northern limit of its known migration, early in June. The time of its coming into Norton Sound corresponds with the breaking up and disappearance of the ice. Nelson observed that "the largest of these salmon run during the few days just preceding and following the breaking up of the ice, and thence on until the end of the season they decrease gradually in size and quality." In the Yukon the season lasts only about a month. Capt. L. P. Larsen informed me that the King Salmon is the first to appear in the Nushagak. Here the run is short, scarcely continuing into August. At the Karluk the species arrives late in May. Very few were seined there during the month of August. We saw stragglers on the 4th, 6th, and 27th of the month, and a few spawning fish were in the upper part of the river August 21. On the 4th of August a fine male of about 35 pounds, with the spermaries little developed, was seined on the beach. In its stomach I found forty-five capelin. Mr. Charles Hirsch states that the species is only an occasional visitor at Karluk.

The King Salmon continues to enter some of the rivers for the purpose of spawning until August. The height of the season, however, is reached by the middle of July in most localities. This fish travels up the rivers farther than any other species except the Red Salmon. In the Yukon it ascends far above Fort Yukon, more than 1,500 miles from the mouth of the river. Dr. George M. Dawson records its occurrence in the Lewes River as far as the lower end of Lake Marsh, where it was found in considerable numbers early in September. According to Indian authority it pushes on almost to the headwaters of the tributaries to the Lewes on the east side.

The King Salmon does not ascend rivers rapidly unless the spawning period is close at hand. It generally plays around for a few days, or even a couple of weeks, near the river limit of tide-water. After entering the fresh water to begin its journey to the headwaters of the stream it moves rapidly until it finds suitable gravelly bottom in clear water. No food is taken in fresh water. When a barrier to its ascent is met I am told that the fish charges at it repeatedly and persistently without regard to the consequences to itself. The nest-building habits have been so often described that it is unnecessary to repeat them here. The spawning takes place, as before remarked, near the headwaters of streams in clear shallow rapids. As far as we can learn, only those fish that ascend the streams short distances return to the ocean after spawning, and September is the month in which the spent fish go down to the sea. Turner mentions a female weighing 38 pounds, which had spawned and returned to the sea and was caught at Unalashka, September 25, 1878. This female was in fine condition for eating

There is no reason why the King Salmon should not return down the Karluk, as the distance is very short and the fatigue of the journey up-stream is very slight. There is ample testimony of a conclusive nature to the effect that after a King Salmon ascends 500 miles from the sea it never returns to it alive.

Mr. Charles Hirsch informed me that the Karluk natives watch for the King Salmon in May, and set up a great shout as soon as they discover it. Like the other species, it can be seen about 1½ miles off shore in great schools, but before coming

nearer the schools break up. There is no salt-water fishery for this salmon in Alaska, except along the beaches.

No falling off has been observed in the supply of the King Salmon; in fact the number used is very small in comparison with that of the Red Salmon.

The only destruction of King Salmon known to me was incidental to the efforts to prevent Red Salmon from ascending certain streams by an impassable fence, and this no longer exists.

The Dog Salmon (*Oncorhynchus keta*).

(Plate XLVI, fig. 2.)

This is one of the least important of the Alaskan salmon to Americans, but one of the most valuable to the natives. It is found chiefly in the small rivers and creeks, and is usually very abundant in all parts of the Territory as far north as Hotham Inlet, and probably Point Barrow. Its flesh is comparatively pale, and it deteriorates so rapidly in fresh water as to prove very unattractive to white people. The jaws become enlarged and distorted, and the flesh unpalatable.

In the rivers of California and British Columbia it is said to appear seldom or never in the spring, but in Alaska it makes its appearance on the coast in great schools about the middle of June and continues abundant for nearly a month, after which it decreases rapidly in numbers, disappearing usually about the time of the forming of the ice.

The average size of the Dog Salmon is about 12 pounds, but I have seen individuals that would weigh 20 pounds. On the 30th of August, at Karluk, a haul of a large seine yielded forty Dog Salmon and only one Red Salmon. Early in July the fish-drying frames of the natives on the shores of Cook's Inlet are red with the flesh of the drying Dog Salmon, or *Hyko*.

The natives cut off the head, split the fish in halves, and remove the back-bone, allowing the two halves to remain fastened at the tail. The sides are gashed at short intervals in order to facilitate the drying. The fur traders lay in a large stock of this dried salmon, which is known to the trade as *ukali*. In the fresh-run condition the flesh has a beautiful red color, resembling that of the Red Salmon, but not so brilliant.

In the small streams falling into Alitak Bay, with only a few exceptions, this fish and the Little Humpback are the principal salmon, and the natives dry them for winter use in large quantities. The Sturgeon River, according to Mr. Charles Hirsch, never contains anything but Dog Salmon and Humpbacks. In the Karluk the Dog Salmon is only an occasional visitor. At St. Paul, Kadiak, Mr. Washburn says that the *Hyko* arrives about July 1, and there is only one annual run.

Early in July the red color of the skin of the *Hyko*, or Dog Salmon, is somewhat remarkable in being interrupted at intervals along the sides, causing a sort of resemblance to bands.

The Silver Salmon (*Oncorhynchus kisutch*).

(Plate XLVI, fig. 3.)

The Silver Salmon is considered an excellent fish in the Puget Sound region, but is not so highly esteemed in the northern part of Alaska. It is used to some extent for canning, but is far less important for this purpose than the Red Salmon. It reaches a weight of about 30 pounds; the average weight in Alaska is less than 15

pounds. This species in Alaska, as in the Puget Sound region, is a fall-running fish. It does not ascend the streams to any great distance, and I have seen spent fish of this species coming down alive in the fall to within easy reach of salt water. Whether the species actually leaves the fresh water after spawning is uncertain. There is a conflict of observation on this subject.

Mr. John W. Clark, agent of the Alaska Commercial Company at Nushagak, a man who is noted for his veracity and intelligence, states that he has seen Silver Salmon come down the river alive in the spring. In some other Alaskan rivers Captain Lansburg, superintendent of the Thin Point Cannery, has seen only black and lank-looking salmon of this species during the winter.

At Afognak the species arrived August 5, 1889, but there was no extensive run until about the end of that month. A small Silver Salmon was seen at Karluk August 4. The species was not abundant there, however, until early in September, when about seven thousand were caught at one haul of a seine. It was about this time that one of Capt. L. P. Larsen's men at Karluk hooked a very large Silver Salmon, probably weighing over 30 pounds. This species is only an occasional visitor at Karluk. When it runs there it generally begins about the last of August, according to Mr. Charles Hirsch. Mr. Washburn informed me that it arrives at St. Paul late in August or in September, and that there is only one annual run. A few fish of this species are found in the small river in Olga Bay, near the cannery of the Arctic Packing Company. In the river at Thin Point, a small and very shallow, but constant, stream, both Silver and Red Salmon are found, the latter predominating. The season closes here early in September.

The Silver Salmon make their nests among the gravel and stones, from which they clean all dirt and slime. They use their snouts in collecting material for the nests, and Turner states that he has seen them with the snout worn off past the muzzle. After the spawning season, and during their stay in fresh water, they continue to be very much emaciated and in poor condition generally.

No decrease has been observed in the supply of this salmon as far as we are informed. Its late arrival in most localities limits the season during which it can be caught, and this serves as a sort of protection for the species.

The Humpback Salmon (*Oncorhynchus gorbuscha*).

(Plate XLVII, figs. 4 and 5.)

This is the smallest, the most abundant, and the most widely distributed of the Alaskan salmon. Its average weight is about 5 pounds, and individuals weighing 10 pounds are very uncommon.

The Humpback may be recognized readily by its excessively small scales, and, in the breeding season, by its greatly distorted jaws and enormous hump. This species is found in all parts of the Territory. Its range is known to extend several hundred miles to the eastward of Point Barrow, and probably includes the Mackenzie. Speaking of their extraordinary abundance, Turner has aptly remarked that "they appear at the surface of the water like the pin-drops of an April shower."

Mr. Charles Hirsch informed me recently that from about the 6th of July, 1880, there was in the Karluk River, continuing for five weeks, a glut of Humpback Salmon which kept all other salmon out of the river. It was impossible to pull a boat across

the stream, owing to the great quantities of salmon. A haul was made with a 15-fathom seine at 6 a. m. and the men were dressing fish from that one haul until 6 p. m. About 140 barrels were dressed. These were loaded in bulk into a small schooner, and then the men were occupied three hours in clearing the seine, in which the remaining salmon were about 4 feet deep.

The Humpback Salmon arrives at St. Paul, Kadiak, about the 10th of July, and there is only one run a year. From the statement of Mr. Hirsch, above referred to, it will be seen that it makes its appearance on the western side of the island at about the same time. Mr. Turner records the date of arrival at St. Michael's as about the 25th of July, and the period of running about five weeks. Nelson's earliest specimens were taken at St. Michael's July 24. He states that the species is rather numerous until the end of July, with more or less common stragglers until late in the fall. We found Humpbacks in good condition in Plover Bay, Siberia, about the middle of August.

The species continues to enter the rivers usually for a period of about five weeks, but it is not regular in its appearance. The enormous run in the Karluk, mentioned above, was exceptional, for the fish seldom enters that river. In the Yukon, during some years, according to Mr. Nelson, only a few are taken, and at other times they are present in such excessive numbers in the lower part of the river that the fish-traps must be emptied several times a day.

This salmon is much addicted to jumping out of the water. In the vicinity of St. Paul, Kadiak, one of the commonest sights was this breaching of the Humpback Salmon. Fishermen at this village told me that the sea run Humpback often contains a small fish, which, from their description, must be the capelin.

In the Karluk River, as already mentioned, the species continued to enter for five weeks, and then dead fish began to float down the stream, and this continued about a month. It does not go far from salt water and frequently enters streams which are too shallow to cover its fins. Its business in the fresh waters is simply to deposit its eggs, after which, apparently, it dies on the spawning-grounds or is carried to sea in a dying condition. Spawning takes place within a few rods of the sea. It is a common thing to see large areas of the bottom entirely covered with the eggs, either lying unprotected on the gravelly bottom or partly concealed in crevices between moderately large stones. In Afognak River the eggs were cast among stones about half as large as a man's fist.

There are no signs of diminution of the supply of this fish. A small number are salted annually, and the natives dry large quantities for winter use.

In the fresh run condition this is one of the most palatable salmon in Alaska, and the time is not far distant when it will be a very important species for canning. The flesh is somewhat paler than that of the Red Salmon, yet it has a beautiful color. Properly introduced into the markets this would become a very valuable fish, and its wonderful abundance would establish a great industry.

The height of the spawning season in the Kadiak streams is evidently about the middle of August. In Alexander's Creek, near the Larsen's Cove cannery of the Arctic Packing Company, Messrs. Lewis and Stone found the Humpbacks spawning in vast numbers August 15. Mr. Lewis took some of the eggs and fertilized them with the milt of the males. The eggs are larger than those of the Red Salmon, but smaller than King Salmon eggs and not so bright red. On the 22d of August we saw this

fish in the small streams at the head of the west arm of Uyak Bay trying to run up the rapids to spawn. The current in some places was so swift as to wash the fish away. Eggs were very plentiful between the crevices of the stones. On the 24th of August we found Alexander's Creek full of Humpbacks in all stages of emaciation and decay. In Alitak Bay, September 9, the fish were nearly all dead in the creeks, and Snug Harbor contained many dying Humpback Salmon floating seaward tail first. Messrs. Booth and Stone found Afognak River well filled with spawning Humpbacks August 30. The two tributaries of Afognak River also contained them in great numbers. Mr. Booth found the fish most abundant in the neighborhood of holes excavated in the egg-sized gravel of the bottom, intermingled with stones of 3 or 4 pounds in weight.

After the great run in the Karluk, already referred to, the fish came down dead or in a dying condition for a whole month and the beaches were strewn with dead salmon. The distortion of the Humpback during the breeding season is remarkable and the injury to its fins, and other exposed portions of the body, is excessive. The last stages of this species are repulsive to look upon, but before the extensive emaciation and sloughing away of the skin has taken place the colors of the breeding-fish are rather pleasing, the lower parts becoming milky white, contrasting beautifully with the darker color of the sides and back. This white color sometimes extends upward towards the middle line with interruptions.

The Red Salmon (*Oncorhynchus nerka*).

(Plate XLVIII, figs. 6 and 7.)

This is the blue-back of the lower Columbia River, the *Sawqui* or *Sukkegh* of Frazer's River, and the *Krasnaya Ryba* (or redfish) of the Russians. It does not seem to exist south of the Columbia River. Northward it is found as far as the Yukon, and occurs also in Japan and Kamchatka.

Although next to the smallest of the Pacific salmons this is now the most important species for canning and salting, and its flesh is so red as to win for it a reputation not warranted by its edible qualities. It approaches the shores early in the spring and enters only snow-fed streams. The Red Salmon is not caught, like the King Salmon and Silver Salmon, by trolling in the bays. When it comes into the mouths of the streams, to ascend for the purpose of spawning, the fishing begins.

The size of the Red Salmon varies with the locality and season. Some runs contain much larger fish than others. At Karluk the fish will average nearly 4 pounds apiece without the head, fins, tail, and viscera. The whole fish will weigh 7 or 8 pounds. Individuals of 15 pounds are occasionally seen, but they are uncommon.

Like the King Salmon, the Red Salmon travels long distances up the rivers, pushing on to their sources; unlike the King Salmon, however, the Red Salmon is chiefly a lake spawner, the former fish preferring the headwaters of the principal rivers to their small tributaries.

Red Salmon arrive at St. Paul, Kadiak, according to Mr. Washburn, agent of the Alaska Commercial Company, in June, and there is only one annual run. This gentleman also informed me that there is a little run of small Red Salmon in Little Afognak River as early as April 1, but the principal run comes in June or July. In a river just 10 miles distant from the Little Afognak the first run does not arrive until about May 20. At Karluk, in 1889, and around Kadiak generally, the species arrived late, and

the catch up to the end of July was small everywhere. Turner records the 1st of May as the time when the natives of Attu Island prepare weirs (*zapor* of the Russians) to obstruct the passage of the Red Salmon to their spawning-grounds. The species does not appear to be common on the coast of Norton Sound, according to Nelson, but it is more abundant in the Lower Yukon, the main run occurring about the middle of August and lasting sometimes only two or three days, but usually a week or ten days.

When we left Karluk at the end of August the Red Salmon were still running into that river, but had greatly diminished in numbers and had become so dark in color as to be unfit for canning. At Afognak the run usually lasts only during the first three weeks of July, although they first appear about the middle of June, and as already remarked, a few small ones occasionally come about the 1st of April. The runs of fish appear to vary a good deal from year to year. Some of the fishermen at St. Paul believe that every fourth year is a good salmon year. Mr. Charles Hirsch told me that in Cook's Inlet, the Ninilchic, Kusilov, Kenai, and Sushitna Rivers all have salmon runs, but the kind of fish varies from year to year. We have seen how an unexpected run of Humpbacks may prevent the Red Salmon altogether from entering its chosen river.

Mr. Hirsch says that in coming from the sea the Red Salmon approach from all directions. They have been seen about 1½ miles distant from the land, and when they approach nearer the schools break up. This species is very much given to jumping entirely out of water, and it is a common sight, where this fish abounds, to see a dozen or more in the air at a time. At Karluk the fish play around in the kelp beds, especially when frightened by the seines, and here they are perfectly safe from the fishermen. The Red Salmon does not linger long in salt water after its arrival on the coast. Fresh run fish sometimes go into the river with the tide and out again the same day with the ebb.

Young fish occasionally accompany the adults, but all of those examined by me proved to be males. On the 13th of August we obtained a male Red Salmon 11 inches long to the root of the tail. This example contained numerous intestinal worms.

It is asserted by Mr. Charles Hirsch and others, who have had much experience with the Red Salmon, that no spawning fish of this species ever leave Karluk River alive.

Natives of Karluk informed me that they can catch salmon at any time during the winter through the ice on Karluk River and lake. They assert, also, that all the Red Salmon die in the spring, most of them in April.

After entering the rivers the Red Salmon may return to the salt water as already stated, but if the spawning season be near at hand and the spawning grounds remote they travel up the stream very rapidly. I have seen them playing about in the rapids, apparently resting, during the ascent of the Karluk. Numerous beds of eel grass and other aquatic plants furnish attractive hiding places in which the fish sometimes linger.

The Red Salmon ascends to the lake or lakes, which the river drains, and it is said that this species will not enter a river which does not arise from a lake. The distance traveled in the Karluk is less than 20 miles, and the principal lake is 8 miles long. Red Salmon spawn in this lake and in the short and rapid rivers connecting each of its arms with smaller tributary lakes. The species ascends long rivers, like the Columbia, more than 1,000 miles, to reach its spawning lakes.

This salmon begins spawning soon after its arrival on the coast, and this varies with the locality. The season usually begins in June, and fish, which have not yet spawned, continue to arrive as late as the beginning of September. Spawning certainly takes place in August, as we know from personal observation. Dead fish and others which have spawned and are already dying are very abundant about the middle of this month. We did not find many Red Salmon on our way up the Karluk River. In Karluk Lake, near the sources of the river, ripe Red Salmon were speared by the natives August 17. On the 18th of the same month we found large numbers of dead salmon of this species, and plenty of both sexes, which were spent and nearly dead, in the rivers connecting Karluk Lake with its tributary lakes. In all of the little streams falling into Karluk Lake, in which Red Salmon were found, dead fish were moderately common. We found, also, an abundance of young salmon about 1½ inches long, which I suppose must have been young of the year, hatched from eggs deposited during the preceding winter. Mr. Charles Hirsch informed me that "in March or April the Karluk River is solid full for a whole month of salmon fry going down to sea."

We found salmon nests at the head of Karluk Lake in shallow water near the shore between the mouths of two streams. The nest is a hollow circular pile of stones, and the eggs are placed in the crevices between the stones. In the river connecting the east arm of Karluk Lake with its tributary additional nests of the salmon were observed. In some cases streams fall down into Karluk Lake over bluffs, which are too steep for the salmon to ascend, and the fish were spawning at the mouths of such streams.

Extensive changes take place in the color of the Red Salmon as the spawning season approaches. When it comes in from the sea the skin becomes dark and the beautiful red color of the flesh gives place to a paler tint. In this condition the fish has no commercial value. In the height of the spawning season the sides are suffused with a brilliant vermilion and the head is a rich olive-green, contrasting sharply with the color of the body. The male develops a hump, nearly as large as that of the Humpback, and its jaws are greatly enlarged.

The eggs and young of the Red Salmon have many enemies, and the percentage of fish naturally developed from eggs must be exceedingly small. Every salmon nest has its greedy horde of little fresh-water sculpins, otherwise known as Miller's thumbs, blobs and bull-heads (*Uranidea* spp.), always in readiness to consume the fresh eggs in quantities out of all proportion to their size. The shoal waters around the shores of Karluk Lake, and the shallow streams into which the Red Salmon finds its way for reproduction, contain myriads of these destructive little sculpins. Another source of destruction to the eggs is found in the dolly varden trout (*Salvelinus malma*), which is only too common on the spawning grounds of the salmon. This trout consumes large quantities of the fresh salmon eggs. The waters referred to contain, also, a great many sticklebacks (*Gasterosteus* sp.), some of them of very large size, and it is probable that these little fish destroy eggs.

Chief among the destroyers of the young fish are terns, gulls, ducks, and loons, which are very common in that region. I shot some terns and gulls near the south end of Karluk Lake and upon holding them up by the legs small salmon dropped out of their mouths. Towards the end of August the shallow parts of Karluk River were visited by hundreds of gulls, chiefly young of *Larus glaucescens* and *L. brachyrhynchus*,

which were feeding upon young salmon. Bears consume large quantities of the breeding fish. They may be seen standing at the edge of the stream, where the water is shallow, and occasionally striking salmon with their claws and throwing them on the shore, where they are eaten alive. We found a dolly varden trout just released by a bear which our approach frightened away. One of the gill-covers of this fish was half torn off, but no other injury was visible. We saw Red Salmon partly eaten, but still alive, lying on the shore after the retreat of the bears, which were disturbed while feeding. Other enemies of the salmon attack it in the sea. Among them are the salmon shark (*Lamna cornubica*), porpoises, and sea-lions. We found all the species of salmon more or less covered with parasitic *copepods*. Collections of these were made, but the species have not been determined. At Afognak Mr. Booth observed a very serious cause of destruction of salmon. The estuary of Afognak River is generally left bare at low tide and great numbers of salmon are thus stranded, many of which die before the next tide rescues them.

Red Salmon are seen in salt water off the mouths of the rivers in large schools in the spring. The season of their approach to the shores has already been referred to, and also the fact that they are not observed farther than about 1½ miles from the shore. No attempt has been made to take Red Salmon until it comes to the shore. It is not caught by trolling, like the King Salmon and the Silver Salmon.

The catch of Red Salmon has been increasing, owing to the increase in the number of persons engaged in the fishery and in the effectiveness of the implements used in its capture. The size of seines has been greatly enlarged and the number of boats, seines and men largely augmented. That there will be a falling off in the supply very soon there can be no doubt. I have already remarked that the number of spawning fish in Karluk Lake and its tributaries last year was unexpectedly small. It is true that young salmon, from 1½ inches to 2 inches in length, were very abundant, but they were the result of the spawning of the previous season.

There was early in the season of 1889, and in previous seasons, injudicious obstruction of the ascent of spawning fish in the Karluk River. At one time an impassable weir, similar to the *zapor* of the Russians, was placed in this river. At the time of our visit we saw the remains of pound nets made of wire netting, which interfered so seriously with the ascent of the fish that they were dismantled by unknown parties and were not re-established.

The Steel Head (*Salmo gairdneri*).

(Plate XLIX, figs. 9 and 10.)

This large black spotted trout is known also as Hard-head and Gairdner's trout. The Russian name is *Soomga*. In some of our eastern markets, at this date, it is the "Kennebec Salmon."

This species sometimes reaches a weight of 30 pounds, and individuals of that size bear a close resemblance to *S. salar*. The Steel-head is found from Monterey, California, to Bristol Bay, Alaska, and is very abundant in some parts of the Gulf of Alaska. This trout has been considered a winter spawner, but females full of ripe eggs were seen by me near Sitka, June 10, 1880. Spent fish of this species are frequently taken with the spring run of the King Salmon, so that in all probability the usual spawning time is late in the winter or very early spring.

This species, according to Mr. Charles Hirsch, arrives at Karluk in August in small numbers. I saw a moderately large number of Steel-heads at Karluk on September 4, but their abundance was nothing in comparison with that of other species. It is seldom used at Karluk. I saw a few small individuals in process of drying there.

The spawning habits of the Steel-head are scarcely known. At Sitka we were told that it spawns in lakes not far from the sea and immediately after spawning goes into the salt water.

Another large black spotted species is Clark's trout (*Salmo purpuratus*, Plate XLIX, fig. 11). This occurs in southern Alaska and north to the Bristol Bay region; it grows to a length of 30 inches, and must soon become commercially valuable.

The Dolly Varden Trout (*Salvelinus malma.*)

(Plate XLVIII, fig. 8.)

This handsome species bears a very close resemblance to the sea trout of Labrador. It is known to commerce under the name of Salmon Trout. In some parts of the West it is called the Bull Trout. The Russian name of the species is *Goletz*, and in Kamtchatka it is the *malma.*

The average weight of this trout in the sea fishery at Kadiak is about 2½ pounds. It reaches a length of 30 inches, and individuals weighing 8 pounds are often taken. It increases in size to the northward.

The Dolly Varden is a migratory species and passes much of its time in the sea near the river mouths; it enters the rivers late in the fall and descends in the spring. At St. Paul Mr. Washburn informed me that it arrives at that place in April. It remains in the bay near St. Paul throughout the summer. Mr. Charles Hirsch told me that it reaches Karluk in the latter part of May and runs through the whole season. Dolly Vardens of a pound or more can be found in the streams at any time during the summer. We saw them in abundance throughout the Karluk in August, and in the small streams tributary to Karluk Lake. Nelson found them at Unalashka early in June, and in the Yukon in the same month, but he says they are most numerous in the fall just before and after the streams freeze over. They enter the rivers and go up to their headwaters for the purpose of spawning. The spawning season is in winter and may begin very early in this part of the year. A female, opened on the beach at Karluk August 2, contained eggs which seemed to be nearly ripe.

Individuals taken at sea sometimes have capelin in their stomachs. In Karluk River, near its mouth, we saw many examples feeding on eggs of the Red Salmon, which had been thrown into the water from the fish-cleaning houses. On the 5th of August we found a female Dolly Varden with very small ovaries. This example was long and slender. On August 16 a spent or sterile *malma* was found above the rapids in a little stream tributary to Karluk River. At the head of Karluk Lake, August 19, was discovered a very much emaciated trout of this species, which was struggling in the water and nearly dead. The inside of its mouth was full of large lernæan parasites.

The Dolly Varden spends the entire summer in salt water near the mouths of the rivers after it has reached a certain age; younger individuals remain in the rivers and lakes. Many thousands of this trout are caught in the seines hauled for salmon, and

fisheries exist for this species alone in various localities. It is put up in pickle and sold in San Francisco. The demand there, however, is limited.

No diminution of the supply of this trout has been observed. There is great destruction of this fish at Karluk in the seining for Red Salmon, where thousands of Dolly Vardens are taken and left lying unused on the beach. Something should be done to prevent this waste of good fish. Bears destroy a great many of these trout and water birds consume immense numbers of the young. At sea sharks, porpoises, seals, and sea-lions prey extensively upon the adults.

METHODS, CONDITIONS, AND STATISTICS OF THE SALMON FISHERIES.

APPLIANCES AND METHODS.

The fleet engaged in carrying cannery outfits, supplies, men, and products in the season of 1889 included 13 steamers, 4 steam schooners, 1 ship, 13 barks, 2 brigs, 10 barkentines, and 23 schooners, a total of 66 vessels.

The earliest clearing date which I have observed was January 30, and the latest on my list is September 20, 1889. Many of these vessels are chartered by the fishing companies for the season or the trip.

The number of dories employed at Karluk is about 200; the Karluk Packing Company alone has more than 50. At Afognak about 40 dories are used, and the number in Alitak Bay is probably not over 50. Several of the canning companies have steam launches for towing their scows and lighters. All of the companies have a sufficient number of the latter for loading and unloading their vessels, and all handling of freight to and from vessels must be done by means of the scows and lighters, as there are no wharves on the bay and no possibility of establishing them. The steam launches can tow lighters and flat-boats into the river at high tide, but not during low water nor on the half tide. Columbia River boats are used to some extent by the fishing companies at Kadiak, chiefly for making short voyages between stations.

Most of the fish used in the canneries are caught in seines varying from 150 to 250 fathoms in length, and from 16 to 20 feet in depth. The usual size of the mesh is 3¼ inches. Gill-nets also are used at Karluk, in Prince William Sound, and some other localities. Soft-laid twine is preferred to the hard laid for beach seining at Karluk, as it does not chafe so much on the rocks. A purse-seine was used August 7 by Mr. Barker outside of the kelp, and did reasonably well. The kelp is a great hindrance to the seining at Karluk, but affords excellent shelter for the salmon. The bottom of the bay is thickly covered with it, and its fronds float up to the surface except over about a half mile adjacent to the river mouth. The species is known as Bull-kelp.

We were informed that 36 canneries were in operation in Alaska in 1889, and we are indebted to Capt. H. E. Nichols, of the U. S. Coast Survey, for a chart showing the locations as nearly as could be ascertained. The canneries are situated as follows: Eight are on Kadiak Island, and 2 on Afognak; on the Nushagak there are 4; on the east side of the peninsula of Alaska, 5; in Cook's Inlet, 2; in Prince William Sound, 2; on Kayak Island, 2; in Lynn Canal, 3; Icy Strait, 1; Takou River, 1; Baranoff

Island, 1; Stickene River, 1; Klawak, 1; in Behm Canal, 3; in Tongass Narrows, 1, and at Port Tongass 1—the last doubtful.

The exact value of the buildings and machinery was not ascertained. The capital stock of the companies, however, varies from about $75,000 to $300,000, and it is fair to estimate the capital invested in this business at not less than $4,000,000.

The printed list of the salmon canneries on the Alaskan coast is taken from the San Francisco Commercial Herald and Market Review.

Salmon canneries of Alaska.

(Plate LXXXVII.)

Name of company.	Where located.	Brand.	Agents.	Home office.
Alaska Coast Fishing Co	Kadiak Island		Cutting Packing Co	San Francisco.
Alaska Packing Co	Nushagak	Polar Bear, Ice King	D. L. Beck & Sons	Do.
Alaska Salmon Packing and Fur Co.	Loring	Naha Bay Brand	Cutting Packing Co	Do.
Alaska Improvement Co	Kanatak & Kadiak	Canoe	James Madison	Do.
Aleutian Islands F. & M. Co	Kadiak Island	Kodiak	Scotchler & Gibbs	Do.
Arctic Fishing Co	Cook's Inlet	Arctic	Cutting Packing Co	Do.
Arctic Packing Co	Bristol Bay	Red, King, and Silver	C. C. Rohlffs	Do.
Arctic Packing Co	Karluk	Red, Aurora Borealis	do	Do.
Baranoff Packing Co	Clarence Straits	Wigwam	Williams, Brown & Co	Do.
Bartlett Bay Packing Co	Bartlett Bay		do	Do.
Boston F. & T. Co	Yes Bay	Sea Lion	do	Do.
Bristol Bay Canning Co	Bristol Bay	Polar and Excelsior	W. B. Bradford	Do.
Chilkat Packing Co	Chilkat	Glacier	Frank H. Foote	Do.
Chilkat Canning Co	Pyramid Harbor		Murray & Co	Astoria, Oregon.
Chignik Packing Co	Chignik	Our Taste	S. B. Peterson	San Francisco.
Chignik Bay Co	Chignik Bay	Comet, Guardian, and Crown.	D. L. Beck & Sons	Do.
Central Alaska Co		Northern Light	Scotchler & Gibbs	Do.
Moira Packing Co	Cape Fox	Moira	Taylor, Young & Co	Portland, Oregon.
Cape Lees Packing Co	Cape Lees	Iceberg and Totem-stick.	Townsend, McGovern & Co.	San Francisco.
Glacier Packing Co	Stikeen	Lion and Neptune	Delafield, McGovern & Co.	Do.
Hume Packing Co	Kadiak	Karluk	George W. Hume & Co	Do.
Kodiak Packing Co	do	North Pole and U. S. brand.	Kodiak Packing Co	Do.
Karluk Packing Co	Kadiak Island	Horseshoe	Karluk Packing Co	Do.
Nushagak Canning Co	Nushagak	Moose Head Brand, Red, King, and Silver.	Louis Sloss & Co	Do.
Northern Packing Co	Kenai	Anchor Brand, Red, King, and Silver.	do	Do.
Northwest Packing and Trading Co.	Klawack	Challenge	R. A. Wilson	Do.
Pacific Packing Co	Prince William Sound.	National	Louis Sloss & Co	Do.
Pacific Whaling Co	Copper River	Orca	Capt. J. N. Knowles	Do.
Peninsular Trading and Fur Co		Compass	Scotchler & Gibbs	Do.
Prince of Wales	Prince of Wales Island.	Coat of Arms	Cutting Packing Co	Do.
Pyramid Harbor Packing Co	Pyramid Harbor	Raven	D. L. Beck & Sons	Do.
Royal Packing Co	Afognak	Chieftain	Louis Sloss & Co	Do.
Russian-American Packing Co	do	Russian-American Brand	Russian-American Packing Co.	Do.
Shumagin Packing Co	Chignik	Warren's Alaska	W. D. Smith	Astoria, Oregon.
Thin Point Packing Co	Thin Point	Coleman's Flag	L. Sloss & Co	San Francisco.
Western Alaska Packing Co	Ozernoy	Walrus	W. B. Bradford	Do.

The canneries at Karluk, and on Kadiak generally, get their supply of fresh water from the adjacent mountain streams. At Karluk they make little reservoirs at suitable elevations and from these carry the water by surface pipes of iron into the canneries, thus utilizing the force of gravity.

The plant of a canning company usually includes, besides a cannery building proper, a fish house and wharf, a salting house, containing tanks for curing salmon, a cooper shop, barrel house, a machine-shop, a lodging-house and mess-room, a store-room and a warehouse. The method of handling the salmon after they are caught is as follows: The fish are thrown from the boats into large bins in the splitting-house, where they

are prepared for the cannery by cutting off the heads and fins, and removing the viscera. The different steps in this process are performed by different groups of men, one set cutting off the heads, another removing the fins, while still another scrapes out the viscera. After this the fish are washed and finally thrown into hand carts, to be hauled into the cannery, where they pass through various processes, almost all of which are carried on by machinery. The Red Salmon is first cut into lengths suitable for the size of the can. These pieces are carried along and fed into cans, inequalities in the filling being supplied by hand work. The cans are then topped in the topping machine, from which they pass to the soldering machine, and then are subjected to the processes of venting, cooking, steaming, testing, cooling, japanning and labeling.

The number of canneries in Alaska was greatly increased in 1889. Prior to 1888 the islands of Kadiak and Afognak contained only one or two establishments. The Karluk Packing Company at Karluk was the largest. In 1889 the number of canneries at Karluk was increased to five, and three additional firms came to that place to seine fish for canneries located at other places. The yield in 1889 was larger than in 1888, so that no decrease in the number of salmon has been observed as yet; of course the catch has been divided among a large number of companies and the individual take has fallen off in some cases. As an illustration of the injurious effects of over seining at Karluk it may be stated that previous to 1889 seining was carried on almost exclusively in Karluk River and there was no fishing done on the ocean beach except at very low tides, when there was not enough water to seine in the river. In 1888 a seine of 100 fathoms set in Karluk River took 17,000 fish at one haul. In 1889 the rivalry to obtain fish was so great that seining was done principally in salt water, as near the river mouth as possible, and the length of the seines was increased in most cases to 250 fathoms.

PRODUCTS OF THE SALMON FISHERY.

The productive streams of the Territory are generally small and have their sources in large lakes. The great rivers of the Territory from the Bristol Bay region northward do not furnish the yield which we might reasonably expect from their superior size, but these rivers are in the nature of undeveloped territory, with the exception of the Nushagak.

Nearly one-half of the entire yield of salmon in Alaska is now taken near the mouth of a small river, the Karluk, which at low water is only a few yards wide and has a length of less than 20 miles.

According to the Commercial Herald and Market Review, of San Francisco, the Alaska salmon pack of 1889 amounted to 629,260 cases in cans and 6,930½ barrels in salt. Two thousand cases of 48 pounds each is considered a great day's work for a first-class cannery, and is seldom exceeded, but on the 5th of August, 1889, the Karluk Packing Company canned 2,412 cases by extraordinary efforts.

The value of the output for 1889 was nearly $3,000,000. The market returns given below will show what share the different companies had in this yield.

Alaska salmon pack of 1889.

Arrived.		Vessel.	Barrels.	Cases.	Agents.
June	10	Bertha, str		3,665	Karluk Packing Co.
July	20	Jeanie, str		5,000	Pacific Steam Whaling Co.
	21	Ida Schnauer, sch		6,615	Alaska Improvement Co.
	23	Bertha, str		12,194	Karluk Packing Co.
	31	C. C. Funk, bkt		1,648	Western Alaska Packing Co.
	31	Hope, bk	31	10,400	Aleutian Island F. & M. Co.
Aug.	5	F. S. Redfield, sch		1,400	Scotchler & Gibbs.
	7	Comet, sch		5,035	Bradley & Co.
	10	Courtny Ford, bg		7,539	D. L. Beck & Sons.
	12	N. Thayer, bk		13,206	Arctic Packing Co. & Rus. Amer. P. Co.
	14	Jennie Stella, sch	59	8,000	Arctic Packing Co.
	19	Modoc, bkt		5,000	Chignik Bay Packing Co.
	27	St. Paul, str		3,600	Thin Point Packing Co.
	28	Louis, sch		12,767	Hume Packing Co.
	28	Vesta, sch		12,145	Karluk Packing Co.
	29	Sonoma, bk		19,644	D. L. Beck & Sons.
Sept.	1	Sea Waif, bg		1,250	Bristol Bay Packing Co.
	10	Electra, bk	130	27,764	Nuchigak Packing Co.
	10	Will W. Case, bk	6	16,220	Arctic Packing Co.
	10	Retriever, bkt		18,711	Northern Packing Co.
	11	Bertha, str		16,500	Karluk Packing Co.
	11	Jennie, str	69		Northern Packing Co.
	16	Oneida, sch	232	5,013	Pacific Packing Co.
	21	Ida Schnauer, sch	126	9,211	Arctic Fishing Co.
	21	Harry Morse, bk		361	Central Alaska Co.
	22	Wm. Renton, sch		2,540	Peninsular T. & F. Co.
	22	Haytien Republic, str	146	24,069	Kodiak Packing Co.
	22	...do		5,529	Arctic Packing Co.
	26	Jeanie, str	60	9,830	Pacific Steam Whaling Co.
	27	J. A. Borland, bk	73	19,553	Thin Point Packing Co.
	28	City of Puebla, str	127	13,645	Various.
Oct.	8	M. Winkleman		14,299	D. L. Beck & Sons.
	8	K. Flickinger, bkt		5,536	Chignik Bay Packing Co.
	8	Dashing Wave	503		Lynde & Hough.
	8	Viking, sch	33	2,880	Arctic Packing Co.
	8	Al-Ki, str	293	21,003	Various.
	8	Cas. Hayward, sch	890		Glacier F. & T. Co.
	9	Portland, bkt		6,158	Shumagin Packing Co.
	9	Laura Madsen, sch	152	13,794	Arctic Packing Co.
	10	Elsinore, bk		3,037	Western Alaska Packing Co.
	11	Margaret, bk		22,561	Russian-American Packing Co.
	11	Alden Besse, bk	14	31,300	Scotchler & Gibbs.
	12	Corea, bk	64	21,608	Arctic Fishing Co.
	14	Novelty, sch		14,412	Royal Packing Co.
	14	...do		5,686	Karluk Packing Co.
	14	...do	450		Arctic Fishing Co.
	22	St. Paul, str		1,900	Thin Point Packing Co.
	25	Farallon, str	6½	11,100	Bristol Bay Canning Co.
	26	Kodiak, sch	369	353	Karluk Packing Co.
	27	Dora, str		108	Alaska Commercial Co.
	28	Hera, sch	693	3,287	Golden Gate Salmon Co.
	28	Hattie Gage, str		605	Scotchler & Gibbs.
	28	Coryphene, bk		21,833	Hume Packing Co.
	28	Bertha, str	6	8,939	Karluk Packing Co.
	29	Beulah, sch	77	11,370	N. Pacif. Trading and Packing Co.
	29	Quickstep, bkt		12,364	Alaska Improvement Co.
	29	Dora, str		108	Thin Point Packing Co.
	29	Karluk, str		3,462	Karluk Packing Co.
	30	Nic. Thayer, bk		16,592	Arctic Packing Co.
	31	Undaunted, sch	375		Bowen, Colwell & Co.
Nov.	3	Hope, bk		19,122	Aleutian Island Fshg. & Mng. Co.
	3	Alaska, str	27		Arctic Packing Co.
	4	Arago, sch	43	3,763	Baranoff Packing Co.
	5	Signal, str		18,500	Bristol Bay Canning Co.
	9	Haytien Republic, str	6	18,538	Kodiak Packing Co.
	10	Corona, str	481	8,952	Various.
		Various	139	9,286	Do.

PREPARATION OF FISHERY PRODUCTS.

The native methods of curing salmon by sun drying and smoking have been so often described that I need not refer to them here. The processes of canning have also been fully recorded. The following notes on the method of salting Humpback Salmon at St. Paul will sufficiently describe the method of salting in general. Salting Humpbacks began at St. Paul about the 10th of July. The first dory load of

"colored" fish was brought in July 29. The percentage of both sexes, whose flesh is becoming light while the skin grows darker, is large. One can tell with almost certainty from looking at the outside just what the inside appearance of the fish will prove to be; a bright silvery female and a male with scarcely developed hump will show flesh of a very pretty pink, though not so red as in the *nerka;* a fish with dark slaty sides and head will have pale flesh; of course the male and female in the height of the breeding season have very pale meat.

The *gorbuscha* exceeds in numbers all the other species; in the prime condition it is as good to eat as any other salmon. The salting season for prime fish is short, only a few weeks as a rule.

The dory carries three men who seine the fish best on half or three-fourths tide and bring them to the wharf to be split for salting. The load averages 10 barrels of eighty fish each. A little saltpeter is used to set the pink color and, if possible, deepen it. A boy gaffs the fish to a place near the splitting table, where another boy cuts off the heads and passes the body to the splitters. The two splitters make a cut along the left side near the dorsal outline, ending it with a little downward curve on the tail. The viscera are scraped out and the backbone cut away; a few moves of the knife scrape away the blood and other gurry, and then the fish are thrown into a washing vat with two compartments, one for red fleshed fish, the other for pale. The Aleuts buy the latter and are said to prefer the male with a decided hump. At all events they select such fish when given permission to take some home for the table. After the fish are washed and rubbed clean with a broom they are placed in a perforated box and wheeled on a truck to the salting house. For the first salting one-half sack of salt is used for a barrel of salmon; the fish remain in the first pickle about a week; for repacking one sack of salt is needed for three barrels of 200 pounds each. The fish are washed in the pickle and rubbed clean with a scrub-brush before repacking.

TRANSPORTATION AND MARKETS.

Elsewhere will be found a statement to the effect that sixty-six vessels were engaged during the season of 1889 in the Alaskan salmon trade. The products of the fisheries are consigned to the agents of the companies, in San Francisco, Astoria, and Portland, who dispose of them in foreign markets, principally in England.

FINANCIAL ORGANIZATION.

The fishermen of Kadiak as a rule receive $40 a month, and board and lodging, for their work, besides $5 a thousand for the fish they catch. They are carried to Alaska and back without expense to themselves. I have been informed that the average earnings of the fishermen for six months are about $300. Most of the work in the canneries is done by Chinese, whose services are obtained by contract with their agents in San Francisco. The information in my hands respecting the value of vessels, boats, apparatus, etc., does not cover the ground sufficiently to present it in this place.

THE FISHERMEN.

The number of native fishermen employed at Kadiak is very small. At Karluk one of the companies, the Karluk Packing Company, has about twenty of the natives for one of its seining gangs, but their work is not so satisfactory as that of the white men.

It is said to be very difficult to keep the natives engaged. At Afognak many of the natives are employed about the canneries as carpenters. They are engaged, also, in making boats of various kinds and their labor in this direction is appreciated. The presence of the canneries has not diminished the fish supply of the natives as far as I could learn; it is really easier for them to obtain what they need for winter use than it was before the opening of the canneries. The natives, however, had nets, seines, and other appliances for catching fish before the white men came among them. If the supply of fish should become exhausted by overfishing or any other cause, the effect would be to starve the natives in all localities in which fish is the principal food supply; but if they are sufficiently interested in their own welfare to work for a living, they can get more salmon now than they could before the days of canneries, and will receive good wages and be well supplied with provisions. One great source of trouble with the natives is caused by the illegal sale of intoxicants by the Chinese and, occasionally, some Americans. This traffic is the means of destroying the usefulness of the people and renders them more liable to pulmonary diseases.

Most of the work in the canneries, as already stated, is done by Chinese; the superintendents and other principal men about the canneries are mainly Americans. Among the fishermen may be found Americans, Norwegians, Swedes, Germans, Sicilians, and negroes.

ARTIFICIAL PROPAGATION OF THE SALMON IN ALASKAN RIVERS.

The observations of our party at Alexander's Creek, Uyak Bay, on the naturally deposited eggs of the Humpback Salmon, *Oncorhynchus gorbuscha*, showed that they are a little larger than those of the Red Salmon, *O. nerka*, and a little smaller than King Salmon eggs, *O. chouicha*. Their diameter is about one-fifth of an inch. Mr. Lewis fertilized some of these eggs with the milt of the males and found no difficulty in handling them. Eggs of Red Salmon, *O. nerka*, as already mentioned, were seen in nests around Karluk Lake and the rivers connecting it with its two tributary lakes.

There are no extraordinary difficulties in the way of establishing hatching stations for Red Salmon and Silver Salmon in many of the bays of Kadiak. Alitak Bay and Afognak Bay furnish localities entirely suitable for the undertaking, and I can not see any reason why a hatchery at Karluk might not be practicable and desirable. The canneries get their supply of fresh water with no other trouble than that of piping it in surface pipes from hill-side reservoirs. Lumber, machinery, and workmen are brought from San Francisco. Salmon are extremely abundant. There is no sheltered harbor, but extensive loading and unloading go on with safety in good weather. Supplies can be had the year around. The winter cold is not excessive.

It would undoubtedly be difficult to sustain a hatchery on Karluk Lake, and it may not be necessary to locate one there if the spawning salmon are allowed to go up the river in sufficient numbers. If, however, it should be desirable to occupy the lake for this purpose a road must be constructed from the west end of Larsen's Cove, and Mr. Booth advises that it follow along the foot-hills of the mountain range which bounds the river valley on the east, the valley itself being unsuitable for a road on account of its boggy nature. Lumber would have to be carried to the lake, as the native timber is fit only for fuel.

From what I have heard about Thin Point, on the peninsula of Alaska, it appears to me that the river at that place is well adapted for fish culture; it is short, rapid, constant, and has its source in a large lake. Nearly 20,000 cases of Red Salmon were taken there in 1889.

Alitak Bay has good harbors and several good salmon streams, with plenty of pure water that can be obtained by gravitation.

Messrs. Booth and Stone visited Afognak and were very favorably impressed with the outlook for salmon hatching on the Litnik River. Mr. Booth's report contains the following items of especial interest in this connection:

"Afognak River, especially near the falls, would furnish a very convenient site for hatching purposes. It is near a harbor safe in all directions from storms, has an abundant supply of fresh cold water at all seasons, and abundant timber, which, though not adapted for first-class lumber on account of knots and pitch, is still avail-

able for the many purposes for which second-class material is as good as first-class in that locality.

"Any of the small so-called single portable mills would speedily and cheaply convert portions of these forests into useful shape, and, so long as only enough is cut to supply those having establishments on the islands, no law need be violated.

"In addition to the advantages before mentioned, labor is much easier to obtain here than at many other possible locations. At the village of Afognak, 4 miles from the canneries, native carpenters and boat-builders can be found who could be employed, as they have been by the Royal Packing Company, in the construction of buildings under the supervision of an intelligent American mechanic. These native carpenters are, in most cases, rapid and thorough workmen. Mr. Blodgett, of the Royal Packing Company, showed us a lighter built by them at a cost, including lumber, of $40. A precisely similar one built in San Francisco cost $175, not including freightage to Alaska. The cannery building of the same company, erected in 1888, was built almost entirely by native labor, and is accounted the most substantial cannery building in Alaska. These men also build dories and skiffs and are employed constantly for this purpose by many of the Karluk companies.

"Besides buildings, a short road from the canneries to the site selected would have to be made, as the estuary and upper part of the bay are too shallow for water transportation even in boats. Two small timber bridges about 30 feet in length would be required at the crossing of the two tributary creeks.

"The run of Red Salmon is fairly abundant, but short, lasting only the first three weeks of July, the fish first appearing, however, in the middle of June." [This does not take into account the run of small Red Salmon in April.]

Mr. Stone, to whom the subject of fish cultural operations was especially referred, has entered very fully into the advantages of the Litnik for an initial station, and I will merely call attention to his recapitulation, leaving the details to his complete report. He finds in the Litnik—

(1) A river that is easily controlled and is not subject to excessive fluctuations of rise and fall.

(2) An unlimited supply of water for the hatching-house, furnished by gravitation.

(3) Favorable conditions for capturing the breeding fish.

(4) A central and comparatively accessible location.

He states, further, that the four desirable species of Salmonidæ—Red Salmon, Silver Salmon, Humpbacks, and Dolly Varden Trout (or Salmon Trout)—all ascend the Litnik.

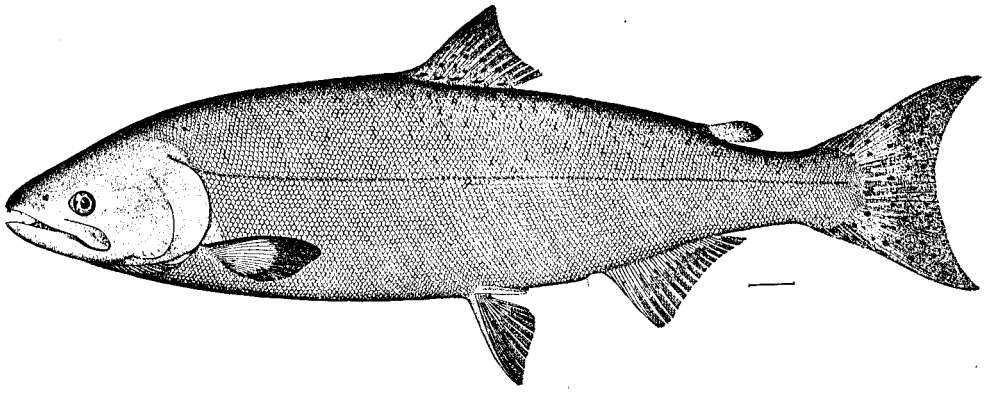


FIG. 1. THE KING SALMON (*Oncorhynchus chouicha*). (See page 190.)

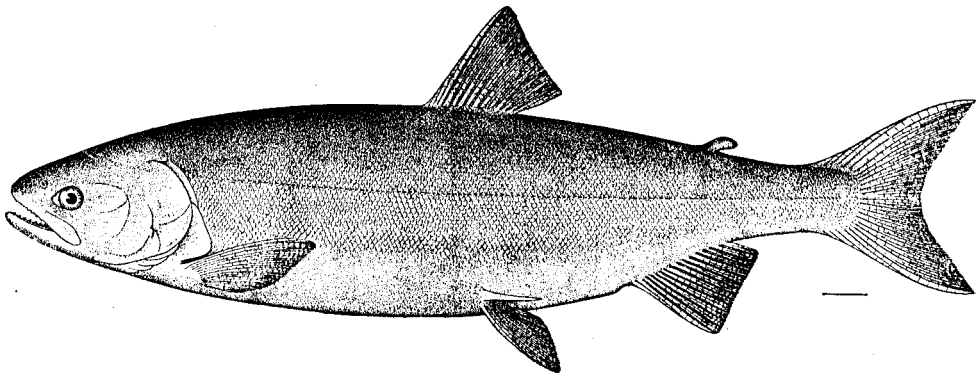


FIG. 2. THE DOG SALMON (*Oncorhynchus keta*). (See page 192.)

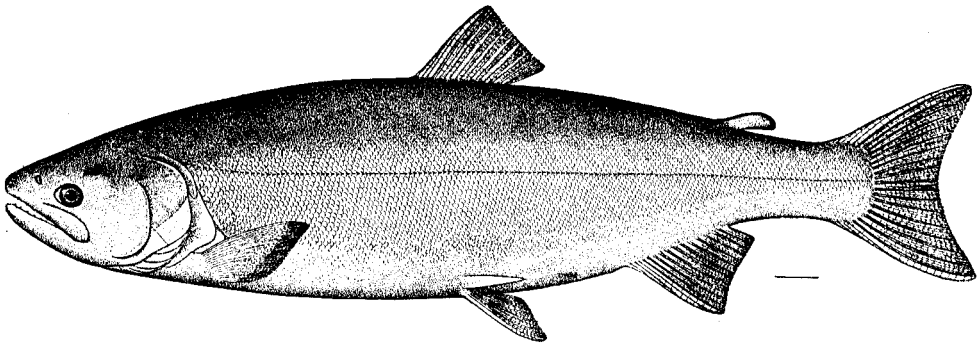


FIG. 3. THE SILVER SALMON (*Oncorhynchus kisutch*). (See page 192.)

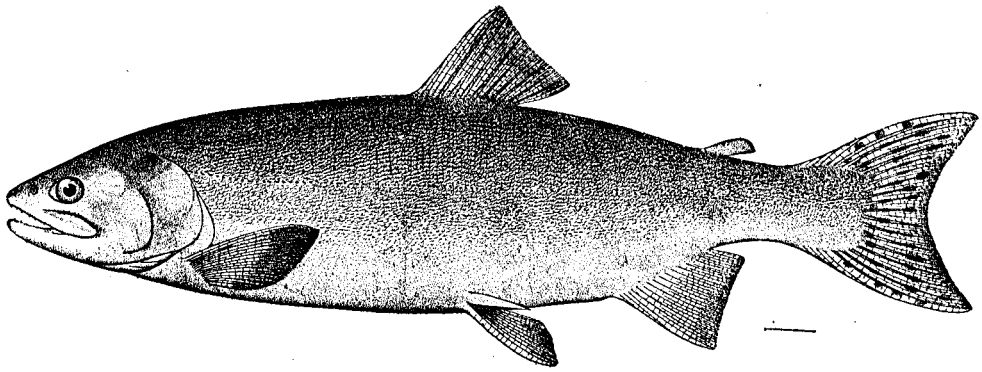


FIG. 4. THE HUMPBACK SALMON (*Oncorhynchus gorbuscha*). Sea-run. (See page 193.)

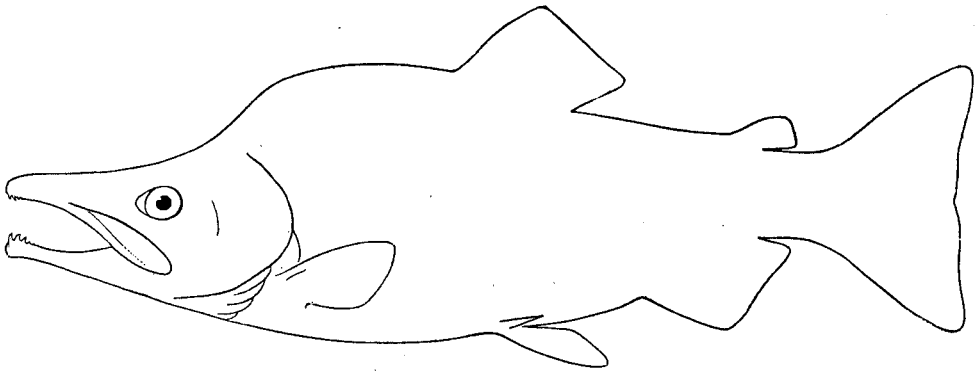


FIG. 5. THE HUMPBACK SALMON (*Oncorhynchus gorbuscha*). Breeding male. (See page 193.)

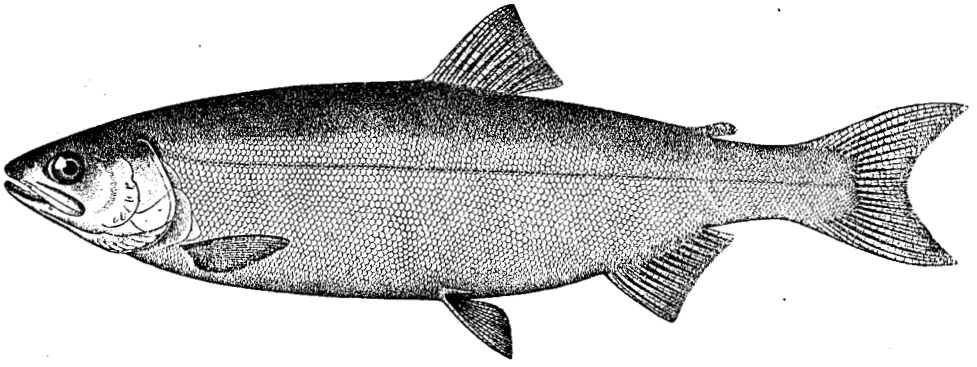


FIG. 6. THE RED SALMON (*Oncorhynchus nerka*). Sea-run. (See page 195.)

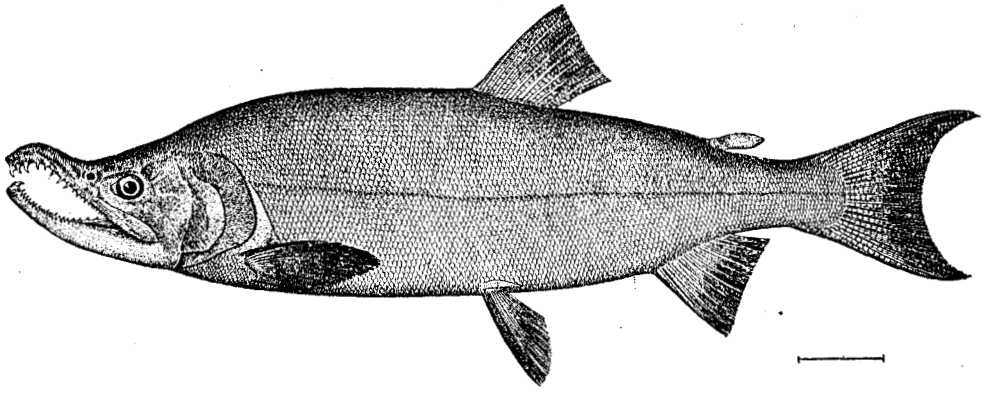


FIG. 7. THE RED SALMON (*Oncorhynchus nerka*). Breeding male. (See page 195.)

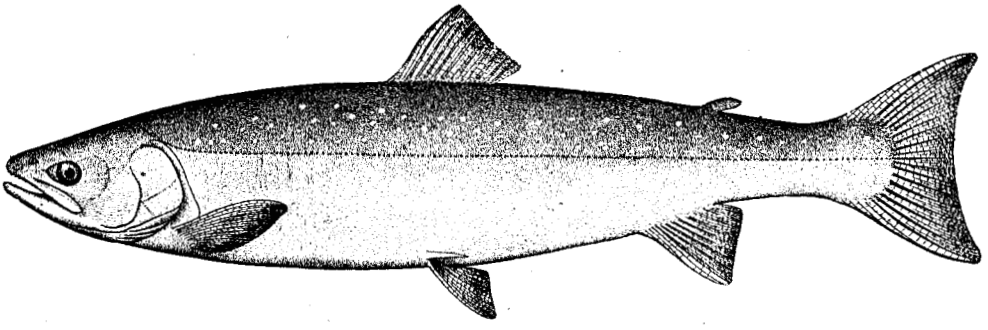


FIG. 8. THE DOLLY VARDEN TROUT (*Salvelinus malma*). (See page 199.)

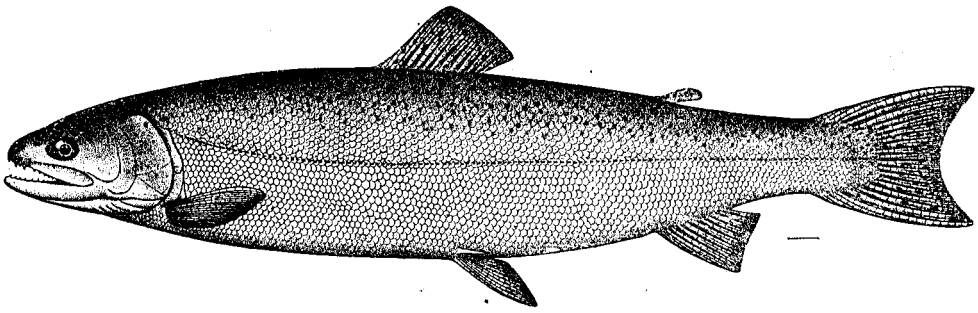


FIG. 9. THE STEEL HEAD (*Salmo gairdneri*). Adult. (See page 198.)

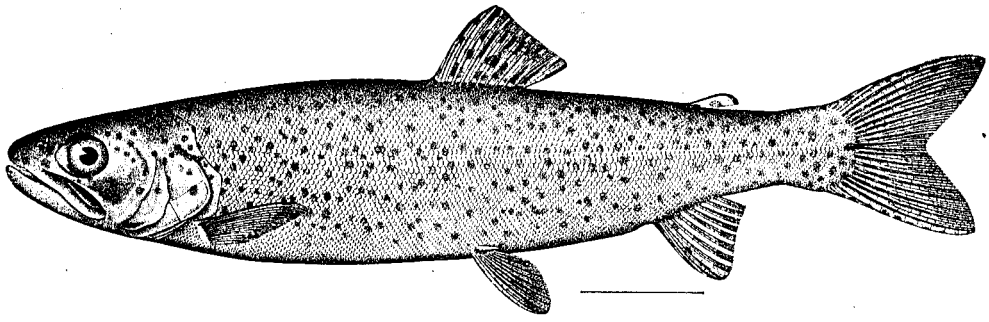


FIG. 10. THE STEEL HEAD (*Salmo gairdneri*). Young. (See page 198.)

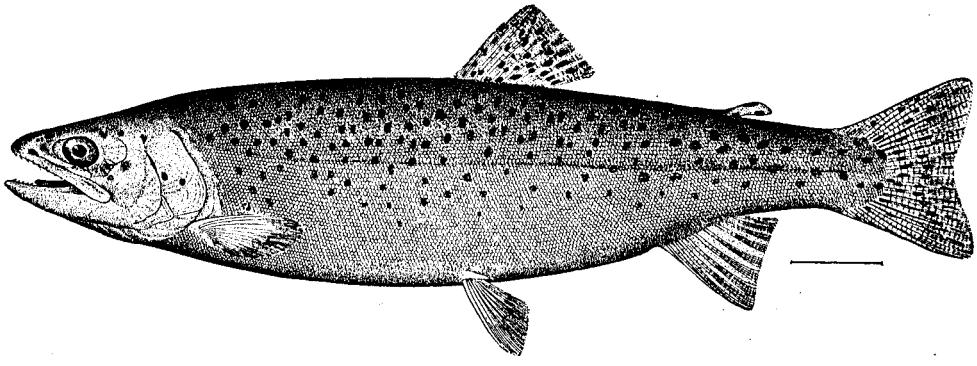
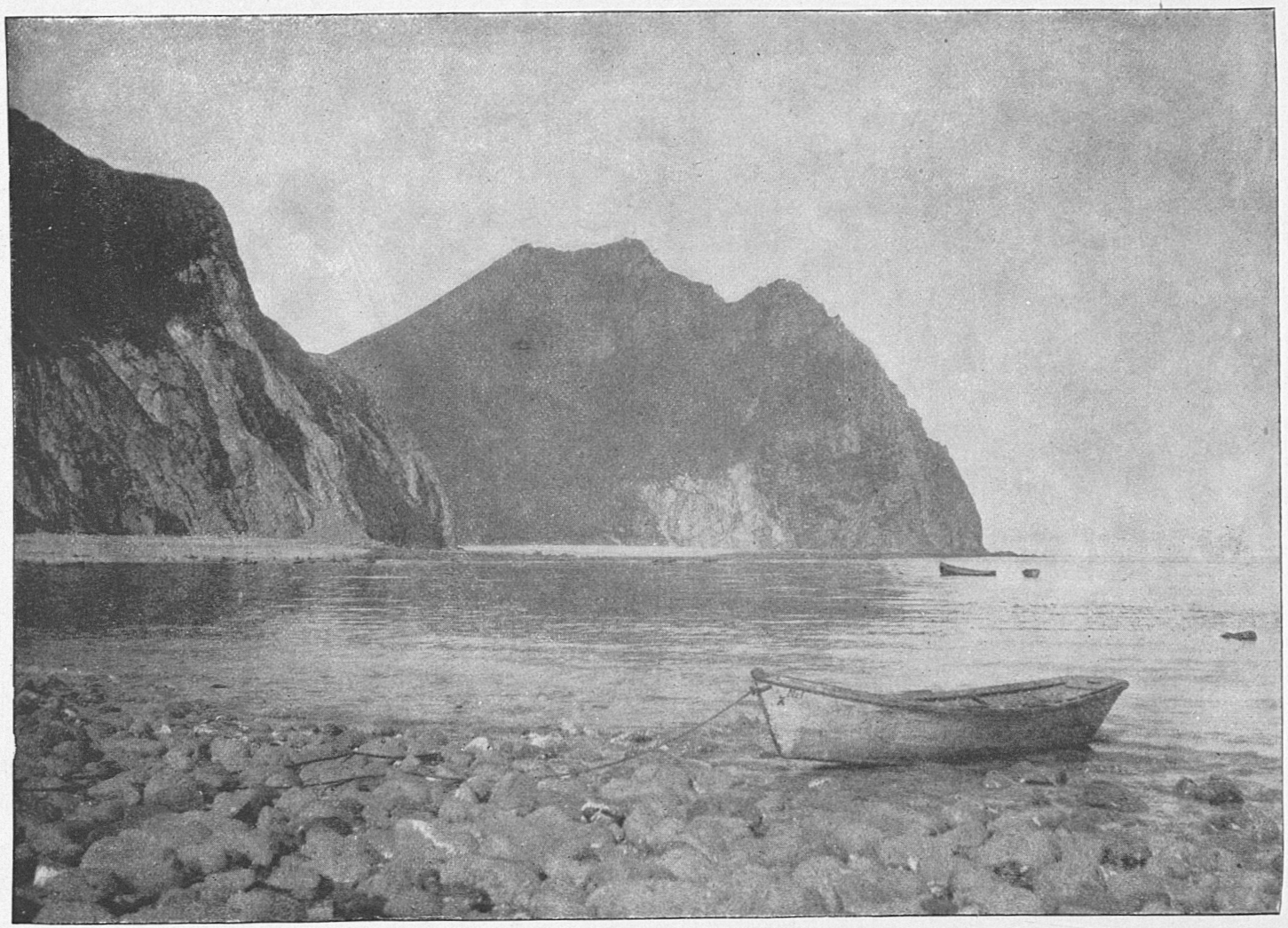


FIG. 11. CLARK'S TROUT (*Salmo purpuratus*). (See page 199.)

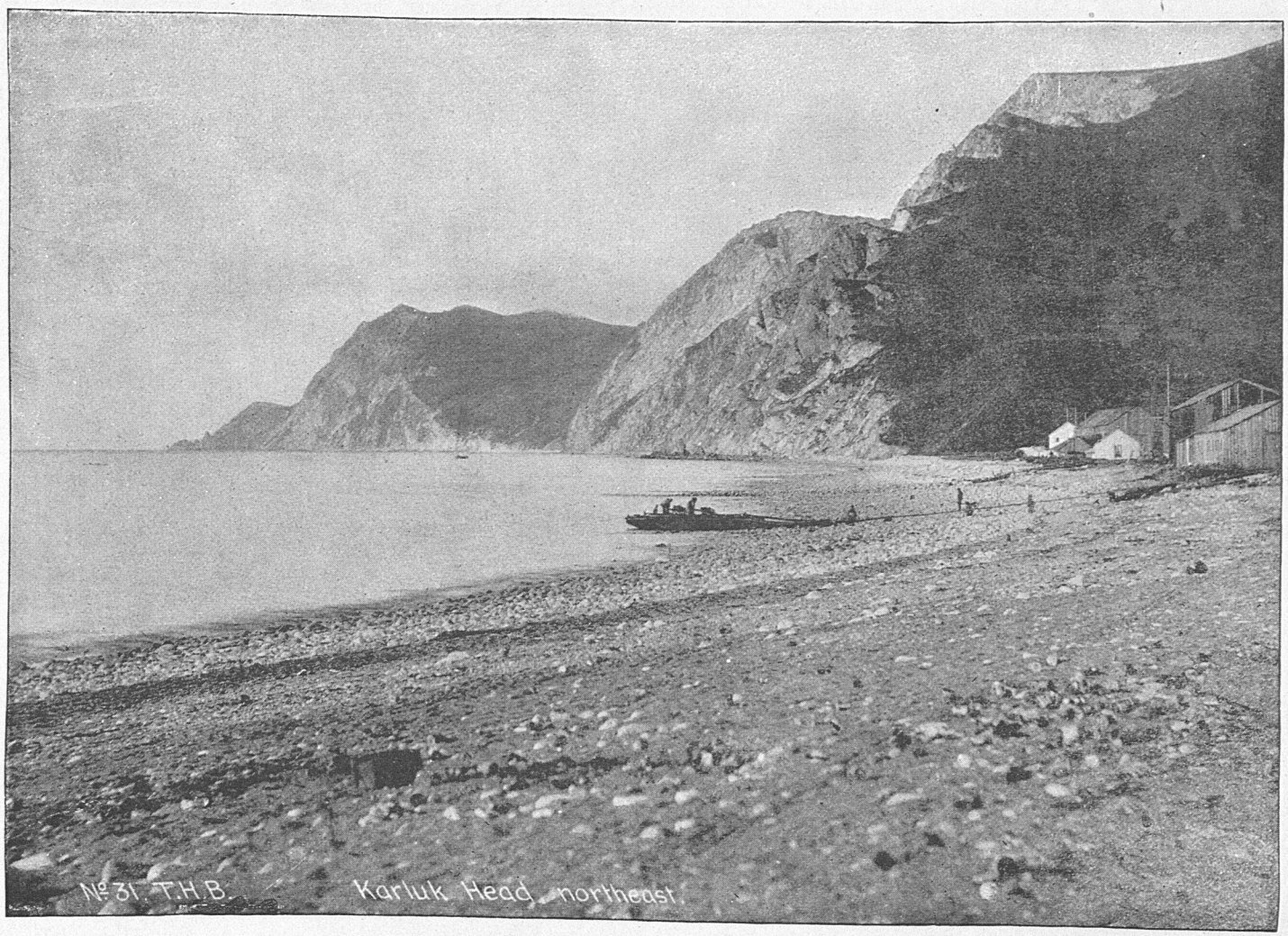
EXPLANATION OF PLATE L.

Karluk Head, or Cape Karluk, is one of the most striking headlands on the island of Kadiak because of its steep slope and the deep notch in its summit, by means of which its identification from sea is easy and certain. It is situated about one-half mile southwest of the mouth of Karluk River and has an elevation of about 1,600 feet. This cape, the highest part of a short spur, diminishes in height somewhat rapidly inland, and is separated from the Karluk River range by a low, level plateau, which, in the rainy season, carries on its surface an extensive shallow lake. The crescent-shaped beach limiting this plateau is made up of coarse pebbles and sand, and is a favorite seining ground for salmon.



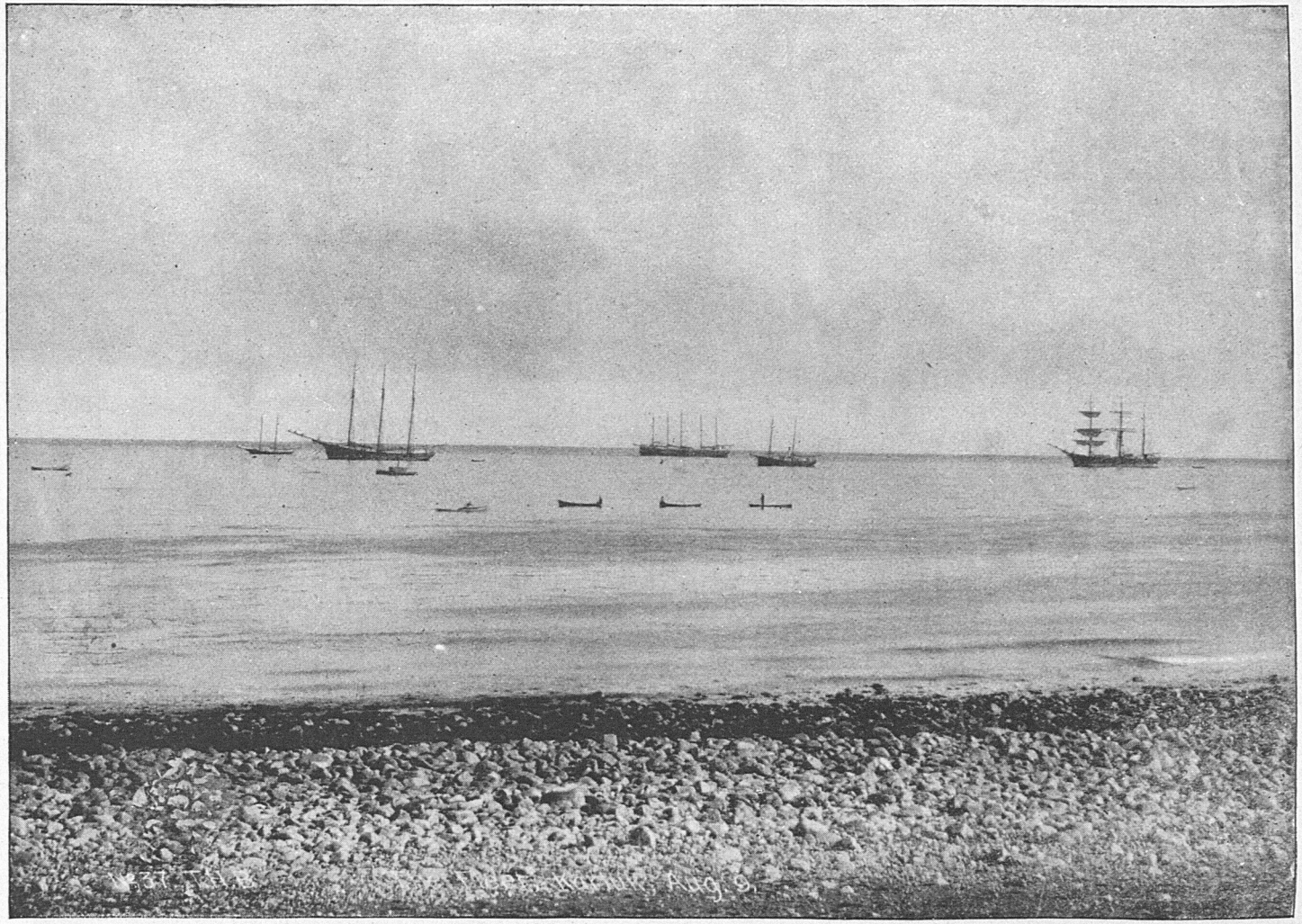
KARLUK HEAD, OR CAPE KARLUK. (See page 176.)

Bull. U. S. F. C. 1889.—(To face page 208.) Bean. Salmon Fisheries of Alaska.

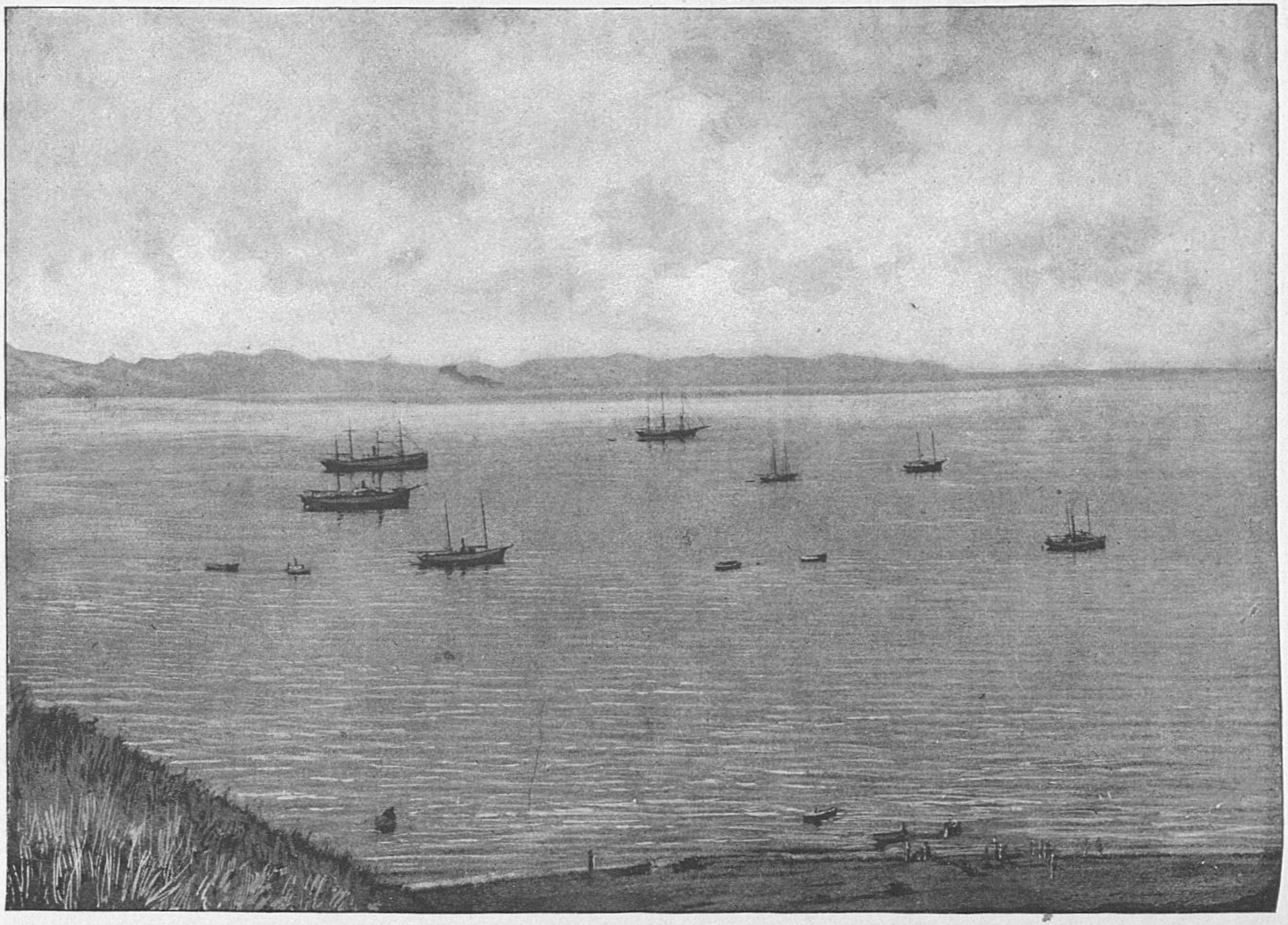


KARLUK CLIFFS FROM KARLUK, LOOKING NORTHEAST. (See page 176.)

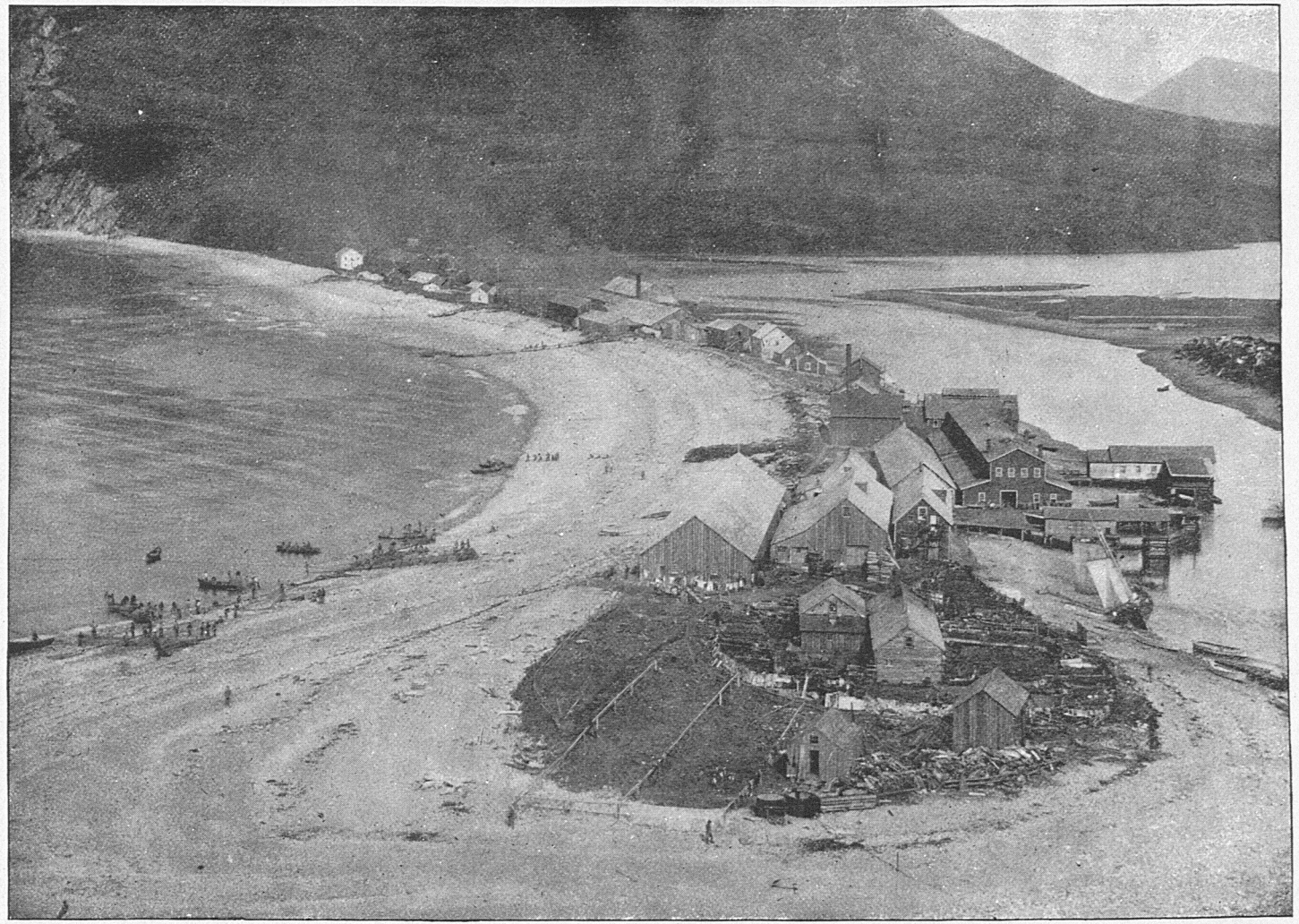
Bull. U. S. F. C. 1889.—(To face page 208.) Bean. Salmon Fisheries of Alaska.



FLEET OF SALMON VESSELS IN KARLUK BAY, AUGUST 9, 1889. (See page 201.)

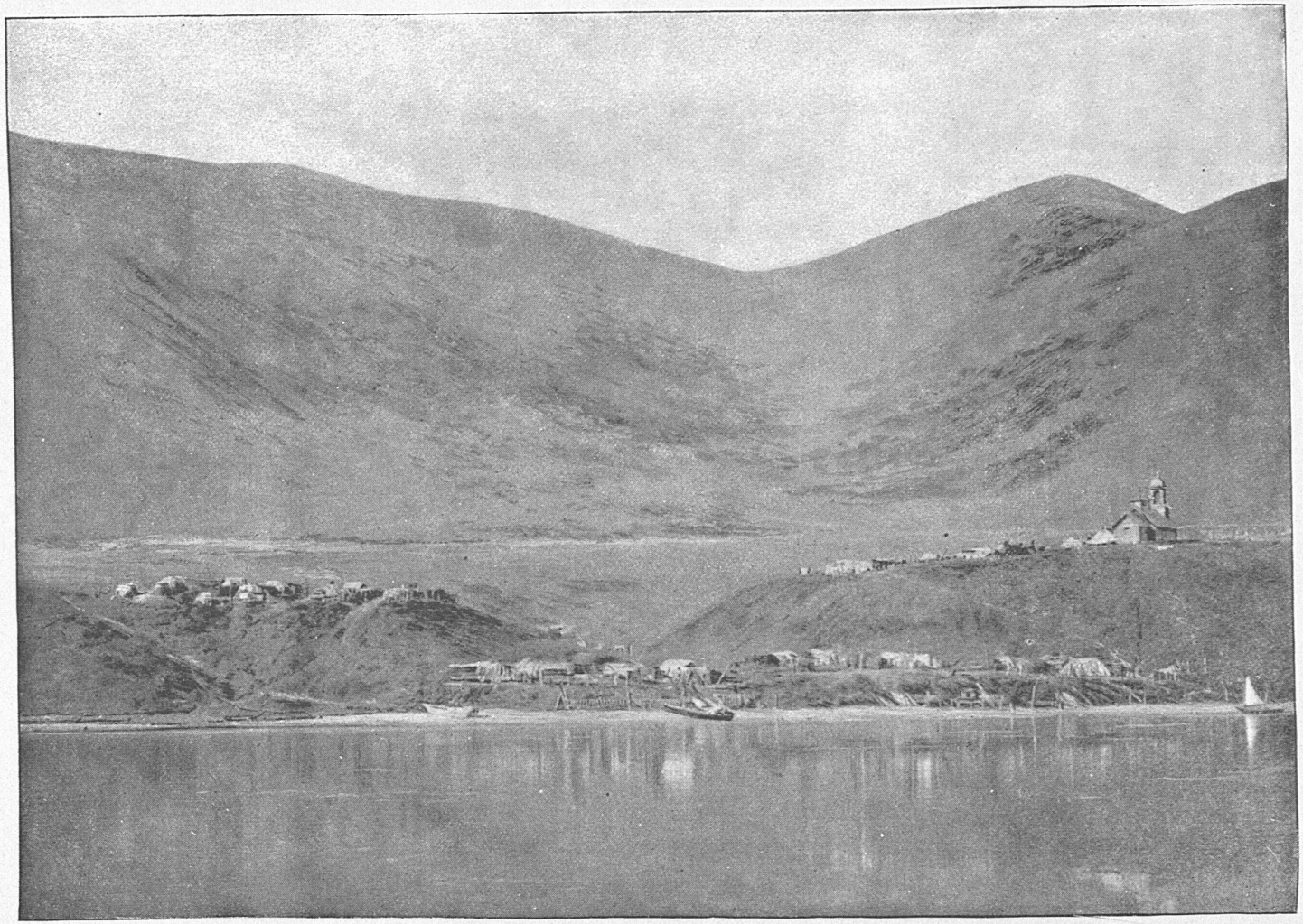


FLEET OF SALMON VESSELS IN KARLUK BAY, AUGUST 27, 1889. (See page 201.)

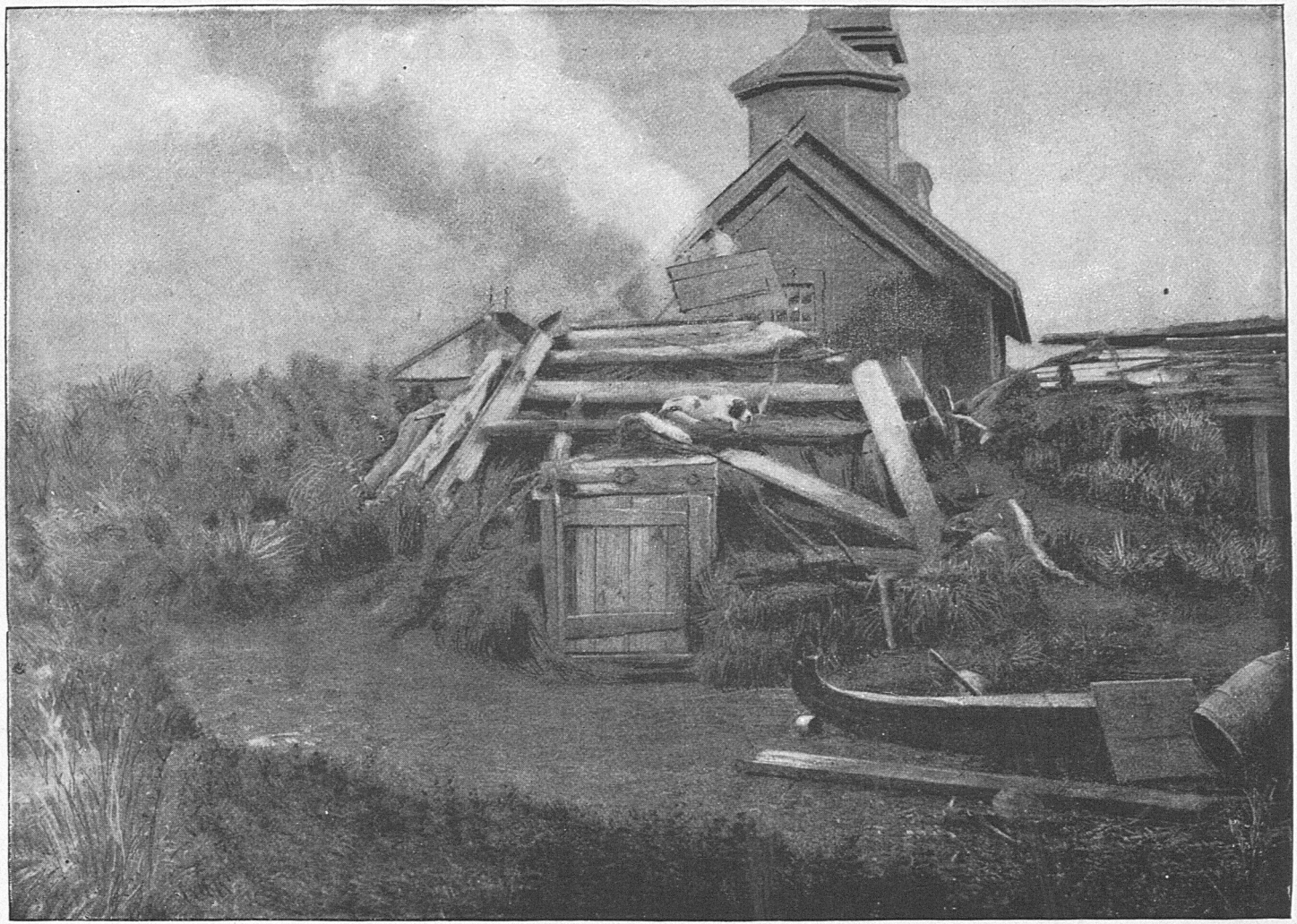


KARLUK PENINSULA, SHOWING CANNERIES, SEINING OPERATIONS, AND KARLUK RIVER. (See page 176.)

Bull. U. S. F. C. 1889.—(To face page 208.) Bean. Salmon Fisheries of Alaska.



NATIVE VILLAGE, KARLUK, KADIAK ISLAND, ALASKA.

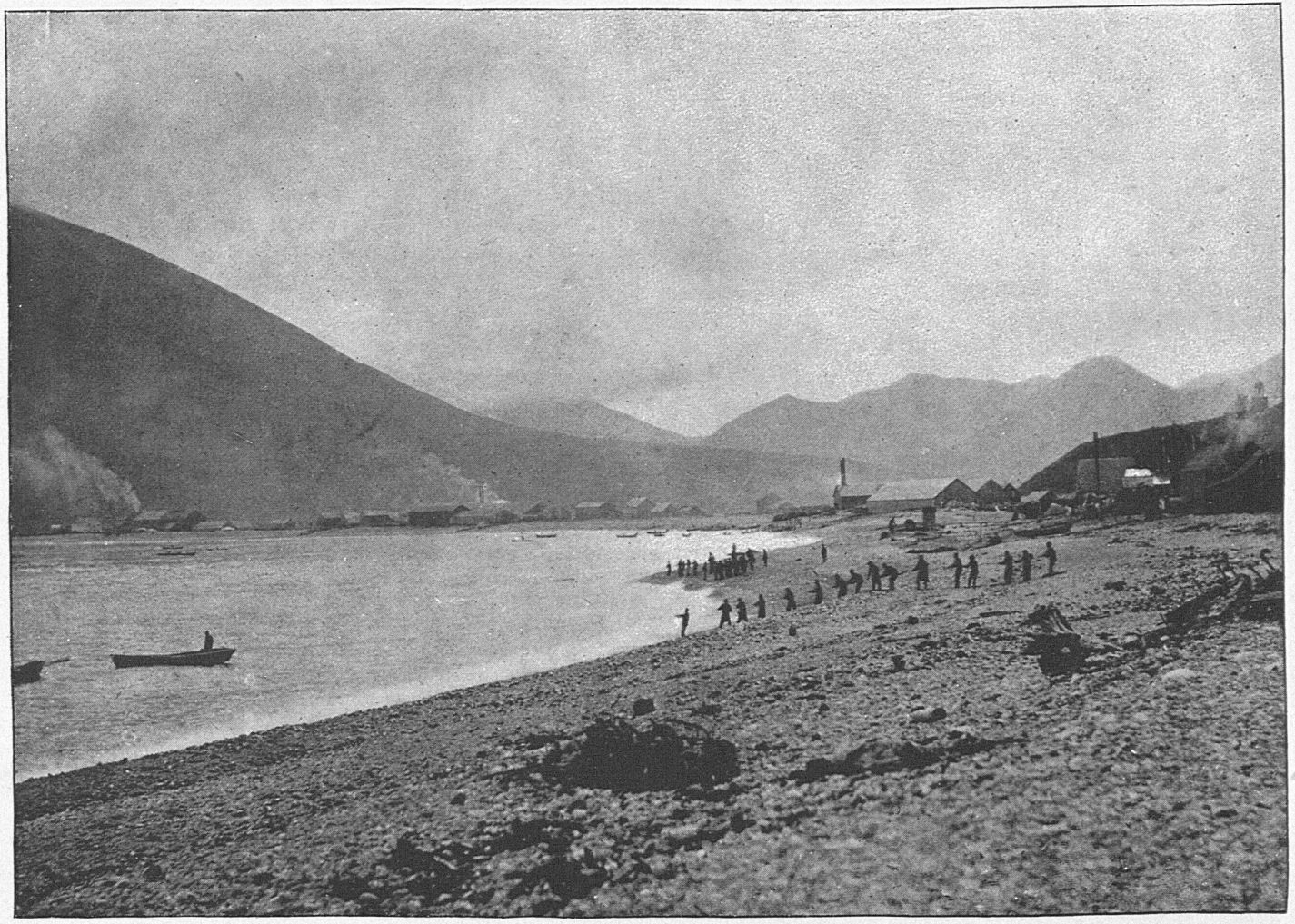


NATIVE DWELLING (BARABARA) AT KARLUK, KADIAK ISLAND, ALASKA. GREEK CHURCH IN BACKGROUND

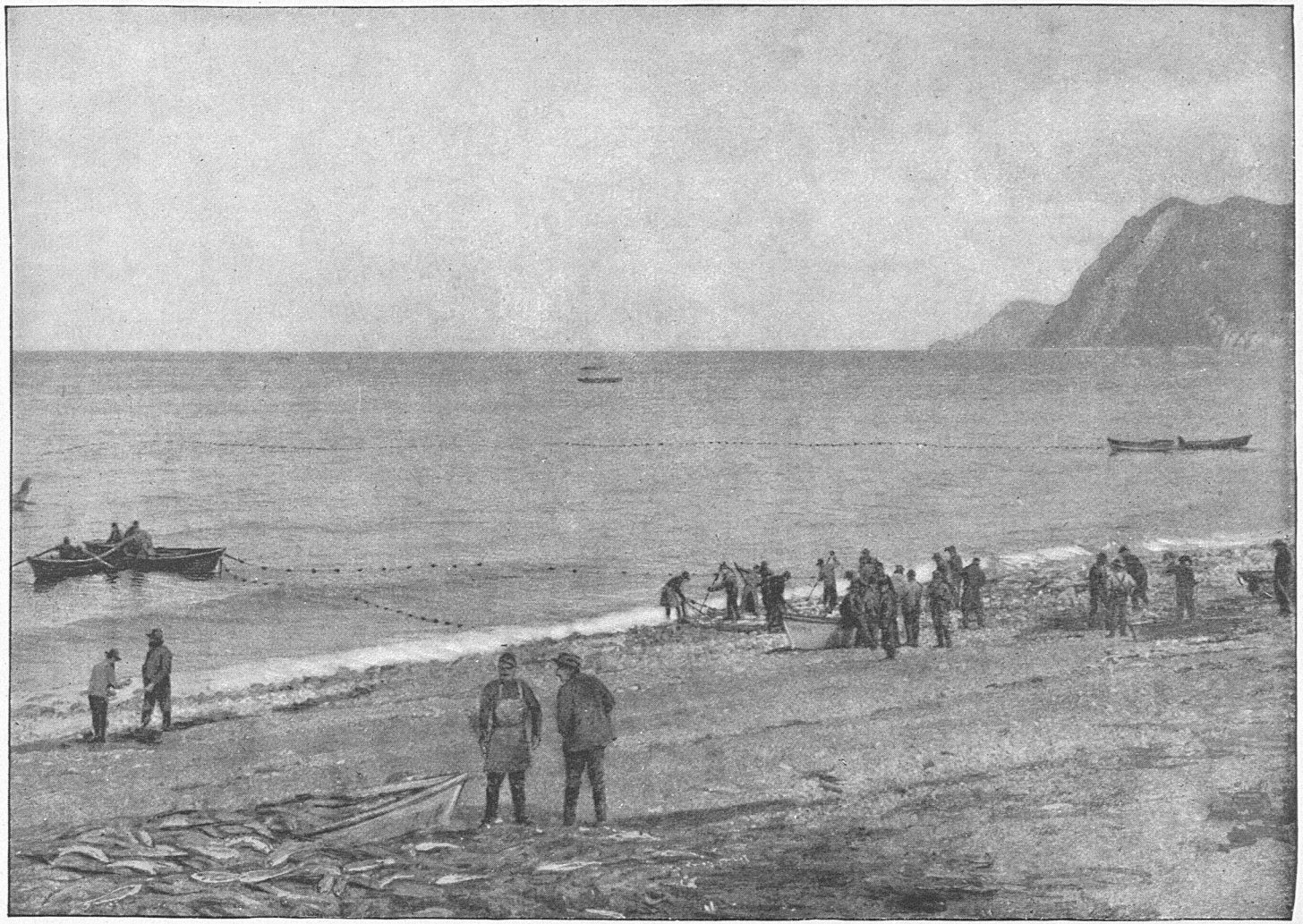
Bull. U. S. F. C. 1889.—(To face page 208.) Bean. Salmon Fisheries of Alaska.

SEINING SALMON AT KARLUK, LOOKING EAST. PILING SALMON ON BEACH FOR TRANSFER TO CANNERIES. SALMON SHARK IN FOREGROUND. (See page 198.)

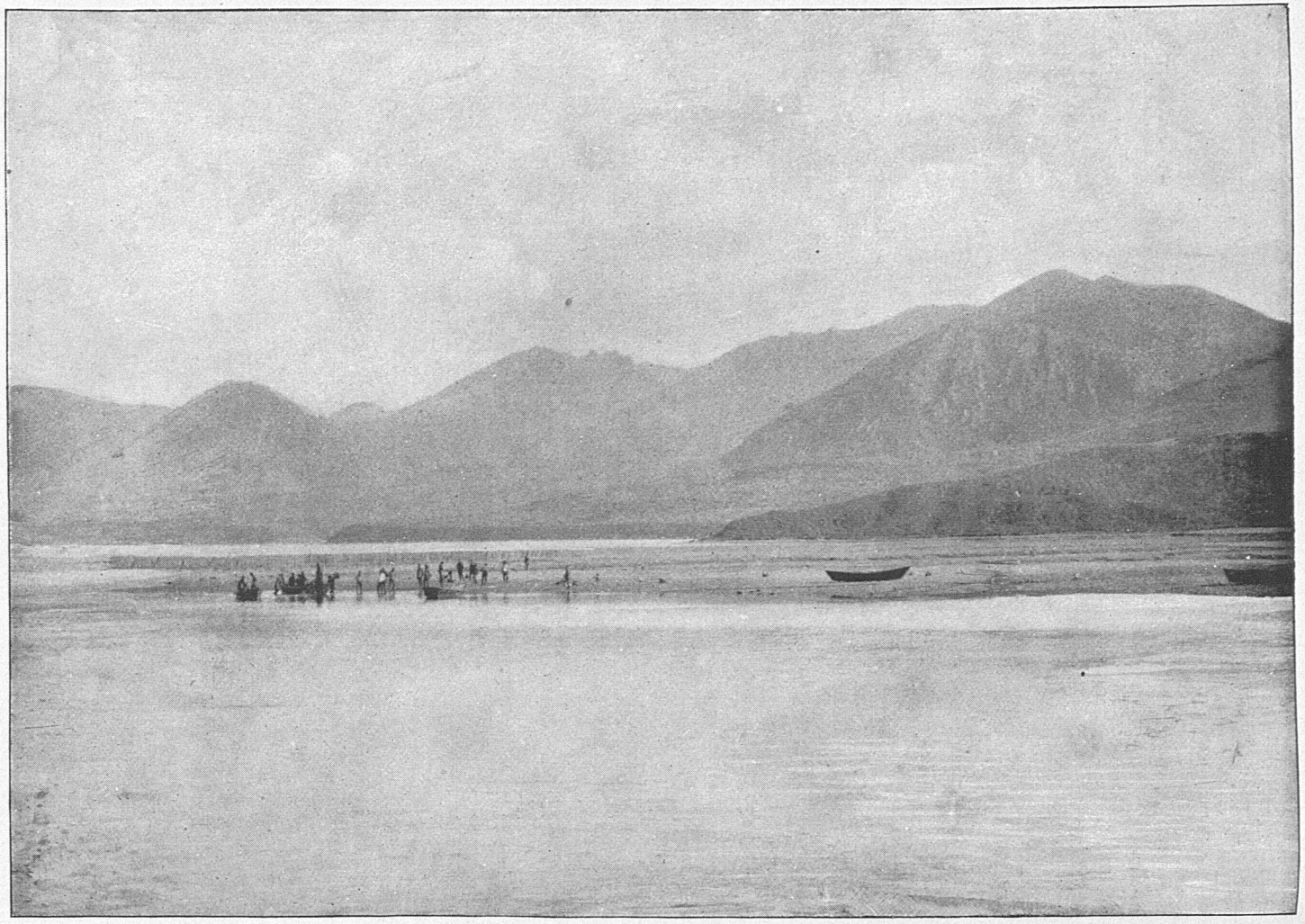
Bull. U. S. F. C. 1889.—(To face page 208.) Bean. Salmon Fisheries of Alaska.



SEINING SALMON AT KARLUK, LOOKING EAST FROM BEACH NEARLY WEST OF ALASKA IMPROVEMENT COMPANY'S CANNERY.

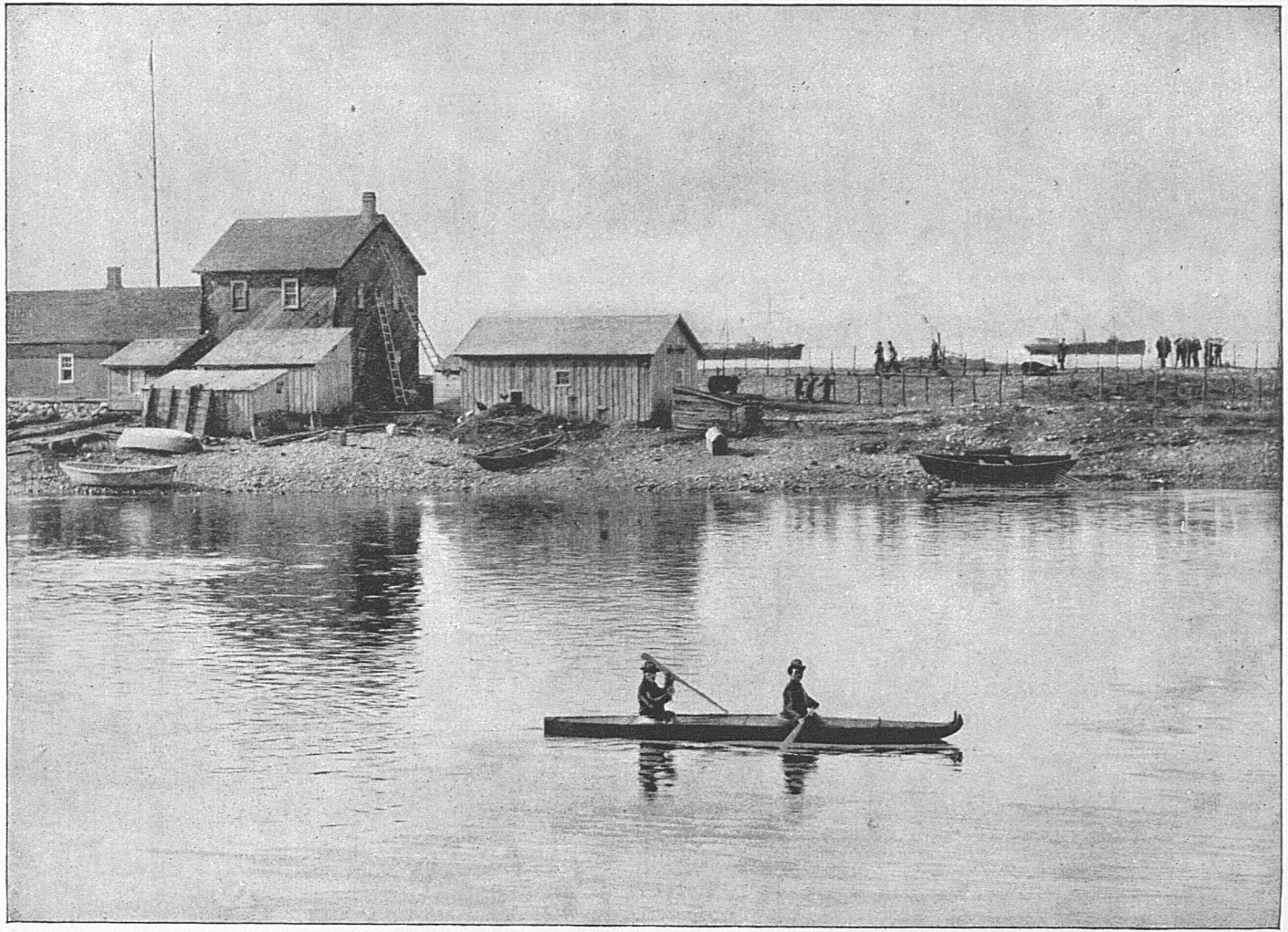


SEINING SALMON AT KARLUK: HAULING SEINE; PEWING FISH ON BEACH; HEAP OF 10,000 SALMON FROM ONE HAUL.

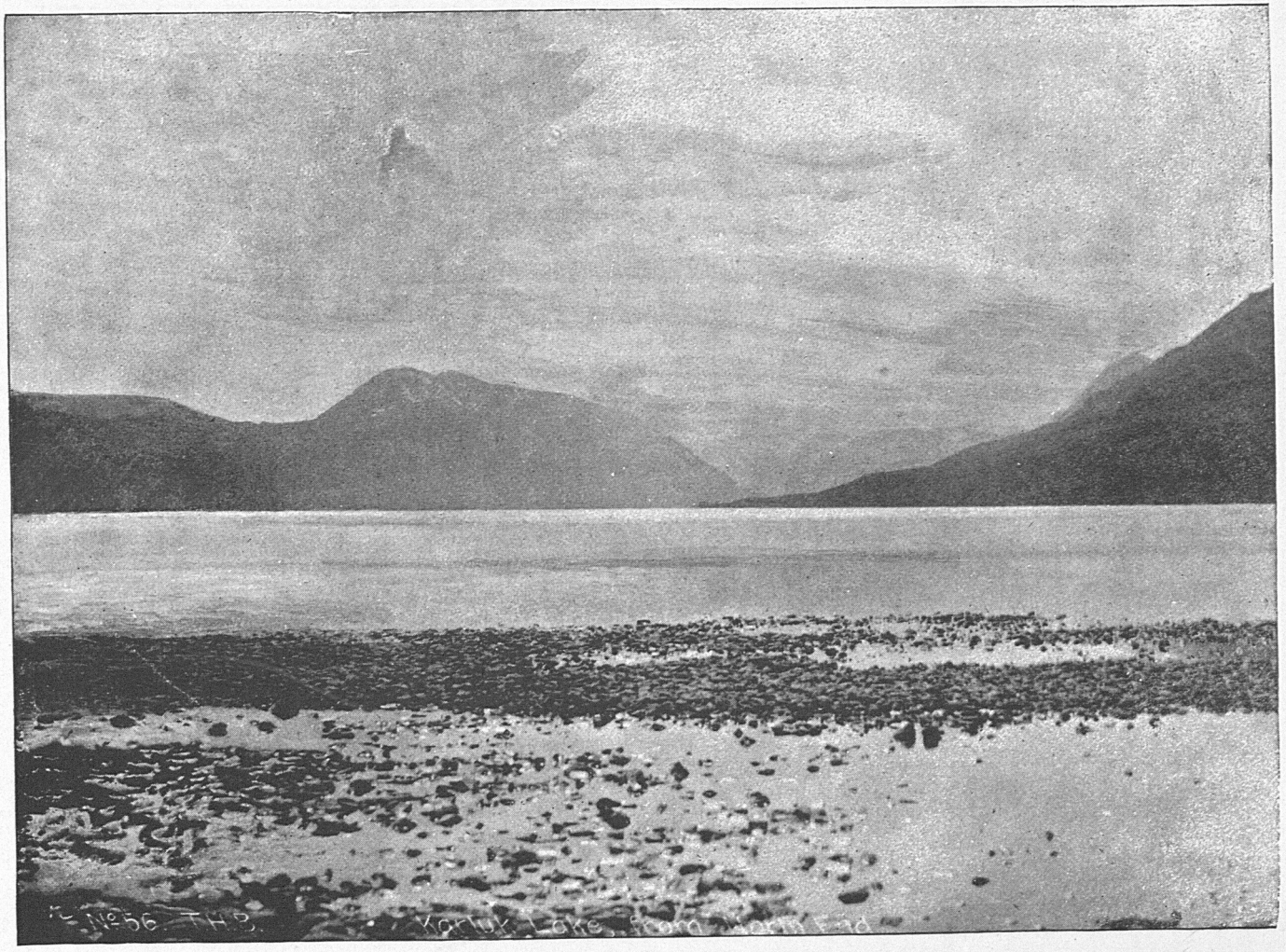


SEINING SALMON IN KARLUK RIVER. (See page 203.)

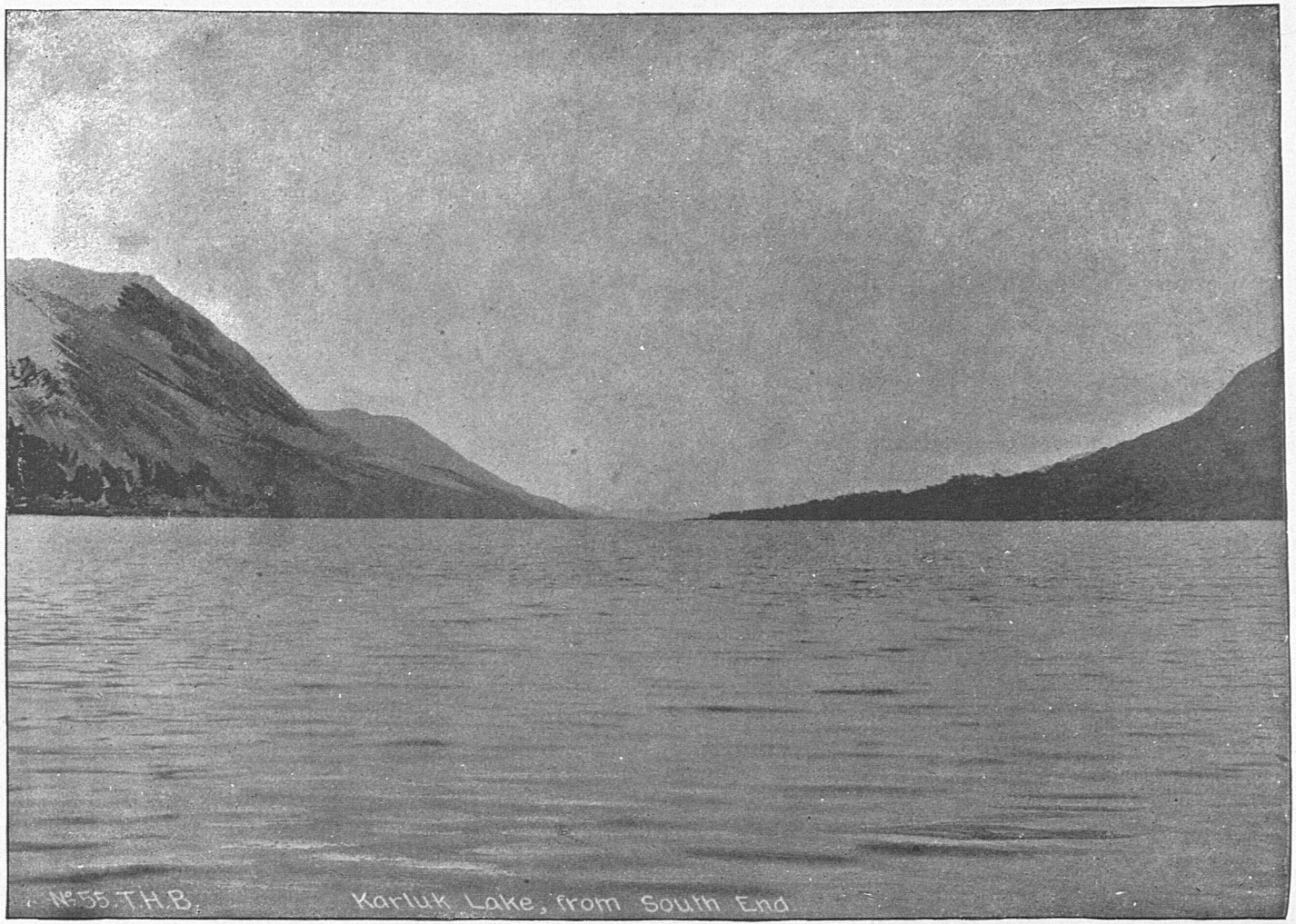
KARLUK RIVER MOUTH. CANNERY OF ALASKA IMPROVEMENT COMPANY. END OF KARLUK PENINSULA. (See page 176.)



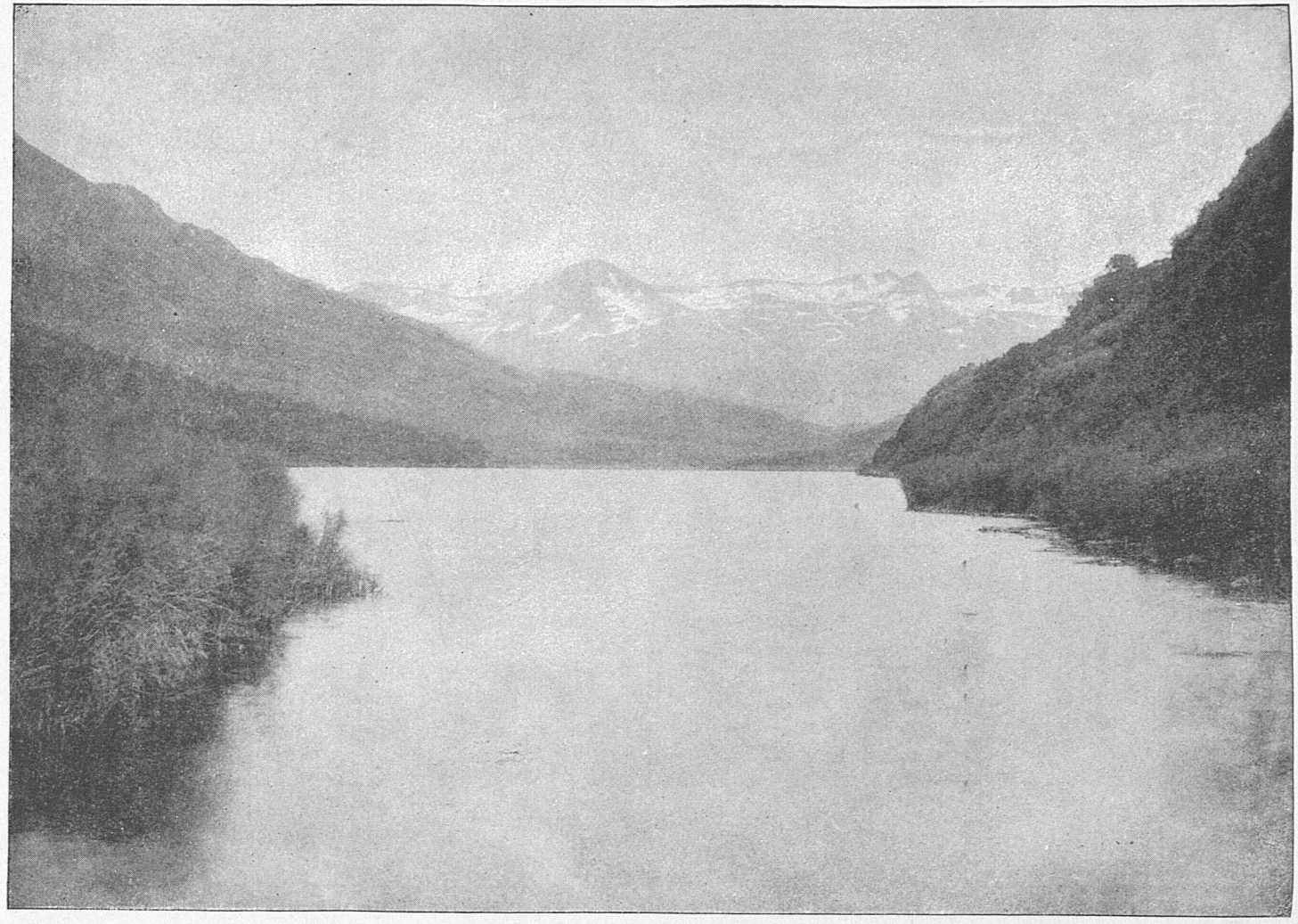
KARLUK RIVER. BIDARKA WITH NATIVES. OFFICE OF KARLUK PACKING COMPANY. STEAMERS BERTHA AND HAYTIEN REPUBLIC.



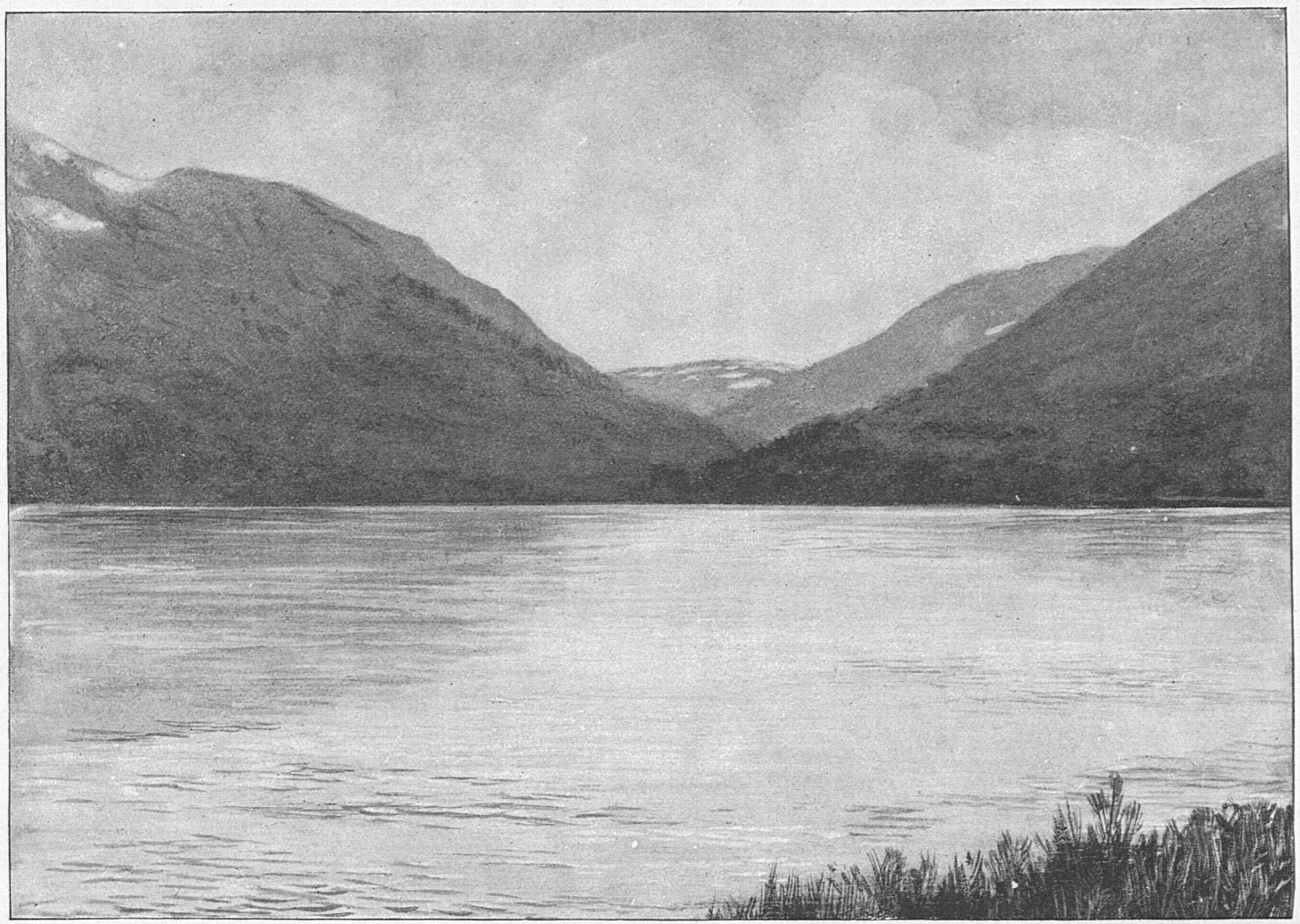
KARLUK LAKE, FROM NORTH END. (See page 179.)



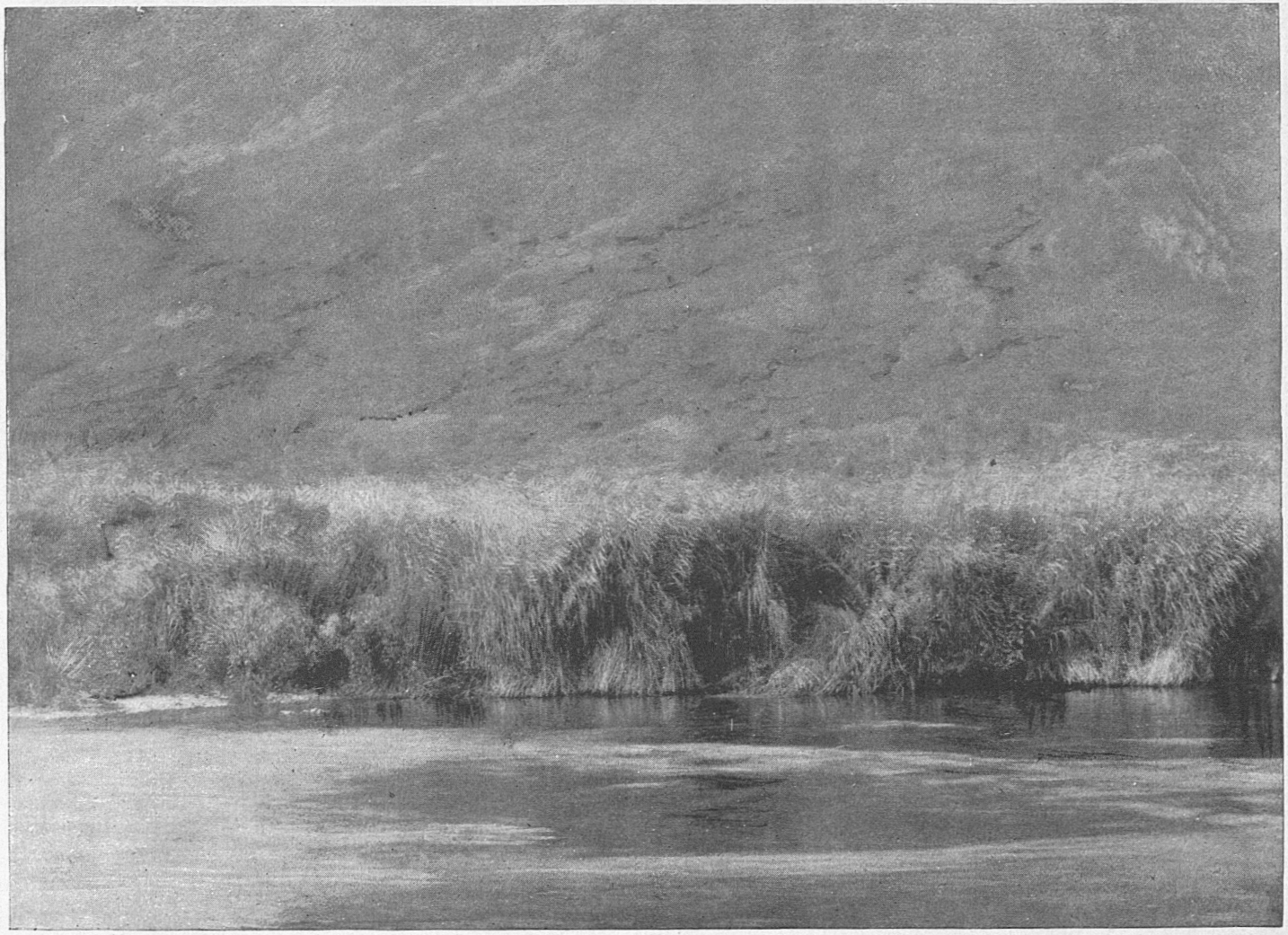
KARLUK LAKE, FROM SOUTH END. (See page 179.)



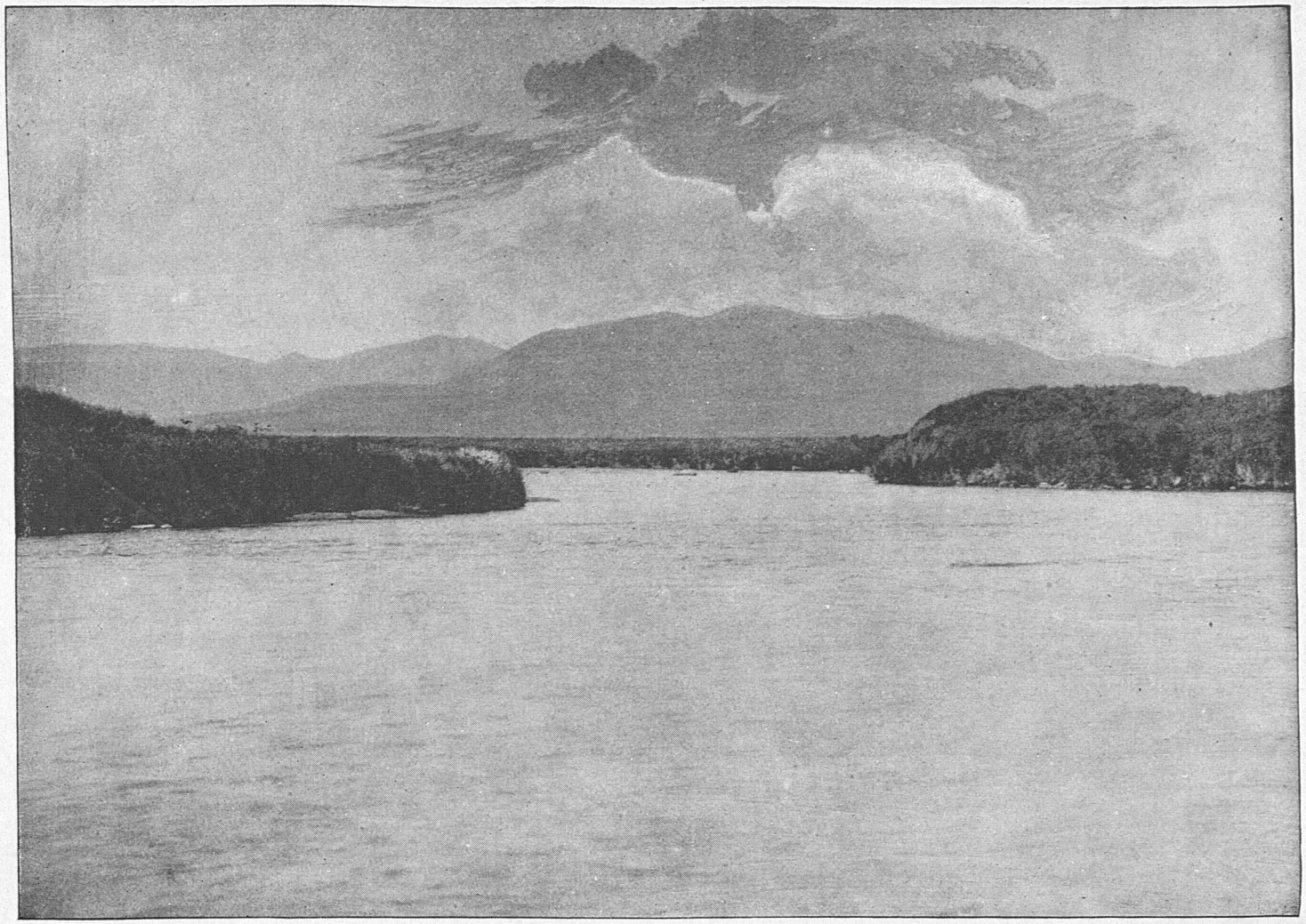
LAKE TRIBUTARY TO WEST ARM OF KARLUK LAKE. BREEDING GROUND OF RED SALMON. (See page 179.)



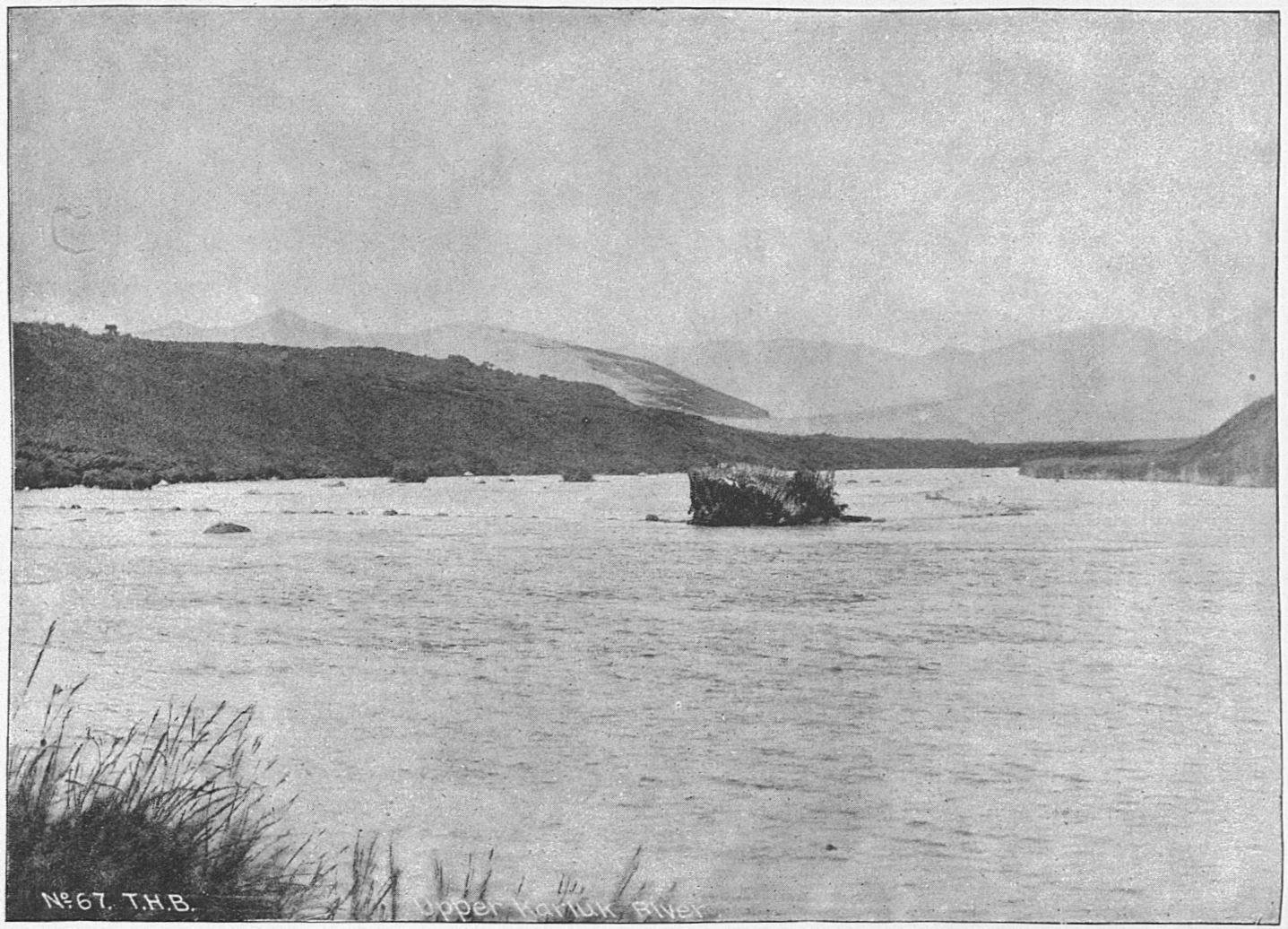
LAKE TRIBUTARY TO EAST ARM OF KARLUK LAKE. BREEDING GROUND OF RED SALMON. (See page 179.)



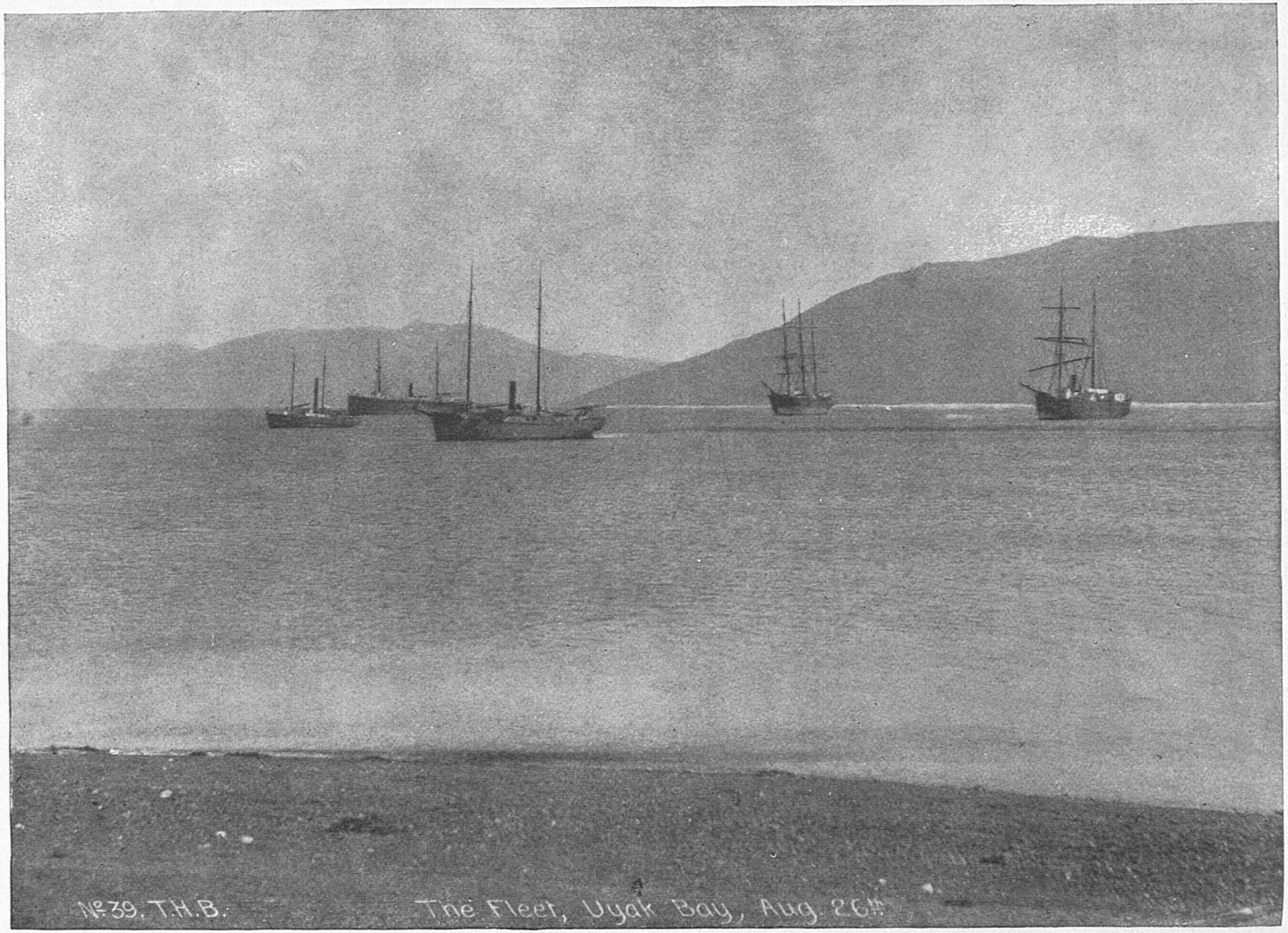
RIVER CONNECTING EAST ARM OF KARLUK LAKE WITH ITS TRIBUTARY LAKE. SALMON BREEDING GROUND. (See page 179.)



KARLUK RIVER SOURCE; KARLUK LAKE IN FOREGROUND. (See page 179.)

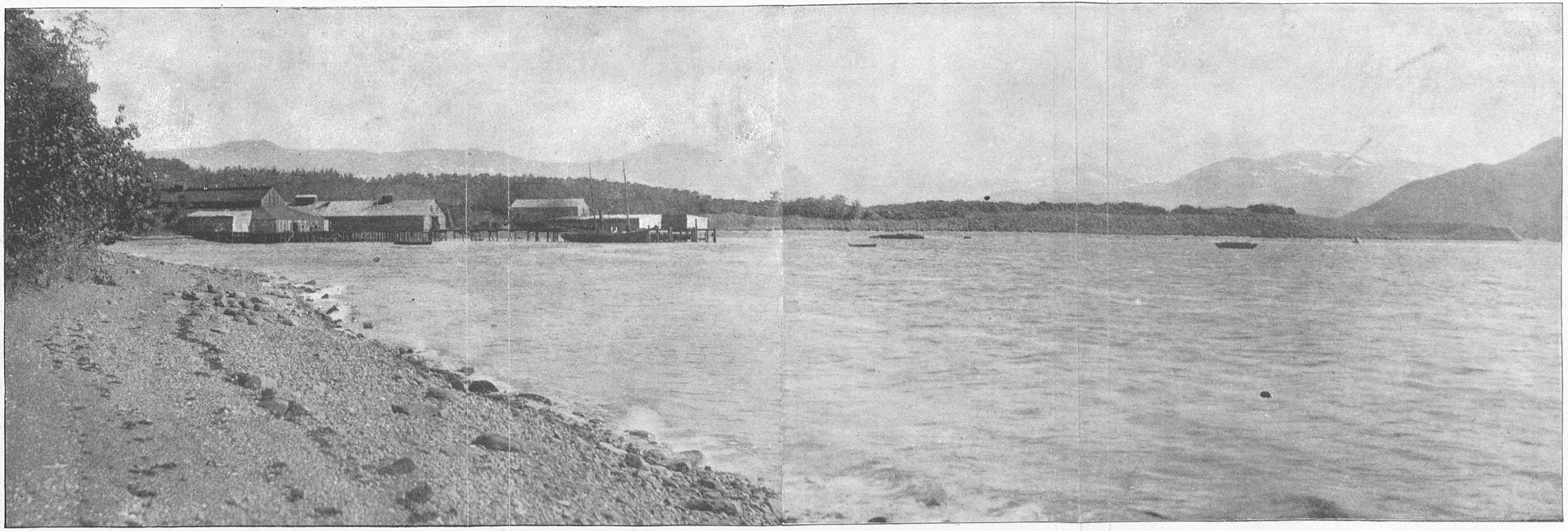


KARLUK RIVER NEAR ITS SOURCE, SHOWING LINES OF BOWLDERS UTILIZED IN BUILDING SALMON TRAPS.

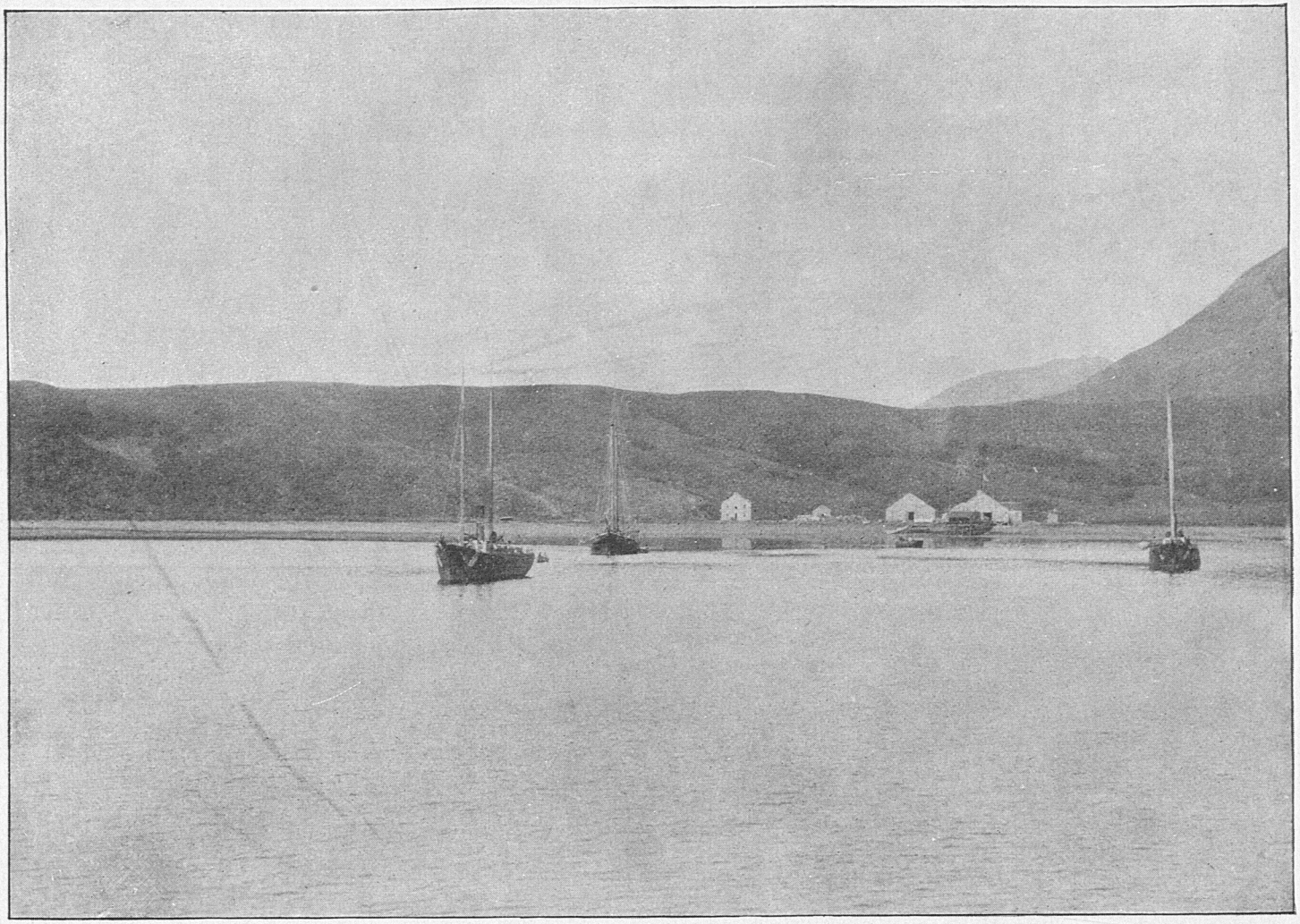


SALMON FLEET IN UYAK BAY AUGUST 26 1889: STEAMER BERTHA, BARK CORYPHENE, STEAMERS ELLA ROHLFFS, HAYTIEN REPUBLIC, AND ALEUT.

(See page 184.)

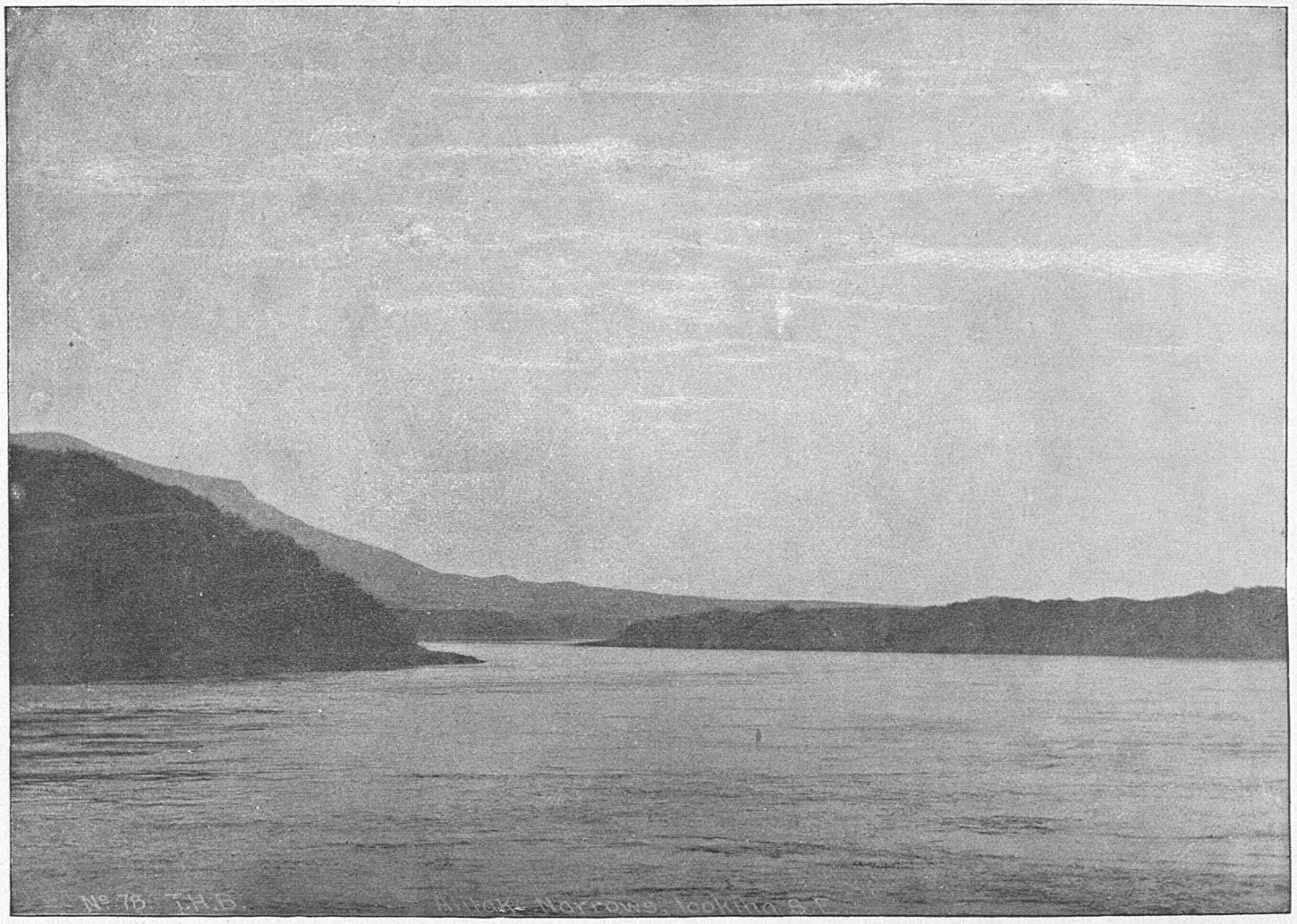


LARSEN'S COVE, UYAK BAY, AND CANNERY OF ARCTIC PACKING COMPANY. (See page 184.)



SNUG HARBOR, ALITAK BAY, CANNERY OF KODIAK PACKING COMPANY. (See page 184.)

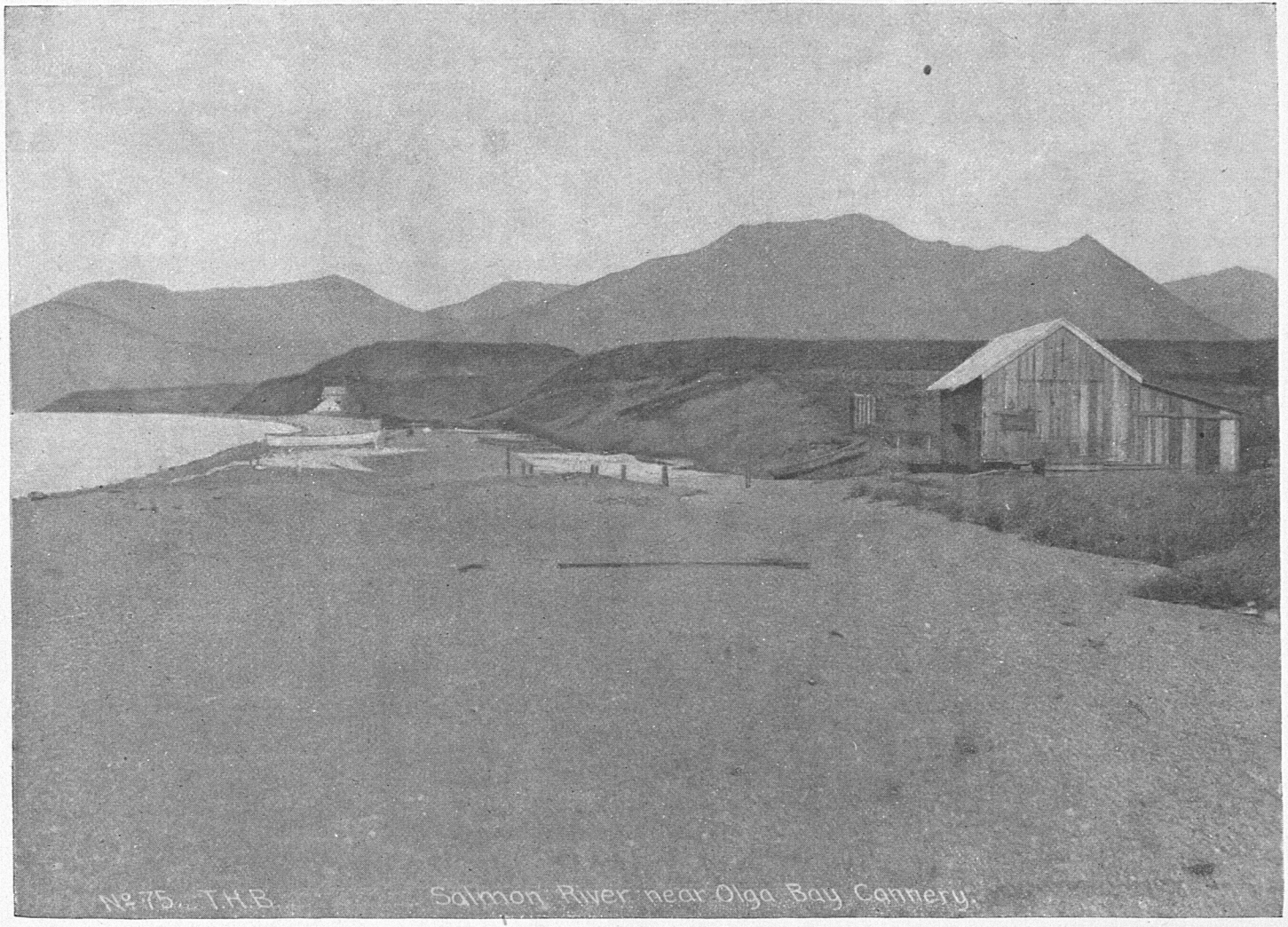
KODIAK PACKING COMPANY'S CANNERY, ALITAK BAY. NATIVE SKIN CANOES OR BIDARKAS. (See page 184.)



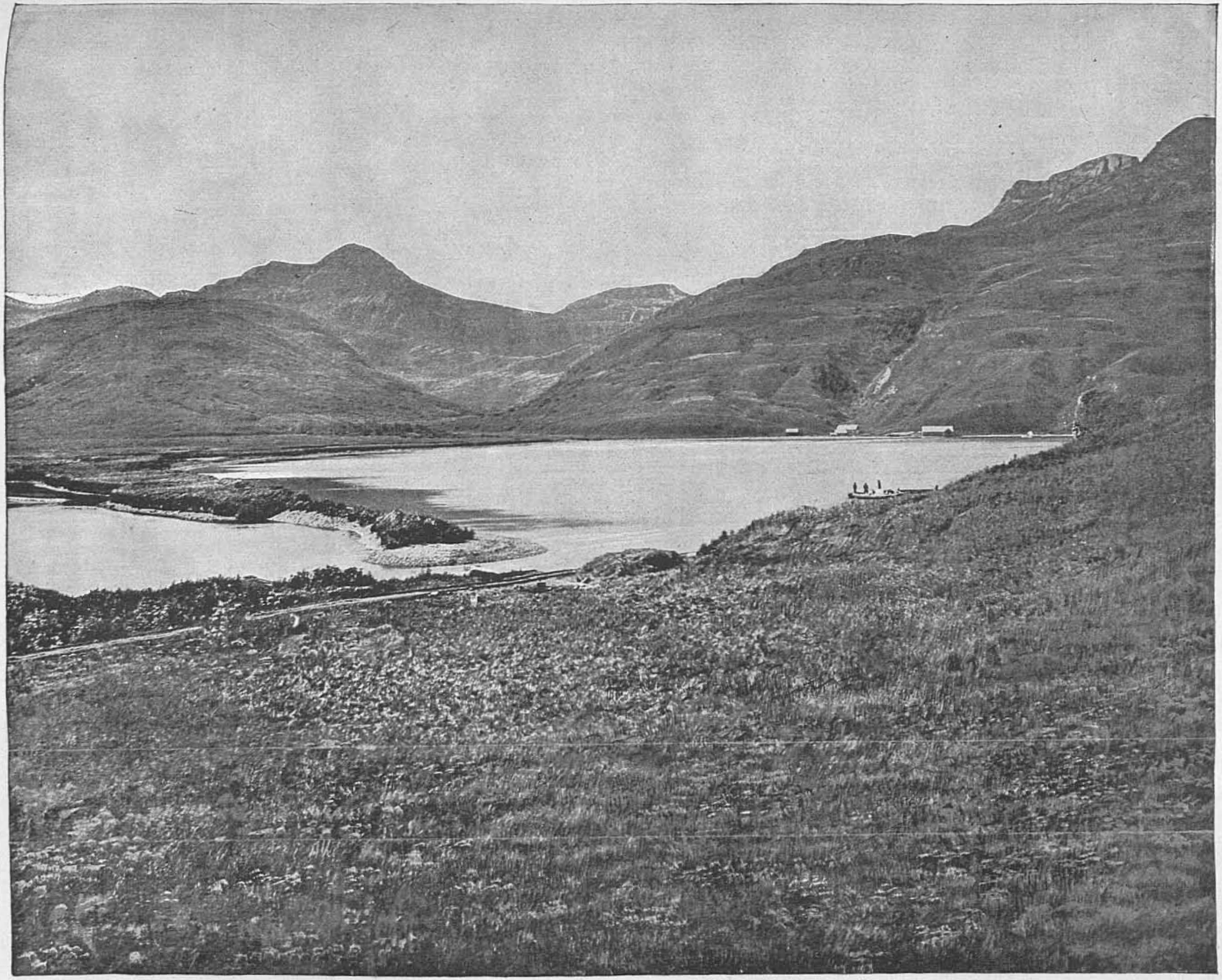
NARROWS IN ALITAK BAY, LOOKING SOUTHEAST, LEAST WIDTH ABOUT 100 FEET. (See page 183.)

ENTRANCE TO OLGA BAY FROM ALITAK BAY, LOOKING SOUTHWEST. (See page 182.)

Bull. U. S. F. C. 1889.—(To face page 208.) Bean. Salmon Fisheries of Alaska.

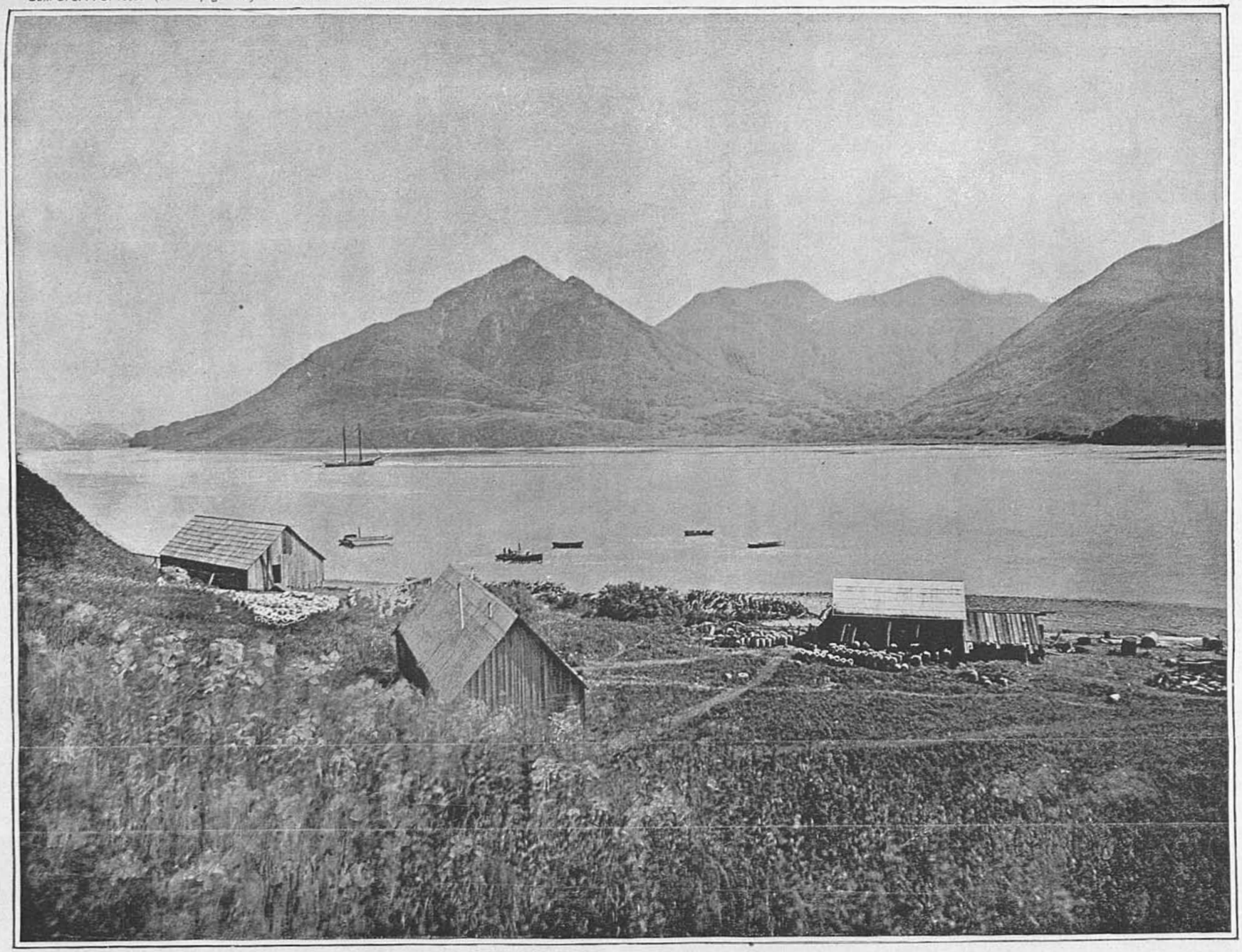


SALMON RIVER FALLING INTO OLGA BAY. OLD SALTING STATION AND NOW A CANNERY SITE. (See page 183.)



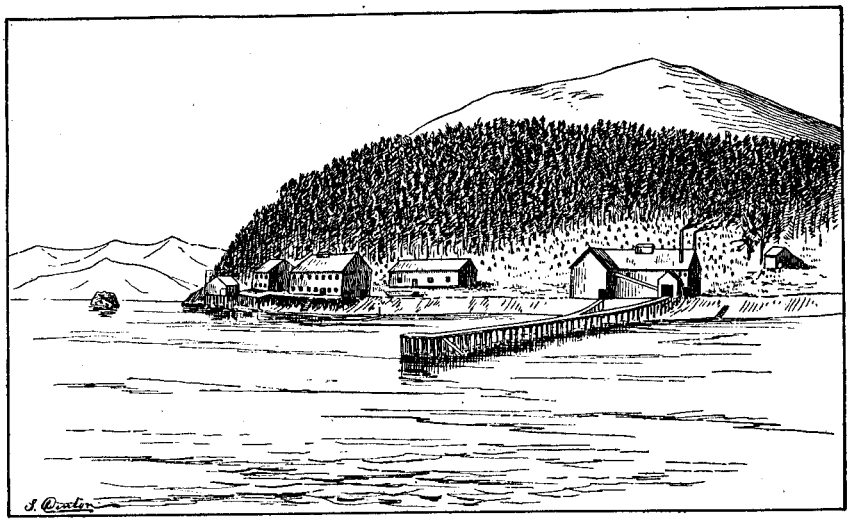
LAKE IN REAR OF THE STATION OF THE ALASKA COAST FISHING COMPANY, PORT HOBRON, SITKALIDAK ISLAND, KADIAK.

(Described in Bull. U. S. F. C., 1888, page 39.)

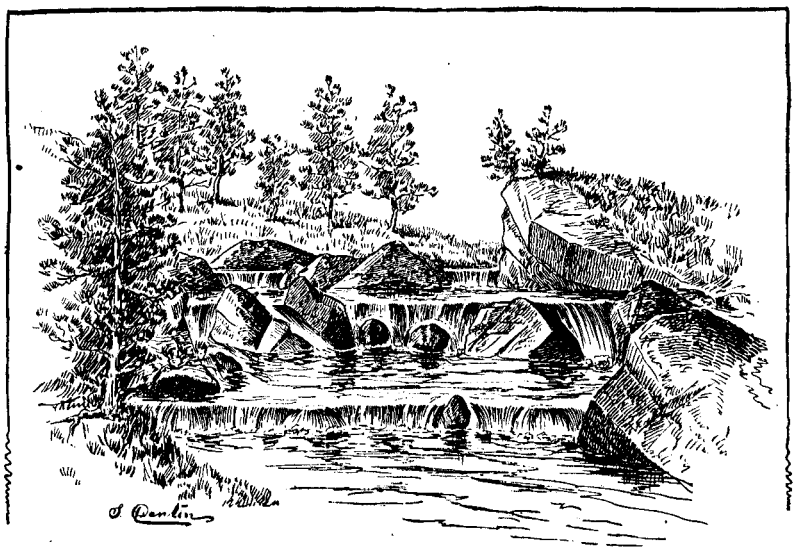


SALMON STATION OF THE ALASKA COAST FISHING COMPANY, PORT HOBRON, SITKALIDAK ISLAND, KADIAK.

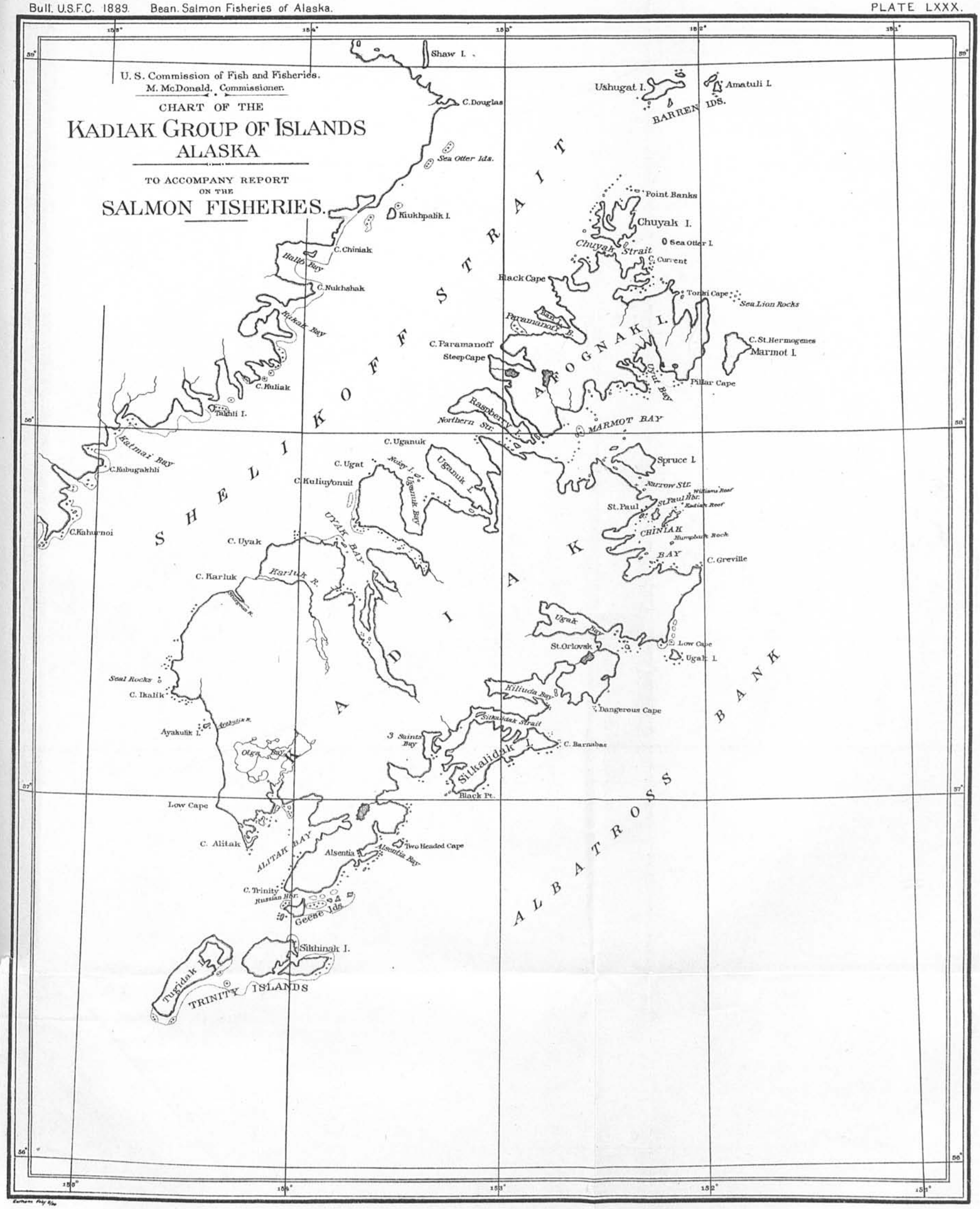
(Described in Bull. U. S. F. C., 1888, page 39.)

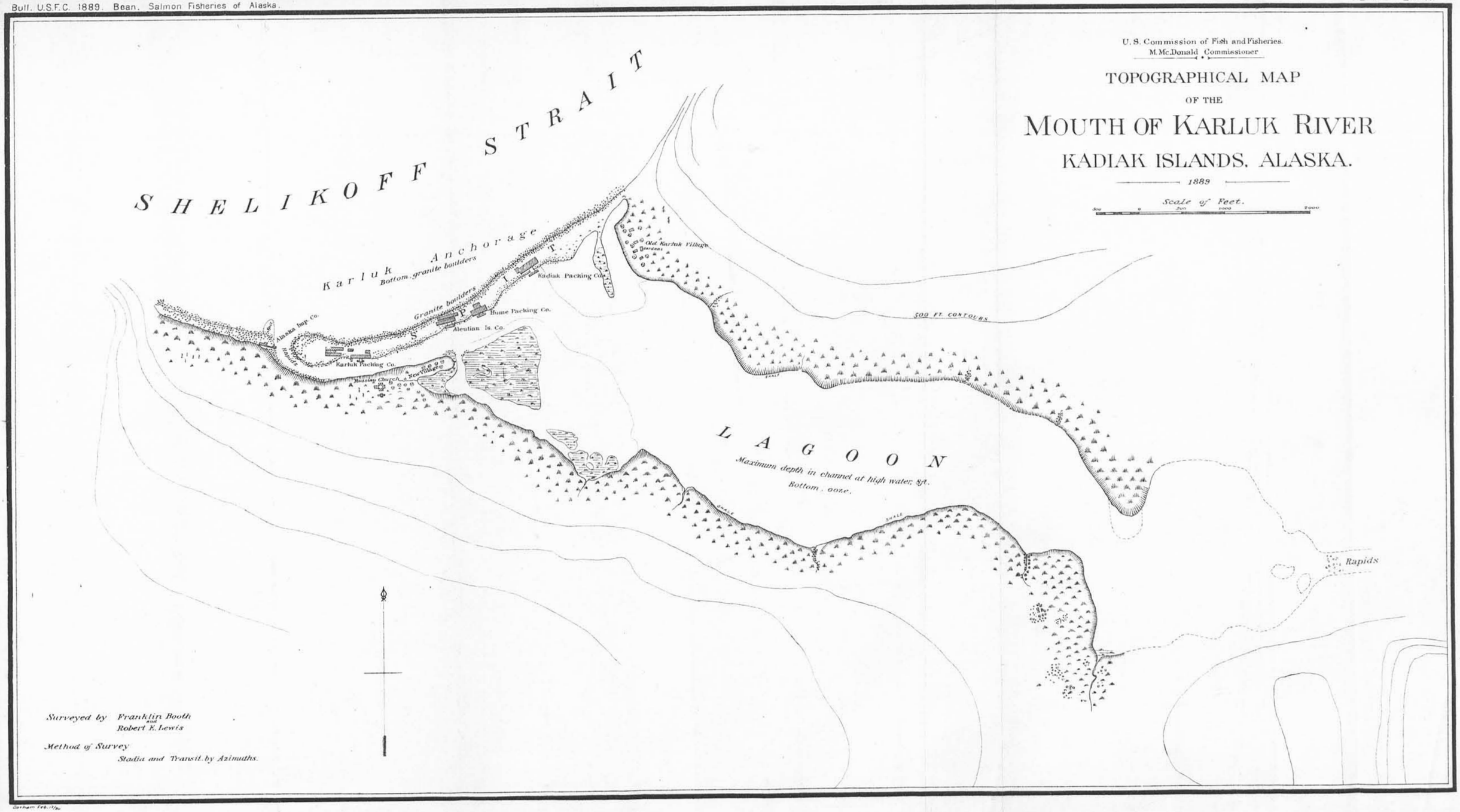


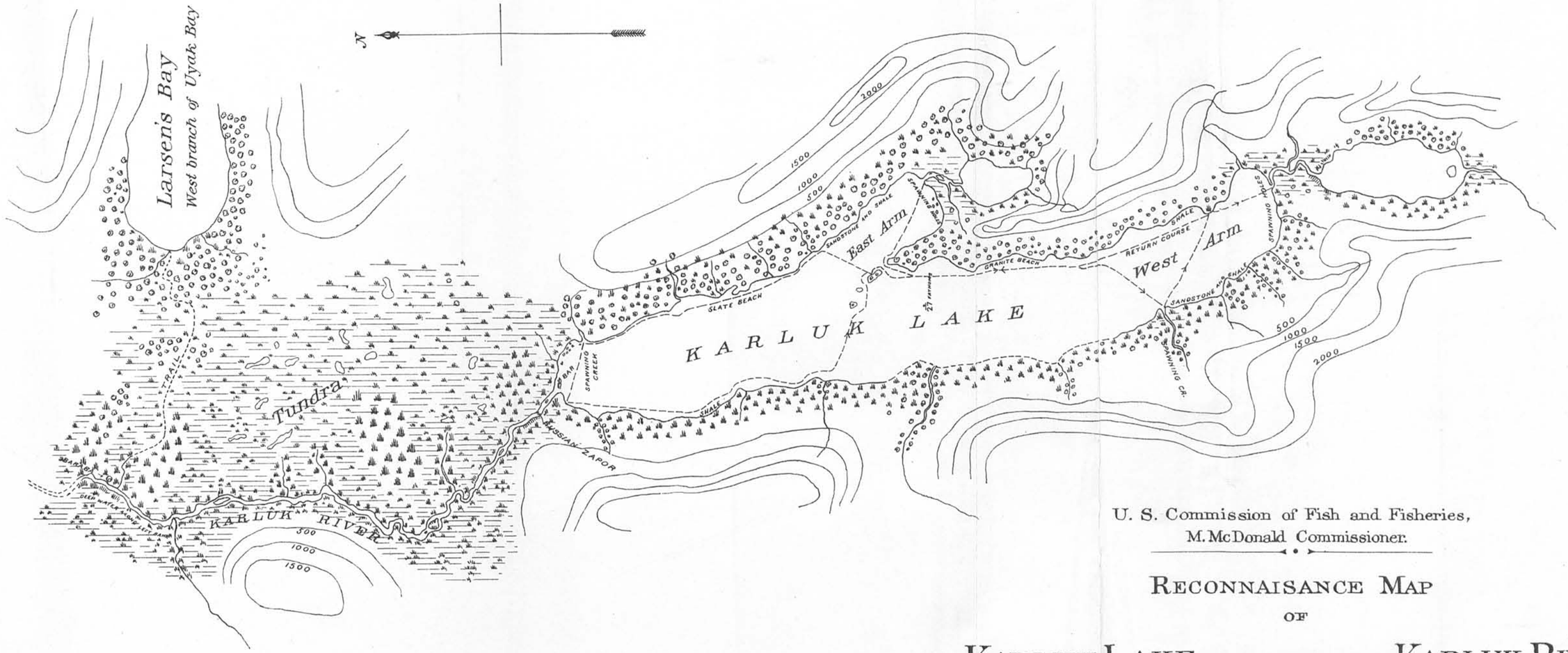
CANNERIES OF ROYAL PACKING COMPANY AND RUSSIAN AMERICAN PACKING COMPANY, AT AFOGNAK. (See page 185.)



CASCADES IN AFOGNAK RIVER. (See page 185.)


U. S. Commission of Fish and Fisheries.
M. McDonald, Commissioner.
CHART OF THE
KADIAK GROUP OF ISLANDS
ALASKA
TO ACCOMPANY REPORT
ON THE
SALMON FISHERIES.
Shaw I.
C. Douglas
Ushugat I.
Amatuli I.
BARREN IDS.
Sea Otter Ids.
Point Banks
Chuyak I.
Sea Otter I.
Chuyak Strait
C. Current
Kiukhpalik I.
C. Chiniak
Halibut Bay
C. Nukhshak
Kiukak Bay
Black Cape
Tonki Cape
Sea Lion Rocks
Paramanoff B.
C. Paramanoff
Steep Cape
C. St. Hermogenes
Marmot I.
Pillar Cape
Uyak Bay
C. Kuliak
Takhli I.
Raspberry I.
Northern Str.
MARMOT BAY
Katmai Bay
C. Kubugakhli
C. Uganuk
C. Ugat
Noisy I.
Uganuk Bay
Uganuk I.
C. Kuliuyonuit
Spruce I.
Narrow Str.
Williams Reef
St. Paul Hbr.
Kadiak Reef
St. Paul
C. Kahurnoi
UYAK BAY
CHINIAK BAY
Humphrey Rock
C. Greville
C. Uyak
C. Karluk
Karluk R.
Ugak Bay
St. Orlovak
Low Cape
Ugak I.
Seal Rocks
C. Ikalik
Kiliuda Bay
Dangerous Cape
Ayakulik I.
Ayakulik R.
3 Saints Bay
Sitkalidak Strait
C. Barnabas
Olga Bay
Sitkalidak I.
Black Pt.
Low Cape
C. Alitak
ALITAK BAY
Alsentia
Alsentia Bay
Two Headed Cape
C. Trinity
Russian Hbr.
Geese Ids.
Sikhinak I.
Tugidak I.
TRINITY ISLANDS
SHELIKOFF STRAIT
KADIAK I.
ALBATROSS BANK


U. S. Commission of Fish and Fisheries.
M. McDonald Commissioner
TOPOGRAPHICAL MAP
OF THE
MOUTH OF KARLUK RIVER
KADIAK ISLANDS, ALASKA.
1889
Scale of Feet.
SHELIKOFF STRAIT
Karluk Anchorage
Bottom, granite boulders
Granite boulders
Kadiak Packing Co.
Old Karluk Village
Gardens
Hume Packing Co.
Aleutian Is. Co.
Alaska Imp. Co.
Karluk Packing Co.
Russian Church
New Village
500 FT. CONTOURS
LAGOON
Maximum depth in channel at high water, 8 ft.
Bottom, ooze.
SHALE
Rapids
Surveyed by Franklin Booth and Robert E. Lewis
Method of Survey
Stadia and Transit by Azimuths.

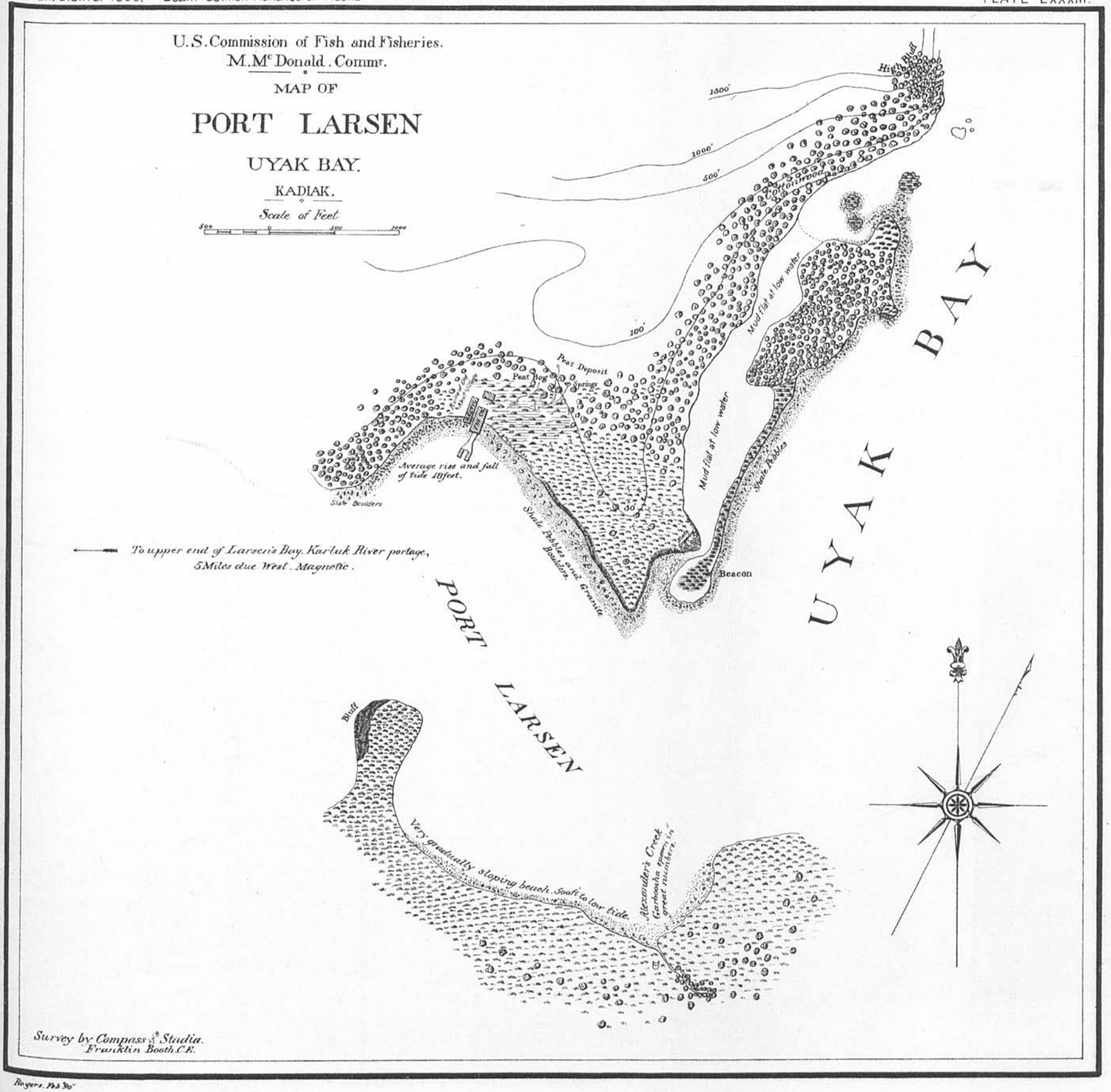


U. S. Commission of Fish and Fisheries,
M. McDonald Commissioner.

RECONNAISANCE MAP OF KARLUK LAKE AND PORTION OF KARLUK RIVER.

Scale of Miles

Gotham Feb. 14/90



Rogers. Feb '90

U.S. Commission of Fish and Fisheries.
M. McDonald, Commr.

MAP OF

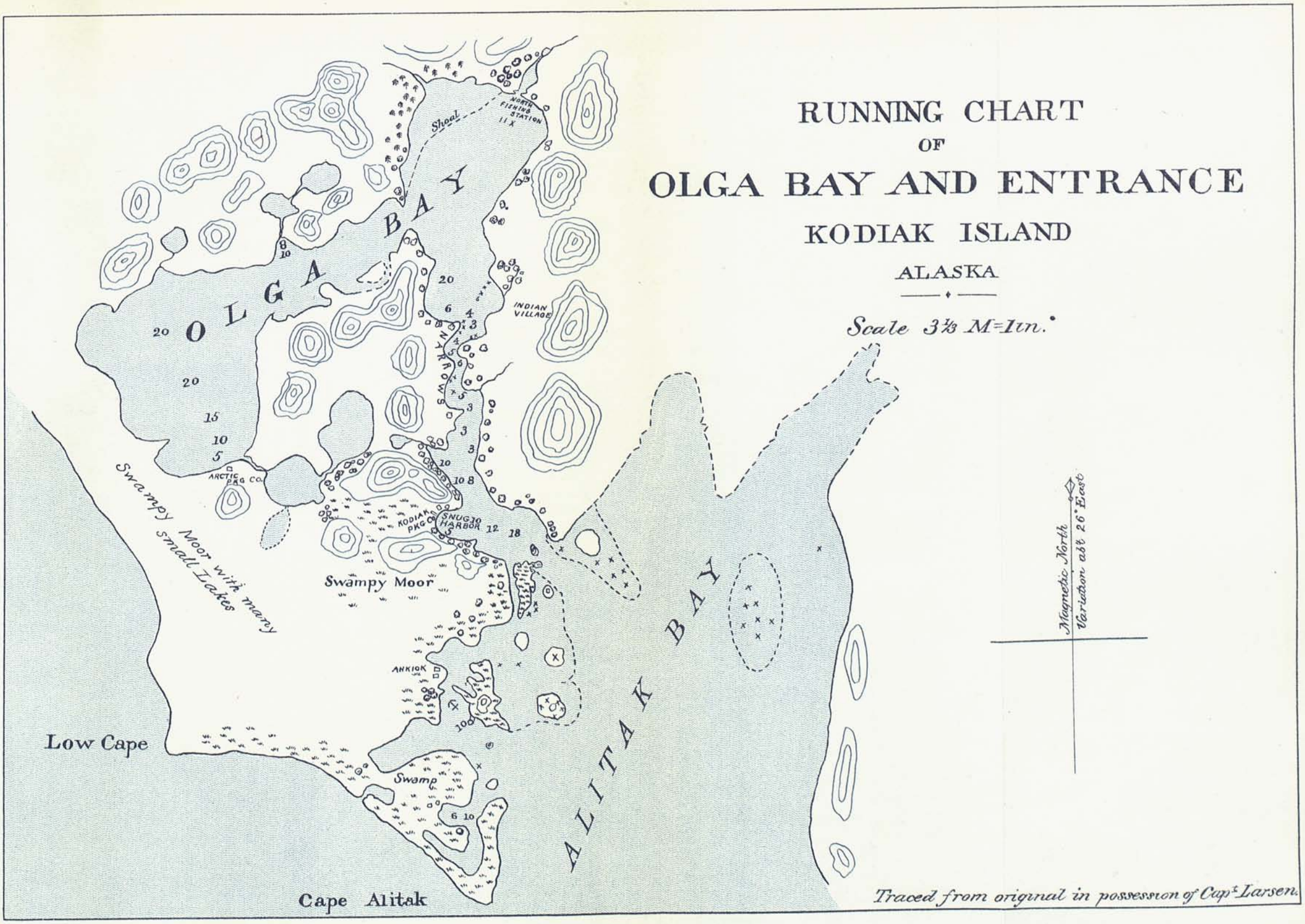
SNUG HARBOR

ALITAK BAY

KADIAK.

Franklin Booth. C.E
Survey by Compass & Stadia.

Rogers. Feb '90.


RUNNING CHART
OF
OLGA BAY AND ENTRANCE
KODIAK ISLAND
ALASKA
Scale 3⅓ M=1in.
OLGA BAY
ALITAK BAY
Shoal
NORTH FISHING STATION
INDIAN VILLAGE
NARROWS
ARCTIC PKG CO.
KODIAK PKG CO.
SNUG JO HARBOR
Swampy Moor
Swampy Moor with many small Lakes
ANKIOK
Swamp
Low Cape
Cape Alitak
Magnetic North
Variation abt 26° East
Traced from original in possession of Capt Larsen.

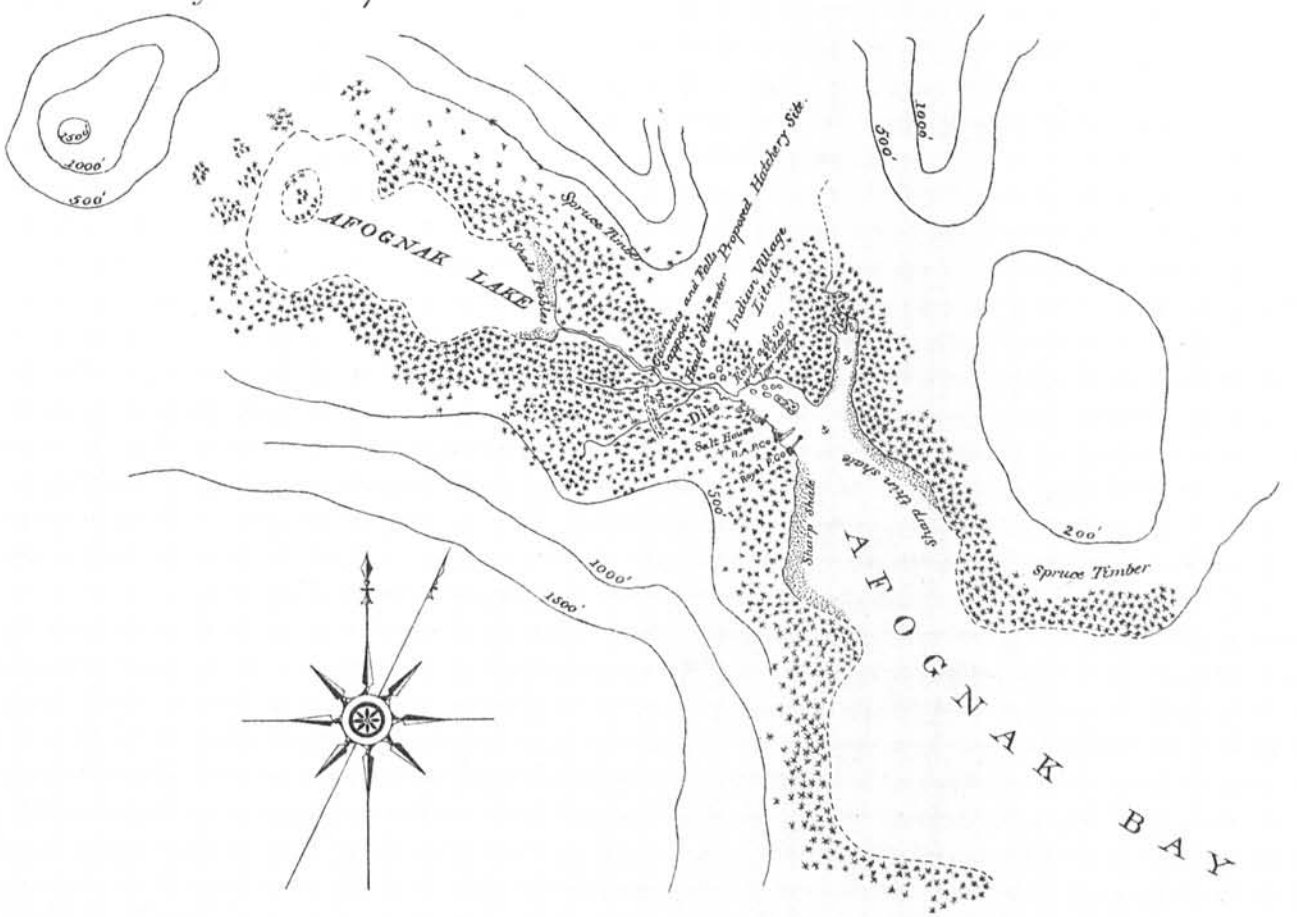
U.S. Commission of Fish and Fisheries—
M. McDonald Commr.

RECONNAISSANCE MAP
OF

AFOGNAK LAKE AND RIVER

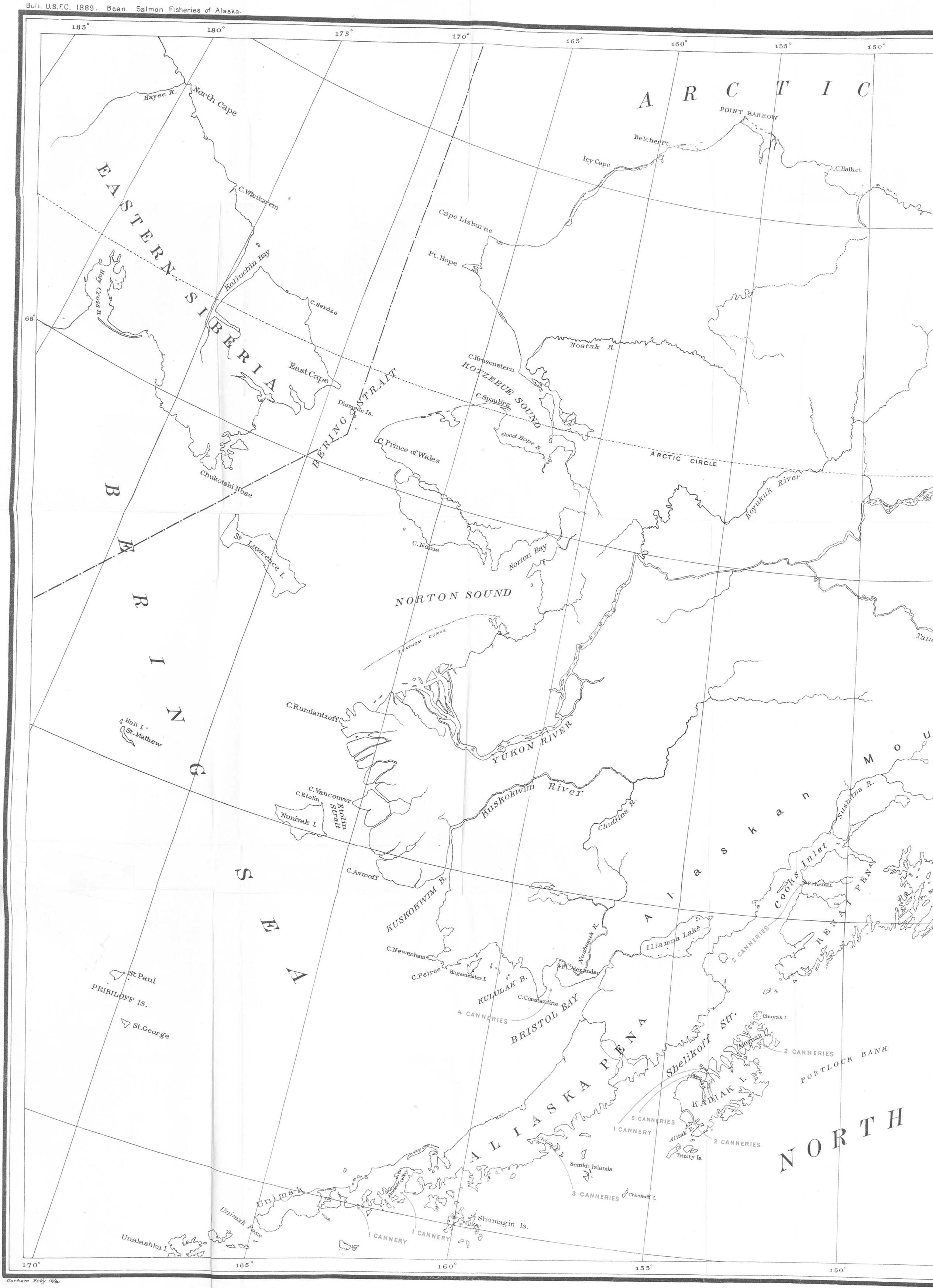
Scale of Miles.

Note.
Average width of river 70ft.
" depth " " 1" Aug 30th.
Velocity abt 1½ miles per hour.

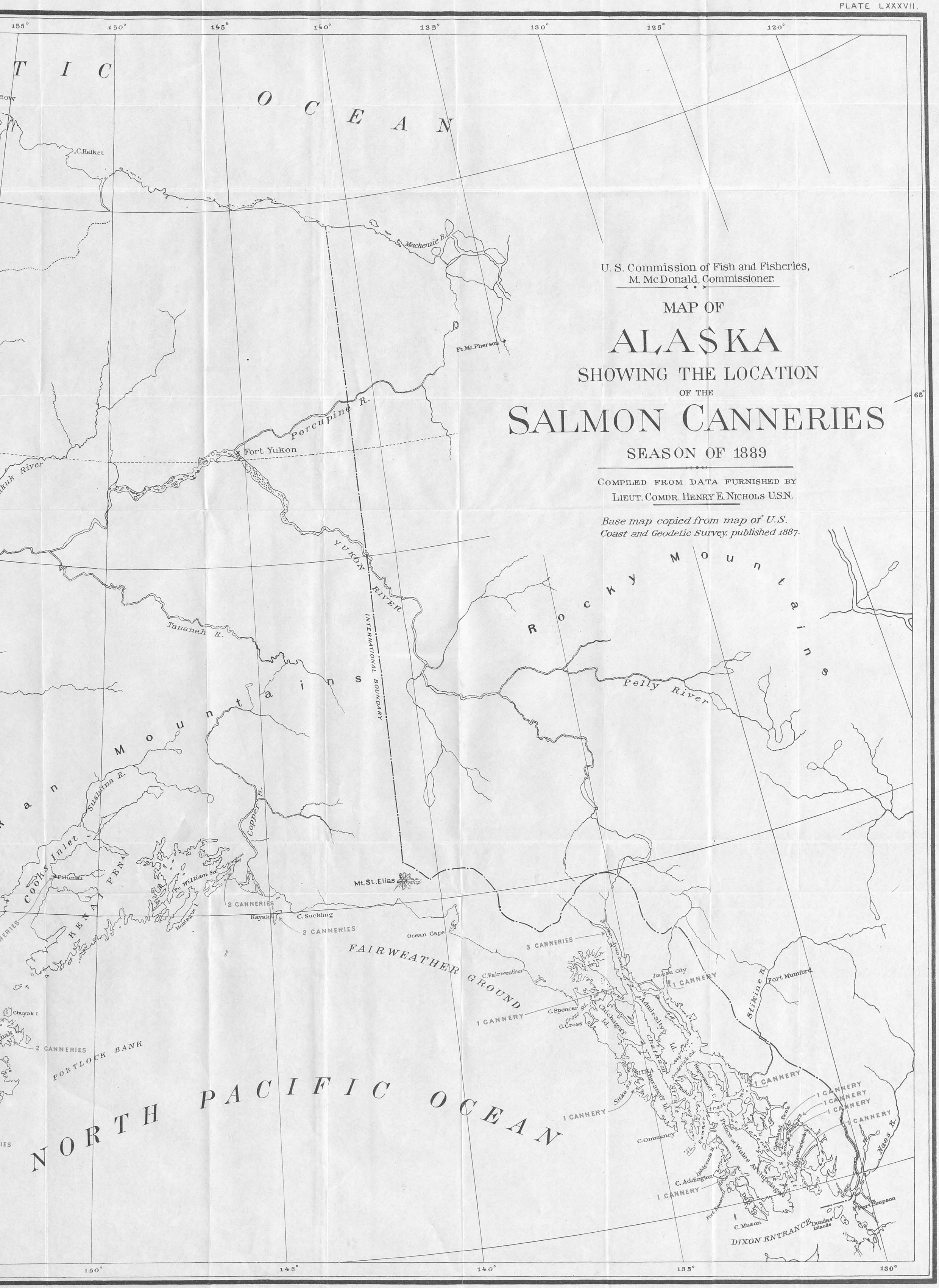


Franklin Booth. C.E.
Directions taken by Pocket Compass.

Rogers. Feb "90"



Gorham Feby 10/90


U. S. Commission of Fish and Fisheries,
M. McDonald, Commissioner.
MAP OF
ALASKA
SHOWING THE LOCATION
OF THE
SALMON CANNERIES
SEASON OF 1889
COMPILED FROM DATA FURNISHED BY
LIEUT. COMDR. HENRY E. NICHOLS U.S.N.
Base map copied from map of U.S. Coast and Geodetic Survey, published 1887.
NORTH PACIFIC OCEAN
ROCKY MOUNTAINS
Mackenzie B.
Ft. Mc. Pherson
Porcupine R.
Fort Yukon
YUKON RIVER
INTERNATIONAL BOUNDARY
Tananah R.
Susitna R.
Copper R.
Cooks Inlet
KENAI PENINSULA
Ft. Kenai
Pr. William Sd.
Montague I.
2 CANNERIES
Kayak I.
C. Suckling
Mt. St. Elias
Ocean Cape
FAIRWEATHER GROUND
C. Fairweather
3 CANNERIES
Juneau City
1 CANNERY
Fort Mumford
Stikine R.
Pelly River
C. Spencer
C. Cross
Chichagoff Id.
Admiralty Id.
Chatham Strait
SITKA
Sitka Sd.
Baranof Id.
C. Ommaney
Prince of Wales Archipelago
Cleveland Pen.
Nass R.
C. Addington
Port Bucarelli
C. Muzon
DIXON ENTRANCE
Dundas Islands
Port Simpson
Chuyak I.
PORTLOCK BANK
C. Halket
155°
150°
145°
140°
135°
130°
125°
120°
65°